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ENVIRONMENTAL IMPACT ASSESSMENT REPORT

EMC
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Environmental Management Consultants

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This Environmental Impact Assessment Report is being submitted as a requirement of Guyana's environmental authorization process.

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ACRONYMS

AoI	Area of Influence
AES	Auditory Encounter Surveys
AKF	Arakaka Formation
AMCAR	Amazon Caribbean Guyana Limited
BCGI	Bauxite Company of Guyana Inc.
BCL	Barama Company Limited
BMF	Banded Manganese Formation
BMG	Bosai Minerals Group
BMP	Barima-Mora Passage
CDC	Community Development Council
CE	Critically Endangered
CI	Conservation International
CSR	Corporate Social Responsibility
DTH	Down-The-Hole
EAB	Environmental Assessment Board
EBAs	Endemic Bird Areas
ECTF	Edinburgh Centre for Tropical Forests
EITI	Extractive Industries Transparency Initiative
EMP	Environmental Management Plan
EN	Endangered
EP Act	Environmental Protection Act
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
FAO	Food and Agriculture Organisation
FI	Floristic Inventory
FMC	Fine Manganese Concentrate

GEZ	Global Ecological Zone
GFC	Guyana Forestry Commission
GGMC	Guyana Geology and Mines Commission
GLSC	Guyana Lands and Surveys Commission
GMI	Guyana Manganese Inc.
GNBS	Guyana National Bureau of Standards
GoG	Government of Guyana
GPF	Guyana Police Force
GPHC	Georgetown Public Hospital Corporation
GRA	Guyana Revenue Authority
GSDS	Green State Development Strategy
GWI	Guyana Water Inc.
HEOC	Health Emergency Operation Center
HSE	Health, Safety and Environment
IAIA	International Association for Impact Assessment
IBA	Important Bird Area
IFC	International Finance Corporation
IUCN	International Union for the Conservation of Nature
LC	Least Concern
LCDS	Low Carbon Development Strategy
LDN	Land Degradation Neutrality
LINMINE	Linden Mining Enterprise
LMC	Lump Manganese Concentrate
MARAD	Maritime Administration Department
MDA	Matarkai Development Authority
MMF	Massive Manganese Formation
MMM	Manganese Mines Management Ltd.

MNR	Ministry of Natural Resources
MoU	Memorandum of Understanding
MRF	Matthew's Ridge Formation
MSG	Multi-Stakeholder Group
NAP	National Action Programme
NBSAP	National Biodiversity Strategy and Action Plan
NDC	Neighbourhood Democratic Council
NDS	National Development Strategy
NEAP	National Environmental Action Plan
NEOC	National Emergency Operations Centre
NLUP	National Land Use Plan
NMF	Nodular Manganese Formation
NTU	Nephelometric Turbidity Unit
OBMI	Omai Bauxite Mining Inc.
OMS	Operation, Maintenance and Surveillance
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated Biphenyls
PDA	Project Development Areas
PL	Prospecting License
PPE	Personal Protective Equipment
RDC	Regional Democratic Council
RMI	Reunion Manganese Inc.
SBPA	Shell Beach Protected Area
SDG	Sustainable Development Goal
SPA	Special Protected Area
SPL	Sound Pressure Level
STD	Sexually Transmitted Disease

TNF	Tenapu Formation
TSP	Total Suspended Particulates
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
VES	Visual Encounter Survey
VU	Vulnerable
WHO	World Health Organisation
WSG	Works Services Group

EXECUTIVE SUMMARY

Manganese mining has historically played a crucial role in the development of Guyana's North West District in Region 1. Manganese occurrences were first observed in Matthew's Ridge, Arakaka and Pipiani in 1937 and by 1957, Manganese Mines Management Limited commenced establishing the facilities and infrastructure required to mine and export manganese ore. Mines facilities included mine buildings and processing plant at Matthew's Ridge some relics of which remain standing at present. The company also transformed public transportation infrastructure by construction of a 48-kilometer (30-mile) railway with adjacent roadway for the transport of ore from Matthew's Ridge to Port Kaituma; built a Bailey bridge over the Barima River at Eclipse Falls and dredged the Kaituma Canal, the Mora Passage and sections of the Barima River. Ancillary shipping infrastructure was also established at Port Kaituma. Mining commenced in 1961, however, by 1968, a precipitous fall in the price of manganese caused operations to cease. Over the eight-year operational period, a total of 1.7 million tonnes of manganese ore was exported. Operations never resumed although multiple attempts were made by several different investors in the 1980s as well as in 2008 and 2011.

Guyana Manganese Incorporated (GMI) was created in 2016, as a subsidiary of the Bosai Minerals Group of the People's Republic of China, to invest in the resuscitation of manganese mining, processing in Matthew's Ridge and export from Port Kaituma. The investment will focus on the historic, previously mined sites located in Matthew's Ridge. Ore mined and processed in Matthew's Ridge will be transported overland to Port Kaituma for transnational shipment to Trinidad and Tobago. The project locations are shown in Figure ES-1.

Statutory Framework and Purpose of the EIA

The Environmental Protection Act (1996) requires GMI to seek environmental authorisation from the Environmental Protection Agency (EPA) for establishing facilities at Matthew's Ridge and Port Kaituma for mining, processing and transport of ore. Accordingly, GMI submitted an Application for Environmental Authorisation in January 2019. Based on an assessment of the Application, the EPA determined that an Environmental Impact Assessment (EIA) was required for the project. The EPA also advised GMI to submit a separate Application for Environmental Authorisation for project facilities in Port Kaituma. In September 2019, the EPA issued two Construction Permits to allow construction of project facilities to commence at Matthew's Ridge and Port Kaituma while the EIA preparation process was ongoing. The EPA subsequently issued a Terms and Scope to guide the preparation of the EIA.

The goal of this EIA is to provide a comprehensive and factual assessment of the project, its potential impacts and required mitigation measures so as to satisfy the requirements of the Environmental Protection Act as well as the EIA Terms and Scope issued by the EPA.

The EIA was prepared by a team of consultants from Environmental Management Consultants (EMC). EMC is a registered consultancy with the EPA of Guyana and a member of the International Association for Impact Assessment (IAIA). EMC has extensive experience in Guyana's mining sector including the preparation of EIAs and Environmental Management Plans. EPA approved the EIA team in November 2019. The draft EIA was submitted to the EPA in September 2020. Based on feedback from the review of the draft EIA by the EPA, the Environmental Assessment Board (EAB), and other stakeholders the EIA was revised during March to April 2021.

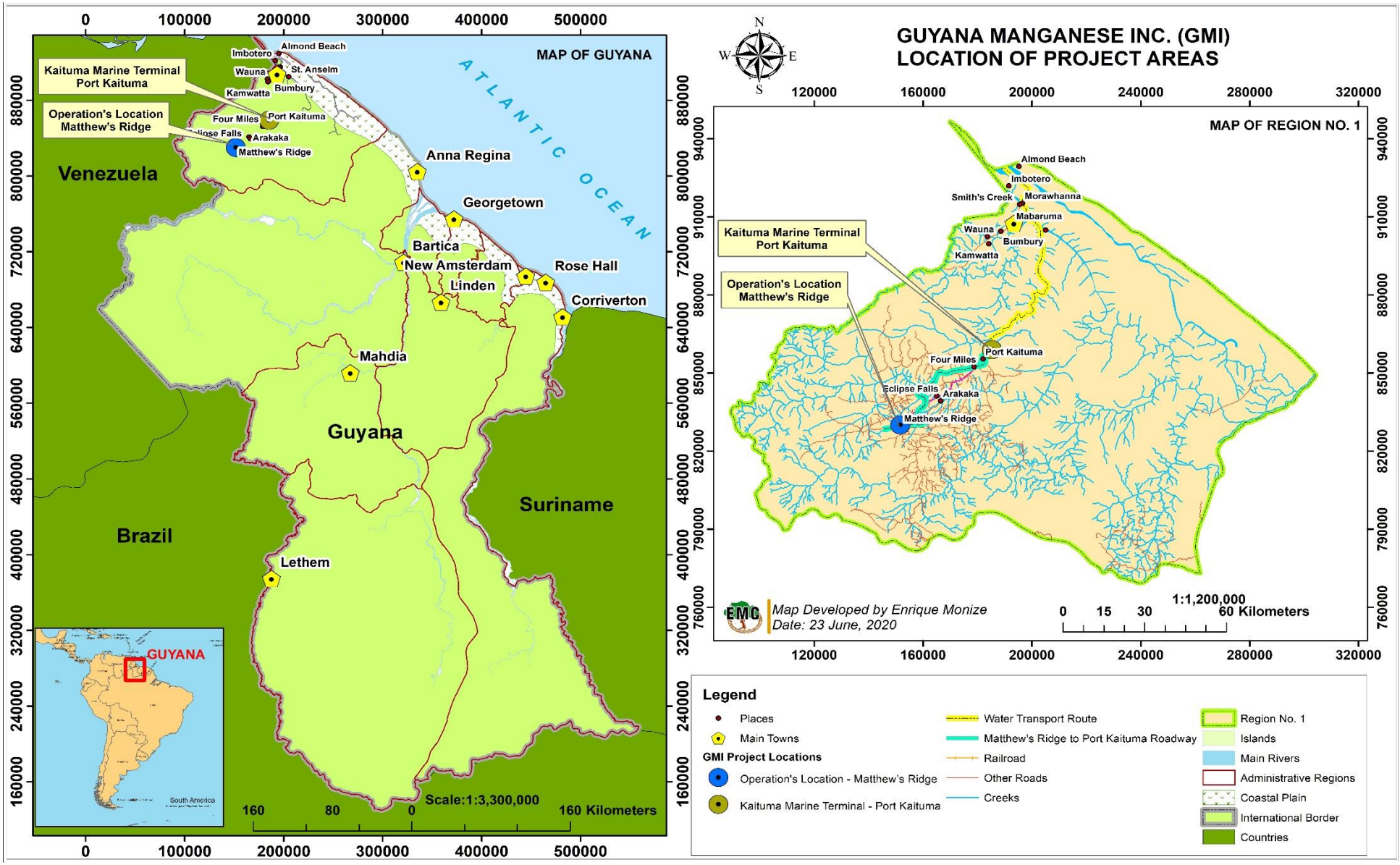


Figure ES-1: Project Locations in Region 1

EIA Methodology

The EIA was prepared in phases. The initial phase involved a comprehensive review of the legislation, policies, strategies and guidelines which constitute the regulatory framework for the project. Thereafter, the EIA was prepared in three phases. The first phase focused on establishing the baseline environmental conditions first through a comprehensive analysis of secondary data, including data collected by a prospective mining company in 2012 of the Matthew's Ridge footprint, and subsequently through the collection of primary data on ambient noise levels, ambient air quality, surface and ground water quality, biological surveys and socio-economic conditions. During the second phase, potential environmental and social impacts of project activities during the construction, operational and closure phases were then assessed. The final phase was to identify feasible and practical measures to reduce and mitigate and manage the potential negative impacts and risks as well as maximise the positive impacts.

Project Area of Influence

The general Area of Influence (AoI) was determined to be all areas where project activities are anticipated to interact with local communities. Given that the project activities will occur with varying levels of intensity at different locations, three AoI categories were established. The Primary AoI comprises the communities of Matthew's Ridge and Port Kaituma where the main planned project activities will be conducted. The Secondary AoI comprises the area along the Matthew's Ridge to Port Kaituma road which will be utilized for the hauling ore and other materials from the processing plant to the Kaituma Marine Terminal and which will be upgraded by GMI. This road passes through the settlements of Four Miles, a titled indigenous village, and Eclipse Falls. Arakaka, which is the closest community to Matthew's Ridge, is also included in the Secondary AoI since residents from the community are likely to interact with the project on the road transportation and also share essential services with Matthew's Ridge for health care and education. The Tertiary AoI is along the shipping route from Port Kaituma to the Waini River mouth. The AoI is presented in Figure ES-2.

Stakeholder Engagements

Stakeholders were engaged through three unique processes. Firstly, public meetings were held in Matthew's Ridge, Port Kaituma and Mabaruma as part of the statutory EIA scoping process. Secondly, one-on-one meetings were convened with national and regional agencies and institutions to gather information and opinions including concerns and recommendations. These include government offices with regulatory responsibility over various activities within the AoI of the project, infrastructure or navigation entities and a conservation based organisation working in Region 1. Finally, local stakeholders were engaged to provide updates on project implementation and receive feedback on their concerns relating to the project. At the outset, a variety of engagement methods were intended to be deployed. However, most of these consultations could not have been conducted on account of the public health and safety requirements and restrictions arising as a result of the COVID-19 pandemic. Instead, the EIA team conducted telephone interviews to engage directly with key representatives of local authorities and communities.

Impact Assessment Methodology

The potential impacts of project activities were assessed across the various phases using the baseline conditions of the AoI. This was done by establishing the potential interactions between the activities and the characteristics of the existing physical, biological and socio-economic environment. Impacts were considered positive or negative; direct or indirect; short-term or long-term; localised, local or regional and cumulative. Risk ratings were assigned using a Risk Assessment Matrix based on the significance and likelihood of potential impacts occurring. The Matrix is presented in Chapter 7.

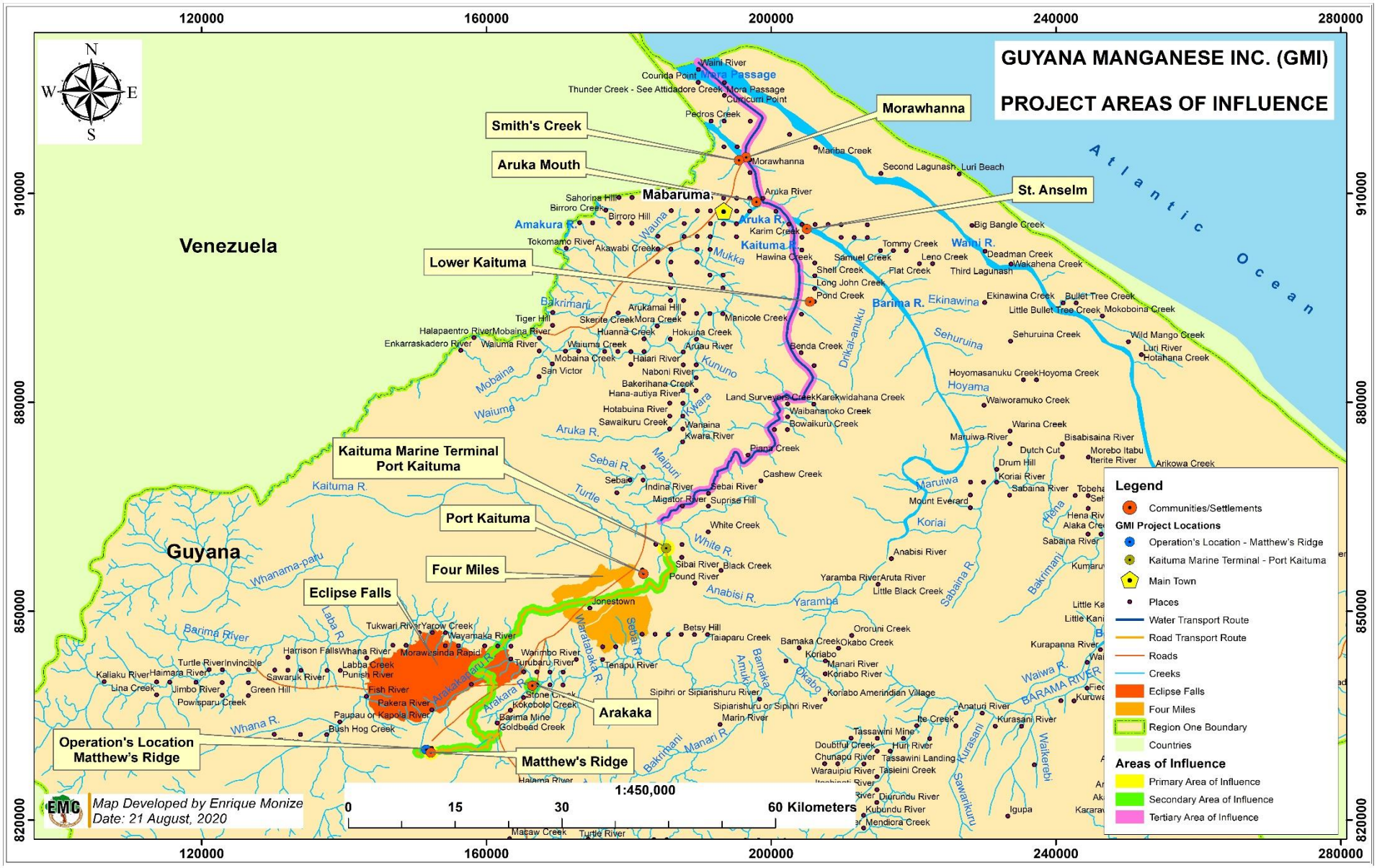


Figure ES-2: Project Areas of Influence

Project Description

GMI plans to invest USD$75 million into the project to restart of manganese mining in Guyana in 2020. Mining will resume after rehabilitation of the previously mined site and infrastructure with the aim of producing 2.0 million tonnes of manganese ore annually for processing to turn out 500,000 tonnes of concentrates for intermediate shipment to Brighton Port, Trinidad. In order to realise this project some 400 workers will be required over a one-year construction period. Project operation is intended to employ over 400 workers, of which 340 (85 percent) would be Guyanese with the others being technical trainers and process specialists from China. At Port Kaituma, the construction of the Kaituma Marine Terminal will require approximately 200 workers over a 7-month construction period while project operation is intended to employ about 30 workers, of which 27 (90 percent) would be Guyanese with the others being administrators and specialist technicians from China. The extraction rates planned when related to current reserves yield a mine and project life of 13 years.

The GMI manganese operations will involve:

- Extraction and processing of the remaining mineral resources at the Matthew's Ridge mining locations.
- Re-establishment of disused and degraded mine infrastructure including mine roads, pit benches, stockpile areas for ore and concentrate, mine administration and facility buildings.
- Construction of a new and relocated processing plant.
- Pumping facilities from the Pakera Lake to support ore processing.
- Water retention sites and dam structures for tailings management.
- Construction of a new Kaituma Marine Terminal comprising of a turning basin, moorage, wharfage for ocean-going barge loading, weigh-bridge, administrative facilities and storage yard.
- Construction of an upgraded overland transportation profile to move processed concentrates from the Matthews's Ridge process plant to the Kaituma Marine Terminal.
- Construction of bypass roads in Matthew's Ridge and Port Kaituma.
- Dredging on the Kaituma Canal for establishment of a turning basin and construction of the Marine Terminal.

<u>Project Alternatives</u>

GMI considered a range of project alternatives to the design which are summarised below:

- *No Project Alternative*: The no-project alternative involves the non-execution of the project and the baseline conditions for the resources examined in Chapters 8 to 20 of the EIA will remain unchanged by either the potential positive or negative impacts of the project.

- *Location of Project Facilities:* There was consideration of retaining as much of the footprint of the previous mining project so as to reduce the footprint of the current project. However, this was not possible for the processing plant and tailings pond at Matthew's Ridge and the wharfing facilities at Port Kaituma given dilapidated state of the infrastructure and encroachment by residences and commercial activities. The locations for these facilities were adjusted to avoid congestion, encroachments on current uses of land and possible land-use disputes. In the case of the tailings pond, GMI identified recoverable manganese resources within the pond itself which will also be processed.

- *Ore Transport from Mines to Processing Plant*: Three options were considered including a truck haulage system, a truck plus semi-fixed crushing station plus belt haulage system, and a truck plus railway system. The truck haulage system was ultimately selected because of advantages

of production scheduling, reducing the environmental footprint, relatively short construction periods and suitability for de-concentrated mining operations.

- *Ore Transport to the Kaituma Marine Terminal:* Consideration was given to a narrow-gauge railway system as was previously used. However, this option was not considered economically feasible given the high up-front costs and relatively limited mineral resources and mine life.

- *Ore Shipment:* Three options were considered including the use of the existing trans-shipment point at the mouth of the Berbice River, creation of a trans-shipment point at the mouth of the Waini River or shipment using ocean-going barges directly to Trinidad. Ocean-going barges was the preferred option given its cost effectives and lower level of environmental and safety risks.

- *Dredging of the Shipping Route:* Consideration was given to dredging of the Kaituma River and the Mora Passage access from the Barima River to the Waini Estuary to improve marine draft. This alternative was not selected and instead barges will be loaded with an amount of concentrate that will allow them to traverse the waterways using the existing draft. Trips will be scheduled to coincide with high tides. Although this option is less efficient, it reduced costs and environment impacts associated with dredging.

- *Use of Explosives:* Consideration was given to the use of explosive blasting or excavator-equipped jack hammers for breaking of the materials within mining pits. Blasting was selected as it will ensure optimum productivity and is a non-continuous source of noise. While the use of explosives could increase safety and environmental risks these could be managed with tight security and blasting being conducted by certified personnel with all security protocols being observed.

- *Ore Washing:* Jigging and heavy media separation were considered. Jigging was selected because of greater comparative productivity and lower costs.

- *Re-Use of Process Water:* Two options were considered for the reuse or single-use discharge of process water from the processing plant. Discharging the process water is the cheaper option since no treatment will be required. However, reusing processing water was selected because of the lower demand for water from seasonal surface flows and to reduce the quantity of tailings to be managed.

- *Tailings Discharge:* Tailings are to be deposited in a conventional manner – end of pipe discharge at 40 percent solids into the tailings pond. Three additional options were also considered including discharge as a thick slurry (60 to 70 percent solids), dewater by filtration and dispose tailings by truck transport, and disposal of tailings into mined out pits. None of these three options were deemed to be economically or environmentally feasible.

- *Airstrip Access Road:* GMI considered upgrading the road leading from Matthew's Ridge community to the airstrip but that option would have involved shared use of heavy project machinery and community vehicles. The option selected was the construction of a bypass road for community use so as to avoid congestion and minimise the safety risks to community commuters.

Project Context

The Socio-Economic Context

The project is located within the Matarkai sub-district of Region 1 which comprises of five principal settlements namely, Matthew's Ridge, Port Kaituma, Arakaka, Eclipse Falls and Four Miles. These settlements constitute the primary and secondary AoI of the project. The sub-district is managed by a Neighbourhood Democratic Council (NDC) and there are also supporting administrative structures like Community Development Councils (CDCs). The titled indigenous village of Four Miles is managed by a Village Council. The sub-district has a total population of approximately 9,100 people with the largest proportions being of indigenous or mixed ethnicity. In recent years, Venezuelan immigrants have arrived in the sub-district but are based primarily in Port Kaituma. A significant percentage of the population is also comprised of young people. The most significant economic activity in the district is gold mining and people freelance (pork-knock) or are engaged in small- and medium-scaled gold mining.

Port Kaituma is the administrative center of the Matarkai sub-district and the head office of the NDC is located there. The river transportation infrastructure makes Port Kaituma the hub for passenger travel and cargo imports, including food, fuel and vehicles. The pubic road network connects Port Kaituma to the other settlements in the sub-district and also leads to communities further afield. In the wider region, most services and infrastructure are located in either Matthew's Ridge or Port Kaituma. The only Secondary School in the sub-district is located in Port Kaituma. In Matthew's Ridge there is a Secondary Department which ends in Grade 9. District Hospitals are located in these two principal settlements while there are Health Outposts in the remaining communities. Dumpsites for waste disposal have been created by these two locations. The Guyana Power and Light and Guyana Water Incorporated provide electricity and water to residents in Matthew's Ridge and Port Kaituma. Airstrips are located in Matthew's Ridge and Port Kaituma and at both locations there are daily return flights originating from the international airport at Ogle. There are Police Stations in Port Kaituma, Matthew's Ridge and Arakaka. Nonetheless, the capacity to meet the demand for these services is limited and residents encounter significant challenges in their daily lives.

The tertiary AoI comprises of five communities namely, Lower Kaituma, St. Anselm, Aruka Mouth, Smith's Creek and Morawhanna. All of these settlements are located on the banks of Kaituma River or the Barima River and both of these Rivers will be used by the project for ore transportation. Residents typically use the rivers for passenger transportation including school-children; livelihood activities such as fishing, transporting harvested manicole or transporting produce to markets; domestic use of water and for recreational purposes.

The Biological Context

The project areas fall within the lowland region of undulating forest lands of northwestern Guyana. The Northwestern District is considered part of the Guiana Shield region as defined by recent regional studies. The ecosystems of the Northwest District are dominated by dense forests which are interlocked among aquatic environments in the form of rivers and creeks, which are seasonally flooded and provide habitats for aquatic biota. The valleys slopes, hillslopes, and ridgetops support forests that are not seasonally flooded. The forest river ecosystems are integrated through surface and groundwater hydrological processes. The surface waters of the region are generally considered "blackwaters", with low pH, high contents of tannins and organic acids from the breakdown of leaf litter. Historical and ongoing human activities within the AoI of the project have modified the primary ecological functions of habitats, resulting in habitat loss. Biodiversity within the AoI of the project are, therefore, habituated to the constantly changing and human-influenced environments of the AoI.

Baseline biological surveys were conducted in Matthew's Ridge in 2012 and in both Matthew's Ridge and Port Kaituma in 2020. The key findings of these surveys are as follows:

- *Flora:* 68 species from of 28 plant families. The dominant forest types encountered were lowland mixed forest and (man-made) open swamp on flat or gently rolling terrain on alluvial soils. No Critically Endangered or Endangered floral species were recorded.
- *Non-Volant Mammals:* 44 species of from 23 families. Endangered and Vulnerable species were reported to occur in the AoI including the giant otter, white-lipped peccary, the giant armadillo, giant anteater, Guiana spider monkey and the lowland tapir. No critical habitats were encountered.
- *Bats:* 31 species from four families all of which were species of Least Concern. No limited range species were recorded.
- *Birds:* 280 species from 46 families all of are widely distributed within the lowland habitats of Guyana and the Guiana Shield. No Critically Endangered, Endangered, endemic or migratory species were recorded. Five species identified are listed as Vulnerable.
- *Amphibians:* 31 species of frogs from six families all of which are widespread in Guyana and the wider Amazonian region. One Vulnerable species was recorded but no other threatened, endemic or migratory amphibian species were found.
- *Reptiles:* 32 species from 12 families. *Echinosaura sulcarostrum* was the only Endangered species recorded and the yellow-footed tortoise was the only Vulnerable species. No endemic or migratory reptilian species were recorded from the project developmental areas.
- *Terrestrial Macro-Invertebrates*: 21 orders. No endemic species were recorded.
- *Fish:* 62 species from 25 families. A notable capture is *Anablepsoides* (*Rivulus) waimacui)* which is an endemic species. No threatened or migratory fish species were recorded.
- *Benthic Invertebrates:* 11 orders. No endemic species were recorded.

There are no legally protected areas and other areas of biological interest which are located near the GMI project footprint within Matthew's Ridge and Port Kaituma. Recently, the Barima-Mora Passage (BMP) has been proposed for special protected area status. The BMP is a major trans-shipment route for goods and services between northwestern Guyana and the capital city of Georgetown, and also to neighbouring Venezuela. Some sections of the propose BMP also form part of the proposed GMI shipping route.

The Environmental Context

The geomorphology of Matthew's Ridge consists of a rugged topography and chains of steeply sloping hills, gullies and peneplained tops. The altitude of the mining area varies from 34 to 235 meters above sea level. Abrupt changes in elevation are related to lithology and geological structures. Rocks are highly weathered and are exposed only along the resistant crest of ridge, river valley and road side cuts. Drainage patterns are sub-dendritic as a result of the strings of ridges. The Matthew's Ridge manganese deposit is underlain by rocks of the Barama Group of the Barama-Mazaruni Supergroup. The Barama Group is conventionally subdivided in three formations: the Arakaka Formation at the top, followed by the Matthews Ridge Formation (MRF), underlain by the Tenapu Formation. Manganese mineralization is confined to the MRF, which is principally a low metamorphic grade, predominantly sedimentary sequence of fine-grained clastic (pelitic) and chemical nature and is clearly related to lateritic weathering of a complex geological sedimentary succession. The project components at Matthew's Ridge are located on three different types of soil. Soils are developed in relation to the topography from depths of less than one meter to over ten meters.

The area around the Port Kaituma settlement and new Kaituma Marine Terminal is defined mainly by the large drainage basin and floodplains that border the Kaituma River. The settlement and the new wharf site are both located directly on the right bank of the river. The floodplain is approximately 3

kilometers wide along the course of the channel with the river generally being in the middle of the floodplain. Parallel to the flood plains, roughly 1.6 kilometers inland on either side of the river the elevation rises to create the limit of the catchment area. This rise in elevation is gentle and gradual, being typically less than 15 meters higher than the river bank. The area within the drainage basin and floodplain is dominated by dendritic drainage patterns. The Kaituma River itself is a major waterway, running for more than 96 kilometers from its confluence with the Barima River. Its drainage basin and floodplains are mature and very well developed. There are small gentle rolling hills within and along the catchment of the drainage. Outside of the floodplain there are steeper hills which are elongated, capped with laterite or have saprock close to the surface making it weather resistant and resulting in higher relief. The project components at Port Kaituma are located on two different types of soil.

Baseline environmental surveys were conducted Matthew's Ridge in 2012 and in both Matthew's Ridge and Port Kaituma in 2020. The key findings of these surveys are as follows:

- *Ambient Noise:* Sound Pressure Levels (SPLs) were measured at project locations and in proximity to key receptors in Matthew's Ridge and Port Kaituma. SPLs were generally within the permissible levels established by the Guyana National Bureau of Standards but were higher around active GMI construction areas in Matthew's Ridge.
- *Ambient Air Quality*: The levels of Particulate Matter ($PM_{2.5}$, PM_{10} and Total Suspended Particulates (TSP)) and gases (carbon monoxide, nitrogen dioxide, sulphur dioxide and volatile organic compounds) were measured at project locations and in proximity to key receptors in Matthew's Ridge and Port Kaituma. Air quality was generally within permissible levels established by the World Health Organisation (WHO) and other international guidelines. However, naturally high levels of PM_{10} and TSP were observed at some locations in Matthew's Ridge.
- *Water Quality:* The concentrations of physio-chemical parameters, residual heavy metals, cations, anions and nutrients were measured for surface and ground water bodies in Matthew's Ridge, Port Kaituma and along the Matthew's Ridge to Port Kaituma public road. Water quality levels were generally within the permissible levels established by the Mining (Amendment Regulations), the WHO and the International Finance Corporation/World Bank. However, naturally high levels of some residual heavy metals including manganese and iron were observed in Matthew's Ridge. Based on data provided by Guyana Water Inc. (GWI), biological parameters were frequently exceeded in the public water distribution in Matthew's Ridge and Port Kaituma.

Impact Assessment

This section summarizes the potential risks of the project resulting from project activities, as well the project's contributions to cumulative impacts. The impacts of the project were evaluated against the baseline conditions of the project areas as discussed above and presented in Chapters 8 to 20 of the EIA. In addition, the impact assessment takes account of the mitigation and management measures which have been built in to the project design and which GMI has committed to implement. These measures are also discussed in this section.

<u>Water Resources</u>

Given the geology of Matthew's Ridge, manganese occurs in naturally high levels in the water supply. The levels of manganese in all surface waters tested in Matthew's Ridge exceeded permissible limits but these water bodies are not used by residents for drinking. However, manganese levels at the Hill 3 aquifer also exceeded the safe levels. Exceeding safe water concentrations of manganese in the water supply are likely to result in several adverse health outcomes. Project activities that expose the manganese ore may also increase the concentration of manganese in surface water flows in

Matthew's Ridge, some of which are used by GWI for community water supply. In particular, a spring in proximity to Hill 5 is used by GWI to supply water to the community and the spring aback the Guyana House which is used by GMI may also be considered exposed. The water flow from the mining pit will be accumulated in the tailings pond or a designated water pond for settling. Dams surrounding the tailings pond, and drainage around the mining pit will be built to prevent the water from contaminating the surface water which is used by the community. The manganese level in the surface water will be monitored regularly. High levels of manganese in drinking water will have potential impacts that are **negative, direct, long-term** and **localised** of **major significance** and are **likely** to continue during the project lifetime. These are **High Risks** with or without planned project activities. Manganese ore to be transported overland and by river to Trinidad is insoluble and therefore, any loss of ore in transit will disperse in the water column and sink. This potential impact is of **negligible significance** and anticipated to occur **rarely** posing **Low Risks** of project activities.

During the dry seasons, water will be pumped from the Pakera Lake to support manganese processing to compensate for lower water levels in the Tailings Pond from which processing water will be reused. During the dry season, it is anticipated that approximately 34,600 cubic meters of water will be pumped monthly. The source and recharge rate of the Pakera Creek are not known. It is anticipated that the Pakera Creek is a seasonal water body with flow and total water available varying significantly with the bimodal rainfall patterns. Moreover, it is expected that there is also groundwater inflow to this water body. Potential impacts to the water balance are **negative, direct, short-term and localised**. In the absence of data on recharge rates and given that the sources are not well known, the potential impact anticipated relating to the disruption to the water balance will be of **moderate significance** and but are considered **unlikely** to occur. In addition, GMI has developed a spring located at the bottom of Hill 5 and commenced pumping water from that spring for domestic purposes. The source of water for this spring or the recharge rate are not known but it is expected that it also is seasonal and is fed by a combination rainfall, flows from groundwater sources and flows from other surface water bodies in the vicinity. In a scenario where the latter two assumptions hold true, it is possible that the secondary water bodies feeding the GMI spring also feed the springs used by GWI (which are also seasonal). Water for domestic purposes will also be supplemented by rainfall which will be captured in tanks located at the Matthew's Ridge facility and to a lesser extent GWI. Potential impacts to the community water balance are of **minor significance** but **likely** to occur. Both potential impacts present **Medium Risks**.

The tailings will be discharged upstream of the processing plant into an engineered containment area referred to as the Tailings Pond. The Pond will serve as a reservoir to accommodate 9.28 million cubic meters of tailings. Failure of the dam along the Tailings Pond can result in effluent being discharged into the environment, which can contaminate nearby soils and water bodies. Based on the dam construction specifications and the reuse of water for ore processing, the containment area will be sufficiently robust to retain the tailings. In addition, a 24-hour monitoring station will be at the tailings pond to facilitate water releases via the spillway as necessary. Effluent discharges, whether accidental or planned, have the potential to individually and cumulatively increase the background concentration of manganese, other pollutants into soils and surface waters in the vicinity of the processing plant and the tailings pond. This impact will be **direct**, **negative**, **localised** and **short-term** of **moderate significance** but are **unlikely** to occur thereby presenting **Medium Risks**.

Discharges of unsettled water from the mining pits can result in water with high sediment loads flowing into waterways resulting in sedimentation and discolouration. GMI will install perimeter drains around the mining pits to prevent the inflow of water which will be directed to a collection/sedimentation pond. Water within the pits will be channeled into sumps located within the pits and allowed to settle before being pumped out of the pit. Pumps installed in the sumps will be used to dewater the pits by pumping water out of the pit to an external collection/sedimentation pond for further settlement. GMI plans to direct this water to the tailings pond so that it will contribute to the water supply for the processing

plant. Mine discharges which will not be directed to the tailings pond will be discharged through settling ponds. Given the planned measures to be implemented by GMI, these impacts are expected to be **negative, direct, localised, short-term** of **moderate significance** and are **likely** resulting in **Medium Risks** of project activities. Risks associated with acid mine drainage are low as discussed in the *Soils and Geology* section.

During periods of heavy rainfall, the haul roads and access roads can become slushy and water with extremely high sediment loads can flow directly into nearby waterways. It is unlikely that GMI's overland vehicle fleet will significantly change these results given that only one return trip will be made daily by the hauling fleet for ore transportation from Matthew's Ridge to Port Kaituma during the wet seasons. However, GMI plans to install turn out drains leading to vegetative areas which will assist in the trapping of sediments contained in the runoff. Installed storm water drains at project facilities at Matthew's Ridge will also lead either to sediment ponds or the tailings pond. At the Kaituma Marine Terminal GMI will install two runoff collection ponds to collect runoff from the ore concentrate storage and others areas and allow it to be settled prior to discharge. Potential impacts from erosion and surface water runoff are expected to be **direct**, **negative, short-term** and **localised** of **negligible** to **minor significance** and **unlikely** to occur. As such, these are associated with **Low Risks** of project activities.

Liquid waste will include sanitary discharges from washrooms, discharges from kitchens, and storm water runoff from waste holding and disposal areas. Sanitary discharges, including discharges from septic systems have the potential to further increase the biological load of surface waters which are already high and in exceedance of safe consumption limits at both Matthew's Ridge and Port Kaituma. However, GMI intends to construct all septic tanks based on GNBS guidelines and install fat/grease traps to filter discharges from kitchen areas. Further, periodic water quality monitoring will be done to determine if GMI activities is contaminating waterways. As a result, potential impacts associated with contamination of surface waters from liquid waste disposal are **negative, direct, localised** and **short-term** of **moderate significance** and will be **unlikely** to occur. This results in **Medium Risks** of the project activities.

During the operational phase of the project, GMI will establish pits into which all project generated solid waste will be disposed at Matthew's Ridge and Port Kaituma. Runoff from these pits can enter waterways, resulting in contamination. These pits should be situated at an appropriate distance from surface water flows so as to prevent contamination. GMI's has instituted a no-littering policy for all project vehicles traversing the Matthew's Ridge to Port Kaituma road during both the construction and operational phases of the project and at the project sites. Potential impacts associated with contamination of surface waters from solid waste disposal are **negative, direct, localised** and **short-term** of **minor significance** and will **unlikely** to occur resulting in **Low Risks**.

In addition, various types of hazardous waste will be generated. GMI will designate special storage areas at Port Kaituma and Matthew's Ridge to collect and store waste oil and other hazardous waste. There are potential impacts of spills of hazardous waste into surface water bodies. Potential impacts associated with contamination of surface waters from hazardous waste management are **negative, direct, localised** and **short-term** of **minor significance** and small spills will be **likely** to occur. This results in **Medium Risks** of the project activities. However, contamination from large-scale accidental discharges are considered **Low Risks** given the mitigation measures which will be implemented.

The waste dumps, mine pits and the rejects/tailings pond typically are sources of inflow to groundwater due to seepage. However, because of the impermeability of the saprolite layer this would not likely occur at Matthew's Ridge. This impact may be **direct, negative, localised** and **short-term** of **minor significance** and **unlikely** to occur during the life of the project thereby posing **Low-Risks**.

At Port Kaituma, discharges from small-scale gold mining sometimes significantly contaminate surface waters and require residents to temporarily discontinue use of waters from the Canal and its tributaries because of elevated mercury concentrations as well as elevated turbidity levels. Project activities related to dredging of the Kaituma Canal in the vicinity of the Marine Terminal may also potentially increase the turbidity of some sections of the Kaituma Canal requiring temporary discontinuation of these waters for domestic purposes. The potential contamination from upstream small-scale gold mining activities and dredging of the Kaituma Canal occurring at the same time is expected to significantly elevate turbidity levels. These impacts are **direct, negative, short-term, cumulative** and **localised** of **minor significance** and are expected to **rarely** occur making them **Low Risks**.

At Matthew's Ridge, during prolonged dry seasons or drought conditions, the combined use of water by GMI and the Matthew's Ridge community of water supplied by GWI may result in water shortages. Potential water shortages during prolonged dry seasons may be augmented if the springs used by GMI and GWI share the same source. Potential impacts of shortages of water to be used for domestic purposes are **direct, negative, short-term, cumulative** and **localised** of **minor significance** and are **unlikely** to occur making them **Low Risks**.

Soils and Geology

Mine reclamation is the process of restoring land that has been mined to a natural or economically usable state. Potential for legacy issues from un-rehabilitated mines are **direct, negative, localised** and **long-term**. However, with the present level of environmental awareness and regulation it is **unlikely** that this impact will occur, but it is of **extreme significance**. As such, it is a **High Risk** of this project**.**

Foreseen erosion will be physical and mechanical. After vegetation clearing has occurred erosion by wind and water will most certainly occur until slopes are stabilized mechanically or by use of vegetation. The removal of vegetation and dewatering of the pits will promote erosion of the dried-out material. The waste dumps will be similarly devoid of vegetation for some period, exposed to the sun, become dry and then subject to erosion by wind and surface water. Impacts from erosion are **negative, direct, localised and long-term** of **moderate significance** and will **certainly** occur, making it a **High Risk** of this project.

Topsoil has to be removed, stockpiled and then used in reclamation and mine rehabilitation. The period for which it has to be stockpiled will vary based on the progression of the mine plan, but it will be in timeframes of years. Topsoil will be eroded while stockpiled resulting in loss of volume and it will deteriorate and lose the characteristics that make it topsoil by compaction and creating an anaerobic condition. The topsoil will however return to its natural state when redistributed and natural processes are promoted. These impacts are **negative, direct, localised, short-term** of **minor significance** but **certain** to occur. As such, it is **Medium Risk** of this project.

The construction of water storage, fuel storage, and other mineral processing facilities will all be in the thousands of tons. These loads will contribute to subsidence at their respective locations. All open pit mines are subject to several forms of landslide. The use of explosives will amplify the risks of landslides occurring. By the end of the project, there will be 9 waste dumps with a combined twenty million cubic meters of material reaching up to 30 meters in height. In addition, there will be seven clusters of open pits reaching depths of forty meters, these pits will begin in the soft saprolitic material and progress down to the sap rock and fresh rock. Subsidence may increase the possibility of landslides occurring. Due to the nature of open pit mining potential impacts of land subsidence are expected to be **direct, negative, localised** and **short-term** of **minor significance**. Subsidence is **certain** to occur and landslides are **likely** to occur but both may be mitigated by following slope design parameters and careful monitoring. These are **Medium Risks**.

Tests for acid rock drainage and metal leaching confirmed that old and future process tailings do not represent the potential to leach metals above IFC guidelines or generate acid as defined by the guidance criteria of the Global Acid Rock Drainage Guide (GARD; INAP 2012). This is due to the fact that most of the sulfides which may cause acid mine drainage have already been chemically removed by the prolonged oxidizing conditions which have prevailed during the deep weathering of the strata. The potential impacts of acid mine drainage are **negative, direct, localised, short-term** of **minor significance** and **unlikely** to occur. As such, it is a **Low Risk** of this project.

This mine is projected to consume more than 2.7 million kilograms of emulsion explosive material over the life of the mine. Given that the blasting will occur inside the lower levels of the open pit the walls of the pit themselves will act as shields. Also, with careful control and adherence to the regulation and best practices the blasts should be executed within safety parameters. Potential impacts of flyrock are expected to be **direct, negative, localised** and **short-term**. Depending on the size of the fly rock it can vary in significance from **negligible** to **minor**. The likelihood of occurrence depends on the blast design, which would factor in as best as possible the structural and mechanical properties of the materials involved, ideally there should be no fly rock. As such, these impacts are **unlikely to occur,** making these potential impacts a **Low Risk** of this project.

In Matthew's Ridge many buildings and structures are located on stilts and on the slopes of hills and other unstable foundations and may be impacted by vibrations from blasting. The geotechnical investigations calculated blast pattern parameters which should be within safety limits. Potential impacts of ground vibrations are **direct, negative**, **localised** and **short-term.** These potential impacts are **certain to occur**, but under ideal conditions the significance is likely to be **negligible to minor.** As such, these potential impacts are **Low Risk** of this project.

Many of the open pits in this project will require blasting to occur at or below the water table. There will also be the water against the retention dams of the Pakera Lake and tailings pond. The waterways that are intersected by the roads will also have characteristics similar to the dams. At all of these places the soft material is wet, saturated or close to saturated. These structures will be vulnerable to blast induced liquefaction if the PPVs reaching them are too great. This risk may increase the possibility of flooding, subsidence and landslides. Potential impacts of blast induced liquefaction are **direct, negative, localised** and **long-term.** However, it is **unlikely to occur** and its **significance minor** making it a **Low Risk** of the project activities.

Ancillary activities of the project which involve the construction and rehabilitation of roads will require the extraction of laterite from pits within the Matarkai sub-district. Laterite from these sources were already being extracted by the two contractors engaged by the Government. GMI will continuously utilize laterite from these pits during the operational phase of the project for road maintenance. It is likely that Government contractors will also utilize laterite from these pits for road works. Increased extraction of laterite may potentially contribute to the depletion of these resources throughout the project lifetime and may require the identification and establishment of new laterite pits. This potential impact is expected to be **direct, negative, long-term, cumulative** and **localised** of **minor significance** and are **likely** to occur making them **Medium Risks**.

Potential impacts of large or small scale spills of fuel are discussed in *Hazardous Waste and Other Waste Materials*.

Air Quality

Increased emissions of dust generated by project vehicles are anticipated to result in several potential impacts. Existing challenges of managing dust levels from the road during the dry season will be amplified for residents of Eclipse Falls where there are no provisions for wetting this section. The dry

seasons, in combination with frequent passages by vehicles, may result in rapid drying of the road surface therefore still exposing communities such as Four Miles to dust emissions. Increased dust generated along the Matthew's Ridge to Port Kaituma road is also likely to reduce visibility for all road users, including pedestrians, and contribute to adverse impacts to vegetation. The potential impacts associated with dust emissions are **negative, direct, short-term** and **localised** of **moderate significance** but are **certain to occur**. As such, dust emissions associated with increased temperatures and variable precipitation present **High Risk** to the project. Project activities are expected to significantly increase the traffic traversing the Matthew's Ridge to Port Kaituma Road and is likely to intensify existing levels of dust generated. Road use by project and non-project vehicles are expected to expose road users, including users of light vehicles such as ATVs, and the residents of Eclipse Falls to significant amounts of dust. This impact is expected to be **direct, negative, long-term, cumulative** and **localised** of **moderate significance** and are **certain** to occur resulting in **High Risks**.

Particulate matter can be generated from mining operations including stripping of topsoil, blasting, open pit mining, ore processing as well as ore handling and transportation. Entrained dust may also be generated from ore stockpiles and waste piles. In general, particulates generated may be relatively inert dusts which have potential to cause inflammatory responses in the lungs. However, manganese dust and fumes may also be released from these sources, the inhalation of which are associated with adverse health outcomes. Emissions modelling for the dispersion of TSP indicate that environmental exposure to particulates will be well within safe levels. Given the relatively high TSP concentrations at the source, occupational exposure may be high and may occasionally exceed the Occupational Safety and Health Administration (OSHA) permissible limits both for exposure to inert dust as well as exposure to manganese dust. These risks will be greatest for workers in the active mine sites and at the processing plant. However, mitigative measures will be in place including personal protective equipment (PPE) provision, daily wetting of the mine site and enclosure of processing machinery. Potential impacts of exposure to particulate matter including airborne manganese, will be **direct, negative short-term** and **localised** of **moderate significance** but **likely** to occur resulting in **Medium Risks.**

The combustion of diesel by the project is likely to increase the emission of 'diesel particulate matter'. However, the emission of diesel PM can be reduced if cleaner burning fuels are used by the project and engines are fitted with particle trapping filters or scrubbers. Dispersion modelling for gases show that concentration levels peaks within the first 100 metres from the source then decrease with distance from the Matthew's Ridge Power Plant. In addition, gaseous emissions from the combustion of fuel will come from non-stationary sources such as heavy vehicles, machinery and barges but the emissions from these will not significantly increase beyond the resulting modelled concentrations. These sources are transient and easily dispersed in the open air. Both environmental and occupational exposure to high concentrations of gases from project activities are expected to be low. These potential impacts from fuel combustion are **negative, direct, short-term** and **localised** of **negligible** significance but **certain** to occur. As such, air pollution from project activities are **Low Risks**.

Ozone formation will be limited by the expected dispersion patterns of nitrous oxides and VOCs from the Matthew's Ridge Power Plant and other fuel combustion sources. As such potential impacts of air pollution from fuel combustion are **negative, direct, short-term** and **localised** of **negligible** significance but **unlikely** to occur. As such, air pollution from project activities are **Low Risks**.

Climate and Climate Change

Climate change is a global issue of significant importance. The project is vulnerable to several adverse impacts of climate change including variable precipitation patterns, decreased annual average rainfall, increased heavy rainfall events and an increased number of hot days. In addition, this project

represents an increase in greenhouse gas emissions but its contribution to national emissions levels will be negligible. Moreover, reclamation and re-vegetation provide the opportunity to reduce the net greenhouse gas emissions associated with the project. Based on these factors, the potential impacts to climate change of the greenhouse gas emissions from this project is **negative**, **direct, short-term** and **localised** of **minor significance** but **certain** to occur resulting in **Medium Risks** of project activities. Cumulative impacts of fuel combustion from both project and non-project activities in the primary and secondary AoI are similarly **negative**, **direct, short-term, cumulative** and **localised** of **minor significance** and **certain** to occur presenting **Medium Risks.**

Land cover change associated with the project may also have an impact on the Land Degradation Neutrality (LDN) initiative being implemented by the Guyana Lands and Surveys Commission (GLSC). Progress in achieving LDN targets are land cover change measured as the conversion from forested lands to shrubs, grasslands or sparsely vegetated areas, and changes in soil organic carbon. Potential impacts on the national LDN initiative are **negative**, **direct, short-term** and **localised**. Given the low levels of deforestation associated with the project, the significance of these impacts is **negligible** but **certain to occur** presenting a **Low Risk**.

Biological and Ecological Resources

Vegetation clearing in mature forests areas, though limited to the footprint of the new access road from Port Kaituma to the new storage and wharf facility will create new forest edge. The creation of new forest edge may increase the vulnerability of intact mature forest to edge effects. Additionally, most animal species follow established patterns in their daily and seasonal movements. The riparian vegetation along the rivers and streams within the project impacted areas and the AoI is considered an important wildlife corridor that provides a stabilizing shelter for semi-aquatic fauna particularly small birds and mammals, and serves as a nutrient-rich food source for their prey. Vegetation clearing in mature forests areas may have a barrier effect which may be further intensified if road construction and expansion clearing create a berm or barrier of a mix of vegetation waste and surplus soil parallel to cleared area. The intensification of the barrier effect will add additional stress and restrictions on the movement of less mobile species. These are potential **negative, direct, long-term and localised impacts** of **moderate significance** but are **certain to occur**. These impacts present a **High Risk**.

During construction there could be the possibility of hydrocarbon contamination of the aquatic systems from accidental spills of lubricants and fuel and other contaminants. Hydrocarbons introduced into aquatic environment may change aquatic plant and animal growth, mortality and communities. These impacts are expected to be **negative, direct, short-term and localised impacts** of **major significance** and **likely to occur** thereby posing **High Risks**.

Traffic along roads can affect wildlife directly, by collision, or indirectly, by disturbance. Animal species not adapted for rapid movement on the ground across open spaces are particularly vulnerable. Human-wildlife conflicts often increase during road construction and operation. Roadkill of wildlife may be prevalent if drivers and vehicle users are not educated on cautionary driving to prevent road accidents with wildlife. Hunting and gathering of wildlife by workers may occur if not strictly managed. These impacts are expected to be **negative, direct, short-term and localised** of **moderate significance** and **likely to occur** thereby posing **Medium Risks**.

Process discharge to the tailings pond will contain sediments which will result in decreased transparency and a reduction of light available to aquatic plants, a primary food source for aquatic organisms. Further, the suspended sediment will ultimately settle onto instream habitat features (e.g., downed wood, gravel, etc.) or the bottom substrate causing embeddedness, which will decrease the value of instream habitat for macroinvertebrates and fish. Impacts of discharges from the Tailings

Pond are expected to be **negative, direct, short-term** and **localised** of **minor significance** but **certain to occur**. These impacts pose a **Medium Risk**.

The loss of predominantly secondary growth vegetation from land clearing activities are associated with impacts to the loss of natural habitats and intensification of habitat fragmentation as well depletion of soil nutrients and erosion contributing to sedimentation of surface flows and eutrophication. In addition, the tailings area will be scraped of topsoil material, grasses and trees as part of the preparation process for the facility to receive tailings, mainly as a measure to mitigate changes in the water (nutrient) quality of the tailings pond during operation that could lead to the formation of a lentic environment. These are potential **negative, direct, short-term and localised** impacts of **moderate significance** but are **unlikely to occur**. These impacts present a **Medium Risk**.

The deposition of tailings to the tailings pond during mine operations will likely cause a rise in the ground water level/table in surrounding areas, which may lead to the creation of a swamp/wetland habitat with ensuing changes to the micro-climate of the pond edges. The creation of a new wetlands may be positive in terms of enhancing overall biodiversity. However, the environmental change if it occurs will be long term and may have a direct impact on the vegetative structure of the affected area in that it may facilitate the proliferation of vegetation more adapted to abiotic conditions. This impact is, however, expect to be medium risk and will be confined to the areas of the pond edges. These potential impacts are expected to be **negative, direct, long-term and localised** of **moderate significance** and **likely to occur** thereby posing **Medium Risks**.

Processing water for ore processing and power plant engine cooling will be extracted from the Pakera Lake via the dam intake structures. The withdrawal of water from the Pakera Lake may become a concern if the rate of withdrawal exceeds the rate of natural replenishment, especially during the dry seasons. Intensive extraction of water from the pond may induce water stress in the ecosystems of the pond and the adjoining Pakera Creek beyond their natural variability when ecosystem needs are not met. Water stress induced changes may include changes in quantity (over-exploitation and altered flow regimes) and quality (excess nutrient, pollution and less biodiversity). GMI intends to reduce, or even cease production activities during the dry season to maintain the equipment and focus on the transportation of ore from Matthew's Ridge to Port Kaituma. Potential impacts from the intensive extraction of water from the Pakera Lake are expected to be **negative, direct, long-term and localised impacts** of **major significance** and **unlikely to occur** thereby posing **Medium Risks**.

Traffic on the access road during the operation phase would impact the early succession/edge and secondary forest habitats located along this road by increasing dust, which will settle on vegetation. Dust accumulation on plants has been found to impair biological functions including metabolism and photosynthesis, stunt growth, make them more susceptible to disease, and even cause mortality. Potential impacts of dust accumulation on plants are expected to be **negative, direct, long-term and localised** of **negligible significance** and **certain to occur**. This impact is expected to be **Low Risk**.

Habitat loss and displacement impacts will extend to benthic fauna in areas where river dredging is anticipated. Impacts to benthic fauna will similarly be limited to the relatively small riverbed areas of the Kaituma Canal as compared to the vast areas of available riverbed habitat that will be left untouched by dredging activities during construction. Riverbed areas affected by dredging are expected to recover and normalize within the short term. The impacts of habitat loss and displacement impacts on terrestrial and aquatic fauna are **negative, direct, short-term and localised** of **negligible significance** and **likely to occur**. This impact is expected to be **Low Risk**.

The physical disturbance and noise produced by equipment may impose additional stresses upon wildlife and may lead to increased migration away from impacted areas. While disturbances may be stressful for some wildlife, other species may easily adapt to and thrive successfully in the area owing

to the phenomenon of habituation. The presence of workers and work camps during construction may promulgate the presence of domestic and synanthropic species. Synanthropic species tend to increase due to the availability of food from worker camps. Predator and scavenger species may also be attracted to the site for fleeing or dead animals. These impacts are **negative, direct, long-term and localised** of **negligible significance** and **likely to occur**. This impact is expected to be **Low risk**.

Noise and Vibrations

An estimation of blasting noise propagation demonstrated that airblast overpressure is expected to be below a stringent limit of 115 to 120 dBA limit for airblast overpressure with distance of community receptors located within 500 meters of the site. GMI will develop a Blasting Plan to include safe blast radii for blasting in various areas earmarked for mining. Estimations of continuous and short-term operational noise from the other planned project activities revealed that noise levels are not expected to exceed the permissible levels for industrial operations at distances of 50 meters from the source. Given the community receptors at Matthew's Ridge are located at distances that exceed 1,000 meters of the project activities, no significant impacts of noise nuisance are anticipated. However, receptors on to the east, west and south of the Kaituma Marine Terminal on Canal Bank, Port Kaituma will be, in some cases, within 100 meters of the noise sources. Estimated noise levels from haul trucks are also well within the permissible limits for transportation and are consistent with maximum SPLs recorded in the baseline assessment. Although noise from haul trucks may exceed minimum noise levels in some communities, the source is mobile and moves relatively rapidly from the vicinity of any receptor. Noise sources during the closure phase will be similar to the construction related SPLs. No post-closure impacts are anticipated, since no noise-generating activities or equipment will be present once the Project is decommissioned. As such, these potential impacts of noise nuisance are expected to be **negative**, **direct**, **short-term**, and **localised**. The impacts are anticipated to be of **minor significance** and are **certain** to occur during the lifetime of the project. This results in **Medium Risks** from planned project activities.

Project staff, in particular mine workers, are also considered receptors to noise from mine blasting activities. Although the minimum safe blast radius outlined by GGMC should be maintained, GMI should outline further measures in the Blast Plan to ensure that occupational safety and health of workers of maintained. As such, impacts associated with noise exposure to workers from blasting are **negative**, **direct**, **short-term**, and **localised.** The impacts are anticipated to be of **minor significance** and are **likely** to occur during the lifetime of the project. Project workers will frequently be within 15 meters of various noise sources for continuous time periods depending on their job and may also be exposed to noise levels which exceed safe occupational levels. However, GMI will provide ear protection to workers who will be exposed to significant levels of occupational noise. The potential impacts of exposure to dangerous levels of occupational noise are **negative, direct**, **short-term** and **localised** of **major significance** but are **unlikely** to occur. As such, exposure to occupational noise are associated with **Medium Risks**.

Adverse impacts associated with vibration PPV is typically associated with structural damage to buildings within the blast radius. This includes buildings and facilities constructed for the project as well as any residential dwellings or other social infrastructure within the blast radius. As the PPV strength diminishes with distance, structural damage is not expected for any of the dwellings in Matthew's Ridge. As a result, structural damage associated with blast vibrations have potential impacts which are **negative**, **direct**, **short-term** and **localised** of **minor significance** but **likely** to occur and present **Medium Risks** of project activities.

Vibration caused by travel of haul trucks and heavy machinery will be short-lived. Trucks are supported on flexible suspension systems and pneumatic tyres and are therefore not an efficient source of ground

vibration. Any vibration caused by a truck hitting a pothole or other obstruction will be localised, diminishing rapidly with distance. Project roads will be maintained on a regular basis to assure the smooth travelling of vehicles, including trucks. Vibration impacts associated with heavy vehicles (haul trucks) and machinery are **negative**, **direct**, **short-term**, and **localised.** The impact significance is expected to be **negligible.** Finally, there may be vibration associated with pile and sheet driving at Port Kaituma as part of the construction of the Kaituma Marine Terminal. Given the land distance and the water bodies separating the Terminal from the residences, vibrations may be dampened and potential impacts are anticipated to be **negative**, **direct**, **short-term** and **localised** of **minor significance.** These impacts are **unlikely** to occur resulting in **Low Risks**.

Potential impacts of noise and vibrations from project and non-project heavy vehicles traversing the roadway are **direct, negative, short-term, cumulative** and **localised** of **negligible significant** but are **almost certain** to occur thereby resulting in **Low Risks**.

Transportation

GMI will upgrade the laterite surfaced road to more exacting engineering specifications for safe and efficient concentrate transport, material supply and personnel movement, as well as for use by the general public. The upgrades will result in an 8-meter dual-lane road and gradients not exceeding 9 percent, and will also have a minimum turning radium of 15 meters. In some sections, there will be widening of the road, the straightening of curves, the creation of improved sight lines and the installation of safety signage. Drains and culverts have already been installed along the roadway with some being done by the Government contractors and others by GMI. GMI will also refurbish and reinforce the bridge across the Barima River at Eclipse Falls with an abutment bridge. Construction of the bypass road at Port Kaituma will present the opportunity for persons to access areas which were previously difficult to access. This can result in an increase in activities in this area, including farming, and pork-knocking. Potential impacts associated with GMI's rehabilitation of the Matthew's Ridge to Port Kaituma public road are **positive, direct, long-term** and **localised** of **moderate significance** and **certain** to occur.

The project will utilize airstrips at both Matthew's Ridge and Port Kaituma for the transportation of staff and cargo, as needed. Given that GMI will focus on recruiting most its workforce from local communities in the Matarkai sub-district, it is not anticipated that the project will contribute to any notable increases in passenger air travel. Overall, GMI's activities are not expected to significantly increase air traffic in the area or contribute to wear and tear of the local airstrips. On the other hand, charters of flights to transport personnel or deliver essential supplies may support local air service operators to increase revenues resulting in impacts that are generally **positive, direct, short-term** and **regional** of **minor significance** and **certain** to occur.

The NDC and GMI have entered into a formal Memorandum of Understanding (MoU) under which the NDC waived tolls for GMI's vehicles entering Port Kaituma and GMI committed to repairing and maintaining the internal roads and bridges in Matthew's Ridge. However, the NDC has shared its dissatisfaction with GMI in fulfilling its obligations but GMI contends that the possible reason for this view by the NDC and RDC is limited communication between GMI and the local authorities. The potential impact of non-fulfilment of the MoU are **negative, direct, short-term** and **localised**. These impacts are of **moderate** significance and are **likely** to occur during the project. Non-fulfillment of the MoU with the NDC is a **Medium Risk** of the project.

During the dry season, project related traffic is expected to 10-fold the number of heavy vehicles entering Port Kaituma per day while in the wet season the increase is expected to be 5-fold. Increased traffic is likely to be associated with several potential impacts. Increased emissions of dust generated by project vehicles are anticipated to result in several potential impacts to residents of communities

abutting the road, in particular Eclipse Falls, and road users. Increased dust generated along the Matthew's Ridge to Port Kaituma road is also likely to reduce visibility for all road users, including pedestrians, and therefore contribute to unsafe driving conditions. Increased dust levels could also lead to adverse impacts to biodiversity. Increased traffic could also contribute to unsafe road use conditions and an increase in vehicular accidents along the Matthew's Ridge to Port Kaituma public roadway and stakeholders have reported unsafe driving practices including speeding by project vehicles. These impacts are **negative, direct, short to long-term** and **localised.** Increased dust emissions are considered to be of **moderate significance** and **certain** to occur and increased risks of accidents are considered to be of **major significance** and **likely** to reoccur. Both are **High Risks**. In addition, cumulative impacts of increased traffic from project and non-project vehicles on dust generation is considered to be a **High Risk** while increases in accidents and incidents are considered as **Medium Risks.**

Transportation of ore from the Marine Terminal in Port Kaituma will be facilitated by three 3000-tonne self-propelled ocean-going barges. Residents from the communities along the river transportation routes use these waterways on a daily basis, typically using canoes or other small vessels fitted with outboard engines, for transportation of people from their homes to other villages or economic hubs in Port Kaituma and Mabaruma. Children from these communities also travel on a daily basis to attend school in Mabaruma and Port Kaituma. The risks of accidents involving smaller vessels are likely to arise if GMI's barge encounters another large vessel en route in the narrower waterways such as the Kaituma River and also risks associated with collisions with other large vessels. As such, these potential impacts are **negative, direct, short-term** and **localised** of **moderate significance**. However, if GMI develops appropriate safety measures and engage with local communities on the barging schedule these potential impacts are **unlikely** to occur creating **Medium Risks.**

GMI will allow share use of project roads including the bypass roads constructed in Port Kaituma and Matthew's Ridge. This will likely result in pedestrians as well as a range of non-project light vehicles, such as ATVs and SUVs utilizing these roads. In some instances, mines vehicles will use existing public roads to transport ore from the tailings pond to the processing plant, or from Hill 9 to the commencement of the bypass road. Potential unsafe road use conditions resulting in accidents as a result of GMI heavy vehicles interacting with community traffic are **negative, direct, short-term** and **localised** of **moderate significance** but **unlikely** to occur and are **Medium Risks**.

Potential impacts of accidental detonation of explosives during transportation can be fatal for the handlers and are **direct, negative, long-term** and **local**. These impacts can be mitigated by careful handling during transportation and following all safety and security protocols established by the Government and international best practices. These impacts are of **major significance** but will be **rare**. As such, accidental detonation during transportation is a **Medium Risk** of the project.

In addition, GMI's heavy vehicles sharing use of the community roads may accelerate the deterioration of these roads. Potential impacts of accidents involving project vehicles and machinery using internal project roads in an unsafe manner are of **moderate significance** but **unlikely** making them **Low Risks**. The potential impacts of GMI's vehicles contributing to deterioration of roads used to haul ore are **negative, direct, long-term** and **localised** of **minor significance** but **unlikely** to occur. As such, these are **Low Risks** of the project since the company will continuously maintain the roads.

Road construction and maintenance can contribute to traffic delays and affect road safety that will have to be properly managed. Although delays will lead to frustrations, it is unlikely that there will be significant delays or traffic build up given the low volume of traffic which typically uses the road. These adverse impacts will be **direct, moderate, short term** and **localised** of **minor** significance and are **unlikely**. As a result, impacts of road safety or traffic delays during road rehabilitation are **Low Risks**.

GMI plans to create a new turning basin in the Kaituma Canal adjacent to the location of the Kaituma Marine Terminal. In the short term, the dredging will drastically increase the turbidity of the water preventing adjacent residents on the Canal Bank from safely utilizing the water until the water settles again. It is expected that the movement of the barge will disturb the water in the Kaituma Canal and increase sediment loads especially in the dry seasons when water levels may be lower. These impacts will be **negative, direct, short-term** and **localised** of **minor significance** and **likely** to occur making them **Low Risks** of the project.

Hazardous Waste and Other Waste Materials

Non Hazardous Waste

The largest quantities of waste material to be managed by the project are mine waste comprising waste rock and soils, and tailings. It is estimated that 14 million tons of tailings will be generated. It is estimated that 42 million tons of saprolitic soils and transition material as well as hard rock will be produced during the 13-year mine lifetime. Potential impacts of discharges of tailings and mine water are discussed in *Water Resources.* Potential impacts of acid mine drainage and landslides from waste rock piles are discussed in *Soils and Geology*.

GMI has maintained a good standard of housekeeping during the construction phase of the project and has designed measures to mitigate the potential impacts of poor management of waste generated by the demolition, construction and operational phases. However, it is expected that significant quantities of waste will be generated during the operational phase of the project and more than one scrap-yard or laydown facility will have to be created and this increases the potential adverse impacts on aesthetics and health and safety. The proper management of these types of waste can mitigate or minimise adverse impacts during the operational phase of the project. However, the non-biodegradable waste streams are likely to be a legacy of the project. Potential impacts of management and disposal of demolition, construction and operational waste are **negative, direct, long-term** and **localised** of **moderate significance** and are **likely** to occur making them **Medium Risks**.

The spoils from dredging of the Kaituma Canal were used as material fill for the Marine Terminal. Based on the 2020 water quality baseline, the physio-chemical characterization demonstrated that the water quality in the vicinity of the Marine Terminal was good. As a result, the sludge excavated from the Kaituma Canal is not expected to be acidic or contain oily residues or contaminants that may leach into soils. Given the small area of the Canal being dredged, significant quantities of spoils are not likely to be generated during the project lifetime. Potential impacts of soil contamination from the disposal of dredge spoils are **negative, direct, long-term** and **localised** of **minor significance** and is **unlikely**. As such, these are **Low Risks** of project activities.

During the construction process, food waste is collected on a daily basis and disposed of with regular waste. During the operational phase of the project, a disposal pit will be established and maintained into which food waste will be disposed directly. The pits will be covered to avoid flies and rodent infestations as well as malodour from leachate. Leftover food can be donated to local farmers to be used for poultry rearing purposes or for composts. Potential impacts from the disposal of food waste include waste serving as attractant for pests and vectors as well as the generation of malodours as the waste biodegrade. These potential impacts are **negative, direct, short-term** and **localised** of **minor significance** and is **likely** to occur. As such, these are **Medium Risks** of project activities.

Domestic wastewater will be generated principally from the sanitary facilities such as toilets and bathrooms and from the kitchens. All of the toilets are connected to septic systems which are fitted with soak-away systems and if sewage has to be hauled a third-party contractor will be hired. As such, the discharge of most liquid sewage generated onsite will be filtered prior to discharge into the

environment or will be collected by a third party. The kitchen facilities are fitted with fat traps. The impacts of improper disposal of domestic wastewater are **negative, direct, short-term** and **localised** of **moderate significance** and is **unlikely** to occur. As such, these are **Medium Risks**.

Hazardous Waste

Spent oils, lubricants and filters will be an inevitable byproduct of any project activities which require the combustion of fuel. During the construction phase of the project, waste oils generated from fuel combustion were collected in drip containers and stored in drums. Options for final use of these waste oils are still being considered and include contracting the transport of the waste oils to Bosai operations in Linden, transporting to another recycling facility or providing to chain saw operators. Ultimately, disposal of waste oils may involve a combination of these approaches. On-site uses, such as use as a dust-inhibitor, will be avoided. There are risks of spillages when significant quantities of waste oils are consolidated in storage without a secondary bunded containment. These risks may be amplified if waste oils will be transported over significant distances over existing road and river transportation networks. Potential impacts of spills resulting are **negative, direct, long-term** and possibly **regional**. Potential spills will be of **major significance.** Used oil filters will be drained and the waste oil collected from these sources will be consolidated in storage. When completely drained, used oil filters will be disposed of with general solid waste. Potential impacts of waste oil leaks from used oil filters are of **moderate significance**. These impacts are **unlikely** to occur if proper collection, storage and handling practices are maintained. As such, these are **Medium Risks** of project activities.

During the operational phase of the project, sewage sludge will be removed from the septic systems by a contractor on an as needed basis. Sludge will be disposed and covered with soil in a mine waste pit which will be excavated and dedicated for this purpose. Future excavation of this waste pit for project activities will be prohibited. Sludge will not be treated prior to disposal and may contain harmful components such as pathogenic organisms, organic compounds, heavy metals and excess phosphorus and nitrogen. These effects can be immediate or time-delayed and could potentially be harmful as a result of its leaching capability. In addition, untreated sewage sludge could also be a biohazard if it is discharged from the barge. Potential impacts associated with the disposal of sewage sludge are **negative, direct, long-term** and **localised** of **moderate significance** and are **unlikely** to occur given the management measures which will being implemented. As such, these are **Medium Risks** of project activities.

Other sources of hazardous waste include used batteries, chemical waste, the disposal of explosive residues including misfires and defective explosives, the histoplasmosis contaminated debris buried in the stockpile area, and waste containing CFC-22, HCFCs and Polychlorinated Biphenyls (PCB). Improper storage, handling and disposal of these waste are likey to lead to potential impacts that are **negative, direct, long-term** and **localised** of **moderate significance**. GMI has developed waste management strategies to guide storage and disposal of these waste. If these measures are fully implemented then impacts will **rarely** occur. As such, these are **Low Risks** of project activities.

Potentially Hazardous Waste

Potentially hazardous waste streams include scrap metal, particularly retired vehicles and machinery, if the lubricating oils, waste oil, fuels and any other hazardous materials and waste are not drained or otherwise removed before the scraps are retired, open containers and spent tyres may collect and pool rain water and inadvertently become breeding grounds for vectors, improperly disassembled electronic waste and soils contaminated by large spills of hazardous materials and waste. The impacts associated with improper handling and disposal of these waste are **negative, direct, long-term** and **localised** of but will **rarely** occur if appropriate mitigation measures are implemented. As such, these are **Low Risks** of project activities. However, small scale spills are likely to occur from most project activities and can happen relatively frequently as a result of poor handling practices by employees.

The effects of these discharges over time may increase the concentration of hydrocarbons in soils. Potential impacts of contamination from relatively frequently small scale spills are **direct**, **negative, localised** and **long-term** of **minor significance** but **likely** to occur. As such, accumulated contamination resulting from small spills are a **Medium Risk** of project activities.

Landscape and Aesthetics

The infrastructure remaining from the previous mining operation was left in a state of disrepair, resulting in unsightly structures within the project areas. To facilitate GMI's project, some of these derelict structures were removed completely and replaced, while others were refurbished. This has resulted in improving the aesthetics of the area. Further, the clearing of secondary vegetation in some of the project areas has also improved the aesthetics. In addition, GMI has commenced efforts to contribute directly to the improvement on the community infrastructure particularly the roads within Matthew's Ridge. GMI will also improve the Matthew's Ridge to Port Kaituma roadway by resurfacing and widening the road surface with drainage and improving siting on curves to permit reliable and safe two-way transport. Further, the Company will rehabilitate and reinforce the Eclipse Falls bridge. As such, the impacts from the removal or rehabilitation of old project infrastructure and construction of new facilities are **positive, direct, long-term** and **localised** of **moderate significance** and **certain** to occur.

The Project will affect landforms by open pit mining, establishment of waste dumps for the storage of mine waste including waste rocks, soils and process tailings. The open pit mines will be located on the footprint of the previous mining activities but there will be extensions of the footprint for the establishing of waste dumps and tailings facilities. The project will also allow for the rehabilitation of some of these previously used areas including the abandoned waste dumps. GMI will be required to prepare a Closure and Decommissioning Plan to ensure that these sites are progressively reclaimed during the project life and closed out in an acceptable manner at the end of the project. In addition, the construction of the Kaituma Marine Terminal will require the permanent modification of approximately 4 hectares which will change the aesthetic of the immediate area which consists mainly of houses and farmlands. As such, the potential impacts to landforms are generally **negative, direct, long-term** and **localised** of **moderate significance**. The potential impacts are **likely** to occur during the project lifetime and results in **Medium Risks** of the project.

Existing or previous small scale gold mining activities have degraded lands within a 10 to 20-kilometer radius of the AoI at Matthew's Ridge and are visible during both in-bound and out-bound flights from the Matthew's Ridge airstrip. During the operational phase of these project, when there are multiple active open pits and waste dumps there is potential to lower the aerial aesthetics of Matthew's Ridge approach. However, these impacts are likely to be significantly reduced and return to better than baseline conditions after mine rehabilitation has occurred following the closure and decommissioning of this project. These potential impacts are **direct, negative, long-term, cumulative** and **localised** of **negligible significance** and are **almost certain** to occur. As such, they are **Low Risks** of the project.

Cultural Heritage

Heritage sites are fixed features in the environment, occurring within specific spatial confines. There are 47 known cultural heritage sites in the Matarkai sub-region none of which are within the AoI. However, a combination of factors significantly increases the likelihood of inadvertent discoveries including proximity to known archaeological sites, the interaction of project infrastructure with community-owned historical heritage sites, the absence of a comprehensive assessment of the cultural, archaeological and natural heritage of the project areas and the total footprint of the project areas. Increased activities in the project areas also increases the likelihood of intentional looting or

disturbance of known archaeological sites. Heritage resources, if lost, are impossible to recover and the importance of these resources to people and the scientific community cannot be overstated. Impacts associated with the inadvertent or intentional destruction of heritage sites are **negative**, **direct**, **long-term** and **localised** of **moderate significance** but **likely to occur.** As a result, damage of loss of cultural property is a **Medium Risk** of the project.

Socio-Economic Environment

Given the challenges of employment and poverty in the AoI and the Region, project employment is expected to be of a considerable boost to the local economy and social wellbeing of the current population resulting in significant **positive, direct** and **regional impacts**. The potential impacts of employment are **long-term** as they are likely to last for the construction and operation phases of project and end after the project is decommissioned. The benefits of vocational training are also **long-term** and transferrable making employees more attractive for recruitment elsewhere when the project ends. This underscores the importance GMI maximising employee training during the construction and operational phase. GMI is in a unique position to encourage growth of the community economy and promote well-being. In particular, the company may explore boosting local procurement and designing a proactive programme of Corporate Social Responsibility (CSR) interventions in consultation with local communities. These impacts are of **moderate significance** and are **certain** to occur during the project lifetime. The cumulative impact of economic development from project activities in combination with prevailing livelihood activities are **positive, direct**, **cumulative, regional** and **long-term** of **moderate significance** and **certain** to occur.

Although GMI will give preference to employees from Matthew's Ridge and Port Kaituma, it is inevitable that that workers will be recruited from other areas of Region 1, other administrative regions in Guyana and Chinese expatriates. Indeed, GMI's labour force during the construction phase of the project was already reflective of such a labour force composition. Moreover, as typical of large projects, local vendors and service providers, including sex workers, may be attracted to the area. Moreover, matriculation of locals and immigrants, including possibly Venezuelan immigrants, seeking employment typically occurs particularly during the formative years of the project. This effect may be amplified in Matthew's Ridge where operations will be more intensive and more employees will be based. This has the potential to create pressure on strained resources and public services including water, health-care, waste disposal and security. The potential impacts associated with migration for employment are expected to be **negative, direct** but **short-term** and **local** of **major significance** and are **likely** to occur making them **High Risks**. The cumulative impact of project workforce on these resources and services in combination with existing community pressures is **negative, indirect, cumulative, local** and **long-term** of **moderate significance** and **likely** to occur. As such, these are **Medium Risks** of the project.

Manganese mining in Matthew's Ridge has left a legacy of success stories related to employment, economic growth and development for the Matakrai sub-district. The reopening of the mine several decades later has awakened expectations of employment and economic prosperity for the residents of communities within the Matakari sub-district and the wider Region 1. Beyond employment, residents also expect GMI to contribute to the social and economic development of the communities including enhancement of community infrastructure including rehabilitating roads and bridges and supporting the provision of social services foremost of which interventions are expected in education and water. However, expectations are starting to diminish in part due to a perception that GMI is not fulfilling its obligations to the NDC and that operations are delayed. Socio-cultural shifts in Matthew's Ridge have also arisen because, based on an agreement with the NDC and in the interest of public safety, access to the Pakera Lake has been restricted. These potential impacts are considered to be **negative** and **direct.** If no mitigation or management measures are employed, these may possibly be **local** and

long-term of **moderate significance** and are **likely** to occur. Impacts associated with either unachievably high or negative community expectations pose **Medium Risks.**

Indigenous peoples are one of Guyana's most vulnerable social groups due to relatively poor socioeconomic conditions, low levels of formal employment, the remote locations of some communities where the capacity to respond to emergencies is inadequate or non-existent, insecurity of land tenure and poor access to vital services, foremost of which are health-care, water and education. As discussed in the Baseline Conditions, indigenous peoples living in communities that are part of both the primary and secondary AoI of the project already share all of the vulnerabilities listed above. Planned project activities may further amplify these vulnerabilities. These potential impacts are **indirect, negative, localised** and **long-term**. However, addressing the fundamental vulnerabilities faced by indigenous peoples is beyond the scope of this project. Nonetheless, GMI should strive not exacerbate these vulnerabilities and instead, contribute to managing their impacts by promoting social and economic inclusion in the project, meaningfully engaging indigenous populations, promoting safety and well-being of indigenous peoples and contributing to lifelong learning both academically as well as vocationally. As such, these potential impacts are of **moderate significance** and are **likely** to occur with **Medium Risks** to the local indigenous populations. In addition, cumulative impact on indigenous communities where elders work out of the village for extended period either with GMI or in the gold mining industry **negative, direct, cumulative, localised** and **short-term** of **moderate significance** and **almost certain** to occur and is a **High Risk.**

Other minority groups are at risk of greater poverty and are highly vulnerable. Although gold mining is prevalent in Region 1, most of rural poor employed in this industry are waged employees of small and medium scale miners. As previously discussed, Venezuelan migrant populations and small segments of the local creole population including women and children are also considered vulnerable populations. While these groups are socially integrated into the wider population, they must be specially considered given unique challenges related to lack of resources, limited education, language barriers, limited power to effect change and poor employment. These potential impacts are considered to be **negative**, **indirect, localised** and **long-term** of **moderate significance** and are **unlikely** to occur posing **Low Risks**.

In addition, as previously discussed the project will share resources with local communities including road and river transportation networks. These impacts are discussed under *Transportation*. Similarly, the project has required the resettlement of residences and small farmlands and these impacts are discussed below under *Land Acquisition, Resettlement and Livelihoods*.

Health

The possibility of a COVID-19 outbreak remains high and as of August 2020, the number of cases continued to increase nationally as well as in Region 1. As at August 2020, there has been zero positive cases among the employees of GMI. The company should continue to implement and strictly enforce the measures which were instituted to control the spread in its workforce. Nonetheless, it is recognized that this situation can only be partially managed by GMI even if all measures are followed to prevent occupational spread given that employees may engage in unsafe behaviours when not on duty. As a result, the risk of transmission remains high particularly given the density of the workforce accommodation at both Matthew's Ridge and Port Kaituma. Adverse health outcomes associated with the spread of COVID-19 in the project locations are **negative, direct, long-term** and **regional.** These potential impacts are of **extreme significance** and are **likely** to occur resulting in **High Risks**.

As part of the design of the mine areas, GMI has incorporated several features to reduce the likelihood of mine collapse based on the material type and safety limiting factors. Nonetheless, the risks of pit cave-ins remain and damage can be significant. Mining equipment and machinery can be damaged

beyond repair and in worst-case scenarios pit cave-ins can result in injuries or loss of lives. There are numerous health risks associated with the transportation and use of explosives in GMI's operations. By law, explosives and detonators have to be transported separately and stored separately under armed security. During blasting activities, workers can be exposed to high levels of noise, vibrations or may be hit by fly rock. However, these potential impacts can be managed and mitigated if safety measures for maintaining a safe blast radius and using all required PPEs are followed. Potential injuries or fatalities will be **negative, direct, short-term** and **localised** of **extreme significance** but will occur **rarely** making them a **Medium Risk** of the project.

Workers exposure to high concentrations of manganese in the air for a prolonged period are at risk of serious neurological illnesses. However, occupational exposure to inhaled manganese dust or particles can be managed if appropriate PPEs are used by vulnerable workers. In addition, the crushers and the jigging machines are contained. Further, the particulates on the conveyor belt will be suppressed by spraying of water. The mining site will also be wetted frequently in the dry season. Adverse health outcomes are **negative, direct, long-term** and **localised.** If appropriate PPEs are utilised, this potential impact will be of **moderate significance** and **likely** to occur during the project lifetime. As a result, occupational exposure to manganese dust are **Medium Risks** of the project.

The project will have continuous construction of mining pits, roads and temporary housing during its lifetime. The employees will be at risk from a combination of factors in each situation. GMI provides relevant PPEs to all workers and their use should be strictly enforced on the jobsite. Road construction and repairs will have to be properly managed by GMI. These adverse impacts will be **negative, direct, short-term** and **localised** of **moderate significance** but are **unlikely** to occur if appropriate occupational safety and health measures are followed. As a result, injuries or fatalities associated with construction work are **Medium Risks** of the project.

The economy of Matthew's Ridge and Port Kaituma will be significantly boosted by the additional incomes generated as a result of the project. This is likely to attract many persons to the area including sex workers. There are sex workers operating in the area currently who are mainly from Venezuela. Growth in the sex worker industry can increase the risk of local persons contracting Sexual Transmitted Infections and Sexual Transmitted Diseases (STDs) including HIV/AIDS. It is critical to note that COVID-19 can be spread by sexual contact during sex work and by casual sex. It is expected that there will be an increase in the use of drugs and alcoholism associated with mining booms in the local communities. Visiting workers who are alcoholics or drug users can encourage the locals, including local youth, to abuse alcohol or participate in illegal drug use. These adverse impacts will be **indirect, negative, long-term** and **localised** of **moderate significance** and **likely** to occur during the project lifetime. These potential impacts present **Medium Risks** of negative health outcomes.

GMI has sealed the tunnels from which bat droppings and debris infected with the spores which causes the histoplasmosis outbreak originated and has ceased all operations to excavate tunnels which were not yet explored. Although the infected materials were buried, the spores may be released again if the area is disturbed in the future. As a result, potential impacts of another histoplasmosis outbreak are expected to be **negative, direct, short-term** and **localised** of **moderate significance** but will **rarely** and are a **Low Risk** of the project.

Region 1 has a high incidence of vector borne diseases and the regional assessment identified malaria was the chief human pathogen. In particular, the mosquitoes that cause malaria as well as sand flies that cause leishmaniasis breed in Matthew's Ridge. Malaria can be diagnosed by both the Pakera District Hospital and the Port Kaituma District Hospital and can be treated effectively. However, given the high incidence of these diseases in the area, and the ongoing gold mining activities which also contribute to vector breeding, project activities are expected to increase vector breeding marginally. As a result, potential impacts of increased vector borne diseases as a result of the project activities

are expected to be **negative, direct, long-term** and **localised** of **negligible significance** but **likely** to occur during the lifetime of the project. Potential increases in vector borne diseases are a **Low Risk** of the project.

GMI will be using hazardous materials in its operations. Adverse health outcomes associated with exposure to hazardous materials if proper health and safety procedures are not followed can occur. As a result, potential impacts of dangerous exposure to hazardous materials are expected to be **negative, direct, long-term** and **localised** of **moderate significance** but will occur **rarely** during the lifetime of the project. Potential increases in surface water contamination from fuel exposure to types of hazardous materials to be utilised are a **Low Risk** of the project.

Potential impacts of air pollution and water from the project activities are discussed in *Air Quality* and *Water Quality* above. In addition, potential impacts of the project on road and river transportation safety are discussed in *Transportation*.

Land Acquisition, Resettlement and Livelihoods

The project required resettlement of residences and farmlands in Matthew's Ridge and Port Kaituma. None of the people who were resettled had legal rights of access to the land. However, these are largely vulnerable groups of persons occupying state lands. Nevertheless, there are alternative areas available to which these persons can relocate. These displacements are considered to be **direct, long-term** and **localised,** of **moderate significance** and are **certain** to occur during the construction and operational phase of the project. Physical displacement and resettlement are of **Medium Risk** to the project. Physical displacement impacts were significantly reduced based on the measures implemented by GMI to reach fair settlements based in part on third-party property valuations. The NDC was involved in all negotiations.

Access to the Pakera Lake, which the community had utilised for recreation and other purposes, is now restricted by GMI so as to ensure the safety of residents since the lake is now flooded due to GMI rehabilitating the dam and water control structure. Within Matthew's Ridge, there are limited recreational facilities and the use of the lake, especially during the dry season when the water level within the lake is lower, is an important source of recreational activity for residents. The NDC agreed that GMI can implement the measures to restrict access to ensure public safety, but would need to offset the impacts by assisting in providing additional sources of recreation. The impact relating to this loss of recreation activity can be considered to be **direct**, **negative, short-term, localised** of **minor significance,** and is **certain** to occur. Socio-cultural displacement is a **Low Risk** of the project.

Environmental and Social Management Plan

The mitigation and management measures which GMI has committed to implement, or which implementation has already commenced during the construction phase of the project, have significantly reduced the risks associated with potential impacts of the planned project activities. As a consequence, the significant majority of impacts assessed in this EIA are of Low or Medium Risk. Moreover, none of the potential impacts assessed were associated with Critical Risks to any of the resources considered. Nevertheless, there are potential impacts which were assessed to be associated with High Risks even after all mitigation measures were implemented including:

- Manganese levels in surface and ground water bodies exceeding permissible limits increasing to exposure to waterborne manganese which has been associated adverse health outcomes. This is due to prevailing environmental conditions in Matthew's Ridge and would be considered a High Risk even in the absence of the project.
- Legacy issues arising from non-rehabilitation of the mine areas.

- Physical and mechanical erosion from vegetation clearing and de-watering of mine pits.
- Increased traffic on the Matthew's Ridge to Port Kaituma public road leading to significant emissions of dust and increased risks of vehicular incidents and accidents.
- Vegetation clearing of mature forests leading to the edge effect and barrier effect.
- Accidental discharges of fuel or other contaminants into waterways, particularly during the construction phase of the project before bunded secondary containments are ready.
- Planned and unplanned migration into Matthew's Ridge amplifying pressure on strained resources and social services.
- Adverse outcomes associated with the spread of the COVID-19 pandemic. Although the project has implemented measures to prevent occupational transmission of this disease, effectiveness is limited by employee behaviours when off-duty.
- Cumulative impact of indigenous peoples working in the gold mining industry or GMI for extended periods of time contributing to socio-cultural impacts such as a loss of culture.

In addition to the mitigation and management measures which GMI has committed to implement, the EIA team recommended a suite of mitigation measures which may further lower the risk profile of this project. These measures are comprehensively outlined in an Environmental and Social Management Plan (ESMP) for all Low, Medium and High Risks. However, GMI should prioritise the implementation of the measures listed below to address all High Risk impacts presented above:

- Develop a water quality monitoring programme, in partnership with GWI, to regularly monitor manganese levels in the Matthew's Ridge community water supply. If manganese levels exceed safe consumption levels, GMI should work with GWI to make an alternative source of drinking water available for community members.
- Ensure that the quality and quantity of effluent streams to be discharged to the environment, including overall mine works drainage and discharges from the tailings pond are managed and treated to meet the applicable effluent discharge limits from national and international guidelines, as applicable.
- Prepare Closure and Decommissioning Plan shorting after commencing operations in consultation with local and institutional stakeholders. This Plan is anticipated to demonstrate that closed out Matthew's Ridge and Port Kaituma facilities will represent minimal long-term deleterious legacies.
- Prepare and implement an Erosion and Sediment Control Plan.
- Employ slope stabilisation and soil wetting techniques to reduce erosion.
- Instituting dust reduction methods in the absence of road wetting of the Matthew's Ridge to Port Kaituma public road, in particular the sections of the road passing through Eclipse Falls. These methods may include reduce speed limits of project vehicles passing through the village to reduce dust levels generated.
- Ensure that there is progressive reclamation of mined out sites.
- Develop an air quality monitoring programme to determine levels of manganese in the air at high-risk worksites (manganese extraction and processing) and sensitive receptors down-wind of these sites. The air quality monitoring programme should also measure the concentrations of other air pollutants including dust generated along the Matthew's Ridge to Port Kaituma Road in the vicinity of Eclipse Falls.
- Institute measures to facilitate safe road transportation including reducing speed when traversing through communities and rules for yielding with respect to non-project heavy and light vehicles.
- Host awareness sessions with local communities to increase their awareness of transportation safety practices by GMI such as right-of-way practices and opportunities for reporting poor driving practices by project staff.
- Install safety signage on the roadways including roadways which may intersect with heavy vehicles and mines machinery.

- Restrict vegetation clearing for road construction of 8 meters or less and retain as much canopy cover as possible.
- Field-test the procedures of the emergency response plan for clean-up of any accidental discharges from the operations.
- Provide training, including practical training, for employees on proper handling and management measures for hazardous materials and wastes.
- Construct bunded secondary containment structures with impervious bases for the storage of all hazardous materials and hazardous wastes.
- Ensure spill kits are available at all locations where hazardous materials and wastes are stored.
- Develop a Grievance Mechanism accessible to community and provides for timely and meaningful action to be taken by the company.
- Schedule periodic meetings, on a quarterly or bi-annual basis, with the RDC, other local authorities and residents of the primary AoI to provide updates on the implementation of project activities and receive feedback and recommendations. Recommendations could include potential CSR contributions from GMI to support or strengthening existing social services, particularly in Matthew's Ridge.
- Continue to implement protocols to prevent occupational spread of the COVID-19 pandemic and provide awareness to employees on the importance of maintaining these protocols when off-duty.
- Develop an awareness programme for employees, in consultation with community members, of cultural practices in the local communities and how these should be respected. In this regard a Code of Conduct for workers may be developed.

All of the measures in the ESMP should be supported by several standalone Plans that will provide a strategic approach to the implementation of the ESMP by GMI. These include:

- *Erosion and Sediment Control Plan*: to identify potential pollutant sources that may contribute to erosion and the sediment loads of storm water runoff, document the best practices that will be implemented in order to prevent, to the maximum extent practicable, erosion from occurring and sedimentation from leaving the site and entering the storm drain system during all phases of construction and document erosion control, sediment control, and good housekeeping that must be implemented.

- *Water Management Plan*: to support the achievement of long and short term water management and to set realistic and achievable water use efficiency, water quality and conservation goals.

- *Waste Management Plan*: to provide guidance for the reduction, handling and disposal of waste throughout the lifetime of the project including the construction and operational phases. The Plan should identify all of the waste streams and waste types to be generated from planned project activities and detail their origins, provide information on the steps taken to lower the quantities of waste generated from the project and provide an overview of the methods to be used for waste recovery, recycling and disposal.

- *Blasting Plan*: to guide the blasting operations and ensure that all blasts are conducted safely. The objectives of the Blasting Plan will be to, identify risks, hazards and controls, identify site-specific requirements, introduce blasting as part of the overall task, control the blast process from design to initiation, evaluation and misfire treatment, implement a review process to ensure that the objectives are met and ensure the safety of the public, site personnel and surrounding properties.

- *Closure and Decommissioning Plan*: to produce safe and sustainable final landforms that will evolve over time in a manner compatible with the surrounding landscape, produce a diverse mosaic of sustainable native ecosystems within the forest landscape with the aim of conserving biodiversity and maintaining evolutionary potential, control erosion and develop self-sustaining water management infrastructure, mitigate any exposure hazard from residual chemicals and/or mining wastes, and provide suitable conditions for establishment of a vegetation cover where practical.

- *Relocation and Resettlement Plan*: to treat customary and formal rights as equally as possible in devising compensation rules and procedures. The plan should address the issues raised by the different tenure systems found in a project area, including the compensation eligibility so as to improve or restore the livelihoods and standards of living of displaced persons, and to improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites. This Plan is only required if additional resettlement is required when the project is operational.

- *Stakeholder Engagement Plan*: to develop a stakeholder analysis of the project, initiate open, two-way dialogue while seeking to communicate project activities to stakeholders, foster involvement and identify issues and possible solutions face by stakeholders and charter a communication roadmap throughout the life of the project.

- *Indigenous Peoples Plan*: to address potential project impacts on indigenous peoples (IPs) and outlines means by which IPs can be integrated into the project in order for the development to meaningfully contribute to their social and economic wellbeing. The plan should aim to ensure free prior and informed consultations among affected indigenous groups, avoid and/or minimise any adverse impacts the project may have on indigenous communities living around the project area, ensure the project benefits are accessible to indigenous groups in the area, ensure indigenous peoples are involved in the implementation and monitoring of activities and minimise socio economic and socio-cultural impacts within communities as a result of direct and indirect impacts of project related activities.

- *Training Plan*: to support the streamlining of employees training and education efforts in a way that ensures that operations are conducted safely, there is compliance with laws and regulations, and that support more effective work processes that increases production while reducing risks, wastes and inefficiencies.

- *Grievance Mechanism:* to provide stakeholders at different levels with a clear mechanism to channel grievance, provide an accessible, transparent and efficient complaint procedure and provide and define clear roles and responsibilities of the parties handling the grievance.

In addition, GMI has developed an Emergency Response and Contingency Plan outlining the response procedures and preventive measures that are essential for effective and timely management of an emergency. This Plan is intended to provide for a prompt and effective response to any incident which compromises the environment and safety of the project site and its adjacent environs, and the health and safety of employees, contractors, the public or visitors arising out of the existence and use of GMI's site, facilities and operational assets. The Emergency Response and Contingency Plan makes provisions and outlines procedures to be followed for injuries to persons, explosive mishaps, fuel spills, fire response, flooding response and emergency medical evacuation to Georgetown.

GMI also developed a Monitoring Plan to ensure the environmental and social safeguards identified and implemented are effective to minimise, mitigate and manage the impacts from the project. The implementation of the monitoring plan allows GMI meet its statutory obligations and demonstrate

compliance with its various permits. GMI will continue to institute, maintain and monitor the environmental status of its operations through scheduled collection of samples, data, interpretation against standards and the recording and reporting of any critical issues or trends.

ESMP Implementation

The implementation of the ESMP will be the responsibility of the Health, Safety and Environment (HSE) Department. The HSE Department will be headed by a HSE Officer, who will be in charge of the overall HSE aspects of GMI. Three to four technicians, who will have responsibility for different aspects in accordance with their professions will be employed and will report to the HSE Officer. The HSE Officer will report to the Vice General Manager of the Company.

Conclusion

It is recognized that the project is neither technically complex nor inherently threatening to people or to the environment since most of the project's physical components are situated in "brownfield" locations where were impacted by the previous mining operation. Construction activities has been ongoing in the project areas in preparation for the operational phase of the project. GMI proceeded with construction once it was granted two Construction Permits by the EPA. Nevertheless, the EIA still addressed impacts associated with both the construction and operational phases of the project.

The potential impacts of project activities were assessed across the various phases using the baseline conditions of the project areas and the planned project activities. This was done by establishing the potential interactions between the activities and the characteristics of the existing physical, biological and socio-economic environment. In addressing the impacts the mitigation and management measures currently in place were examined. In addition, planned mitigation measures to be implemented by GMI were also considered. Where it was felt that gaps still existed or there was need for additional mitigation and management measures these were identified and recommended. In this regard, the ESMP was prepared. It is expected that GMI will fully implement the ESMP, which should be updated periodically to reflect adjustments which may be made as the implementation of the project progresses.

This EIA has examined the project and assessed its potential impacts. The EIA Team is confident that there is a clear understanding of the current and potential impacts from the implementation of the project and has recommended the required mitigation and management actions that need to be taken. Once there is adherence by GMI the potential negative impacts can be avoided or mitigated and the project could realize social, economic and ecological benefits.

Chapter 1 - Introduction

1.1 Background

Manganese mining has historically played a crucial role in the development of Guyana's North West District in Region 1. Manganese occurrences were first identified in 1937 at three principal locations namely Matthew's Ridge, Arakaka and Pipiani. By 1957, Manganese Mines Management Limited, a subsidiary of Union Carbide, commenced establishing the facilities and infrastructure required to allow for the storage and export of ore. Accordingly, the company established mine buildings and a processing plant at Matthew's Ridge; constructed a 48-kilometer (30-mile) railway with adjacent roadway for the transport of ore from Matthew's Ridge to Port Kaituma; and built a Bailey bridge over the Barima River at Eclipse Falls. The company also cut the Kaituma Canal; established ship loading, ore concentrate storage, fuel tankage and housing at Port Kaituma; and dredged the Barima River and Mora Passage. In 1961, the first shipments of ore were made using two converted shallow draft oil tankers. However, by 1968, a precipitous fall in the price of manganese caused operations to cease and continue on a 'care and maintenance basis' for several years. Over the eight-year operational period, a total of 1.7 million tonnes of manganese ore was exported. Operations never resumed although multiple attempts were made by several different investors in the 1980s as well as in 2008 and 2011[1].

In 2016, GMI was created as a subsidiary of the Bosai Minerals Group of the People's Republic of China to invest in the resuscitation of manganese mining, processing and export in Matthew's Ridge and Port Kaituma. The investment will focus on the historic, previously mined sites located in Matthew's Ridge. Ore mined and processed in Matthew's Ridge will be transported to Port Kaituma for transnational shipment to Trinidad and Tobago.

Based on the planned project activities, the project will interface primarily with settlements in Matthew's Ridge and Port Kaituma, including residences along the Canal Bank in Port Kaituma. Road and river transport routes will also occur in proximity to other settlements including titled indigenous villages. Haul trucks on return trips between Matthew's Ridge to Port Kaituma will traverse on the public road that runs through the Amerindian villages of Eclipse Falls and Four Miles. Barges on return trips from Port Kaituma to Trinidad will utilise rivers and other waterways adjacent to indigenous villages such as Smith's Creek and other communities such as Morahwanna.

The project is anticipated to bring many developmental benefits to Region 1. During scoping meetings conducted as part of this EIA process, residents and other stakeholders of Matthew's Ridge, Port Kaituma and other communities in Region 1, including indigenous communities, expressed expectations of increased employment as a result of the project. Moreover, representatives of the regional administration of Region 1 also welcomed the project and noted that the region as a whole could experience economic development as a result of the project[2]. Since 2018, GMI has made contributions to communities and regional authorities towards their development. At a national level, the project is expected to contribute to foreign exchange earnings from the export of manganese and therefore is expected to contribute to an increased Gross Domestic Product.

1.2 Purpose of the EIA

The Environmental Protection Act 1996 requires GMI to seek environmental authorisation from the EPA for the establishing of mining, processing and transport facilities and for the mining and processing of ore and which includes activities at Matthews Ridge and Port Kaituma. As such, GMI submitted an Application for Environmental Authorization in January 2019. The EPA subsequently

[1] Paragraph was compiled mainly from GMI April 2020 Revised Project Summary – Section 2.0.
[2] Minutes of the Public Scoping Meetings are presented in Appendix D1.3.

determined that an Environmental Impact Assessment (EIA) was required for the project and informed GMI in July 2019 that the company must prepare and submit an EIA before an Environmental Permit is granted. The EPA also indicated that a separate Application for Environmental Authorisation should be submitted for the Port Kaituma Wharf facilities even as this aspect of the project is addressed by the EIA. The EPA further indicated that Construction Permits will be issued to GMI so that the company can commence the establishment of the infrastructure and auxiliary facilities to support the mining, processing and transport of ore. Two Construction Permits to allow for construction activities at Matthew's Ridge and at Port Kaituma were issued to GMI by the EPA in September 2019.

This issuance of the Construction Permits allowed for the construction/installation of key project features to occur concurrently with the preparation of the EIA. Under the aegis of the Construction Permits, GMI has significantly advanced the construction/installation and rehabilitation of the main project components of the bypass roads in Matthew's Ridge and Port Kaituma, including fixed plant structures and other project buildings, and auxiliary facilities for the mine sites.

The EPA, once it had determined that an EIA was required, also prepared draft Terms and Scope for the EIA which was shared with the company and the EIA consultants. Scoping meetings on the project were then held in Mabaruma, Port Kaituma and Matthew's Ridge in July 2019. These meetings were organized by GMI, with support from the EPA, and included participation from Government institutions, other relevant stakeholders and the public. After the scoping process was completed the feedback gathered was used to finalize the Terms and Scope for the conduct of the EIA. The finalized Terms and Scope was provided by EPA to GMI in October 2019 and is included in Appendix A. This set the basis for the commencement of the EIA process.

1.3 Goal and Objectives of the EIA

The goal of this EIA is to provide a comprehensive and factual assessment of the project, its potential impacts and required mitigation measures so as to satisfy the requirements of the Environmental Protection Act as well as the EIA Terms and Scope issued by the EPA. In this context, the objectives of this EIA are to:

- Describe the planned project activities and project components including but not limited the construction and operational phases and outline the main alternatives which were considered;
- Describe the existing conditions at the project locations given that the mine sites are mostly 'brownfields', and taking account of studies conducted previously and baseline data collected specifically for this EIA;
- Assess the potential environmental, biological and socioeconomic impacts that could result from planned project activities during the construction and operational phases, and identify the risks associated with these impacts;
- Identify potential residual impacts and impacts associated with unplanned events;
- Describe measures to be undertaken to mitigate and monitor the risks arising from potential impacts; and
- Present Environmental and Social Management Plans to manage the potential impacts of the project including residual impacts and impacts associated with unplanned events.

1.4 EIA Team

The EIA was prepared by a team of consultants from EMC. EMC is a registered consultancy with the EPA of Guyana and a member of the IAIA. EMC has extensive experience in Guyana's mining sector including in the preparation of EIAs and Environmental Management Plans. The team to conduct the EIA was proposed to the EPA, and approval of the team by the EPA was communicated to GMI in November 2019. The core EIA Team comprised:

- Mr. D. Grant Feasby – EIA Technical Team Leader and Mining & Environment Specialist
- Mr. Khalid Alladin – Environmental Management Specialist and Team Coordinator
- Mr. Omar Persaud – Geologist
- Mr. Bjorn Jeune - Geologist
- Dr. Francis Clarke – Biodiversity Specialist
- Mr. Kemraj Parsram – Environmental and Regulatory Specialist
- Mr. Hance Thompson – Biodiversity Specialist
- Ms. Kandila Ramotar – Environment and Climate Specialist
- Mr. Lakshman Richard Persaud – Community Engagement Specialist
- Ms. Louisa Daggers – Social-Cultural Specialist
- Mr. Enrique Monize – GIS Specialist

Detailed Curricula Vitae for each of the team members are presented in Appendix B. It should be noted that the core EIA Team was supported by several other personnel, including experts in various areas relevant to the conduct of the EIA.

1.5 Components of the EIA

This EIA has been prepared in compliance with the Environmental Protection Act, the Environmental Protection (Authorisation) Regulations (2000) and the EPA's Environmental Impact Assessment Guidelines—Volume 1, Version 5 and Volume 2, Version 4. Importantly, the preparation of the EIA was guided by the Terms and Scope for the EIA provided by the EPA. The EIA is outlined in the following components:

- **Executive Summary** – presents a synopsis of the EIA, including baseline information, potential impacts, and mitigation and monitoring measures.

- **Chapter One** – This Chapter provides an introduction to the EIA, including a background, scope of the EIA, and the team that conducted the EIA.

- **Chapter Two** – This Chapter outlines the methodology employed in the EIA preparation, and includes limitations encountered.

- **Chapter Three** – This Chapter provides a description of the national policies, legislation and international agreements relevant to the project and the regulatory bodies which will have oversight of the project's activities.

- **Chapter Four** – This Chapter provides a description of the project, including its location, components and activities.

- **Chapter Five** – This Chapter discusses the alternatives considered in the project development.

- **Chapter Six** – This Chapter details the engagement with stakeholders as part of the EIA process, including their feedback provided.

- **Chapter Seven** – This Chapter outlines the methodology utilised to identify/predict and assess impacts and mitigation measures.

- **Chapter Eight** – This Chapter addresses Water Resources and describes the baseline information, impacts and mitigation and monitoring measures relating to this environmental component.

- **Chapter Nine** – This Chapter addresses Soils and Geology and describes the baseline information, impacts and mitigation and monitoring measures relating to this environmental component.

- **Chapter Ten** – This Chapter addresses Air Quality and describes the baseline information, impacts and mitigation and monitoring measures relating to this environmental component.

- **Chapter Eleven** – This Chapter addresses Climate and Climate Change and describes the baseline information, impacts and mitigation and monitoring measures relating to this environmental component.

- **Chapter Twelve** – This Chapter addresses Biological and Ecological Resources and describes the baseline information, impacts and mitigation and monitoring measures relating to this environmental component.

- **Chapter Thirteen** – This Chapter addresses Ecosystem Services and describes the baseline information, impacts and mitigation and monitoring measures relating to this environmental component.

- **Chapter Fourteen** – This Chapter addresses Noise and Vibrations and describes the baseline information, impacts and mitigation and monitoring measures relating to this environmental component.

- **Chapter Fifteen** – This Chapter addresses Transportation and describes the baseline information, impacts and mitigation and monitoring measures relating to this environmental component.

- **Chapter Sixteen** – This Chapter addresses Hazardous Materials and Waste, and other waste types and describes the baseline information, impacts and mitigation and monitoring measures relating to this environmental component.

- **Chapter Seventeen** – This Chapter addresses Landscape and Aesthetics and describes the baseline information, impacts and mitigation and monitoring measures relating to this environmental component.

- **Chapter Eighteen** – This Chapter addresses Cultural Heritage and describes the baseline information, impacts and mitigation and monitoring measures relating to this environmental component.

- **Chapter Nineteen** – This Chapter addresses the Socioeconomic Environment and describes the baseline information, impacts and mitigation and monitoring measures relating to this environmental component.

- **Chapter Twenty** – This Chapter addresses Health and describes the baseline information, impacts and mitigation and monitoring measures relating to this environmental component.

- **Chapter Twenty One** – This Chapter addresses Land Acquisition, Resettlement and Livelihoods and describes the baseline information, impacts and mitigation and monitoring measures relating to this environmental component.

- **Chapter Twenty Two** – This Chapter presents the Environmental and Social Management Plan.

- **Appendix** – includes all supporting information to the EIA.

It should be noted that the Terms and Scope for the EIA recommended that separate chapters be prepared for the areas of Resource Efficiency and Risks and Risks Assessment. However, Resource Efficiency was addressed within the relevant chapters such as Water Resources, Soils and Geology, Transportation, Climate and Climate Change, Biological and Ecological Resources, etc. Risks relating to the project was addressed in all of the chapters dealing with the environmental components.

Chapter 2 - Approach and Methodology

2.1 Approach

The EIA was prepared during the period November 2019 to September 2020 following agreement on the Terms and Scope of the EIA between the EPA and GMI. The draft EIA was submitted to the EPA in September 2020. Based on feedback from the review of the draft EIA by the EPA, the Environmental Assessment Board (EAB), and other stakeholders the EIA was revised during March to April 2021. As previously indicated in Chapter 1 the EIA was prepared by EMC who commissioned a multidisciplinary team of consultants with varying expertise. The preparation of the EIA was guided by the Terms and Scope of the EIA, as well as EPA's EIA Guidelines.

Prior to the commencement of the EIA preparation process the EIA Team attempted to gain a good understanding of the project and the project environment so as to determine the best methodology for the conduct of the EIA. Some of the initiatives undertaken are outlined below:

- Multiple visits were made by the EIA Team members to the project sites. The initial visit was conducted in August 2018 and follow up visits in 2019 and 2020 in order to gain a firsthand understanding of the project sites and environment.

- Meetings and discussions were held with key company officials to fully understand the project and project related information were provided by GMI to the team of consultants. These engagements with the company personnel continued throughout the EIA preparation process.

- Information was shared by GMI on the project with the consultant team and these were reviewed, including the project's Feasibility Study Report, the Mine Plan and the Project Summary.

- Initial engagements were carried out with key stakeholders at the project sites which provided an early insight as to the concerns and expectations of the communities and local stakeholders regarding the project within and around the project areas.

During this phase clarifications were also sought with the EPA on some aspects of the Terms and Scope of the EIA to ensure there is common understanding on what is required to be addressed by the EIA. These initiatives contributed greatly to developing the methodology for the conduct of the EIA.

2.2 Methodology

The EIA preparation was done in phases. Early in the process a review of the national policies, plans and legislation, as well as international agreements was done to understand the regulatory and institutional framework within which the project will be required to operate. Thereafter, the EIA preparation was conducted in three main phases. The methodology utilised to prepare the draft EIA is outlined in Figure 2-1 and further described below.

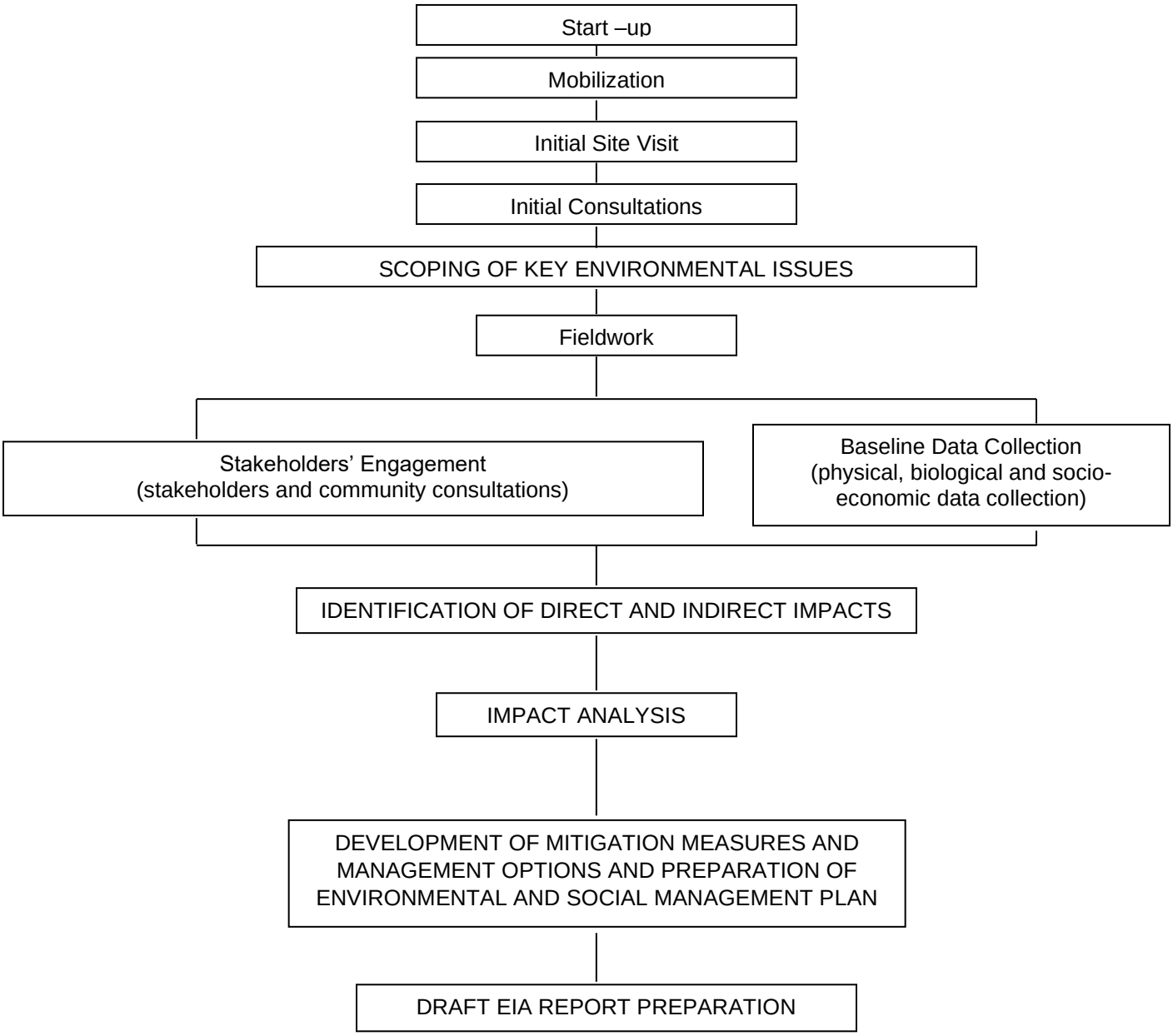


Figure 2-1: Methodology for the EIA

2.2.1 Establishing the Baseline

Collection of primary and secondary data on the physical environment, biological and ecological resources and socio- economic and cultural context of the project areas formed an integral part of the EIA and was done over the period November 2019 to July 2020.

Secondary data for the project environment exists at the level of Government institutions and GMI. Institutions from which secondary data was sourced include the Regional Democratic Council (RDC) Region One, Ministry of Health, Ministry of Amerindian Affairs, Civil Defence Commission, Guyana Forestry Commission (GFC), Maritime Administration Department, the Hydrometeorological

Department, etc. There is a significant amount of data existing for the project environment at Matthew's Ridge which was collected by RMI during the period 2011 to 2012. This data was handed over to GMI when it acquired the project and was provided to the consultant team. The data includes baseline on noise, air quality, water quality, hydrology, meteorology, biodiversity, demography and the socioeconomic environment.

To complement the existing data, to address the gaps, and ensure updated data is available and utilised for the purpose of the EIA, the team conducted baseline surveys to collect data at the main project sites of Matthew's Ridge and Port Kaituma, as well as along the roadway from Port Kaituma to Matthew's Ridge. Surveys were conducted to collect baseline data for the following environmental components:

- Noise
- Air Quality
- Water Quality
- Biological Resources
- Socioeconomic Environment

The methodologies employed for the execution of the baseline survey are presented in the chapters addressing the respective environmental components, and further details are included in the related appendices.

During this phase stakeholders' engagement were also conducted to determine the concerns and recommendations of stakeholders so these can be addressed in the EIA. Engagements were done with stakeholders at the community level, as well as with institutions and agencies. Details on the stakeholders' engagements are presented in Chapter Six and the related appendix, including the methodology employed.

2.2.2 Impact Analysis

After establishing the baseline conditions of the project areas, the potential environmental and social impacts of project activities during the construction, operational and closure phases were then assessed. This was done by establishing the potential interactions between the activities and the characteristics of the existing physical, biological and socio-economic environment and within the effective area of direct and indirect influence. The methodology employed for the impact prediction and assessment is detailed in Chapter Seven.

2.2.3 Mitigation and Management Planning

Mitigation and management planning were done to identify feasible and practical measures to reduce and mitigate the potential negative impacts as well as maximise the positive impacts. Procedures to be undertaken in the event of an emergency situation were examined, and a framework proposed to implement, monitor and assess the effectiveness of the mitigation measures recommended. Mechanisms to engage with project stakeholders and address grievances were also developed. An Environmental and Social Management Plan was prepared and outlines the measures to be implemented to prevent, manage and monitoring possible environmental and social impacts which may be derived from the project.

2.3 Study Areas/ Area of Influence

The general project's AoI was determined to be all areas where project activities and interaction with communities will occur. This includes the project sites at Matthew's Ridge and Port Kaituma, and the

land and river transport routes. However, given that the project activities will occur at different locations and at varying levels of intensity, as well as having different level of interaction with communities, it was decided to have three categories of AoI (primary, secondary, and tertiary). The primary AoI are the communities within which the main project activities are to be conducted, which are at Matthew's Ridge and Port Kaituma. The secondary AoI is the area along the Matthew's Ridge to Port Kaituma road which will be utilised for the hauling of materials from the processing plant to the Kaituma Marine Terminal and which will be upgraded by GMI, including the bridge at Eclipse Falls. This road passes through the Four Miles and Eclipse Falls communities where there may be some interactions with community members by company personnel. Arakaka, which is the closest community to Matthew's Ridge is also included in this group since residents from the community will have interaction with the project. The tertiary AoI is along the shipping route from Port Kaituma to the Waini River mouth. However, given the planned shipping operation, no interaction with the communities along this route is anticipated. Most of the areas along the roadway and river route are uninhabited. However, most of the project activities will occur close to areas which are inhabited hence the focus on these areas in the development of the AoI. The project's AoI is shown in Figure 2-2.

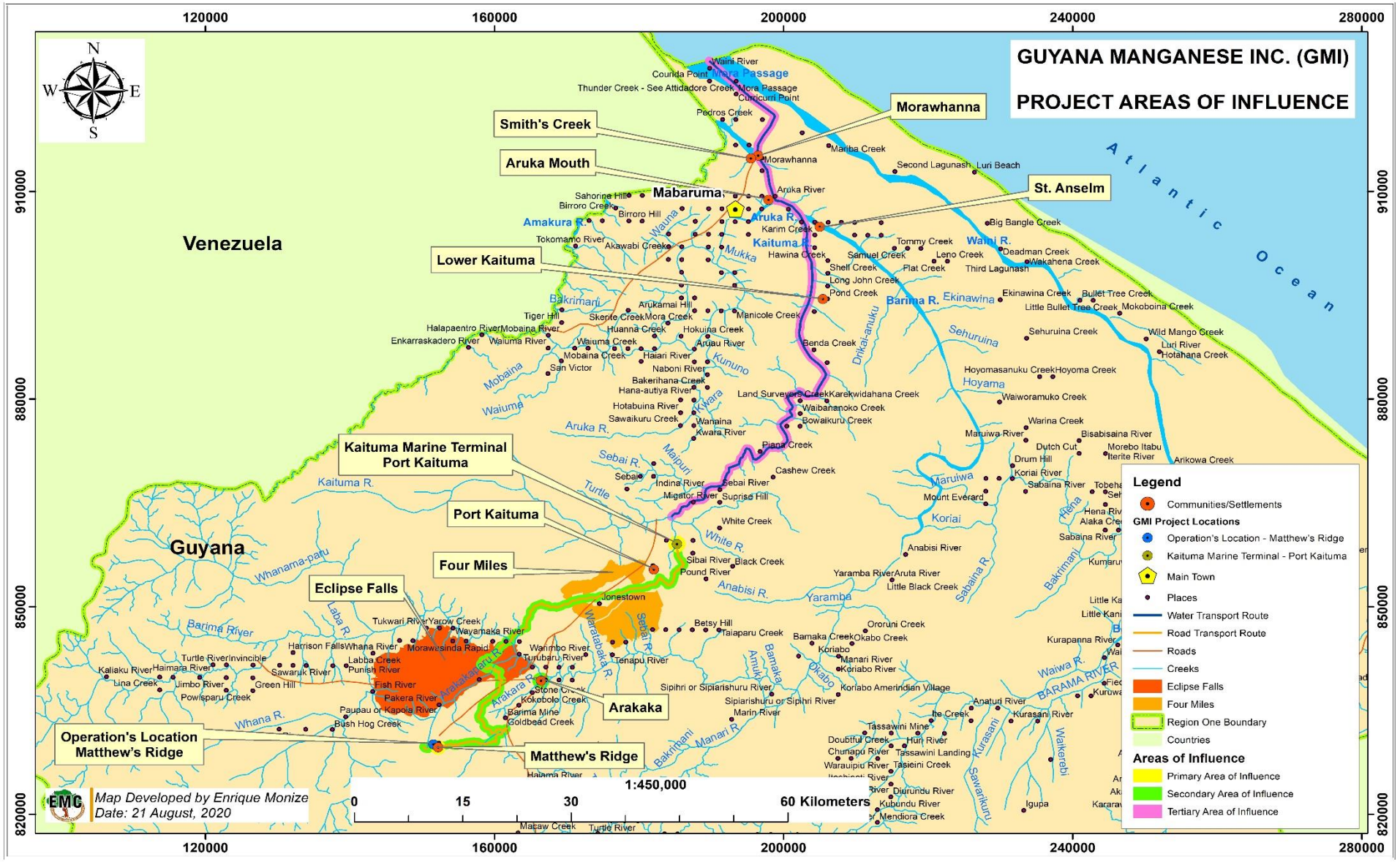


Figure 2-2: Project Areas of Influence

2.4 GIS and Spatial Analyses

There is a growing need for spatial data and spatial analysis across all disciplines that require facts and information related to the position of and the relationship between objects on the earth's surface. Such objects may include the location of natural resources, individual buildings or land parcel boundaries etc. In this regard, Geographical Information Systems, or as it is commonly known GIS, provides such a platform that offers the most modern technologies for developing geospatial data and analyses. Today, GIS plays a major role in all areas of studies worldwide and has been adopted by most institutions in Guyana which are responsible for spatial information and management of resources. As such, the use of GIS was critical in the execution of this EIA.

2.4.1 Data Collection and Storage

The conduct of this EIA was heavily dependent on GIS to provide spatial data and analyses to aid in the conduct of field exercises, analyses of the data, and presenting the information in the EIA report. GIS encompassed two types of data - primary data, which is data collected from field work; and secondary data, which is the data extracted from existing datasets/databases. This allowed a mixed-method approach whereby both primary and secondary spatial data contained qualitative and quantitative components. Digital data was available and stored in both raster and vector models (as raster data and vector data).

Primary data were mainly provided by GMI digitally, in dwg format or AutoCAD files which contained spatial data collected from field activities and remote sensing, via the use of satellite imageries. Other primary data were collected by EMC team members via the use of Global Positioning System (GPS) during field work. Ground truthing exercises were also conducted by the GIS Specialist in order to validate existing primary datasets as well as to fill gaps. Primary spatial data were presented in vector format which enabled all datasets to be populated with useful attribute data and which were both qualitative and quantitative in nature.

Raster model, which uses equally sized square cells called pixels to represent features, comprised scanned topographic map sheets, satellite imageries and a plethora of scanned and digital maps produced by the various agencies. These were properly geo-referenced and digitised by the GIS Specialist in order to produced vector replicas.

All vector data were represented as either a point, line or polygon feature type and were separated according to the feature that was being represented. These datasets were all contained within a geo-database. In some cases, shape files were used for faster outputs and data sharing which was essential during the COVID -19 travel restrictions and the general fact that the project area was not easily accessible.

GIS related work was conducted using several software. However, the main software used was ArcGIS suite in which the six main functions of GIS were well utilised. These functions included the following:

1. Capturing Data – inputting geographical data (coordinate) and tabular data (attribute).
2. Storing Data – using the two basic data models, vector and raster.
3. Querying Data – using specific features based on location or attribute value.
4. Analyzing Data – for answering questions regarding the intersection of spatial relationships between multiple datasets.
5. Displaying Data – for visualizing geographic features using a variety of symbology.
6. Output Data – for displaying results in a variety of formats, such as maps, reports and graphs.

Data were stored using the following Geographic Coordinate Systems:

1. PSAD 1956 UTM Zone 20N and 21N
2. GCS WGS 1984

2.4.2 Spatial Data Analyses

Analyses were executed through two geographic analysis techniques (proximity analysis and overlay analysis) used in GIS and the querying function, as is outlined below:

1. Proximity analysis – this enables buffering to determine the proximity between features.

2. Overlay analysis – this enables the combination of two layers to create new layer that contains the attributes of both. Six different inputs to the analysis were included:

    - Point in Polygon
    - Line in Polygon
    - Polygon on Polygon
    - Line on Line
    - Point on Point
    - Point on Line Overlay

3. Querying - GIS offers the ability to derive queries. This function was utilised to explore several requests for special criteria that were based on attributed information. Two types of queries were used that of Structure Query Language and that which included the use of the identify tool in ArcMap.

Statistical analyses were also conducted to provide the team with certain technical information pertaining to area size, distances etc.

2.4.3 Presentation of Data and Information

All data were presented and outputted through graphic displays including mostly maps, but also charts and tabulated reports representing derived information products.

2.5 Challenges and Limitations

The following were the key challenges which were experienced in the completion of this EIA:

- **COVID 19 Pandemic** – The COVID 19 pandemic stepped in during the scheduled baseline data collection and stakeholders' engagement period. Prior to the pandemic most of the engagements with agencies and institutions were completed, as well as the biological data collection. However, the implementation of national restrictions, affected other activities. The implementation of the national restrictions including the curfew, requirements of practicing social distancing, limited or no travel options, as well as the need to ensure the safety of the EIA Team members, impacted the socio-economic field work aspect of the process. Face to face and community meetings could not be held and travel to the project sites were restricted. As such, additional meetings which were planned with the communities could not be held. Likewise, follow up face to face engagements with relevant institutions such as the NDC and the RDC could not be done. However, this did not affect the process since the EIA Team utilised other approaches to engage these stakeholders, such as telephone and email contacts with representatives of these institutions and communities. In addition, the physical baseline surveys were delayed and eventually had to be conducted with an adjustment to the planned methodology. Data collection during the curfew hours was affected and the duration of surveys

had to be reduced to minimise the risk of possible exposure to team members. Nevertheless, all baseline surveys were conducted. Overall, while the COVID 19 pandemic significantly delayed the fieldwork, which in turn delayed the preparation of the draft EIA, the stakeholders' engagements and baseline data collection were eventually completed with minor adjustments to the methodology without compromising the quality and thoroughness of these activities.

- **Commencement of Construction** – GMI commenced rehabilitation and construction at Port Kaituma and Matthew's Ridge prior to the commencement of the EIA process. The EPA had issued two separate Construction Permits to the company to conduct these works. This affected the baseline data collection to some extent since the main project sites were already disturbed and there was the presence of various construction related activities ongoing. However, this did not impact on the understanding of the pre-project baseline conditions since existing baseline data collected by RMI during 2011-2012 were utilised. Also, the EIA Team collected baseline data in representative areas similar to and in close proximity to the project sites which were not disturbed by current works. Another challenge encountered relating to the commencement of construction is that the EIA is supposed to addressed both construction and operational impacts. However, construction is well advanced. Nevertheless, the EIA addresses all construction related impacts, including those which may have already occurred and potential impacts from works still to be done.

Chapter 3 - Policy, Legislative and Regulatory Framework

3.1 Overview

The GoG has established policies, strategies and plans, enacted legislation and set up institutions to support and regulate the mining sector, including addressing environmental management. This chapter describes those policies, legislation, strategies, plans, international agreements and the regulatory institutions relevant to the GMI project. The environmental related permits and licenses which GMI is required to obtain are also described. A summary is presented in Table 3-1.

Table 3-1: Policies, Legislation, Regional and International Agreements, Institutional Framework and Permitting relevant to GMI's Project

Policies, Strategies and Plans	
	Guyana Green State Development Strategy: Vision 2040 (2019)
	Low Carbon Development Strategy 2013
	National Development Strategy 2001 – 2010
	National Environmental Action Plan 2001 – 2005
	National Land Use Plan 2013
	National Biodiversity Strategy and Action Plan 2012 -2020
	National Action Plan to Combat Land Degradation 2015 - 2025
Legislation	
	Constitution of Guyana 1980
	Environmental Protection Act 1996
	Environment Protection Regulations 2000
	Mining Act 1989
	Mining Regulation 1989
	Mining (Amendment) Regulations 2005
	Explosives Act, 1973 and Regulations
	Blasting Operations Act, 1998 and Regulations
	Occupational Safety and Health Act, 1997
	River Navigation Act, 1891
	Sea Defence Act, 1883
	Protected Areas Act, 2011
	Amerindian Act 2006
	National Trust Act 1972
	Natural Resources Fund Act 2019
	Forest Act 2009
International Agreements	
	Extractive Industries Transparency Initiative
	United Nations Convention to Combat Desertification
	United Nations Convention on Biological Diversity
	United Nations Framework Convention on Climate Change
	Convention on International Trade in Endangered Species of Wild Fauna and Flora
Institutional Framework	
	Ministry of Natural Resources
	Environmental Protection Agency
	Guyana Geology and Mines Commission
	Regional Democratic Council Region #1
	Guyana Forestry Commission
Environmental and Mining Permitting	

	Environmental Permitting
	Mining Permitting
	Other Permitting

3.2 Policies, Strategies and Plans

Several key policies, strategies and plans have been established to guide development activities to ensure natural resources are sustainably utilised, while preventing, reducing and or minimising environmental risks and impacts. These policies enunciate the GoG's goals in the management of the mining sector and various environmental issues.

3.2.1 Green State Development Strategy: Vision 2040[3]

The Green State Development Strategy: Vision 2040 (GSDS) was launched by the GoG in 2019. It outlines the Government's twenty-year plan for development that follows a green agenda. The vision of the green agenda is defined by sustainable, low-carbon and resilient development that uses its resources efficiently, and sustained over generations. The main objective of the GSDS is development that provides an improved quality of life for all Guyanese derived from the country's natural wealth in particular its abundant natural resources of land, water, forests, minerals and aggregates, and biodiversity. The GSDS builds on existing development strategies such as the National Development Strategy, the Poverty Reduction Strategy and the Low Carbon Development Strategy. The GSDS is also aligned with Guyana's commitment to achieve the 2030 Sustainable Development Goals (SDGs) outlined by the United Nations.

According to Annex A (3) of the GSDS[4], the Guyana Geology and Mines Commission (GGMC) has divided Guyana into six (6) mining districts based primarily on the location and availability of minerals. Three types of mining leases are issued in these districts based on the scale of the operations namely: small-scale claims (457.5 x 244m or 11.16 hectares or 1.6km of river); medium-scale prospecting permits (up to 486 hectares); and large-scale prospecting licenses (up to 5,180 hectares). Medium- and large-scale prospecting permits can also be renewed annually or converted to a Mining Permit. As of 2011, a total of 22,566 permits were issued for a total area of 9,400,859 ha (approximately 44 percent of the national land area). However, many of these claims were not actually utilised, and in many instances, the allocated mining permits overlap with logging leases.

Based on these circumstances, the GSDS outlines *Development Objective B: Sustainable Management of Natural Resources*[5] as one of the key objectives to manage Guyana's natural resources wealth. An expected outcome of this Development Objective is that by 2040, Guyana preserves its natural capital through institutionalised and prudent management of natural resources (land, forests, minerals and water). Further, the GSDS outlines the following three (3) policy recommendations for the management of precious metals, minerals and aggregate resources:

- Improve geospatial mineral resource mapping, estimation and quantification so as to improve the capacity for evidence-based mineral resource and aggregate exploitation.

- Research and study options for using financial securities to rehabilitate mined-out sites with the objective of rehabilitating these sites in a timely manner and to an appropriate standard to

[3] Ministry of the Presidency, 2019. Green State Development Strategy, Vision 2040 Volume 1 – Policy Recommendations, Financial Mechanism & Implementation. Pg 6, 93 – 97.
[4] Annex A (3) Analytical Evidence to Support Guyana's Green State Development Strategy: Vision 2040 on the Sustainable Management of Natural Resources. Pg. 14
[5] Ministry of the Presidency, 2019. Green State Development Strategy, Vision 2040 Volume 1 – Policy Recommendations, Financial Mechanism & Implementation. Pg 35 – 54.

safeguard public safety, and to return the site to more productive uses as future green economy investments. This research would also include consideration of increasing the value of bond from GYD $200,000.

- Review and update mining laws and improve capacity for enforcement and monitoring. In addition, fines against illegal activities should be increased and law-breakers should be prosecuted to the full extent of the law.

Additional policy recommendations for sustainable management of other natural resources which are relevant to the mining sector include: establishment of a National Physical Development Plan to guide land use and land allocations; prioritising the allocation and establishment of a total of two (2) million hectares of land for legal protection; and strengthening sustainable forest management for low-emissions development.

The GSDS provided the guiding framework for the preparation of a National Mineral Sector Policy Framework and Plan 2019-2029 which was initiated by the Ministry of Natural Resources (MNR). [6] A draft of this policy has been prepared and is currently being reviewed. The policy has been designed "*to manage the development of Guyana's mineral sector in a holistic, integrated, responsive, and responsible manner*". The draft policy recommends that, in order to organize the policy ideas to transform the mineral sector, the following three themes should be adopted:

(i) optimizing governance (as measured by the actual and perceived improvements in how the MNR, GGMC and other agencies manage the industry in terms of fairness, transparency, efficiency, and stakeholder participation;
(ii) optimizing compliance (as measured by the extent to which miners respect and comply with laws, regulations, standards and responsible practices; and
(iii) optimizing performance (as measured by the contribution of the industry to the achievement of economic goals)[7].

It should be noted that the draft National Mineral Sector Policy Framework and Plan recognizes the planned commencement of the GMI manganese project and its potential to significantly contribute to the mining sector.

3.2.2 Low Carbon Development Strategy

Guyana's Low Carbon Development Strategy (LCDS) is a long-term development strategy which was prepared in 2009 and updated in 2013. The LCDS presents the country's vision and plan for the forest to be protected and maintained in an effort to reduce global carbon emissions while at the same time attracting resources for development through avoided deforestation (REDD+) that would put Guyana onto a low carbon growth path. The LCDS recognizes the mining sector's high economic value and contribution to employment and socio-economic development and advocates a balanced approach to land use to optimize socio-economic benefits while minimising deforestation and forest degradation impacts. Under the framework of the LCDS there has been a push for mining to adhere to the laws and regulations governing the sector and to operate in accordance with international standards.

3.2.3 National Development Strategy

The National Development Strategy (NDS) 2001-2010[8] prepared by the GoG sets out the primary development policy framework for Guyana. It provides a framework for national planning and captures a number of cross-sectoral issues such as the environment, forestry, agriculture, mining, tourism and

[6] https://dpi.gov.gy/draft-national-mineral-sector-policy-framework-and-plan-2019-2029-available-for-public-review-and-comment/
[7] Source: Draft National Mineral Sector Policy Framework and Plan 2019-2029
[8] While the duration is from 2001 – 2010 currently it is still considered to be relevant.

fisheries, among others. The strategy proposes a programme of diversification focusing on the production of non-traditional commodities, for both the domestic and exports markets, with a view to broaden the base of Guyana's economy while at the same time consolidating and expanding the performance of traditional sectors such as mining.
Chapter 16 of the NDS focuses on mining and places emphasis on actions to mitigate the harmful consequences to the environment of certain types of mining through increased monitoring and enforcement and utilising the most appropriate and up-to-date environmentally friendly methods.

3.2.4 National Environmental Action Plan

In the National Environmental Action Plan (NEAP), 1994, the GoG outlined its environmental policy objectives for the sound management of the environment and natural resources. The NEAP outlined several policy objectives, one of which calls for the GoG to ensure that environmental assessments of proposed development activities which may significantly affect the environment are undertaken.

In keeping with this environmental policy objective, the Environmental Protection Act was introduced in June 1996 and the legal framework for authorizing development activities was established. Further, the Act established the EPA and outlines the legal process for undertaking sustainable and effective management of the environment and its natural resources.

Specifically, for the mining sector the NEAP recommended the following:

- *Enforce conditions of mining licence approved for large and medium scale miners especially in the areas of ecological, environmental and health management.*
- *Develop and promote national operating guidelines and procedures at the management unit level.*
- *Develop and promote criteria and indicators as performance standards for evaluating and assessing mining operations.*
- *Promote the participation of miners and other stakeholders in the development of management and performance standards.*
- *Collaborate with specialised agencies to promote environmental and public awareness programmes among miners and other stakeholders.*
- *Promote in-house training and education programmes to equip mining officers to conduct environmental and water quality tests and the enforcement of mining and environmental laws.*

3.2.5 National Land Use Plan

The National Land Use Plan (NLUP), which was prepared in 2013 provides a strategic framework to guide land development in Guyana and is guided by a number of national policies and strategies that have a direct relevance for land use and land management. The NLUP recognized the importance of the mining sector to Guyana while at the same time gives prominence to the challenges of multiple land uses, in particular between forestry and mining.

The GoG, in 2019, initiated the commencement of the preparation of a National Land Policy over an 18 month period with support from the Food and Agriculture Organisation (FAO). [9]

[9] https://dpi.gov.gy/consultations-to-begin-soon-on-guyanas-national-land-policy/

3.2.6 National Biodiversity Strategy and Action Plan (NBSAP)

Guyana's first NBAP (1999-2004) was prepared with the overall goal "*to promote and achieve the conservation of Guyana's biodiversity, to use its components in a sustainable way, and to encourage the fair and equitable sharing of benefits arising out of the use of Guyana's biodiversity*". The second NBAP (NBAP II) covered the period 2007-2011 and followed a thematic approach rather than a programmatic approach. The four thematic areas addressed were forests, agriculture, coastal resources, and marine and freshwater resources. Cross-cutting issues were also identified. During 2014 the NBAPII was revised and updated to the National Biodiversity Strategy and Action Plan (NBSAP) 2012 to 2020. This Plan sets out the vision, the roles, duties and obligations of the state and its citizens and the actions to protect, conserve, use sustainably and share equitably the benefits arising from biodiversity. It provides the guidance and support actions for biodiversity and sets out the national priorities and the strategic objectives to be achieved. It allows as well, partners at all levels to better identify how they can contribute and support Guyana in meeting its national biodiversity vision while meeting at the same time, its obligations to the UNCBD. To this end the Plan incorporates the goals of the UNCBD Strategic Plan for Biodiversity 2011-2020 and selected Aichi 2011- 2020 Targets.

The NBSAP has nine strategic objectives. One of these objectives is to '*Improve the status of biodiversity by conserving ecosystems, species and genetic diversity and by restoring biodiversity and ecosystem services in degraded areas'*. One of the priority actions outlined in the plan to achieve this objective is to rehabilitate and restore degraded areas with particular focus on mined out areas.

3.2.7 National Action Plan to Combat Land Degradation

Guyana prepared a National Action Programme (NAP) in 2006 to serve as the guiding framework for implementing actions to combat desertification and promote sustainable land management. At the time of preparing the NAP, Guyana's natural resources were not viewed as under immediate threat that warranted quick reaction and land degradation had not reached a critical proportion as is evident in many parts of the world. As such, Guyana's approach to the preparation of the NAP was one of prevention rather than response and adopting an approach that was proactive rather than reactive.

In 2015 Guyana prepared an Aligned NAP. This Aligned National Action Plan 2015-2025 builds on the previous NAP from 2006, and is aligned with the United Nations Convention to Combat Desertification (UNCCD) Strategic Plan 2008-2018. The Aligned NAP aims to ensure that agricultural, pasture, mining, forest, coastal and other land uses and resources are managed as sustainable, productive systems that maintain ecosystem productivity and ecological functions while contributing directly to the environmental protection, economic growth and social livelihood of the people of the country. The Aligned NAP provides consideration for the need for urgent efforts to integrate and strengthen existing National Policies, Strategies, Action Plans and the planning framework for conservation, promotion of sustainable land management and combating the exacerbated effects of degradation[10].

The Aligned NAP outlines the approach and roadmap towards continuing to enhance the way of managing land and resources in Guyana, and consists of and is governed by a set of overarching principles: Achievement of Sustainable Development; Land management governance and policy; Education, training and awareness; Knowledge information and research; Evaluation and monitoring and; Partnership and financing. The Aligned NAP focuses on the primary sectors on which Guyana has depended and will depend upon in the future. In the mining areas, the focus is on reclamation of previously mined out areas while ensuring current mining practices include mine rehabilitations.

[10] GLSC, 2015. National Action Plan to Combat Desertification

3.3 Legislation

Several pieces of legislation, directly or indirectly relevant to GMI's project, are discussed in this section, including those focusing on environmental issues and mining. Resource specific legislation are further discussed in the specific chapters covering physical, ecological and socio-economic resources.

3.3.1 Constitution of Guyana

The 1980 Constitution of Guyana, Chapter II outlines the principles for the political, economic and social system. Specifically, Articles 2:25 and 2:36 of the Constitution provides the base for a national environmental policy and emphasizes these as key principles for the functioning of Guyana's social and economic systems. The roles of both the State and citizens are outlined in the Constitution.

Article 2:25 of the Constitution states that *"every citizen has a duty to participate in activities to improve the environment and protect the health of the nation".* And Article 2:36 states that *"The well-being for the nation depends upon preserving clean air, fertile soils, pure water and the rich diversity of plants, animals and eco-systems".* Further Article 149J states that *"(1) Everyone has the right to an environment that is not harmful to his or her health or well-being (2) The State shall protect the environment for the benefit of present and future generations, through reasonable legislative measures designed to (a) prevent pollution and ecological degradation; (b) promote conservation; and secure sustainable development and use of natural resources while promoting economic and social development."*

3.3.2 Environmental Protection Act, 1996

Environmental protection and management are governed by the Environmental Protection Act (EP Act) 1996. The Act is the first comprehensive environmental legislation in Guyana. It established the EPA as the responsibility agency for environmental management and detailed the functions of the organisation. The Act provides for *"the management, conservation, protection and improvement of the environment, the prevention and/or control of pollution, the assessment of the impact of economic development on the environment, the sustainable use of natural resources and for matters incidental thereto connected therewith".* Under the Act the EPA is mandated to coordinate environmental management and outlines the legal process for undertaking sustainable and effective management of the natural environment. It is through this process that GMI is required to conduct this EIA in order to obtain an environmental authorisation from the EPA for its project. The process to obtain this authorisation is further described in Section 3.6.1.

3.3.2.1 Environmental Protection Regulations

Regulations on Environmental Authorisation, Hazardous Waste Management, Water Quality, Air Quality and Noise Management were established under the Environmental Protection Act in 2000. These regulations, referred to as the Environmental Protection Regulations, are described below.

<u>Environmental Protection (Authorisation) Regulations 2000</u>
These regulations outline the requirements for an environmental authorisation and the rules governing the issuance of such authorisation. The regulations also stipulate the responsibilities of the permit holders once an authorisation has been issued.

<u>Environmental Protection (Water Quality) Regulations 2000</u>
These regulations require registration and environmental authorization by any person whose construction, installation, operation, modification or extension of any facility cause the discharge of effluent. They 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. GMI will be required to ensure its operation does not negatively affect the quality of water in the streams within the project site govern by its Mining Permit.

Environmental Protection (Air Quality) Regulations 2000
These regulations require the registration and environmental authorization by persons with facilities that emit contaminants into the atmosphere to pollute the air from any of its processes. Elements related to parameter limits on air contaminants and emission samplings are also stated in the regulations. The list of air contaminants for which parameter limits are to be set by the Agency are also detailed in the regulations. No air quality standards have been developed to date but compliance with international guidelines such as those by WHO is recommended. GMI will be required to implement measures to prevent or reduce air emissions as well as to monitor air quality within the project site.

Environmental Protection (Noise Management) Regulations 2000
Operators executing various activities that cause or emit noise above a required threshold are required to apply to the Agency for an environmental authorization. The EPA is responsible for establishing standards for permissible noise levels in industry, construction and other areas. GMI is required to ensure noise emanating from its operations is within the established limits.

Environmental Protection (Hazardous Waste Management) Regulations 2000
The Environmental Protection (Hazardous Waste Management) Regulations require that any person operating a facility that generates, treats, stores, disposes or transport hazardous waste must notify the EPA and apply for an authorisation. The Regulation also outlines the provision for reporting, emergency preparedness plan, list of hazardous characteristics and hazardous waste to be controlled. Some amount of hazardous waste is generated by mining operations including waste oil, oil filters and used batteries. GMI will be required to implement the most appropriate methods for the handling, storage and disposal of hazardous waste generated by the operation.

3.3.2.2 Environmental Protection (Litter Enforcement) Regulations

These Regulations which were passed in 2013 provide for the enforcement against litter offences. It is an offence under these regulations to (a) place litter in a public place; (b) permit or cause another person to litter a public place or; (c) have litter on private premises that pose a health risk. Under the Litter Prevention Regulations, companies such as GMI are required to ensure that solid waste generated by their operations are managed and disposed of in an acceptable manner.

3.3.2.3 National Environmental Standards

The Environmental Protection Regulations require the EPA to develop limits for various parameters. The EPA has so far, in collaboration with the Guyana National Bureau of Standards (GNBS), developed the following standards and which are applicable to this project and should be complied with:

- Interim Guidelines for Industrial Effluent Discharge into the Environment. (Water Quality Standard); and
- Guidelines for Noise Emission into the Environment. (Noise Standard).

Draft Standard for Industrial Effluent Discharge into the Environment were also prepared in 2015 and prescribes limits for discharges from various operations. However, this standard is still a work in progress.

The Interim Guidelines for Industrial Effluent Discharge into the Environment specifies the discharge limits for various parameters and different types of operations other than mining, forestry and agriculture. There are also general environmental guidelines which identified discharge limits per parameter.

The EPA, as part of its permitting process, has utilised the GNBS Interim Guidelines, guidance from Regulations being developed such as Mining Regulations, and for some projects, included International Finance Corporation (IFC) and World Bank Performance Standards.

The discharge limits which could be applicable to the GMI project are outlined below:

Table 3-2: Industrial Effluent Discharge Limits

Parameter	Acceptable Standard
pH	5.0 – 9.0
Total Suspended Solids	100 mg/l
Dissolved Oxygen	>4 mg/l
Temperature	<40
Oil and Grease	10 mg/l
Turbidity	50 NTU

Noise limits are prescribed for various areas/activities in the noise emission standards. Based on the various categories included in the standard the project falls under the industrial category. The industrial limits are 100 dB during the day and 80 dB during the night. For the construction phase of the project GMI is allowed 90 dB during the day and 75 dB during the night. These are referenced in the Construction Permits issued by the EPA to GMI.

In the absence of national standards for certain parameters, the EPA usually requests compliance with international guidance as is the case for air quality where WHO Air Quality Guidelines is adopted. In the Construction Permits issued by the EPA to GMI, the following limits for air quality have been applied:

$PM_{2.5}$: 10µg/m^3 annual mean
25µg/m^3 24-hour annual mean

PM_{10}: 20µg/m^3 annual mean
50µg/m^3 24-hour annual mean

It is expected that these limits may also be utilised for the operational phase of the project.

3.3.3 Mining Act, 1989

The Guyana Geology and Mines Commission (GGMC) is responsible for the implementation of the Mining Act 1989, which establishes the legal framework for the utilisation of mineral resources in Guyana. The Act makes provision for a system of mineral agreements and licences for regulating prospecting. It gives the Commission the responsibility for establishing regulations for mining and quarrying operations. A mining licence is required in order to mine any mineral and is issued at the discretion of the Minister responsible for mining. The rights of persons in possession of lands grants as well as the privileges of Amerindians in relation to prospecting, mining, quarrying are preserved under this Act. Further regulatory framework under the Act makes provisions for the disposal of sanitary waste and the storage of poisonous substances in mining areas.

The Act also provides for the granting of prospecting and mining licences and quarrying permits by GGMC and for the conduct of geological and geophysical surveys in any part of Guyana. However, there is no significant emphasis on environmental protection enshrined in the Act. Nevertheless, the legal framework under the Act makes provisions for the disposal of sanitary waste and the storage of poisonous substances in mining areas. In addition, Section 85(1) requires compensation to land owners of land damaged by mining activities.

It should be noted that currently efforts are being made to amend the Mining Act.

3.3.3.1 Mining Regulations, 1989

The Mining Regulations were first enacted in 1973 but were subsequently revised in accordance with Section 136 of the Mining Act 1989. These regulations provide a comprehensive framework on the requirements for the mining sector. Environmental considerations were introduced as part of these regulations. For medium and large-scale mining operations the regulations address issues such as permitting the use of cyanide, training in use and handling of poisonous substances and establishing Codes of Practice regarding mercury use, cyanide use and disposal of effluent. These regulations also make reference to an environmental bond to be used by the GGMC to restore the environment where restoration of the said area was not completed. The regulations also stipulate that within one year after the commencement of the regulations every operator of a mine including a new operator, shall submit to the Commission an Environmental Management Plan (EMP) for a period of three to five years and elaborates the requirements for Reclamation and Closure Plans, and Contingency and Emergency Response Plans. These regulations also address discharges into the rivers or creeks and sets Nephelometric Turbidity Units (NTU) limits and penalties for exceeding these; guidance on settling ponds; disposal of hazardous waste; inspection and responsibility of environmentally damaged areas; disposal of effluent and tailings dams; and requirements of the Code of Practice for Environmental Mining.

3.3.3.2 Mining (Amendment) Regulations, 2005

Environmental regulations have been established under the Mining (Amendment) Regulation 2005 of the Mining Act to promote the enforcement of environmental standards in the sector. In general, the regulations establish regulatory control in areas of key environmental concerns and include:

- Management of mining waste.
- Water quality.
- Closure and reclamation.
- Management of the natural environment for exploration and mining.
- Submission of environmental management plans in accordance with an environmental code of practice established by GGMC.
- Contingency and Response Plans.

These regulations are being applied by the GGMC in its efforts to improve performance and compliance in the mining industry. Under these regulations discharge into the environment should not exceed 100 mg/l total suspended solids (TSS) or 50 NTU for turbidity. These regulations also require large and medium scale mining operations to obtain permits for use of poisonous substances such as cyanide, to prepare EMPs, and to conduct environmental effects monitoring.

3.3.3.3 Codes of Practice under the Mining Regulations

Under the Mining (Amendment) Regulation 2005 Codes of Practices have been prepared to provide critical environmental management guidance to the industry. However, these Codes are still in draft

and not yet finalized. The following ten Codes of Practice for Environmental Management have been prepared:

- Use of Mercury
- Tailings Management
- Contingency and Emergency Response Plans
- Mine Effluents
- Mine Reclamation and Closure Plans
- Mine Waste Management and Disposal
- Environmental Effects Monitoring Program
- Quarrying
- Sand and Loam mining
- Use of Small Dams for Tailing and Water Management

The Codes are produced as part of fulfilling the requirement of the Mining (Amendment) Regulations 2005 for environmental management. These Codes point the way, stepwise, to a higher level of understanding and performance in the mining sector. However, the Codes target primarily small and medium scale mining operations.

3.3.4 Explosives Act, 1973 and Regulations

The Explosives Act of 1973 and Regulations regulates the importation, storage, carriage and sale of gunpowder and other explosive substances. The enforcing authorities are the Guyana Police Force (GPF), the Harbour Master and the Customs and Trade Administration Department of the Guyana Revenue Authority (GRA).

Safety and protection of person, public and property is a primary tenet on which this legislation is based. Explosives are to be utilised by GMI in its mining operation and is expected to be imported and managed in accordance with these requirements.

3.3.5 Blasting Operations Act, 1998 and Regulations

This Act regulates persons engaged in blasting activities. Under this Act a Blaster must have a Certificate of Competency before carrying out any blasting activity. The procedure to obtain this certificate is set out in this Act. GMI will be required to engage a certified blaster to conduct its blasting activities in accordance with the Act.

3.3.6 Occupational Safety and Health Act, 1997

The Occupational Safety and Health Act 1997 outlines the procedures for establishing the project and mandates that health and safety facilities are provided, maintained and that the project activities comply with the regulations under the Act. In keeping with the Act and regulations, GMI is expected to put in place a health and safety system which includes facilities, personnel, and management procedures to monitor and manage occupational health and safety hazards.

3.3.7 River Navigation Act, 1891

This Act provides for the safe and convenient navigation in the rivers of Guyana. The legislation outlines the process for certification of persons in-charge of vessels and boats, registration of boats and their masters, control of the size, structure, navigation and mooring of rafts and the general prevention of any accidents in the navigation channel.

In this regard, the transport of materials and equipment as part of the GMI project, including the shipping of ore through the river system of Region 1 would need to conform to this Act and Regulations. Any dredging of the waterways will also need the approval of the Maritime Administration Department (MARAD).

3.3.8 Sea Defence Act, 1883

This Act authorises the Sea Defence Board to take any and such actions as to secure the maintenance of sea, rivers, and outer dams of properties that abut on or are near the river or sea shore.
As it regards the GMI project, the reserve area will need to be maintained to ensure access is available to the Sea Defence Board for inspections, maintenance and repairs of the river defence. The construction of the wharf facility at Port Kaituma will also require the approval of the Board.

3.3.9 Protected Areas Act 2011

The Protected Areas Act provides the framework for the establishment and management of a national system of protected areas, including a mechanism for sustainable long-term financing (the National Protected Areas Trust Fund) and establishment of a Protected Areas Commission. Under the Protected Areas Act, existing and new state-owned protected areas, Amerindian protected areas, privately managed protected areas, and Urban Parks such as the Botanical Gardens and the Zoological Park will comprise the national protected areas system.

Mining is prohibited within protected areas under Section 122 of the Protected Areas Act, except for persons allowed under the Amerindian Act. This includes areas that have been designated and recognised by the Government and areas of titled Amerindian land designated and recognised by an Amerindian Village council as protected areas. Where pre-existing mining operation exists, these must be described when an application for protected area status is being considered.

Under the Protected Areas Act, the Shell Beach Protected Area (SBPA) has been established. The SBPA straddles Administrative Regions 1 and 2, from the mouth of the Pomeroon to the mouth of the Waini rivers. The SBPA is not within proximity to the GMI project or its activities.

3.3.10 Amerindian Act 2006

The Amerindian Act provides for the recognition and protection of the collective rights of Amerindian villages and communities and the promotion of good governance. Under the Amerindian Act, Amerindians have a legal right to traditional mining with the consent of the Village Council and they must comply with the relevant legislation. In addition, a miner who wishes to carry out mining on Amerindian lands must obtain permission from the council of that particular village.

Generally, the Act recognizes the rights of indigenous peoples and communities and provides for participatory governance. The Act supports and encourages their right to preserve traditional culture, cultural landscapes and traditional knowledge and languages as a minority group. Community land shall not be disposed of or otherwise used except in terms of legislation specifying the nature and rights of the members of each community individually and collectively. The Act supports the enforcement of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) and entrusts the management, conservation and protection of cultural lands, artefacts and natural resources within in the scope of the village council and provides for collective decision making with regard to research and development.

While there are no indigenous communities within or adjacent to the project areas. However, there are two indigenous communities along the Matthew's Ridge to Port Kaituma roadway, namely Four Miles and Eclipse Falls. While no operational aspect of the project is expected to impact these communities

GMI will utilise this roadway to transport its ore to the wharf facility at Port Kaituma, which can present safety risks and other concerns to the communities. GMI is also expected to interact with these communities through the provision of training/employment for members of the communities and provision of services through its corporate social responsibility programme, etc.

3.3.11 National Trust Act 1972

The National Trust Act of 1972 provides for the preservation of monuments, sites, places, and objects of historic interest or national importance. The National Trust is the body established under the Act and functions to promote the permanent preservation of buildings of national interest or architecture, archaeological and historic or artistic interest and places of national interest or national importance or beauty for the benefit of the nation. The Act mandates that should there be any cultural or archaeological finds during the implementation of the project, such finds are to be reported to the National Trust. If the National Trust have reason to believe that a site/ area contains a monument, it is in the power of the National Trust to enter the land for the purpose of excavation and assessment of the site (National Trust Act amendment 1997). The National Trust further reserves the right to prohibit or restrict any construction, erection or excavation. GMI has developed and will implement a Chance Find Procedure consistent with Part 6 of the National Trust's Guidelines for the Protection of Monuments and Sites in the event of any artifact being encountered during its operations.

3.3.12 Natural Resources Fund Act 2019

The Natural Resource Fund Act provides the legal framework for the establishment of the Natural Resource Fund that will manage the natural resource wealth of Guyana for the present and future benefit of the people and for the sustainable development of the country. The Act is geared towards ensuring accountability and proper management of income earned by Guyana from the utilisation of its natural resources. The objectives of the Natural Resources Fund are to:

- ensure that volatility in natural resource revenues do not lead to volatile public spending;
- ensure that natural resource revenues do not lead to a loss of economic competitiveness;
- fairly transfer natural resource wealth across generations to ensure that future generations benefit from natural resource wealth; and
- use natural resource wealth to finance national development priorities, including any initiative aimed at realizing an inclusive green economy.

It is envisaged that the Fund, once operationalized, will primarily receive revenue from the oil and gas sector and subsequently from other natural resource sector, including mining.

3.3.13 Forests Act 2009

The Forests Act provides for the sustainable management and conservation of Guyana's state forests resources. The sustainable management of forests ensures that forest produce and amenities derived from that land meets present-day needs and at the same time secures the continued availability and contributions of forest produce and amenities for future generations. The Act also makes provisions for forests operations by giving statutory authority to the Code of Practice for Forest Operations and outlines the requirements to harvest and remove forest produce. Under the Act, the removal of harvested timber from and State Forests Lands can only be done if a removal permit has been issued by GFC. Under the Act, timber is considered as a tree or any ligneous part of a tree that is standing, fallen or felled and any wood that is sawn or not.

3.4 International Agreements

Guyana is a signatory to a number of regional and international agreements and conventions relating to the protection of the environmental and management of its natural resources. Those which are relevant to the project are described below.

3.4.1 The Extractive Industries Transparency Initiative (EITI)[11]

The Extractive Industries Transparency Initiative (EITI) is the global standard to promote the open and accountable management of oil, gas and mineral resources. The EITI Standard requires the disclosure of information along the extractive industry value chain from the point of extraction, to how revenues make their way through the government, and how they benefit the public.

In 2010, the GoG announced its commitment to implement EITI and in 2012 the Government and the EITI Secretariat signed a MoU. As part of efforts to become an EITI candidate country a Multi-Stakeholder Group (MSG) comprising representatives of Government, the Private Sector and Civil Society was formed. In 2017, Guyana submitted its candidature application to the EITI and by October 2017, Guyana became the 53rd EITI candidate country. As a candidate country, Guyana has developed a consensus reporting system that applies to all companies who work in extractive industries considered in the EITI. In Guyana, reporting on the mining sector is one of the key elements of its EITI report.

Guyana's first report under EITI was completed for the fiscal year of 2017 and was publicly released in April 2019 for review. The validation of this report is expected to commence in 2020. Guyana's second EITI report is currently being prepared and is expected to be completed by December 2020.

3.4.2 United Nations Convention to Combat Desertification

The United Nations Convention to Combat Desertification (UNCCD) was adopted 1994 and entered into force in 1996. The UNCCD is the sole legally binding international agreement linking environment and development to sustainable land management. The vision of the Convention's Strategic Plan 2008-2018 is *"to forge a global partnership to reverse and prevent desertification/land degradation and to mitigate the effects of drought in affected areas in order to support poverty reduction and environmental sustainability."* The UNCCD is the only internationally recognized legally binding instrument that addresses the problem of land degradation in dry land rural areas. The UNCCD places human beings at the centre of its concern to combat desertification and mitigate the effects of drought. It recognizes that Governments play a critical role in combating desertification and mitigating the effects of drought and that progress depends on local implementation of programmes in affected areas.

Guyana ratified the UNCCD in 1997, and GLSC is Guyana's National Focal Point Agency to the Convention. As a Party to the Convention, its fundamental obligations are: (1) The preparation of an Aligned National Action Plan to serve as the guiding framework for implementing actions to combat desertification/land degradation and promote sustainable land management and (2) To undertake UNCCD reporting. Guyana has been submitting its national reports on a regular basis to the Convention and had prepared its Aligned National Action Plan (discussed in Section 3.2.6).

3.4.3 United Nations Convention on Biological Diversity

The United Nations Convention on Biological Diversity (UNCBD) is an international agreement to promote nature and human well-being. It was entered into force on 29 December 1993. Guyana signed

[11] Extractive Industries Transparency Initiative, 2019. GYEITI – Guyana Extractive Industries Transparency Initiative.

the UNCBD in 1992 and subsequently ratified the Convention in 1994. Guyana has prepared a National Biodiversity Strategy and Action Plan (discussed in Section 3.2.5) to ensure that its obligations under the Convention are met.

A central purpose of the Convention is to promote sustainable development. It stresses that the conservation of biological diversity is a common concern of humankind, but recognizes that nations have sovereign rights over their own biological resources, and will need to address the overriding priorities of economic and social development and the eradication of poverty. The Convention recognizes that the causes of the loss of biodiversity mostly arise as a secondary consequence of activities in economic sectors such as agriculture, forestry, fisheries, water supply, transportation, urban development, or energy, particularly activities that focus on deriving short-term benefits rather than long-term sustainability. Under Article 7 of the UNCBD Parties should attempt to identify activities that may be detrimental to biological diversity. Where such activities have been identified, Parties should take steps to manage them so as to reduce their impacts. Further, Parties should develop plans and management strategies for the rehabilitation and restoration of degraded ecosystems and the recovery of threatened species. The UNCBD has also promoted the mainstreaming of biodiversity into the productive sectors such as forestry, mining, agriculture and fisheries. Guyana has been submitting its national reports on a regular basis to the Convention and had prepared its National Biodiversity Strategy and Action Plan (discussed in Section 3.2.5).

3.4.4 United Nations Framework Convention on Climate Change and the Paris Agreement

The United Nations Framework Convention on Climate Change (UNFCCC) was entered into force in 1994 to achieve stabilization of greenhouse gas concentrations at a level that would prevent dangerous anthropogenic interference with the climate system. Guyana ratified the Convention in 1994. All Parties to the Convention periodically submit inventories of greenhouse gas emissions and removals as well as information on measures being taken to adapt to climate change impacts. This information is submitted in documents known as National Communications. Parties are expected to submit National Communications at four-year intervals. However, as a non-Annex 1 Party with unique vulnerabilities to climate change and capacity constraints, Guyana has flexibility on submission timelines. To date, Guyana has submitted two National Communications to the UNFCCC and the GoG is advancing preparation of the Third National Communication.

In 2015, Parties to the UNFCCC produced the Paris Agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future. The Paris Agreement builds upon the Convention. Importantly, countries committed to Nationally Determined Contributions to support the objectives of the Convention and the Paris Agreement. Parties have taken voluntary contributions on how efforts taken to achieve the goals of the Paris Agreement. Guyana's Nationally Determined Contribution outlines actions to avoid deforestation, including by minimising emissions from the forestry and mining sectors, and to transition to renewable energy for electricity generation.

3.4.5 Convention on International Trade of Endangered Species of Wild Fauna and Flora

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) was drafted as a result of a resolution adopted by the members of The World Conservation Union (IUCN) in 1963. Guyana acceded to CITES in 1977. The aim of CITES is to ensure that the trade of wildlife does not threaten their survival. Accordingly, CITES requires Parties to the Convention not to trade in listed species other than in accordance with the Convention, to take appropriate measures to enforce the Convention, to prohibit and penalize trade in violation of the Convention and to confiscate illegally traded specimens. Each Party is required to submit an annual report on its CITES trade, containing a summary of information on the number and type of permits and certificates granted, the States with which such trade occurred, the quantities and types of specimens, and the names of species. Failure

to submit an annual report for three consecutive years without providing adequate justification could lead to the suspension of trade with the Party concerned. Guyana has submitted Annual Reports to the Convention with the most recent report being submitted for 2019.

3.5 Institutional Framework

Agencies which fall under the Office of the President, Ministry of Natural Resources and the Ministry of Local Government and Regional Development have oversight as it relates to the development and implementation of mining projects. The keys agencies which have roles to play in developing, permitting, monitoring and providing support to the project are the EPA and GGMC.

3.5.1 Environmental Protection Agency

The EPA was established under the EP Act of 1996. The Agency is governed by a Board of Directors, and falls under the direct supervision of Office of the President. In Sec. 4 (1) (a), of the Act, the EPA is given the mandate to *"take such steps as are necessary for the effective management of the natural environment so as to ensure conservation, protection and sustainable use of its natural resources*". In addition, the Agency is given the overall responsibility to:

- Take necessary steps for effective management of the natural environment to ensure conservation, protection and sustainable use of its natural resources;
- Ensure that any developmental activity, which may cause an adverse effect on the natural environment, is assessed before such activity is commenced;
- Coordinate and maintain a programme for the conservation of biological diversity and its sustainable use; and
- Coordinate the establishment of national parks and protected areas system and a wildlife protection management programme.

The EPA has issued two Construction Permits to GMI covering the construction of project facilities at Matthew's Ridge, and the wharf and access road at Port Kaituma. The EPA has requested that an EIA be conducted prior to the issuance of an Environmental Permit for the operational aspect of the project.

3.5.2 Guyana Geology and Mines Commission

The GGMC is semi-autonomous body governed by a Board of Directors and falls under the direct supervision of the Minister of Natural Resources. The functions of the Commission include:

- Promotion of mineral development;
- Provision of technical assistance and advice in mining, mineral processing, mineral utilisation and marketing of mineral resources;
- Mineral exploration;
- Research in exploration, mining, and utilisation of minerals and mineral products;
- Enforcement of the conditions of Mining Licences, Mining Permits, Mining Concessions, Prospecting Licences (for Large Scale Operations), Prospecting Permits (for Medium and Small-Scale operations) and Quarry Licences;
- Collection of Rentals, fees, charges, levies etc. payable under the Mining Act;

GGMC is responsible for regulating the activities of mining projects including monitoring the impacts of mining operations on the environment and to ensure these impacts are prevented or minimised. The GGMC has direct oversight of the project and has issued a Prospecting License to GMI covering the wider project and will need to issue a Mining Permit for the commencement of extraction of manganese.

3.5.3 Regional Democratic Council Region # 1

The RDCs are the supreme Local Government Organ in each region with the responsibility for the overall management and administration of the Regions and the coordination of the activities of all Local Democratic Organs within its boundaries. RDCs are overseen by the Ministry of Local Government and Regional Development. The main functions of the RDCs are to:

- To administer all services required within its boundaries (services such as health, education, public works, etc.) as set out by the laws.
- To coordinate the activities of the Local Democratic Councils and provide such cooperation and support as required. It should be noted that the RDC has some power delegated to it by the Minister responsible for Local Government.
- To develop regional facilities as it deems necessary.
- Identify economic (revenue earning) projects and assists the Administration in executing works necessary for the development of the region.

Under the RDCs are NDCs. NDCs cover a small geographic area within each region and is tasked with responsibility for the management and administration of these areas within its boundaries. The NDCs are required to approve development activities within their jurisdiction, and provide services such as solid waste collection and disposal, sanitation, drainage, rehabilitation of roads and dams and operation of markets, etc. within the NDC district. The NDCs also oversee environmental health within their areas through the Environmental Health Officer.

The Barima – Waini Administrative Region # 1 RDC has jurisdiction over the area under which the project falls and therefore represents a key stakeholder to the project. The NDC with jurisdiction for the project areas is the Port Kaituma/Matthew's Ridge/Arakaka NDC. This NDC has jurisdiction for both project areas; Port Kaituma and Matthew's Ridge. The NDC is based at Port Kaituma and has a sub-office at Matthew's Ridge for that area.

3.5.4 Guyana Forestry Commission

The Guyana Forestry Commission Act (2007) establishes the GFC as a body corporate and is governed by a Board of Directors. The Guyana Forestry Commission Act details the functions of the Commission including but not limited to the preparation of plans, codes of practice and guidelines for conservation and management of forests, to conduct forest inventories, and to develop and implement forest policy. The Forests Act 2009 gives the GFC the mandate for overall management of Guyana's State Forest Estate. Although GMI will not be involved in the harvesting of timber for commercial purposes, the project has required deforestation for the construction of the bypass road in Port Kaituma. As such, GMI should engage with the GFC regarding harvesting and use of forest resources within the footprint of the Port Kaituma bypass road.

3.6 Environmental and Mining Permitting

GMI is required to obtain environmental and mining related permits and licence to implement its manganese mining, processing and transport project. The main permits and their status are described below.

3.6.1 Environmental Permitting

The Environmental Protection Act 1996 outlines permitting process to be followed for any project that may significantly impact the environment, including projects which are to conduct EIAs. The EPA has developed EIA Guidelines which further details the process. The EIA process commences with the submission of a project application for environmental authorisation to the EPA. The EPA requires

specific information and these include a project summary, design and size of the project, potential environmental impacts [positive and negative] etc. The EPA screens the application and makes a determination whether an EIA is required or not and then notify the proponent. The Agency subsequently publishes its decision in the print media. If an EIA is required for the project the public is given 28 days to submit any written comments/concerns related to the project and its effect on their environment. These submissions detail questions and matters which members of the public may consider relevant to the deliberations of the EIA.

Once an EIA is required the proponent is required to submit to the EPA a team of consultants to undertake the study. A draft terms of reference to execute the study is also prepared by the EPA and shared with the project proponent for review. Public scoping meetings are held to present the proposed project and to garner additional comments/concerns from the public and other stakeholders, thus, aiding the EPA with the finalization of the terms of reference. Once the scoping process is completed the EPA submits the terms of reference to the proponent for the EIA and the consultants proceed to conduct the EIA process.

Once the draft EIA is submitted to the EPA the Agency publishes a notice in the daily print media informing the public that the EIA has been prepared and is available for review within a timeframe of 60-days. The EPA also engages relevant sector agencies and, as necessary, other relevant institutions to review the document to ensure their concerns have been addressed. The Environmental Assessment Board (EAB) as stipulated by the EP Act 1996 Section18 (2) (b), and through the EPA, determines the need for a public disclosures to allow the consultants to present the EIA findings and to provide another opportunity for members of the public to contribute towards designing the environmental management framework for the proposed project by raising environmental concerns related to the project.

The EAB is a body which provides an independent contribution to the development and finalization of the EIA process and makes recommendations which uphold the principles of the EP Act. In order to carry out its functions, the EAB is involved in the EIA process from the point of scoping, through public hearings and finally to establish conditions for the issuance of an Environmental Permit. The EAB evaluates the EIA and recommends to the EPA whether it should be accepted and the terms and conditions of its acceptance which are reasonably necessary to protect human health and the environment.

The EPA then takes into account the recommendations of the EAB, sector agencies, comments of the public and its own review, and decides whether or not the project should be approved. For approved projects, the EPA issues an Environmental Permit with the terms and conditions necessary to effectively manage the environment.

In accordance with the process described above, GMI submitted an Application for Environmental Authorisation to the EPA in January 2019 to establish mining, processing and transport facilities and for the mining and processing of manganese ore and which included activities at Matthews Ridge and Port Kaituma.

The EPA, after screening of the project, informed GMI in July 2019 that the Company must prepare and submit an EIA before an Environmental Permit is granted. The EPA also indicated that a separate Application for Environmental Authorisation should be submitted for the Port Kaituma Wharf facilities, but this aspect of the project should be addressed through the EIA process. The EPA further indicated that Construction Permits will be issued to GMI so that the company can commence establishing the infrastructure and auxiliary facilities to support the mining, processing and transport of ore. Two Construction Permits to allow for construction activities at Matthew's Ridge and at Port Kaituma were issued to GMI by the EPA in September 2019 and are valid until July 31, 2020. The Application for

Environmental Authorisation of the Port Kaituma component of the project was submitted to the EPA on July 02, 2019.

Once the EPA decided that an EIA is required for the project the Agency published its decision in the print media on May 26, 2019, allowing the public and other stakeholders 28 days to make any submission to the Agency on any concerns they may have regarding the project which should be addressed by the EIA. GMI submitted to the Agency a Project Summary and a proposed Team of Consultants to conduct the EIA thereafter. The Team of Consultants was subsequently approved by the EPA and communicated to GMI via letter dated November 05, 2019. The EPA also prepared the draft Terms of Reference for the EIA which was shared with the project proponent and the Consultants. Scoping meetings on the project were held in Mabaruma, Port Kaituma and Matthew's Ridge in July 2019 to inform the terms of reference. These meetings were organized by GMI, with support from the EPA, and participation from Government institutions, other relevant stakeholders and the public. After the scoping process was completed the feedback gathered was used to finalized the Terms of Reference for the conduct of the EIA. The finalized Terms of Reference was provided to GMI in October 2019. This set the basis for the commencement of the EIA process.

3.6.2 Mining Permitting

In order to conduct exploration activities a Prospecting Licence (PL) for the area has to be obtained from the GGMC. The Matthew's Ridge Project consists of four PLs, including at Matthews Ridge, Arakaka and the Pipiani. Exploration and mining of manganese was previously conducted in the area in the 1950s and 1960s, but ceased in 1968. In 2011, Reunion Manganese Inc. (RMI) acquired the PLs, allowing for a re-examination of the prospects. GMI acquired from RMI the following four PLs – PL 1/14/2010, PL 2/15/2010/, PL 3/16/2010 and PL 4/17/2010. The total area of the PLs is 185 km (45,729 acres). PL 1 represents the Pipiani prospect which is 65km southeast of Matthew's Ridge, PL 4 represents the Arakaka prospect which is east of Matthew's Ridge. PLs 2 and 3 contain 18 km of a series of 9 hills at Matthew's Ridge where the bulk of the resources are located. Of these 9 hills, #4 and 5 have been partially mined. The Prospecting Licences expired in July 2019.

To conduct mining of the identified deposits GMI has to obtain Mining Licences from the GGMC. To date the company has applied to GGMC for the conversion of PLs 2 and 3 into Mining Licences. The Company intends to apply to the GGMC to convert PLs 1 and 4 into Mining Licence at a later date.

3.6.3 Other Approvals

To facilitate GMI's mining, processing and transport operations other approvals from government agencies will be required to establish some project components and execute certain project activities. GMI has already engaged these agencies, as is described below:

- GLSC in respect of application for surface rights related to the building a new wharf-site and storage site with an associated 9 KM roadway at Port Kaituma;
- Works Services Group (WSG) of the Ministry of Public Works in relation to the Matthew's Ridge road upgrade and maintenance; and
- Sea and River Defence Board and MARAD in relation to the new wharf site at Port Kaituma, mooring, and river transit and dredging.

Chapter 4 - Project Description

4.1 Overview

GMI, a subsidiary of Bosai Minerals Group (BMG) of the People's Republic of China, has undertaken the resuscitation of manganese mining at the historic, formerly abandoned, Mathew's Ridge site in Matarkai, Region One (Barima-Waini), Guyana.

GMI plans to rehabilitate, and in some cases, replace plant and buildings; rehabilitate and upgrade several mine sites; install a new processing plant; upgrade and widen the Matthew's Ridge to Port Kaituma road; construct a new wharf facility with access road at Port Kaituma; and invest in a new mobile fleet and barging assets.

The project is scheduled to come on stream by October 2020, and will create direct employment for over 400 persons. The annual production and shipment of manganese ore concentrates is targeted at 500,000 tonnes. The project investment is estimated at US$75 million.

Given the dilapidated state of the site and its infrastructure, GMI conducted studies to validate and identify new approaches to operationalize the mine. The verification and upgrade of previous studies, the feasibility study, along with completion of the specific designs were completed and work has commenced on the ground and is well advanced to put in place the infrastructure required for the project.

4.2 Project Background[12]

Manganese occurrences were first identified in Guyana in 1902 by Sir John Harrison during a geological survey of the lower Essequibo River within the prospect now known as the Saxacilli manganese occurrence. In 1937, Dr. Bryn Davies discovered the first occurrence of Manganese within the North West District, mainly at locations identified as Matthew's Ridge, Arakaka and Pipiani. A Union Carbide Corporation (NWGMC) subsidiary company, African Manganese Company Ltd., established the North West Guiana Mining Company, which was later renamed Manganese Mines Management Ltd (MMM) to develop and manage the manganese operations at Mathew's Ridge in 1954.

MMM acquired the leases of the Barima Gold Mining Company and after geological exploration to determine adequate reserves, established mining operations in 1957. MMM dredged the Barima River and Mora Passage; cut the Kaituma Canal and established ship loading, ore concentrate storage, fuel tankage and housing at Port Kaituma. This was followed by the establishment of a thirty (30) mile 3'10" railway, with adjacent roadway, and a Bailey bridge over the Barima River at Eclipse Falls; the creation of the mine site at Matthew's Ridge with the associated similarly named 'company town'; and the establishment of mine buildings and a processing plant. A further rail extension was later made to Arakaka.

The first shipment took place in 1961[13]. Ore concentrates totalling an estimated 1.7 million tons (37% Mn) were exported utilising two converted shallow draft oil tankers, the "Ambrosio" and the "Inverrosa", on four-day cycles to Chaguaramas in Trinidad. Operations ceased in 1968 due to a precipitous fall in the price of manganese in the world market, presumably due to the development of large, high quality, reserves in Brazil.

The operations reverted to GoG and were kept on a 'care and maintenance' basis for a number of years while agricultural projects were undertaken, initially. Later, during the1980s, joint investigations

[12] Compiled based on information from GMI April 2020 Revised Project Summary – Section 2.0
[13] Geological Survey of British Guiana Annual Report 1968, Page 18

by North Korean and Guyanese experts did not result in a resumption of operations. The condition of the infrastructure progressively deteriorated and with the end of rail movement there was loss of rails, rail rolling stock and other related assets. In 2008 Essar Steel of India showed interest but this did not advance to a mine revival.

The decline in economic activity in the Matarkai sub-region was somewhat alleviated with the upsurge in gold mining at the small-scale level, which continues up to the present time. However, the associated result of the decline in economic activity and no site presence has seen the development of unregulated settlement and other activities in the environs of the Matthews Ridge manganese mining, plant, tailings storage and water reservoir areas, as well as along the transport roadways, both at Matthew's Ridge and Port Kaituma. This in turn, posed challenges to a restart of operations since they have imposed significant legacy issues on the new undertaking, requiring substantial costly responses.

In March, 2011, Canada's Reunion Manganese Inc. (RMI) and the Government of Guyana signed mineral agreements allowing for a re-examination of the prospects with the intent of restarting operations. RMI's diligent work confirmed the reserves; produced a pre-feasibility study using G Mining Services Inc. in August, 2013; determined the viable logistical options for an operational restart via WorleyParsons Inc.; did the Gap Analysis through Blaha Consulting; conducted Baseline Environmental Studies through Ground Structures Engineering; and laid the basis for BMG's investment decision.

GMI subsequently acquired the properties from RMI in 2016, established a presence on-site and commenced evaluations and detailed engineering studies, a feasibility study and detailed engineering designs. Work has commenced at Port Kaituma and Matthew's Ridge to construct the required infrastructure and facilities to enable commencement of operation.

4.3 Company Profile[14]

GMI was registered in Guyana on November 17, 2016. Chongqing BMG of Yuzhong District, Chongqing, China, is the controlling shareholder. Starting from small industrial minerals undertakings in Nanchuan, China, BMG was established in July 2003, and has grown into a large-scale manufacturing enterprise with total assets worth over US$1.58 billion and annual sales of up to US$3.16 billion.

BMG has over 7,000 employees of which over 1,200 are non-Chinese. BMG has more than ten manufacturing enterprises in China located mainly in Sichuan and Chongqing. Internationally it owns the Ghana Bauxite Company, Bosai Europe GMBH manufacturing in Germany and, in Guyana, Bosai Minerals Group (Guyana) Inc. and GMI. BMG has successfully adapted the Chinese business development model of "Going Global".

BMG has a focus on industrial minerals in the form of bauxite and its manufactured derivatives, and is now in manganese for the production of various alloys. There is a strong interest in aluminum manufacture and that of ferroalloys. The global company reserves amount to 300 million tonnes of quality bauxite and 30 million tonnes of manganese resources.

BMG's annual production includes 6.5 million tonnes of bauxite; 300,000 of calcined bauxite; 200,000 tonnes of brown fused alumina; 1.6 million tonnes of alumina; 300,000 tonnes of primary alumina; 150,000 tonnes of aluminum products; and 550,000 tonnes of silicate-manganese alloys. The company anticipates that with its Guyana manganese acquisition it will be able to produce 500,000 tonnes of additional concentrates annually. Manganese is often used by the steel industry in

[14] Compiled based on information from GMI April 2020 Revised Project Summary – Section 3.0

deoxidizing and desulfurizing additives and as an alloying constituent. It can improve the rolling and forging qualities, as well as the strength, toughness, stiffness, hardness, wear resistance, and hardenability of steels.

BMG's products command a strong market presence in the China domestic market. Internationally its products are marketed in over 30 countries with placements mostly in Asia, Europe and North America. Its calcined bauxite and brown fused alumina lead the global market in production and sales volume.

In China, the company has been placed regularly and awarded for being certified as: "Top 500 Private Enterprises in China"; "Top 500 Manufacturing Enterprises in China"; "Top 50 Non-Ferrous Metals Enterprises in China" amongst other significant national and regional awards.

BMG is an enthusiastic donor to social welfare charities and has an engaging and responsible CSR attitude. The company's successful ongoing effort in managing the former Linden Mining Enterprise (LINMINE) and Omai Bauxite Mining Inc. (OBMI) in Guyana, since December 2006, is viewed as a significant plus with respect to the manganese undertaking since the company's operatives are well experienced, and work successfully, in the Guyana environment with the country's institutions and nationals. In addition, since acquiring the Linden operation BMG has implemented several measures to improve the environmental compliance of the operation, including improvements in air and water quality.

GMI was established with the sole intent of developing, mining, and processing the manganese resources at Matthew's Ridge to produce manganese concentrates for the international metallurgical market.

4.4 Environmental Policy

Consistent with the policies and established practices of its corporate owner BMG of China, GMI has to adhere to the administrative policies required for sound operational practices necessary to ensure environmental compliance to assure minimal environmental and social impacts. As such, GMI has prepared an Environmental Policy which requires the Company to '*to carry out sustainable, mining and processing operations while reducing and mitigating environmental impacts of GMI's activities'*.

GMI is committed to achieving sustainable development and operation of the Matthew's Ridge Manganese Mining Project by maximising environmental benefits and minimising and mitigating environmental risk and harm throughout project life. GMI intends to carry out sustainable mining, processing and logistical operations while reducing and mitigating environmental impacts of its activities. In implementing this policy, GMI will[15]:

Comply with all applicable Guyana Statutory environmental laws and regulations.

Work with Guyana Government stakeholders to ensure that their environmental requirements are met in execution of the project

Ensure that the project is designed, developed and operated with the incorporation of measures to optimize environmental benefits and the communities and to avoid, reduce and control adverse effects arising out of our activities

Insist and encourage compliance by all relevant stakeholders including employees, contractors, visitors and others working on our behalf by ensuring that they are aware and able to satisfy their environmental obligations

[15] Extracted from GMI 2019 Environmental Management Plan – Section 1.2

Minimise resource usage, pollution and generation of waste, and act to prevent adverse environmental effects

Maintain an informed dialogue with related communities regarding the environmental impact of our operations

Assess the environmental performance of the project through a system of audits and monitoring

Conduct its activities in a safe, responsible and efficient way by addressing the environmental challenges arising from its activities

GMI intends to communicate the requirements of this policy to all employees and contractors and will review and revise the policy periodically to ensure its relevance by any necessary improvement.

4.5 Project Profile

GMI plans to invest US$75 million into the project to restart of manganese mining in Guyana in 2020 after an absence of 50 years.

Mining will resume after rehabilitation with the aim of producing 2.0 million tonnes annually of manganese ore for processing to turn out 500,000 tonnes of concentrates for intermediate shipment to Brighton Port, Trinidad. In order to realise this project some 400 workers will be required over a one-year construction period. Project operation is intended to employ over 400 workers, of which 340 (85%) would be Guyanese with the others being technical trainers and process specialists from China. At the Port Kaituma wharf facility some 200 workers will be required over a 7-month construction period while project operation is intended to employ some 30 workers, of which 27 (90%) would be Guyanese with the others being administrators and specialist technicians from China.

The extraction rates planned when related to current reserves yield a mine and project life of thirteen (13) years. Extension of project life would necessitate continuous, diligent exploration to identify additional reserves targeting, in the first instance, the Pipiani and Arakaka deposits where the resources have not yet been fully evaluated. A continuous operation system will be adopted, 330 days per year, 2 shifts per day, 12 hours per shift.

4.6 Organisational Structure

GMI's proposed organizational structure is as depicted in Figure 4-1 below. Overall responsibility for environmental matters resides with the General Manager of GMI, including environmental compliance and monitoring. Environmental management is prioritized, with the responsibility delegated to a Vice General Manager, who reports directly to the General Manager and oversees the HSE Department. GMI has identified its senior site managers as being responsible for daily implementation of its Environmental and Social Management Plan (ESMP); training and adherence to the plan's requirements, and monitoring, reporting and auditing of the plan.

The HSE Department is currently staffed by two personnel. However, there are plans to increase staffing. Within the department a Health and Safety Unit will be created comprising of three personnel and an Environmental Unit with one person initially, but may be expanded if required.

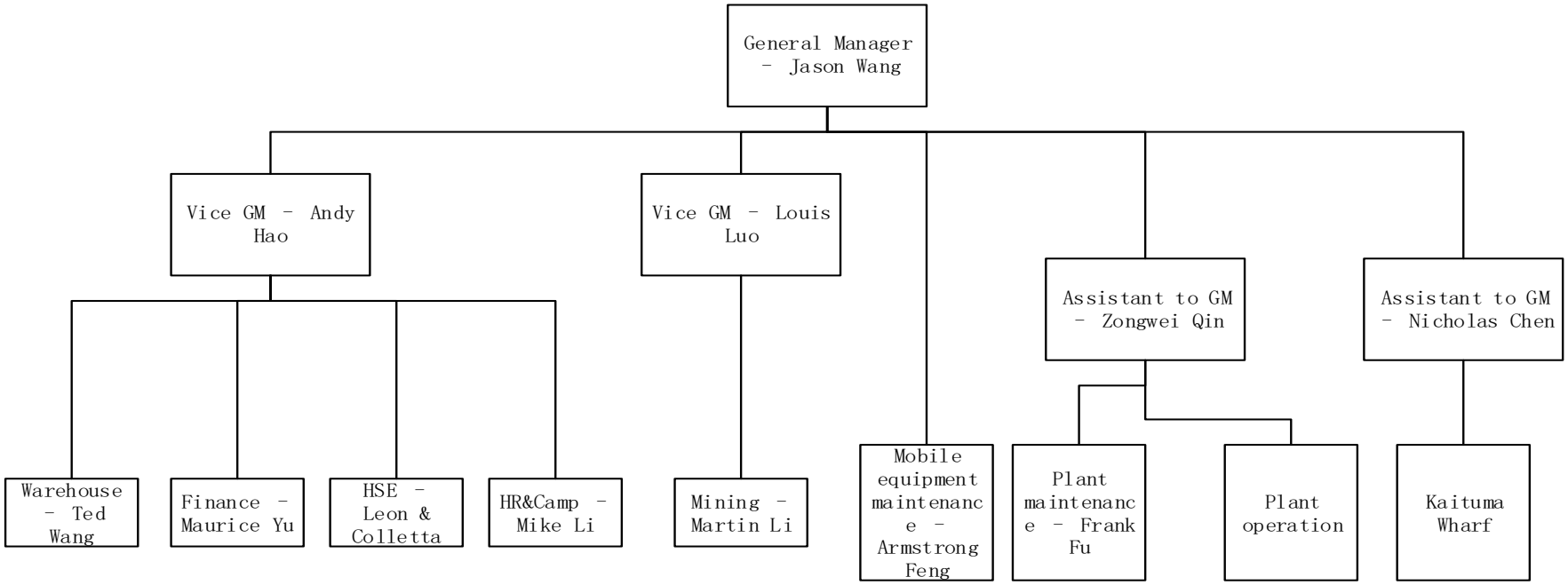


Figure 4-1: Guyana Manganese Inc. Organisational Chart

4.7 Location and Access

The GMI manganese mining, processing and transportation for export Project (the Project) is located in the Barima-Waini Administrative Region (Region One), some 250 kilometres to the northwest of Georgetown as the crow files. The location of the Project areas is shown in Figure 4-2. Major Project locations are: Matthew's Ridge at Coordinates 7° 30' North and 60° 9' West (Figure 4-3) for mining and processing; and the new Kaituma Marine Terminal on the right bank of the Kaituma Canal at Coordinates 7° 45' 46" North and 59° 51' 17" West (Figure 4-4), for concentrate storage and barging shipment.

The Project sites are located on the resources and basic infrastructure developed for the previous manganese mining which was in operation during the early 1960s. Specific operational site placements have been made which has resulted in the relocation of processing facilities with the construction of a new modern processing plant since the old plant is corroded, dilapidated and beyond repair, with squatting encroachment on ore stockpile and waste disposal areas.

Similarly, GMI has taken the decision not to use the old concentrate storage yard and shipping terminal but to relocate to new facilities 5.5 kilometres downstream from Port Kaituma and on the right bank of the canal to avoid congestion, encroachments and potential disputes which could occur once there is any effort to re-occupy the original Port Kaituma site and facilities.

Matthew's Ridge is accessible by one-hour Cessna Air Caravan flights (one hour) daily out of the E. F. Correia International Airport, Ogle, covering a distance of 235 km. Port Kaituma is similarly accessible by air a distance of 217 km. There is no exclusively overland route to arrive at the locations.

Port Kaituma, and the general area is normally accessed in stages by sea from Port Georgetown to Waini Estuary after a journey of 200 kilometres, then by traversing the Mora Passage to join the Barima River at Morawhanna; then by travelling upriver on the Barima River to its confluence with the Kaituma River, thence upriver on the Kaituma River to the entrance of the Kaituma Canal, thereafter up the canal to Port Kaituma. Total marine travel to Port Kaituma is 300 kilometres. Matthew's Ridge is accessible by a 65 kilometre (40 miles) laterite capped all terrain road from the entrance of GMI's Kaituma Terminal access road at Port Kaituma. This journey can take one and a half hour in good weather and on a fair road or two or more hours in poor road conditions and/or in the rainy season.

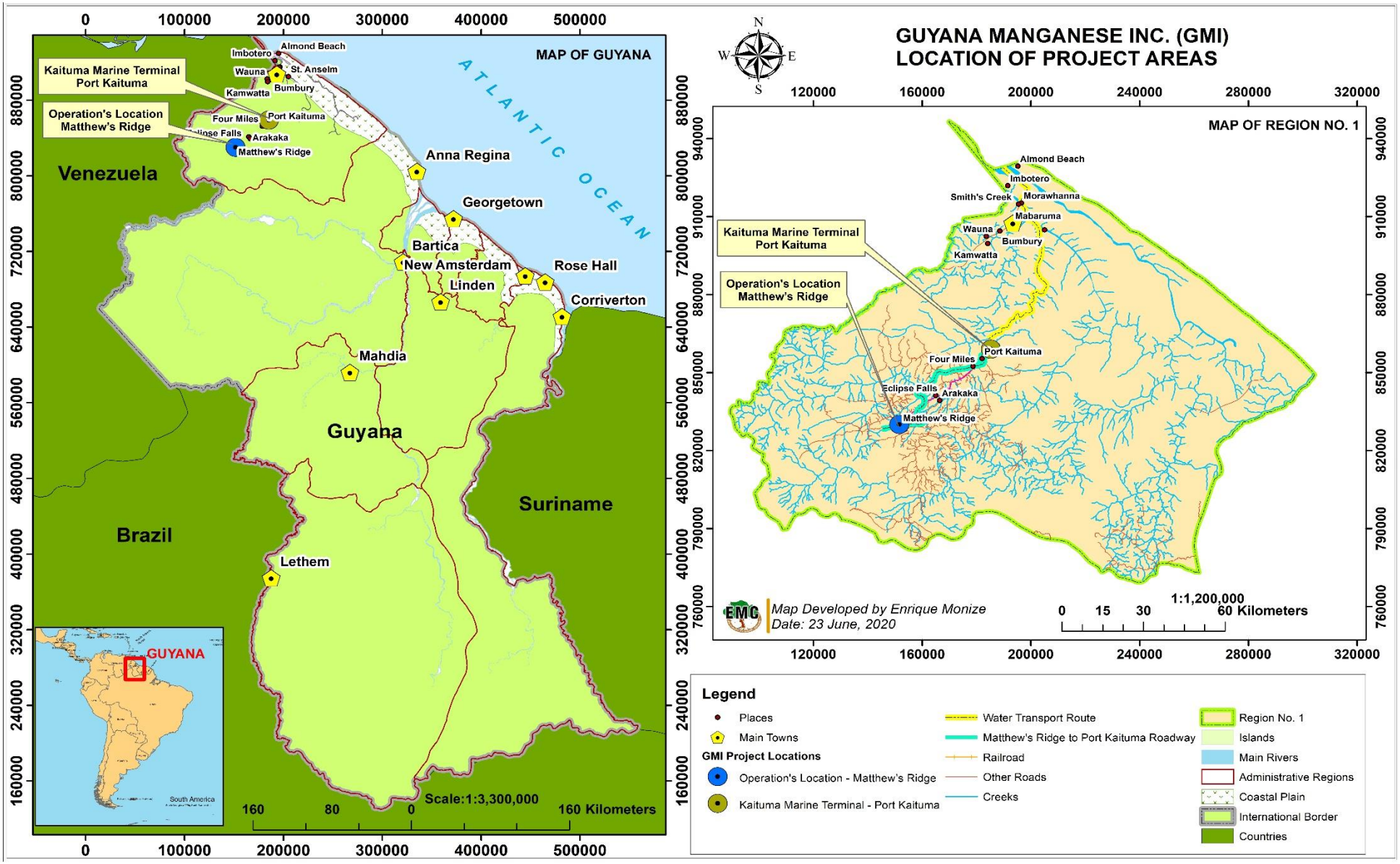


Figure 4-2: Project Locations in Region One

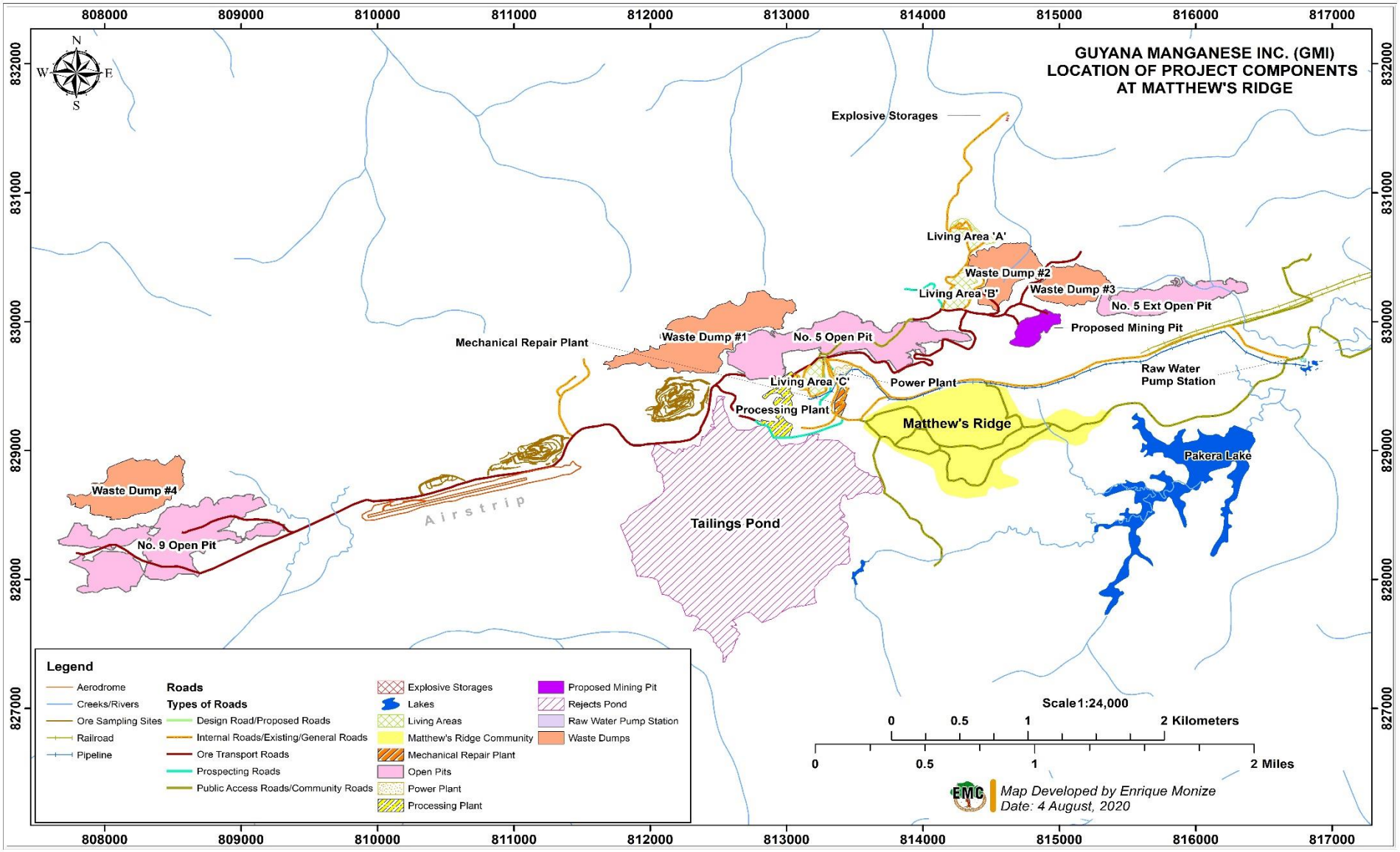


Figure 4-3: Location of Project Components at Matthew's Ridge

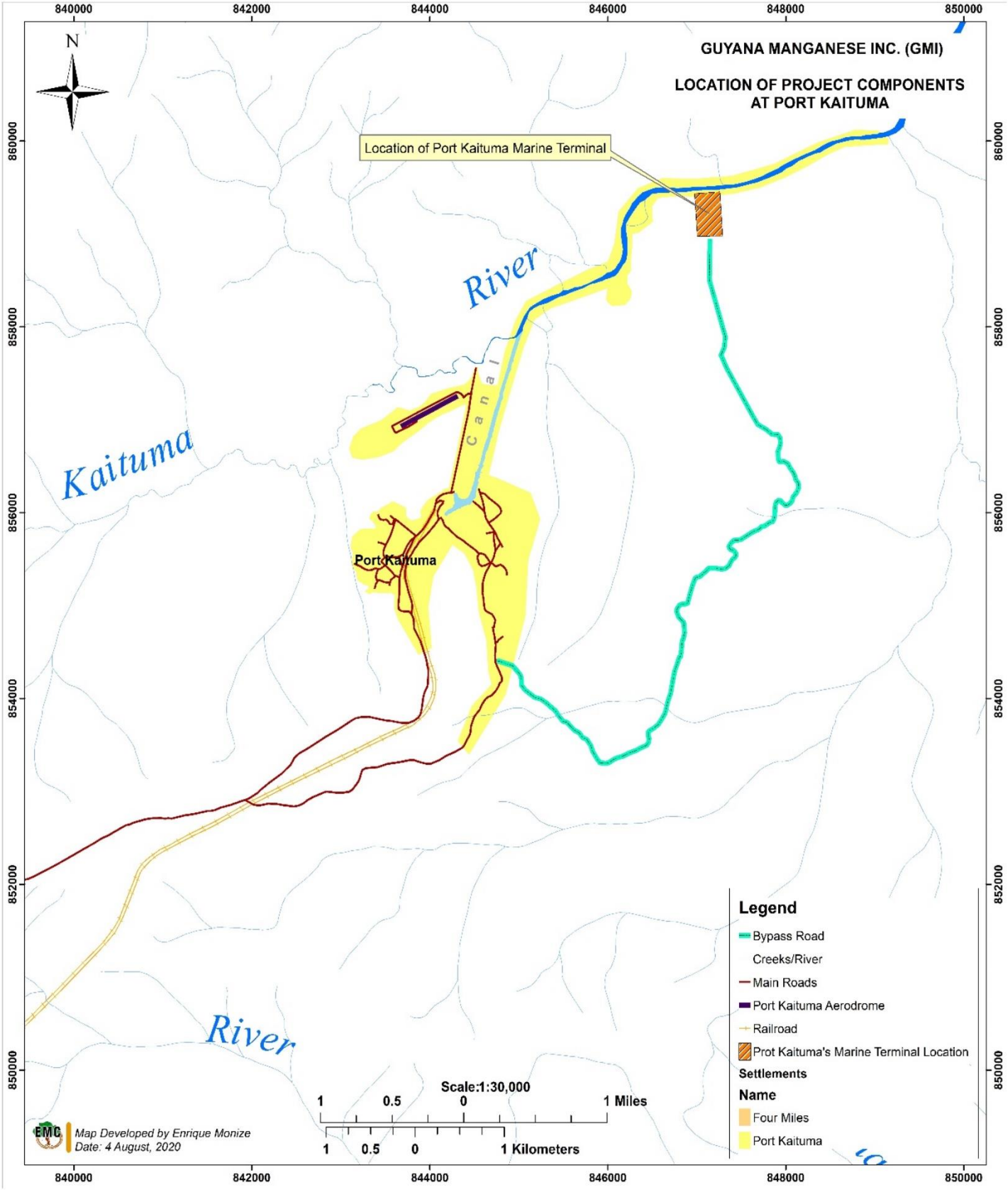


Figure 4-4: Location of Project Components at Port Kaituma

4.8 GMI Mineral Properties

The Matthew's Ridge Project consists of four Prospecting Licences (PLs), namely at Matthews Ridge (2 PLs), Arakaka and Pipiani. In 2011, RMI acquired the PLs, allowing for a re-examination of the manganese prospects. BMG acquired from RMI the following four PLs – PL 1/14/2010, PL 2/15/2010/, PL 3/16/2010 and PL 4/17/2010. The total area of the PLs is 185 km^2 (45,729 acres). PL 1 represents the Pipiani prospect which is 65km southeast of Matthew's Ridge, while PL 4 represents the Arakaka prospect which is east of Matthew's Ridge. PLs 2 and 3, which includes the footprint of the mining project, contain 18 km of a series of 9 hills at Matthew's Ridge where the bulk of the resources are located. Of these 9 hills, #4 and # 5 haven been partially mined.

The PLs expired in July 2019. To conduct mining of the identified deposits GMI has to obtain Mining Licences from the GGMC. GMI has applied to GGMC for the conversion of PLs 2 and 3 into Mining Licences and intends to apply to the GGMC to convert PLs 1 and 4 into Mining Licences at a later date. The PLs can be observed in Figure 4-5.

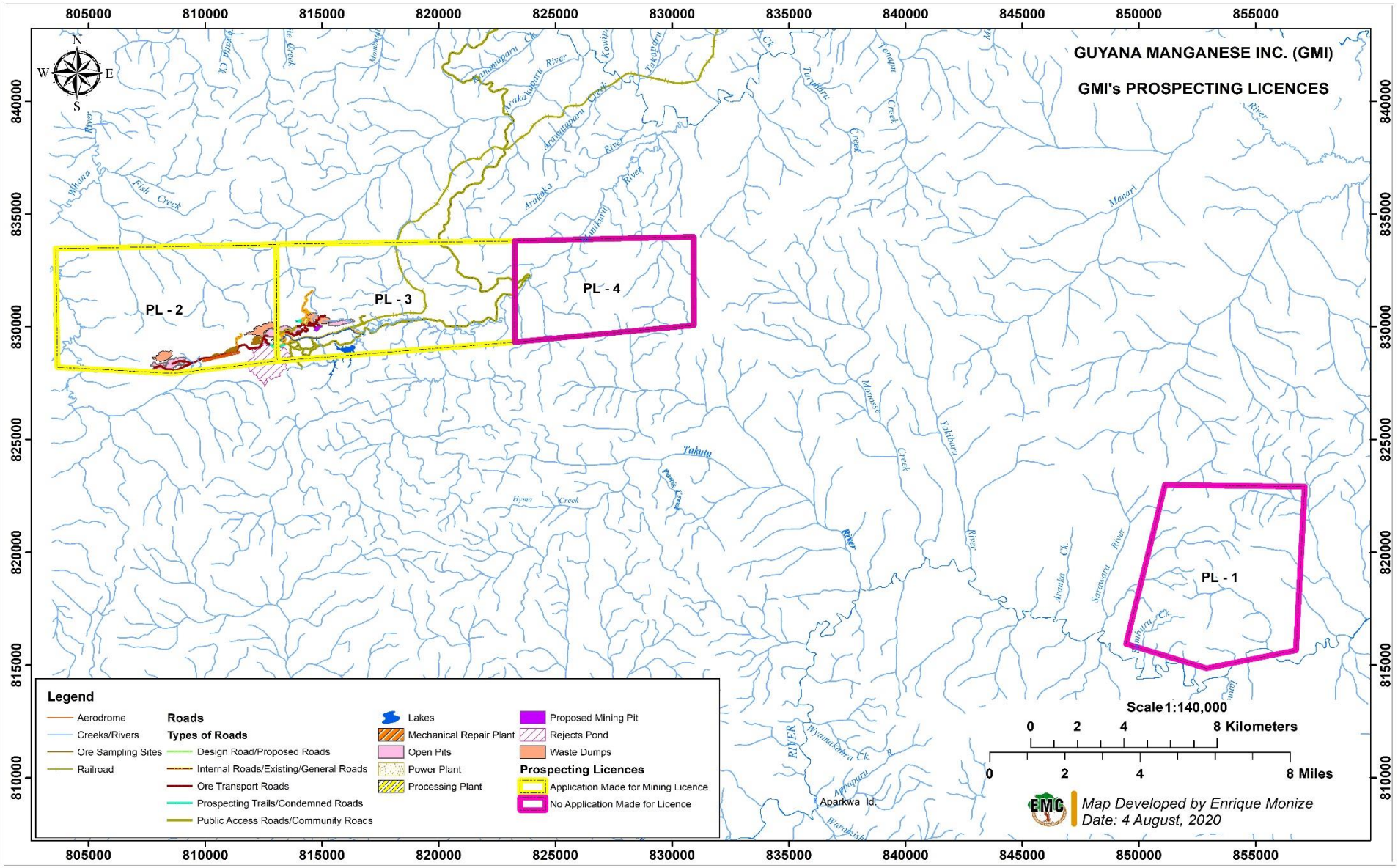


Figure 4-5: GMI's Prospecting Licences

4.9 Ore Reserves

The Matthew's Ridge regional geology is characterized by Barama Group low grade metamorphic rocks, of Proterozoic age (1.9 billion years ago), which were deposited in a marine environment in a basinal setting with lenticular bedding aspects. Locally these beds are steeply folded, overturned and thrusted. The named beds of the Barama Group consist of the: coarse - grained sediments (arenites and rudites) of the Arakaka Formation (AKF); the fine-grained pelites and clastics of the manganese - hosting Matthew's Ridge Formation (MRF); and lastly the meta-volcanic rocks of the Tenapu Formation (TNF), now regarded as the source of the manganese mineralization. The whole package is variously intruded by dolerite sills and dykes of both the Older Basic Intrusive Suite (OBIS- 1.3 bya) and the Younger Basic Intrusive Suite (YBIS – 1.1 bya). Studies of the target Matthew's Ridge Formation conclude that it consists of a complex geological sedimentary sequence which was metamorphosed, tectonically deformed, modified by igneous activity and partially obliterated by intense hydro-thermal action.

Manganese mineralization occurs in deposits trending in a 15 kilometre NE to SW structure of hills and whose average elevation is 150 metres above mean sea level. These hills were identified as Hill 1; Hill 2; Hill 3; Hill 4; Hill 5; Hill 6; Hill 7; Hill 8; and Hill 9. The trend structure is recognised as the limb of a major regional, steeply plunging, anticlinal-fold. The mineral paragenesis is that of manganese silicates, oxides and carbonates, typified by the presence of braunite, spessartite and rhodocrosite as the main economic minerals of interest. Weathered profiles consist of nodular manganese, manganese duricrust, saprolite and sap-rock. Litho-types include: Banded Manganese Formation (BMF); Massive Manganese Formation (MMF) and Nodular Manganese Formation (NMF).

The manganese mineral resources at Matthew's Ridge have been upgraded and increased in quantity as a result of the reduction in the mining cut-off grade and resulting in the head grade to the processing plant falling to 8 percent manganese contained, from the historically 20 percent manganese contained. This is predicated on more efficient and processing technology which adds the use of modern jig circuits to a processing concept which, historically only used washing and screens to recover concentrates. The result has been the more than doubling of the resources thus making for a more viable project.

Various drilling (65,000m), pitting and trench sampling campaigns were carried out to give adequate sampling coverage of the deposits before representative samples were submitted for rigorous quality assurance/quality control (QA/QC) procedures, laboratory analyses, geostatistical analyses, optimization algorithms and process amenability testing to arrive at the final resource estimates. Independent resource validation was conducted by BMG as part of its due diligence procedures pursuant to the acquisition. The reserve summary is presented in Table 4-1.

Table 4-1: Matthew's Ridge Reserve Summary (thousand tonnes)

Measured	Mn %	Indicated	Mn %	Sum Mea+	Ind. Mn %	Inferred	Mn %
16,987	14	5,793	13	22,780	14	637	15

The reserve summary is fully constrained for the measured and indicated categories totaling 22.78 million tonnes. It should be noted that the summary is also based on the re-designation of Hill 2 and Hill 4 as Hill 3, and Hill 6 as Hill 5. The coarse tailings from previous processing, which will be recovered and retreated are also incorporated into the reserves. The total amount of recoverable resource in the tailings is 1,035,900t. Applicable mining deposits are therefore 8 in number encompassing: Hill 1; Hill 3; Hill 5; Hill 5 Ext; Hill 7; Hill 8; Hill 9; and the Tailings. Hills 5 to 9 have been partially mined and 1 to 4 remain as undisturbed deposits. The location of the deposits is shown in Figure 4-6.

High tonnage reserve deposits are Hill 9 containing 4.8 million tonnes, Hill 5 containing 5.5 million tonnes, Hill 5 Ext. containing 3.5 million tonnes and Hill 3 containing 4.7 million tonnes. Details of ore and overburden contained at each deposit, as well as the sequence of mining throughout the mine line, are outlined in Appendix C1. Unconstrained inferred resources for Arakaka are 168,000 tonnes @ 13% Mn, and for Pipiani 1,756,000 tonnes @ 15% Mn giving a total of 1,924,000 tonnes.

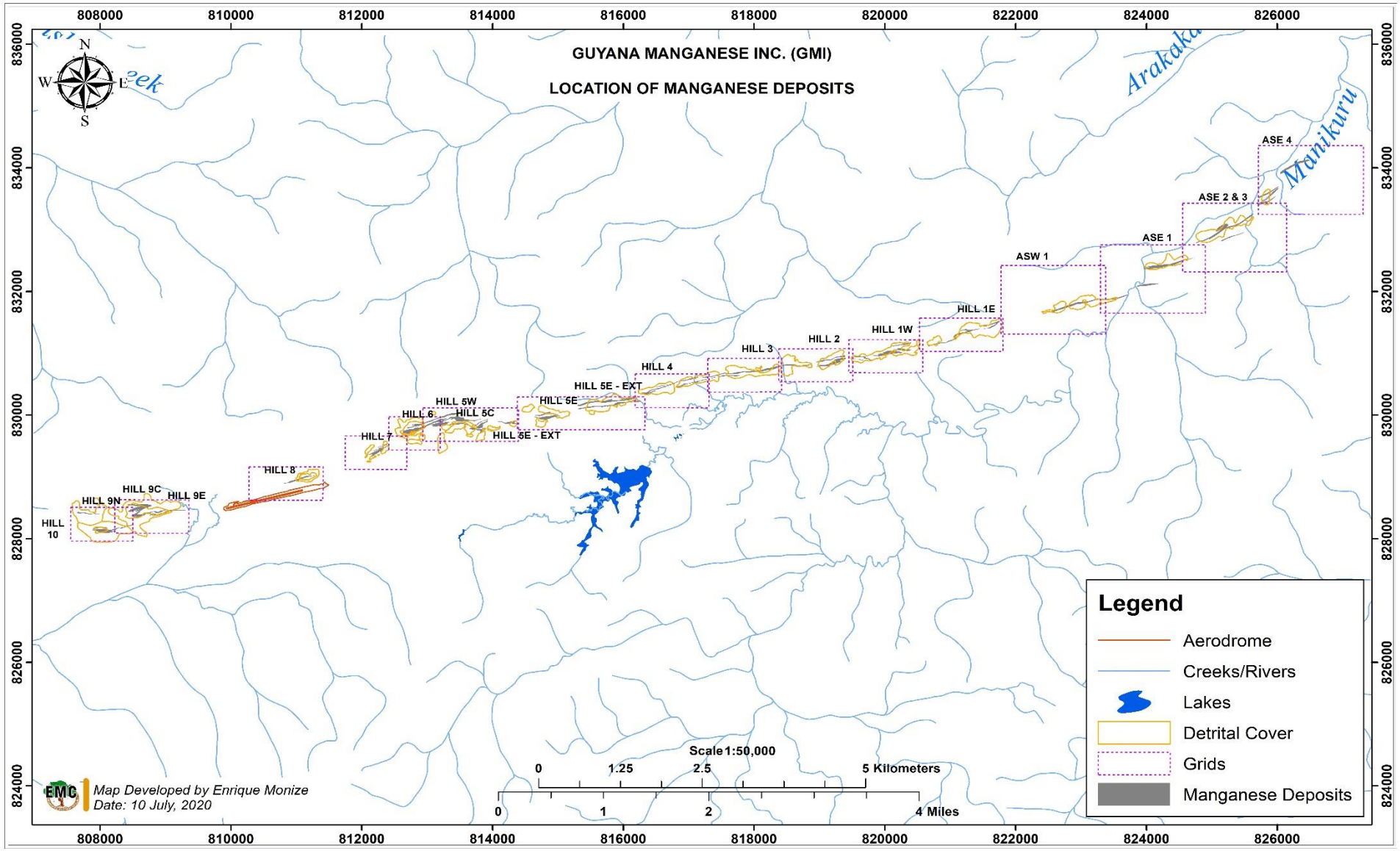


Figure 4-6: Location of the Manganese Deposits

4.10 Project Details

The GMI manganese operations have been designed around:

- the remaining mineral resources at the Matthew's Ridge mining locations;
- the re-establishment of disused and degraded mine infrastructure including mine roads, pit benches, stockpile areas for ore and concentrate, mine administration and facility buildings;
- water retention sites and dam structures;
- the building of a completely new processing plant;
- the construction of an upgraded road profile to move processed concentrates from the Matthews's Ridge process plant to a new storage and wharf facility on the Kaituma Canal; and
- the dredging on the Kaituma Canal for wharf construction.

4.10.1 Construction/Preparation

Project preparation currently involves the complete rehabilitation of the mine site; construction of the new processing plant; establishing the means for water storage, delivery and management; power generation and delivery installation; and the construction and rehabilitation of accommodation, offices, workshops, and a laboratory. Completion of road works, wharf and storage, dredging, employee hiring and training; taking delivery of mine equipment and ocean barges; and the final approvals for project implementation and start-up will allow for the commencement of mining, processing, and transport of concentrate by road, river and ocean operations. Activities relating to the preparation of the site and rehabilitation and construction of the project infrastructure and facilities are described in this section.

4.10.1.1 Site Rehabilitation and Preparation

Since occupying the Matthew's Ridge project site just after the property acquisition, GMI senior management along with consulting groups have established a continuous presence on site. At the same time, mobile equipment was acquired and work was initiated to repair and reopen mine roads and access to benches along with the repair and maintenance of the community roads and the main access branch road to the Matthew's Ridge/Port Kaituma Junction.

Site clean-up activities required the removal of vegetation, steel scrap and derelict vehicles and the repair and ongoing maintenance to buildings and other facilities where possible. Where such facilities are too derelict and beyond useful repair and occupancy these are being removed and replaced or abandoned. The clearing, surveying, levelling, grubbing-out and excavation for new building and facility locations are underway.

Figure 4-7: Existing Facilities which were Rehabilitated and Utilised (Maintenance Shop [left] and Guest House [right])

4.10.1.2 Infrastructure and Facilities Construction

Construction activities involve the identification, planning, laying and setting out of building and facility sites, based on detailed engineering designs. Materials for construction activities, in the form of sand, laterite and stone of various grades are procured locally via contracts. Construction of key project components such as the wash plant, workshop, roads, etc., has commenced based on Construction Permits issued by the EPA. Section 4.11 provides more detail on the project facilities being constructed.

4.10.1.3 Mine and Haul Roads

Mine pit construction will involve the orientation of mining advance in a manner advantageous for the optimal recovery of ore and mine safety. Benches would typically be 30 metres wide with heights of 6 metres and a bench slope of 55 degrees and overall slope angle will be 42 degrees to achieve a minimum factor of safety of 1.10. The bench width will be adequate to accommodate mobile and tracked mine equipment in safe manner. Crest heights will not exceed 84 metres degrees, consistent with geotechnical based constraining safety parameters related to material type and limiting factors of safety arising out of computerized iterative routines.

Haul roads will be constructed as dual-lane 7.5 metre wide for main access and stockpiling while 5 metre single lane ones will form bench access. Maximum road grades will be 9 degrees.

Pit drainage on benches will be assured by catchment berms, drains and culverts to minimise surface water descending into the void. Pumps in sumps with connecting drains will be emplaced in pit bottoms to collect and evacuate underground water springs and seepage, and rainfall, as necessary.

4.10.1.4 Tailings Pond

The tailings pond will encompass an area of 2.3 square kilometers and will be constructed mostly on the footprint of the previous used tailings pond. The tailings pond will be the main water source for the processing plant since the settled water will be reused. The tailings will be concentrated in the settling basin by the use of flocculants, which clump together floating particles in the water to sink to the bottom. The water will then be pumped back to the wash plant by a floating pump installed in the pond.

For the tailings pond a series of seven new dams with a crest elevation of 86 metres will be constructed using mostly local site materials. These dams are designed to ultimately retain 12.5 million cubic metres of tailings and water in the reservoir. Overflow structures are incorporated into the dam design and construction to enable gravity release of excess water. The minimum freeboard of 1m will always be maintained.

GMI is currently building #7 dam and will continue the #3 and #5 dams to the height of 79m before the commencement of production. From there on the dams will be constructed continually according to the volume of tailings up to the final elevation. Annually, the volume of tailings to be discharged for storage after processing is estimated to be 773,333 cubic metres. Considering a tailings bulk density of 1.5 tonnes per cubic metre, this translates into 1,160,000 tonnes of tailings disposed of yearly. Total tailings over the project life is estimated to be 13.92 million tons, or 9.28 million m^3. GMI will ensure that the pressure to the dams will keep at a low level and during operations, will recover a significant portion of the tailings to be used for road maintenance.

Engineering Methods

The dam will be built by roller compaction and concrete sheeting with an 8-m-wide crest, a downstream slope of 1:2.5 and an upstream slope of 1:2.0. The body of the dam will be rolled earth-rock fill and

preferred construction materials are used weathered soil and stone mined in the reservoir. Seepage control composite geomembrane will be installed in the upstream slope of the dam, and the drainage ridge will be set at toe of the downstream slope of dam. To the extent possible, materials required for construction will be sourced locally. The following practices will be followed in dam construction:

- The earth-rock fill dam will be compacted in layers by a 10-ton vibration roller. The compaction degree of the dam body will not be less than 0.96 after compaction is complete.

- The flood interception ditch will be set at the intersection of the abutment and the mountain body in a rectangular section with dimensions of 1 × 1.2m, and a wall thickness of 0.3m. It is a C20 concrete structure.

- The outer slopes will be set with a rectangular section herringbone drain, with dimensions of 0.3 × 0.3m, 0.2m thick. Outer slopes will also be constructed using C20 concrete.

- The spillway will be located west of the tailings pond. It will have a depth of 2m, width of 20m and wall thickness of 400 mm. The stilling basin will be located downstream of the spillway with dimensions of 30m long, 25m wide and 3m high. Both the spillway and basin are reinforced concrete structures.

The layout of the Tailings Pond can be observed in Figure 4-8.

Design Standards

The design, monitoring and maintenance of the tailings pond were informed by several standards and previously conducted studies which are outlined below:

- Code for Design of Tailings Facilities (GB50863-2013)
- Technical Code for Online Safety Monitoring System of Tailings Pond (B51108-2015)
- Technical Regulations for the Tailings Pond Safety Monitoring (AQ2030-2010)
- Regulations on Safety Supervision and Management of Tailings Pond (38th order in 2011 by State Administration of safe production supervision and administration, revised in 2015）
- Safety Technical Regulations for Tailing Pond (AQ2006-2005)
- Code for Seismic Design of Hydraulic Structures in Hydropower Projects (NB 35047-2015)
- Design Code for Rolled Earth-Rock Fill Dams (SL274-2001)
- Standard for Flood Control (GB50201-2014)
- Design Code for Spillway (SL253-2000)
- Pre-Feasibility Study Matthews Ridge Manganese Project (G Mining Services Inc., August 2013)
- Feasibility Study on Matsussite Manganese Ore Extraction and Separation Project of Chongqing Bosai Mining (Group) Co., Ltd. (Zhongye Changtian International Engineering Co., Ltd., (2017)

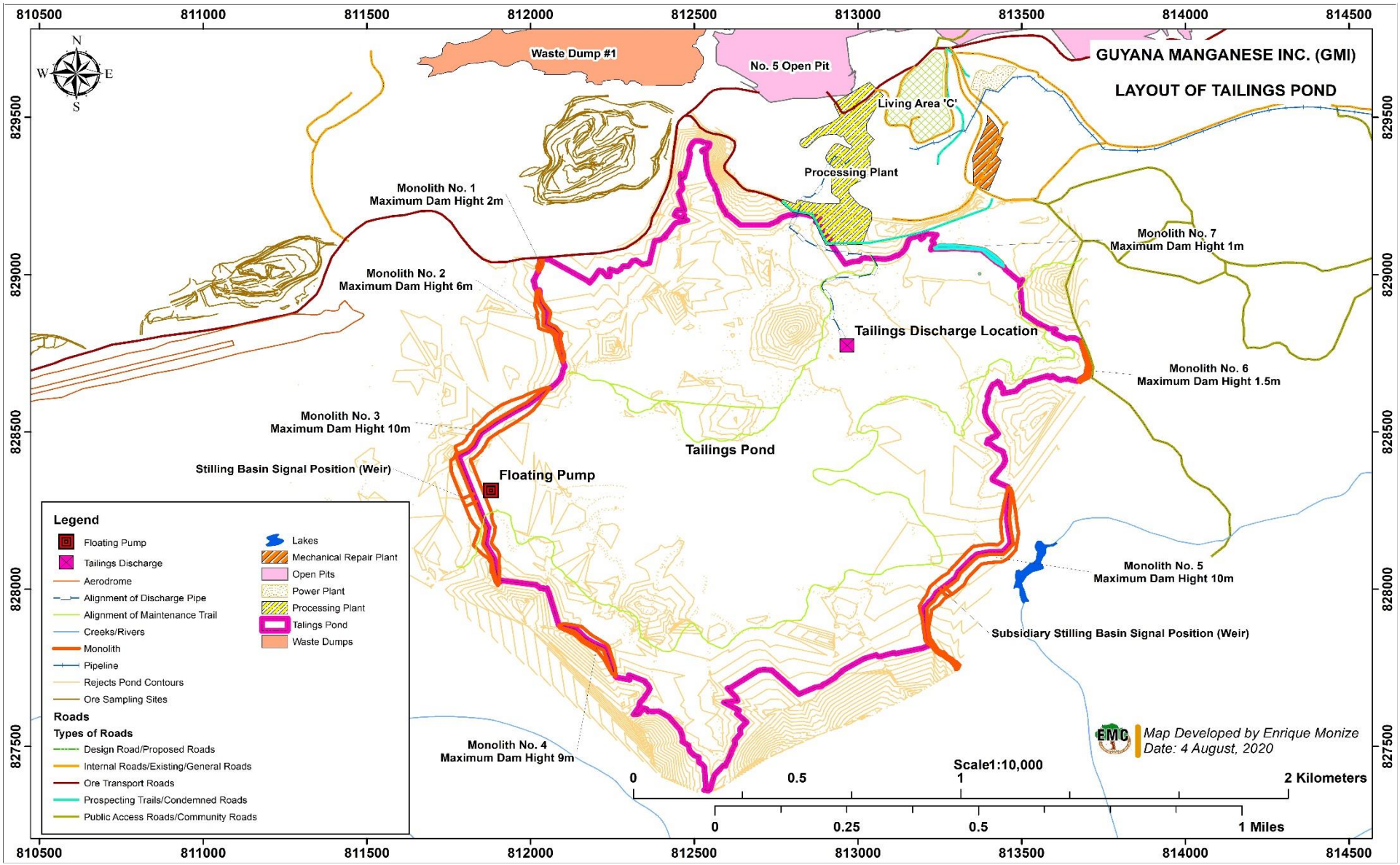


Figure 4-8: Layout of the Tailings Pond

4.10.1.5 Water Supply

Process water will be obtained mainly from two sources, the Pakera Lake and the Tailings Pond.

The Pakera Lake was created to support the previous manganese mining activity by creating a dam across the Pakera Creek, thus serving as a reservoir. A control structure was installed on the dam that released the water from the lake to an area from where it flowed to a pump station, from where it was pumped to the wash plant. The base structure for the old pump station is being utilised. Three electrical pumps are installed, with two operating at any one time and the other serving as a back-up. Each pump has a capacity of 200 cubic metres of water per hour each. It is anticipated that water usage from the Pakera Lake will be mostly during the dry season. At Pakera Lake there will be a complete reconstruction of the dam on the Pakera Lake which has been in a state of disrepair and rehabilitation of the water control structure. The Pakera Lake and the water supply components can be observed in Figure 4-9.

However, most of the water required for processing will be sourced from the tailings pond. GMI plans to reuse as much process water as possible. A barge-mounted floating pump station will be installed in the tailings pond to pump water back to the processing plant. Two electrical pumps would be installed, with one operating at any one time and the other serving as a back-up. Each pump has a capacity of 700 cubic metres of water per hour each. It is anticipated that the tailings pond will be able to completely supply water to the plant throughout the rainy season.

An additional reservoir retaining spring water near to the workshops and powerhouse will provide water for potable and industrial uses. Potable water will be treated prior to use by filtration and chlorination. Rainfall water will be collected in tanks at some locations for domestic and potable use as necessary.

Total daily water demand in cubic metres is 27 for industrial uses; 74 for potable and domestic consumption; and 1,258 for plant processing. Total daily water use is therefore 1,359 cubic metres when the plant is in operation yielding 448,470 cubic metres consumption on a 330 day annual basis.

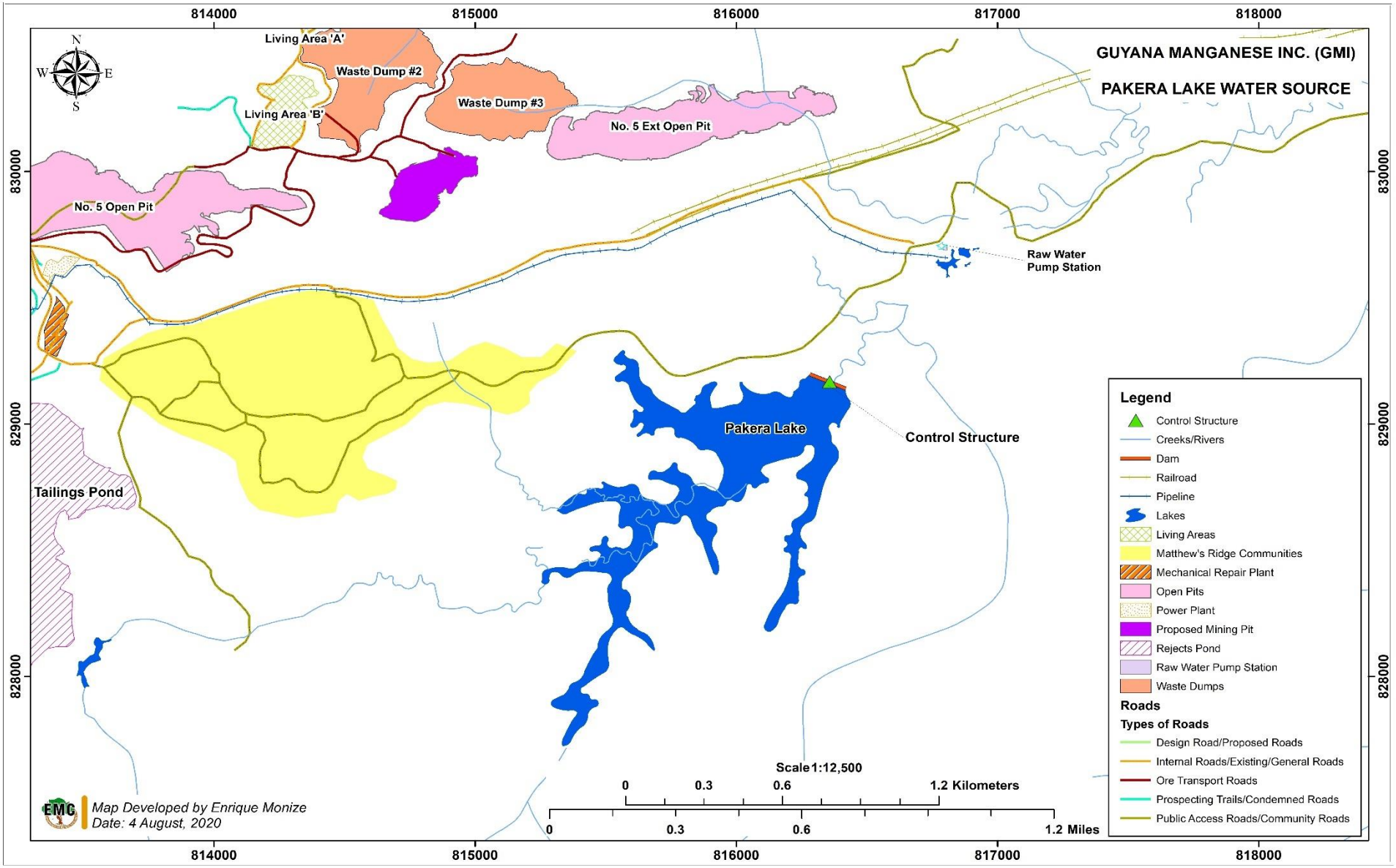


Figure 4-9: Pakera Lake and Water Supply Components

4.10.1.6 Processing Plant

A new process plant is being constructed 200m from the old plant site southwards along the main mine access road. The new plant will occupy a footprint of 1,004 square metres and will be sited on a hillside to take advantage of gravity flow for materials movement in process. Construction of the process plant involves the utilization of aggregates, steel, concrete and the installation of process equipment.

The main features of the plant process installation are rock breaker, pan and vibrating feeders; primary and secondary crushers; wet screen decks with spray installations; conveyors with various sizes; jigs; pumps; air-compressors, motors, bins; tanks, thickeners, fire-fighting equipment and process monitoring and control equipment.

Reticulation for processing will include waterlines for process water, sanitation and housekeeping, and fire control; and cabling for electrical supply and process monitoring and control.

Associated with the plant layout will be the construction of a 200,000 tonne run of mine stock pile and a 40,000 (6400m2*60%*2.5m*4tonnes/m3) tonne concentrate storage yard with a one month surge capacity. The layout of the Processing Plant can be observed in Appendix C2.

4.10.1.7 Transport

The project logistics require the upgrade of current laterite surfaced roads and the construction of a road to the new wharf. These are being done to engineering specifications for safe and efficient concentrate transport, material supply and personnel movement and the continued use of the now public road between Port Kaituma and Matthew's Ridge.

Studies conducted by GMI have identified these options as best suited, considering resource limitation, the project life, and the non-availability of the original railway and the prohibitory high cost of its replacement.

It is envisaged that the project's requirement for continuous road maintenance, particularly in the wet seasons, will present advantages for the Government in relieving it of the resources for road building and maintenance for at least the 13 years of project life. The public should therefore benefit from improved road transport and there could be reductions in local area prices for food and materials.

4.10.1.7.1 Road Transport

Road transport of concentrates to the new Kaituma Wharf site requires the widening and upgrade of the 60km Matthew's Ridge to Port Kaituma road to a maximum width of 8 metres, the installation of culverts and other drainage features, the straightening of curves, the creation of improved sight lines and the installation of safety signage. A new roadway, with similar specifications, will be constructed from Port Kaituma to access the new wharf site on the right bank of the Kaituma Canal. The turn off junction for this road was deliberately chosen to bypass the main community settlement at Port Kaituma. The total carriageway width will be 8 metres for a total distance of 9.7 kilometres.

In addition, the old railway bridge at Eclipse Falls crossing the Barima River will be reinforced with an abutment bridge and refurbished. This will include cleaned-up, significant repair, and strengthened to achieve its original safe and efficient load limits. The structure will be reinforced by building a pillar at 30 meters from the Matthew's Ridge end and a second layer of bailey structure for 42.7 meters long from the Port Kaituma end. The road transport linkage to be utiliseutilised by GMI can be observed in Figure 15-2.

4.10.1.7.2 River Transport

Dredging of the Kaituma Canal will be carried out at a selected location to enable the construction of a turning basin, moorage, wharf-loading facility and manganese concentrates stockyard preparatory to their barging downriver. Dredging will achieve a minimum draft of 4.3 metres alongside the wharf. Materials from the dredging will be used to fill the swamp areas on and surrounding the wharf-site.

The purchase of three (3) 86.8 x 18 x 5.2 metre roll on–roll off (Ro-Ro) ocean-going, self-propelled ocean-going barges will be done to achieve the 500 kilometre water transport of the manganese ore concentrates to Brighton Port in Trinidad and Tobago. The capacity of the barges will be 3,000 tonnes. A restoration of holding areas and river and ocean buoys and lights will be done, under MARAD's guidance, to ensure marine traffic safety. The river transport route to be utilised by GMI can be observed in Figure 15-3.

4.10.1.7.3 Kaituma Marine Terminal

GMI will construct the Kaituma Manganese Terminal, consisting of a turning basin, moorage, wharfage for ocean-going barge loading, weigh-bridge, administrative facilities and storage yard. The Kaituma Marine Terminal will be dedicated to make possible the shipment, via the ocean, of manganese ore concentrates from its mining and processing operations at Matthew's Ridge.

The intended site is at 7° 45' 46" N and 59° 51' 17" W, on the right bank of the Port Kaituma Canal, 5.5 kilometres from Port Kaituma, itself. The site is also reachable by a 9.7 kilometre trail that is being upgraded and widened as a roadway for trucks.

The wharf site and compound will occupy a footprint of 114,000 square meters on a river frontage, with length of 400 metres by 285 metres width. The canal bank will be excavated to allow for space for the turning basin and loading wharf outside of the alignment of the canal to allow undisturbed loading operations. A revetment constructed of steel sheet pilings tied into the bank will stabilize the slope which will have gabion baskets for shore-slope protection. A high-pile wharf construction will be used to attain loading positions for the 3,000 tonne barges.

The compound will be excavated of the soft swamp peats 'pegasse' and silts. Suitable fill materials consisting of sands, loam and laterite would then be placed to be overlain by quarry crusher-run topped off with gravel followed by timber half-logs on the surface.

The wharf will be constructed after the excavation by dredge and excavator of a turning basin into the right bank of the Kaituma Canal at the site. This design was adopted to remove the wharf site operations completely out of the full width of the Kaituma Canal so as to avoid interference with other marine traffic. The turning basin will be trapezoid shaped with a design depth of 5.73 metres. Side slopes of the basin will be stabilized at an angle of 45 degrees with a revetment constructed of geotextile reinforced gabion-stone baskets. The wharf foundation will be constructed of greenheart piles topped by beams and slabs. The greenheart piles will be anchored together in pairs. Steel tube piles will be driven in front of the wharf to form a sheet piling system while anchor piles will be driven on land 20 metres behind the wharf. The enclosed area will then be backfilled with quarry stone crusher run. The backfilled area will be topped with gravel followed by heavy timber planks. Bollard pile clusters and rubber fenders will complete the structure.

The construction will, also include administrative offices, a dormitory, workshop, water and sewage treatment facilities, fuel tanks, generator and transformer. The entire facility will benefit from fencing, lighting and security monitoring. The layout of the Kaituma Marine Terminal is shown in Figure 4-10.

Mobile equipment, in the form of 2 cubic metre capacity front end loaders and 25 tonne trucks, will be on site to manage the stockpiling and load the barges.

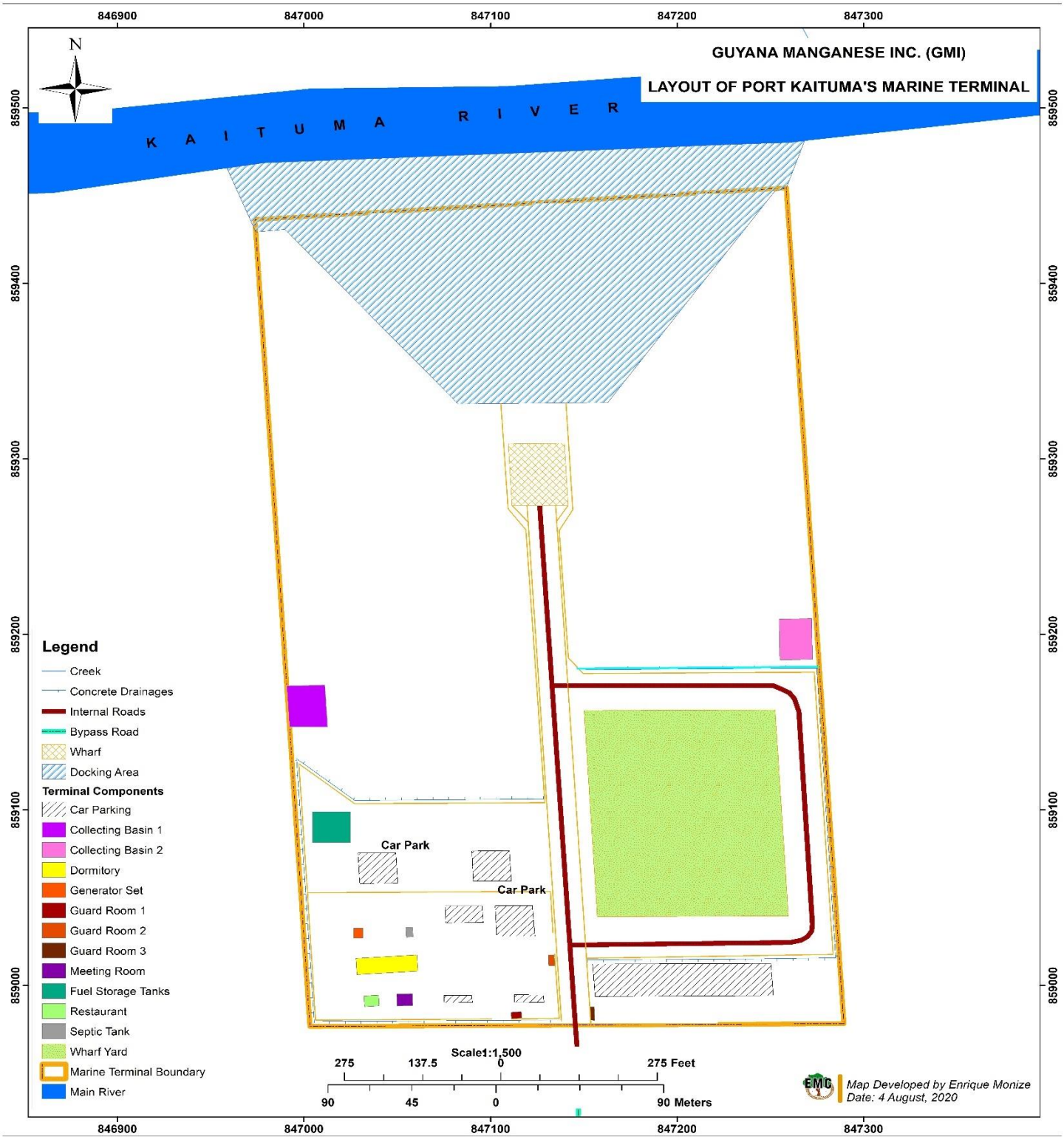


Figure 4-10: Layout of Kaituma Marine Terminal

4.10.2 Mining

Mining will initially be carried out on reserves located on Hill 5, Hill 5 Extension and Hill 9. Open pit mining methods will be employed using tracked and wheeled equipment on a 2 x 12 hour shift basis daily. Pit slopes will be 42 degrees with safety bench widths of 12 metres. Overall void depths will be less than 100 metres on designed Factors of Safety of 1.10. Bench heights will be 6 metres and berm widths will be 5 metres. Minimum working bench widths will be 30 metres. Strip ratios (waste:ore) average 1.5 on annual prime material handling totaling 5 million tonnes.

Mining will be conducted simultaneously in 3 pits and at the tailings pond location in consideration of volumes required, grade variability and the need to reprocess the tailings for recoverable values. The layout of the three pits along with the waste rock dumps are shown in Appendix C6.

4.10.2.1 Waste Removal

Three million annual tonnes of waste will be removed to spoil dumps and backfill areas utilising 2 cubic metre capacity hydraulic mine excavators loading 25 tonne trucks. Waste dumps and backfill sites will be profiled by bulldozer to prevent slippage and soil erosion.

4.10.2.2 Drilling and Blasting

Blasting will not occur in the early years of the mine. Approximately 60% of the rock mass to be mined is saprolite and can be excavated by hydraulic shovels directly. The mining of the other 40% will required blasting to be done. Rock quality designations identified 60 percent of the ore as saprolite and which has easy digging characteristics. The remaining 40 percent is quite hard and would have to be drilled and blasted to allow excavation. One Down-The-Hole (DTH) drill drilling 90 mm holes will be required to achieve the necessary tonnage. Blast design will be in a 3.2m, 2.8m, and 0.6m configuration for spacing, burden and sub-drilling, respectively. Two drills will be acquired which will have the capacity to drill holes angles.

Blasting will utilise emulsion products out of the consideration of wet holes. Controlled blast design using pre-splits, and hole by hole and row by row millisecond delays, initiated by non-electric detonators, will be employed to minimise noise, vibration and fly rock. Annual explosive consumption will be 356 tonnes with 10,890 detonators, 159,720 m Nonel cord and 1,320 exploders.

Blasters will be trained and certified for competence and security. Security oversight and stock verification for explosives and detonators will be done by the GPF who will also secure blasting materials in a magazine facility under 24-hour armed guard.

4.10.2.3 Ore Loading, Hauling and Stockpiling

Ore loading will be done by 5 excavators at separate locations. One excavator will be fitted with a hydraulic hammer to accomplish secondary breaking. Twenty five (25) tonne capacity mine trucks will be used to haul ore to stockpiles. Thirteen trucks would be dedicated to ore handling while twelve (12) would be used for waste removal. It is anticipated that mine recovery will be 95 percent with 5 percent losses. Ore grade of 14 percent manganese, at minus 500 mm sizes, will be dumped into a 200,000 tonne capacity stockpile to achieve a mining rate of 2,000,000 tonnes per year. This stockpile will be located north of the processing plant.

4.10.2.4 Grade and Quality Control

Grade control operations will be maintained, independent of mine management, to assure quality parameters for ore designation. This will be done by mine channel, stockpile and dispatch sampling.

Trained and experienced mine and process samplers will perform these tasks under expert supervision to ensure representative samples for accuracy and reliability of the analysis.

4.10.2.5 Ancillary Mine Operations

Ancillary mine operations such as road building and maintenance; stockpile management; and floor and bench maintenance will be done by three (3) front-end loaders, three (3) tracked dozers and two (2) excavators. Additional equipment for continuous road maintenance includes a jaw crusher; front end loader; an excavator, a grader; a road roller and a water tanker for wetting of the road.

4.10.3 Ore Processing

Processing of ore is designed to produce two product grades: Lump Manganese Concentrate (LMC) at 38 percent Mn, with -19 to +6.3 mm size ranges; and Fine Manganese Concentrate (FMC) at 36 percent Mn with -6.3 to + 0.85 mm sizing.

The ore processing technology that will implemented at Matthew's Ridge has been selected based on the resource mineralogy and extensive metallurgical testing. The manganese mineralogy is variable and complicated throughout the many deposits but could be simplified into two categories – manganese silicates and hydroxides. The primary silicates are braunite ($Mn_6SiO_4O_8$) and spessartite ($Mn_3Al_2(SiO_4)_3$. These minerals have a density (specific gravity, S.G.) of 4.7 and 4.2 respectively significantly higher than gangue minerals such as clay and silica (S.G. 2.5 -2.7). The manganese hydroxide minerals are lighter, but still significantly denser than gangue – e.g. birnessite ((Na, Ca)$Mn_7O_{14}3H_2O$), S.G. 3.3.

The metallurgical testing provided a strong indication that marketable manganese concentrates could be consistently produced using simple clay washing and screening followed by gravity separation. This allows the process to be flexible to accommodate the variable mineralogy and eliminates the consideration of the use of mineral separation chemicals (e.g. froth flotation agents).

4.10.3.1 Crushing and Washing

Ore will be reclaimed from the stockpile using two (2) loaders feeding material through a grizzly with 500 x 500 mm openings. Minus 500mm feed material will be moved by a pan feeder onto a 100 x 100mm vibrating screen whose oversize will go into the primary jaw crusher. Ore would be fed at a head-grade of 14.4% Mn and at minus 500mm sizes. A hydraulic rock breaker would be installed at the crusher to deal with bridging and occasional size reduction required for errant oversize boulders. The crusher will be fed at a rate of 404 tonnes per hour. Plant duty will be for 2 shifts at 12 hours for 330 days annually, with breaks for scheduled maintenance.

Crushed and screened material would then be conveyed into a 2.4x9.6 m long scrubber for scrubbing and washing at 336tph. Scrubber product will be discharged onto a double deck vibrating screen with 21 and 7.0 mm decks recovering -19/+6.3 material. Screen oversize will be routed into secondary crushing by cone crusher. Screen undersize will be further processed on a 0.85mm linear vibrating screen. Minus 0.85 material is pumped to the sedimentation basin.

4.10.3.2 Jigging

The -19/+6.3 and -6.3/0.85 material are routed to separate two and four chamber Batac jigging circuits for the production of LMC and FMC respectively, via process bins. Jigged concentrates will be dewatered on vibrating screens and routed to a 40,000 cubic metre product stockpile separated into LMC and FMC products. Jigged underflows will be pumped to the sedimentation basin.

Products from the jigging circuits will be conveyed out and stored separately on the product stockpiles according to size and grade. Jigging circuits would be fed at a rate of 150 tonnes per hour. Final acceptable product will be LMC grading 38% Mn at -19/+6.3 mm sizing at a yield of 16.84%, and FMC grading 36% Mn at -6.3/+0.85 mm sizes for a yield of 9.52%.

Total plant yield is expected to be 26.36% on a mass basis. The rest of the material consisting of manganese and rock slimes are pumped out as tailings after thickening. Water from the thickeners is flocculated and recycled to processing.

The processing flow sheet is shown in Figure 4-11.

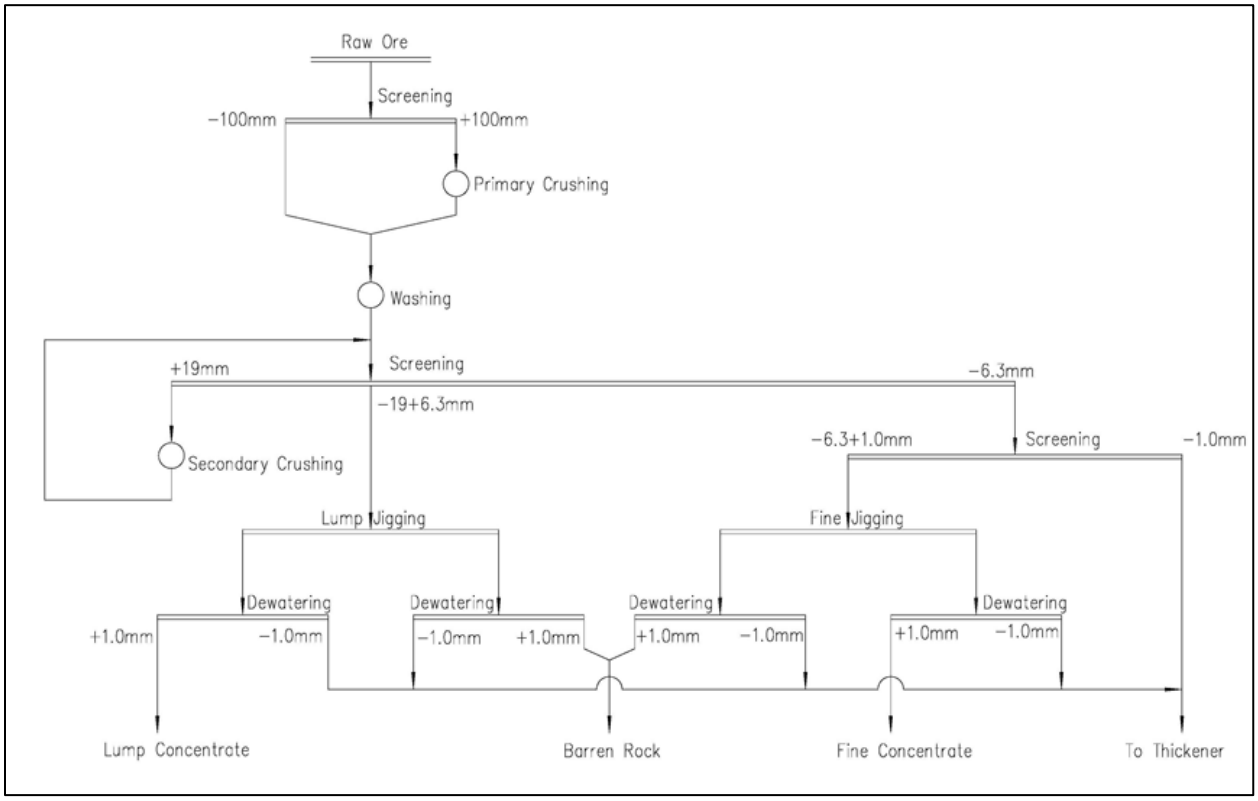


Figure 4-11: Process Flow Sheet

4.10.4 Concentrate Transport and Storage

Concentrates are loaded from the product stockpile by front end loaders onto 25 tonne capacity long-haul trucks and trucked 75 km to the wharf facility and stored according to the two product sizes and grades. Thirty (30) 25-tonne capacity trucks owned by the company, working on a 300 day annual schedule would haul concentrate at a daily rate of 1,700 tonnes on a 3-shift basis. Trained, skilled and disciplined truck drivers would be assigned this task, under constant supervision and monitoring to ensure traffic safety and efficiency.

4.10.5 Barge Loading and Shipping

Three 3000 tonne self-propelled ocean-going barges will be loaded, once per week, to make the 100 km river transit to the Waini estuary, followed by the 400km ocean journey to Brighton Port, La Brea, Trinidad. Barges will be loaded end on by 25 tonne trucks fed by front-end loaders on a 3-shift basis.

Trained barge captains and crews, certified by MARAD will be hired to undertake the barging. GRA customs dispatch and company security inspections will be maintained on a standing basis.

Communications, for safety and progress monitoring, will be made possible by modern instrumentation installed on the barges and at the wharf-site.

4.11 Project Facilities and Equipment

The project facilities and equipment to be utiliseutilised are outlined in Table 4-2.

Table 4-2: Project Fixed and Mobile Facilities and Assets

ITEM	UNIT/CAPACITY	DESCRIPTION
FIXED ASSETS		
Power Station	Six (6) MW	1080kw Units delivering 14.5kv at 60HZ. Operating mode: 4/2 duty/standby operation.
Processing Plant	2 million tonnes ore annually	Crushers, Conveyors, Bins, Scrubber, Pumps; Screening plant, Jigging plant; and Process Control Station. Building 1,008 square metres**.**
Pump Station(s)	3 pumps (200 cubic metres per hour) and 2 pumps (700 cubic meters per hour)	Fresh water pumping station and barge mounted tailings reclaim.
Tailings and Water Management	7 Tailings Dams, 10m high max retaining 2.38km sq.	Reservoir and 9.28 million cubic metres of tailings.
Mine and Mill Shops		Repair and maintenance of operating equipment
QC Laboratory		Preparation and Testing of ore, concentrate and environmental samples by AAS, XRF and gravimetric methods
Stores Building		
Accommodation		For staff, and junior employees totalling 300 during construction and some 200 during operations.
MOBILE ASSETS		
Tracked	6	Bulldozers
	8	Excavators
Wheeled	2	55 tonnes Crane
	30	25 tonnes Trucks
	9	Loaders
	3	Graders
	2	Rollers
	2	Fuel trucks

ITEM	UNIT/CAPACITY	DESCRIPTION
	3	Water trucks
	18	Pickups and SUV
	18	ATV bikes
Barging	3	3000 tonne (86.8 x 18 x 5.2m) Self-Propelled Barges

Workshop

At Matthew's Ridge a mechanical repair workshop will be located 300m to the southeast of the process plant (see Figure 4-3). It will consist of a mechanical maintenance shop, motor vehicle and heavy diesel mechanical maintenance shop, lubricating oil store house, spare parts and metallic material house, separate oxygen and acetylene cylinder storehouse. The location and layout of the workshop and surrounding area can be observed in Appendix C3. A smaller workshop will be constructed at the Kaituma Marine Terminal to maintain and repair ocean going barges, transport trucks, etc. A small workshop may be erected along the Matthew's Ridge – Port Kaituma roadway to service any transport vehicles requiring repairs.

Administrative Area

The administrative office will be located on Hill C. Offices for the various departments such as warehouse, mechanic, engineering, etc. will be located in the compound.

Accommodation

At Matthew's Ridge there will be the management living quarters and workers living area for both expatriates and local workers. The workers living area is arranged in the northeastern side of the processing plant (Hill C). This facility will include sewage systems, water treatment system, rainwater collecting tank, two dormitories, kitchen and mess hall, etc. This accommodation will cater for approximately 200 workers. The management living area is located to the north of the No.5 open-pit, and is an existing facility (Hill A). It consists of 9 houses and approximately 30 persons can be accommodated there. Accommodation for technical personnel is provided in Hill B, which can accommodate up to 70 persons. While the former senior staff housing has been refurbished and upgraded the rest of the accommodation consists of imported pre-fabricated self-contained housing units as the former accommodation from the original 'company-town' have been taken over or gone derelict with the passage of time. The accommodation locations can be observed in Figure 4-3 and layouts are presented in Appendix C5.

Accommodation will also be included for workers at the Kaituma Marine Terminal and will include water supply, sewage system, etc. This accommodation will cater for about 20 persons and the location is shown in Figure 4-10.

Power Plant

At Mathew's Ridge the power plant will be located 250m to the east of the processing plant, near the mechanical workshop (see Figure 4-3). There will be 6 diesel generators with capacity of 1080kW each. It is planned that 4 of the generators will be operating at any one time, with two on standby. The layout of the power plant can be observed in Appendix C4. At the Kaituma Wharf Terminal there will be one small generator of 50 kW, for which the location can be observed in Figure 4-10.

Fuel Supply

During the construction phase diesel consumption is estimated to be around 120,000 liters per month and 930,000 litres during the production phase. Diesel will be transported by vessels to Port Kaituma. Some of the fuel will be stored at this location for use whilst the remainder will be transported to Matthew's Ridge. GMI has two fuel trucks for transporting fuel from Port Kaituma to Matthew's Ridge with a capacity of 20,000 liters each and plans to purchase one or two more fuel trucks with the same capacity in the near future. The fuel trucks will transport diesel from Port Kaituma twice a week in the operation phase. Since the use of gasoline will be minimal GMI intends to purchase this from suppliers at Matthew's Ridge, as is currently being done.

At Matthew's Ridge there will be four diesel storage tanks at the fuel station which are located in close proximity to the power plant. The location and layout of the fuel station can be observed in Appendix C4. Each storage tank will have a capacity of 90,000 liters each. The fuel tanks will be kept within a bund wall, and fire extinguishers, sandbox, and fire hydrant will also be in place. From the fuel station fuel trucks can load the fuel from the tanks to fuel up other vehicles and equipment in the mine. The generators will be supplied directly from the fuel station. At Port Kaituma there will be three fuel tanks. Two of the receptacles will have a capacity of 45,000 liters each, and the other tank will have a capacity of 90,000 liters. These fuel tanks will also be kept within a bund wall, and with fire extinguishers, sandbox, and fire hydrant in place. The locations of these tanks can be observed in Figure 4-10.

Explosive Magazine Storage

The explosive magazine will be stored in a designated facility located north of living area A (see Figure 4-3) and which will store explosives, blasting materials and other accessories. The storage facility will be manned by the GPF. The method of transporting explosives from Georgetown to the site will be based on the advice of the GPF.

Laboratory

A laboratory will be constructed to carry out regular, basic analysis and rapid analysis of internal production samples. The production samples include the raw ore, concentrate, tailings and intermediate products. The laboratory will consist of a crushing room, sample preparation room, filter drying room, drying room, balance and colorimeter room, atomic absorption room, fluorescence analysis room, standard solution preparation room, wet chemical analysis room etc. The laboratory will also be equipped with chemical storage room, equipment storage room, sample storage room, duty room, office etc. The location of the laboratory will be in close proximity to the processing plant and is shown in Appendix C2.

4.12 Project Implementation Schedule

Implementation of GMI's project, beginning with mine site and facility rehabilitation and new mill construction at Matthew's Ridge, through establishment of improved, upgraded roads and new bridges and roads, to the construction of a new wharf with storage and out-loading facilities, and the acquisition of a barge fleet will occupy the period from November 2017 to October 2020. Site preparation and construction works have commenced at both Matthew's Ridge and Port Kaituma and are guided by Construction Permits issued by the EPA in August 2019.

Critical to the achieving of the overall schedule is the timely project approvals from national agencies. These include the Guyana Geology and Mines Commission (GGMC) for issuance of the Mining Lease and approval of the Mine Plan; the GLSC for issuance of the wharf-site land lease; MARAD for wharf, dredging and barge approvals; EPA for EIA review, acceptance and issuance of environmental authorization; GRA for review and acceptance of concentrate export verification; and the Region One

RDC and the Matarkai NDC acceptance of the project. A breakdown of the critical activities is presented in Table 4-3.

Once mining has commenced, based on current reserves, it is expected to last for 13 years. Figure 4-12 depicts the Annual Output Development Curve of the mine. The #5, #5ext, #9 open-pits and the tailings will be mined in the years 1 to 7. After year 7 the #8, #7, #3 and #1 open-pits will be mined sequentially. In the second year, the mining production capacity will reach 2 million tons ore per year. The stable period with this level of production per year is expected for 11 years, then a decrease in the last year of the mine life. The sequence of mining throughout the mine line is outlined in Appendix C1.

Table 4-3: Project Implementation Schedule

Activity	2017				2018				2019				2020				Remarks
Quarter	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	
Mine and Plant Site Clean-Up																	Completed
Engineering Designs & Feasibility																	Completed
Acquisition of Mobile Equipment																	On-going
Rehabilitation of Buildings																	Completed
ESIA Review and Upgrade																	On-going
Acquisition of Construction Materials																	On-going
Accommodation & Mess Construction																	Completed
Construction Crew Hiring																	Completed
Construction of Process Plant																	On-going
Dam-site and Water Structures																	On-going
Power Generation Installation																	On-going
Power, Water and Sewage Lines																	On-going
MR to PK Road/Bridge Building																	On-going
PK to Wharf-Site Road Building																	Completed
Wharf-Site Dredging and Construction																	Imminent
Kaituma Canal and River Dredging																	Not required in 2020
Mora Passage to Waini Dredging																	Not required in 2020
Laboratory Outfitting																	On-going
Mine Shop Outfitting																	On-going
Operations Personnel Hiring																	Suspended
Acquisition of Ocean Barges																	On-going
Operations Personnel Training																	On-going
Explosive Shipment and Blasting																	Not required in 2020
Onset of Mining																	October
Plant Trials and Start-Up																	October
Project Commissioning and First Shipment																	November

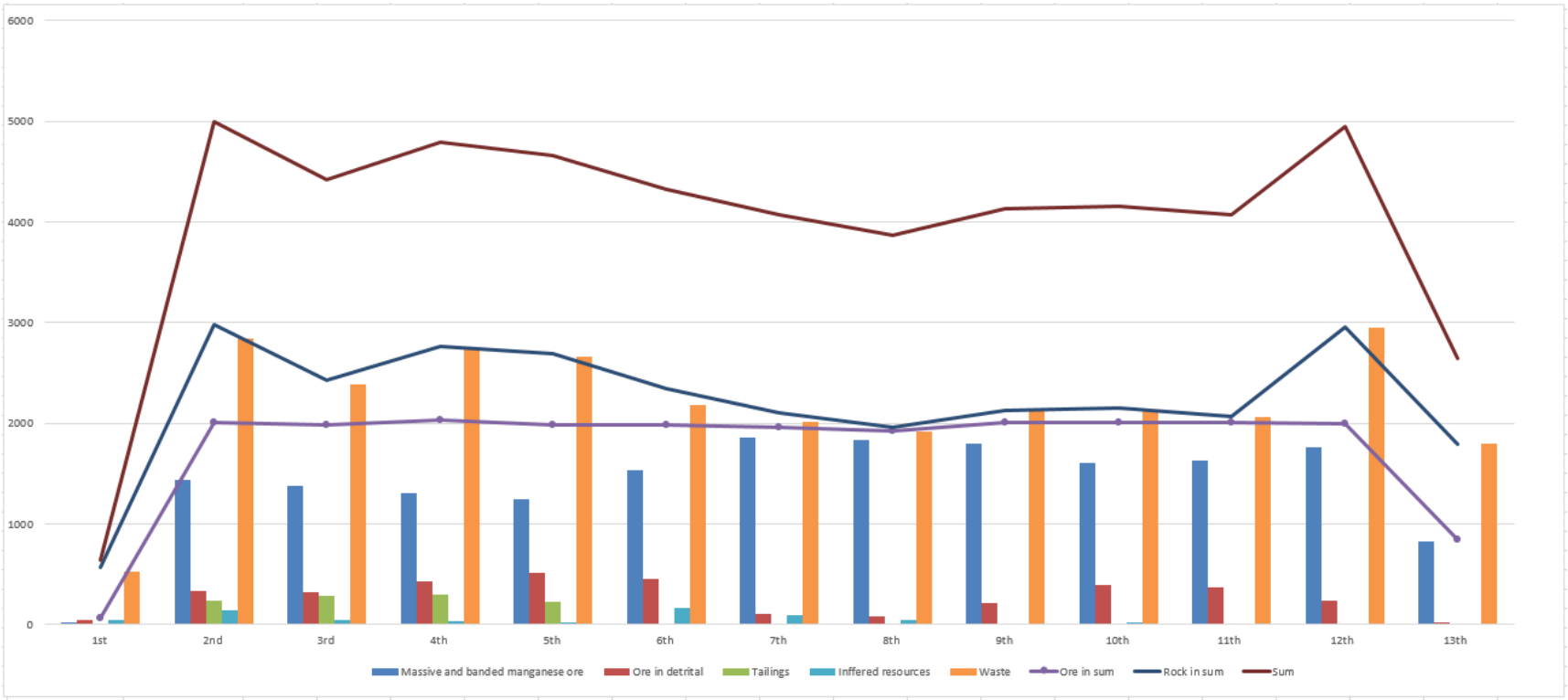


Figure 4-12: Annual Output Development Curve of Mine (Kilotons)

Chapter 5 - Project Alternatives

5.1 Introduction

This chapter describes and assesses the alternatives considered during the planning and design phase of the project and indicates the justification of the preferred options. The key principles in considering alternatives were to minimise the environmental footprint as much as possible and to increase efficiency of operations. Alternatives considered include:

- No project
- Siting of Project Facilities
- Ore Transport from Mines to Processing Plant
- Concentrate Transport from Matthew's Ridge to Port Kaituma
- Ore Shipping
- Dredging of Shipping Waterways
- Use of Explosives
- Ore Washing Process
- Reuse of Process Water
- Tailings Pond Construction
- Tailings Discharge
- Access Road to Airstrip

5.2 No Project

The no project scenario was considered during the preparation of this EIA. This alternative means that the project would not be executed. Preparation to commence manganese mining in Region 1 started in Matthew's Ridge in 1954 with the establishment of a thirty (30) mile railway with adjacent roadway, and a bridge over the Barima River at Eclipse Falls; the creation of the mine site at Matthew's Ridge with the associated similarly named 'company town'; and the establishment of mine buildings and a processing plant to allow first shipments in 1961[16] via Port Kaituma, where shipping facilities were established, including the Kaituma Canal. However, the operation ceased in 1968 due to a fall in the price of manganese on the international market and the facilities were reverted to the Government of Guyana by the Company and were kept on a 'care and maintenance' basis for several initial years while agricultural projects were undertaken[17].

The infrastructure progressively deteriorated and with the end of rail movement there was loss of rails and other assets and rolling stock. This resulted in a decline in socio-economic activity in the Matarkai sub-region. This was later alleviated to some extent with the upsurge in gold mining at the small scale level and which continues up to the present time. Throughout the years there has been the take-over of mining, building and operational sites and facilities, both at Matthew's Ridge and Port Kaituma.

Remnants from the previous manganese mining operation including the abandoned buildings, old wash plant, abandoned mines, roads and other infrastructure remain in some areas. The community of Matthew's Ridge itself is somewhat in a depressed state with a general lack of development, employment, services, etc. If there is no project these challenging conditions are likely to remain. Furthermore, the valuable manganese ore will remain in place, depriving the Government of significant potential earnings.

Implementation of the project could realise several positive impacts, including a clean-up, and rehabilitation of old mine infrastructure and facilities, employment and training for community members, improved services and infrastructure, revenue earnings by the Government, etc. However,

[16] Geological Survey of British Guiana Annual Report 1968, Page 18
[17] Compiled based on information from GMI April 2020 Revised Project Summary – Section 2.0

negative impacts could also occur, especially if management and mitigations measures are not fully implemented. These impacts are described within the EIA. If there is no project then the major positive and limited negative impacts to be associated with the project will not be realized.

The economic feasibility of the GMI Project is supported by market assurance, a critically important factor for the sustainable production of the manganese mineral concentrate. The mining, processing and transport strategies are based on simple, economical and efficient methodology, without compromising safety, security and environmental management.

There is no significant positive impact expected to be derived from the No Project alternative. The remnants from the previous manganese mining operation including the abandoned buildings, old wash plant, abandoned mines, roads and other infrastructure will remain and continue to deteriorate, the community of Matthew's Ridge will most likely remain in a depressed state with a general lack of development, employment, services, etc., and the valuable manganese ore will remain in place, depriving the Government of significant potential earnings. As such, the "No Project" scenario is expected to maintain the baseline conditions for environmental, biological and ecological, and social resources as discussed Chapters 8 to 21 of this EIA. Table 5-1 summarises the potential impacts of the "No Project" Scenario as well as the potential impacts of the Project.

Table 5-1: Potential Impacts of the "No Project" Scenario and Project Implementation

Thematic Areas	Anticipated Impacts of 'No Project Scenario"	Anticipated Project Impact
Government revenues (taxes, royalties, permit revenues).	No additional revenues to be accrued to the Government.	The project will significantly and positively contribute to increased revenues to the Government in the form of taxes, royalties and permit fees. In turn, these revenues are expected to be invested into the development of the country as a whole and Region 1 in particular.
Environmental Resources	Environmental resources are expected to remain unaltered in the "No Project Scenario" as compared with the baseline conditions discussed in: ▪ Chapter 8 – Water Resources ▪ Chapter 9 – Soils and Geology ▪ Chapter 10 – Air Quality ▪ Chapter 11 – Climate and Climate Change ▪ Chapter 14 – Noise and Vibrations ▪ Chapter 16 – Hazardous Wastes and Other Waste Management ▪ Chapter 17 – Landscape and Aesthetics	Potential impacts of the Project activities on physical environment are discussed in detail in the listed Chapters. In general, the Project is expected to negatively impact some of these resources including surface water quality, ambient air quality, noise and vibrations and climate change. However, the significant majority of the potential impacts pose low or medium risks and can be adequately managed or mitigated. The project is also expected to have significantly positive impacts on the physical environment. In particular, project activities would clean up and replace or rehabilitate derelict infrastructure. In addition, mining activities and subsequent rehabilitation will recontour abandoned open mining pits and overburden dumps so as to facilitate natural revegetation or any

Thematic Areas	Anticipated Impacts of 'No Project Scenario"	Anticipated Project Impact
		other land use to be determined. Cleaning up of remnants of industrial solid waste at the Project site will also be a positive impact. In so doing, the Project would contribute to improving safety of the brownfield as well as to improve aesthetics, particularly following proper rehabilitation.
Biological and Ecological Resources	The baseline conditions of biological and ecological are anticipated to remain unchanged in the "No Project Scenario" based on the baseline conditions discussed in Chapter 12 – Biological and Ecological Resources.	Potential impacts of the Project to biological and ecological resources are invariably negative. However, management and mitigation measures could be put in place to address these impacts and minimise their effects on biological and ecological resources. A detailed discussion of the potential impacts to these resources are discussed in Chapter 12.
Socio-Economic Resources	The socio-economic conditions at the project locations are expected to remain largely unchanged in the "No Project Scenario". The primary areas where marginal changes may have occurred include few new additional opportunities for employment may be created in the gold mining industries and expansion of road infrastructural development and maintenance via Government funded projects. In general, most of the baseline conditions outlined in the following Chapters are expected to remain mostly unchanged: ▪ Chapter 13 – Ecosystem Services. ▪ Chapter 18 – Cultural Change. ▪ Chapter 19 – Socio-Economic Environment. ▪ Chapter 20 – Health.	The Project is expected to have several significant positive impacts on employment, improvements of local transportation infrastructure, indirect employment and fence line development as well as local community development. However, negative impacts to socio-economic resources are also anticipated including potential pressures on the public services such as health, housing and security. Several mitigation and management measures could be deployed by the Project to address these potential impacts. A Stakeholder Engagement Plan and a Grievance Mechanism will also be developed by the Project. The Project required resettlement of residents and a few livelihood activities in both Matthew's Ridge and Port Kaituma. All resettled persons were fairly compensated and third-parties, including the NDC, observed the resettlement process. Detailed discussions of the socio-economic impacts of the Project are found in the listed Chapters.

Thematic Areas	Anticipated Impacts of 'No Project Scenario"	Anticipated Project Impact
	▪ Chapter 21 – Land Acquisition, Resettlement and Livelihood.	

5.3 Siting of Project Facilities

At Matthew's Ridge the current project utilises much of the footprint and infrastructure of the previous manganese mining, processing and shipment undertaking which was in operation during the early 1960s. Consideration was given to utilising all of the previously used areas for similar purposes, which would reduce the current project footprint. However, this was not possible for the processing plant. A new processing plant will have to be constructed since the old plant is corroded, dilapidated and beyond repair, and there is some squatting encroachment on the previously used ore stockpile and waste disposal areas. This option will see an increase in the project footprint, but will also ensure the new plant is constructed in a modern and safe manner, and minimising the need to relocate persons. This option will also see a shorter transmission of tailings to the tailings pond, shorter distance for water supply, and will result in less excavation during construction.

At Port Kaituma consideration was given to utilising the old concentrate storage yard and shipping terminal. However, this area is quite congested since it is the hub of the commercial activities at Port Kaituma and would present many challenges to utilise, including relocation of persons and businesses, safety concerns presented by both land and river traffic, inadequate land space, etc. As such it was decided to relocate to a new site 5.5 kilometres downstream from Port Kaituma and on the right bank of the canal to avoid the congestion, encroachments and inevitable disputes, which would occur once there is any effort to re-occupy the original dedicated Port Kaituma site and facilities. Relocation to the new site has minimal impacts, mainly relating to the relocation of a few persons who were living and farming at the location.

5.4 Ore Transport from Mine to Processing Plant

For the transport of ore from the mines to the processing plant three options were considered. These are outlined below:

- **Option 1: Truck Haulage System** - The ore and waste are loaded to dump trucks and transported via mine roads to ore stockpiles for the processing plant and to waste dumps respectively.

- **Option 2: Truck plus semi-fixed Crushing Station plus Belt Haulage System** – Given that the ore strike is approximately 13km an ore haulage conveyor belt is laid out connecting each mine to the processing plant. The mined-out ore is transported by trucks to a semi-fixed crushing station established outside of each open pit and then to the processing plant by conveyor belt. The waste is transported to the waste dumps directly by trucks.

- **Option 3: Truck plus Railway System -** Since the manganese concentrate was transported to Port Kaituma by railway during previous mining operations, the former railway roadbed within the mining area can be utiliseutilised and upgraded. The mined-out ore from the pit is transported to the nearest railway station to each mine by truck and then to the processing plant by railway. The waste is transported to the waste dumps directly by trucks.

Though Option 2 has the advantage of low transportation cost the initial construction investment is high and with a longer construction period. Also, the high silt content of the ore poses adverse effects on belt haulage. Option 3 also has low transportation cost and is hardly disturbed by weather condition. However, the higher initial investment, longer construction period and higher requirement for management precludes Option 3 from being the optimum choice. While the transportation cost of Option 1 is high, the production scheduling is much easier. In addition, the former mine roads can be utiliseutilised which will save initial investment, reduce the project's environmental footprint and shorten the construction and production period. In addition, the truck transportation system is well suited for mines which have de-concentrated mining sub-areas where the life is short for each mining sub-area, as is the case with GMI project. As such, Option 1 has been selected as the preferred haulage system.

5.5 Concentrate Transport from Matthew's Ridge to Port Kaituma

Consideration was given to utilising a narrow-gauge railway, as was previously done, to transport the manganese concentrates from Matthew's Ridge to Port Kaituma. This would have been an efficient transport option when rebuilt. However, given the unavailability of the original railway, the high cost of replacement, and considering the fairly limited resources and project life, this option was considered not feasible. Instead, the current existing road between Matthew's Ridge and Port Kaituma will be utilised. The project logistics require the upgrade of the current laterite surfaced road to more exacting engineering specifications for safe and efficient concentrate transport, material supply and personnel movement as well as use by the general public. It is envisaged that the project's requirement for continuous road maintenance, particularly in the wet seasons, will present advantages for the Government in relieving it of the resources for road building and maintenance for at least the 13 years of project life. The public should therefore benefit from improved road transport and there could be reductions in local area prices for food and materials.

The current road link from the processing plant at Matthew's Ridge to the Port Kaituma roadway is through the Matthew's Ridge community. This was initially considered an option for the company to transport the concentrates, with an upgrade being done to the road and bridge through the community. However, given issues of safety, dust generation, and damage and maintenance of infrastructure, this option was ruled out. These concerns were also raised by community members at the Public Scoping Meeting held at Matthew's Ridge for the EIA. As such, GMI has decided to construct a road from the wash plant, following the alignment on the water supply pipeline, and linking Matthew's Ridge to the Port Kaituma roadway in the vicinity of the pump house. This option will alleviate the concerns associated with traversing through the community. Figure 5-1 shows the current road through the community and the road constructed by GMI for their use.

At the Port Kaituma end consideration was given to utilising the Matthew's Ridge - Port Kaituma road passing through the community to access the Kaituma Marine Terminal. However, similar to Matthew's Ridge, there were concerns regarding safety, dust generation, and damage and maintenance of infrastructure. These concerns were also raised by community members at the Public Scoping Meeting held at Port Kaituma and during engagements with the NDC. As such, this option was ruled out. GMI instead decided to construct a new roadway from the Matthew's Ridge - Port Kaituma road, for a distance of 9 kilometres to access the new wharf site on the right bank of the Kaituma Canal. The turn off junction for this road was deliberately chosen to bypass the main community settlement at Port Kaituma. This will eliminate the concerns associated with traversing through the community and using the community road. Figure 5-2 shows the current roads leading to the community and the road constructed by GMI for their use to access the Kaituma Marine Terminal.

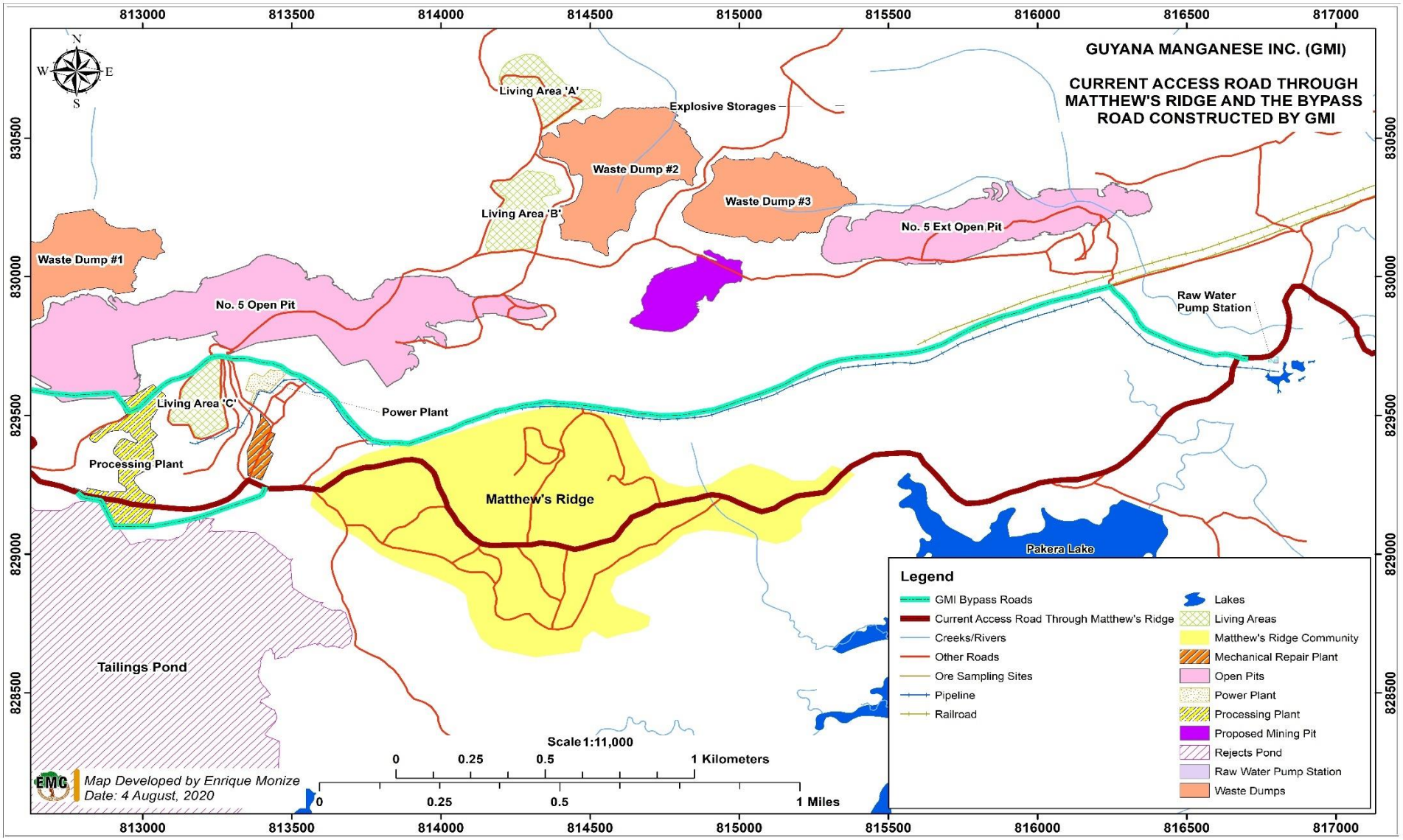


Figure 5-1: Public Road through Matthew's Ridge and Bypass Road Constructed by GMI

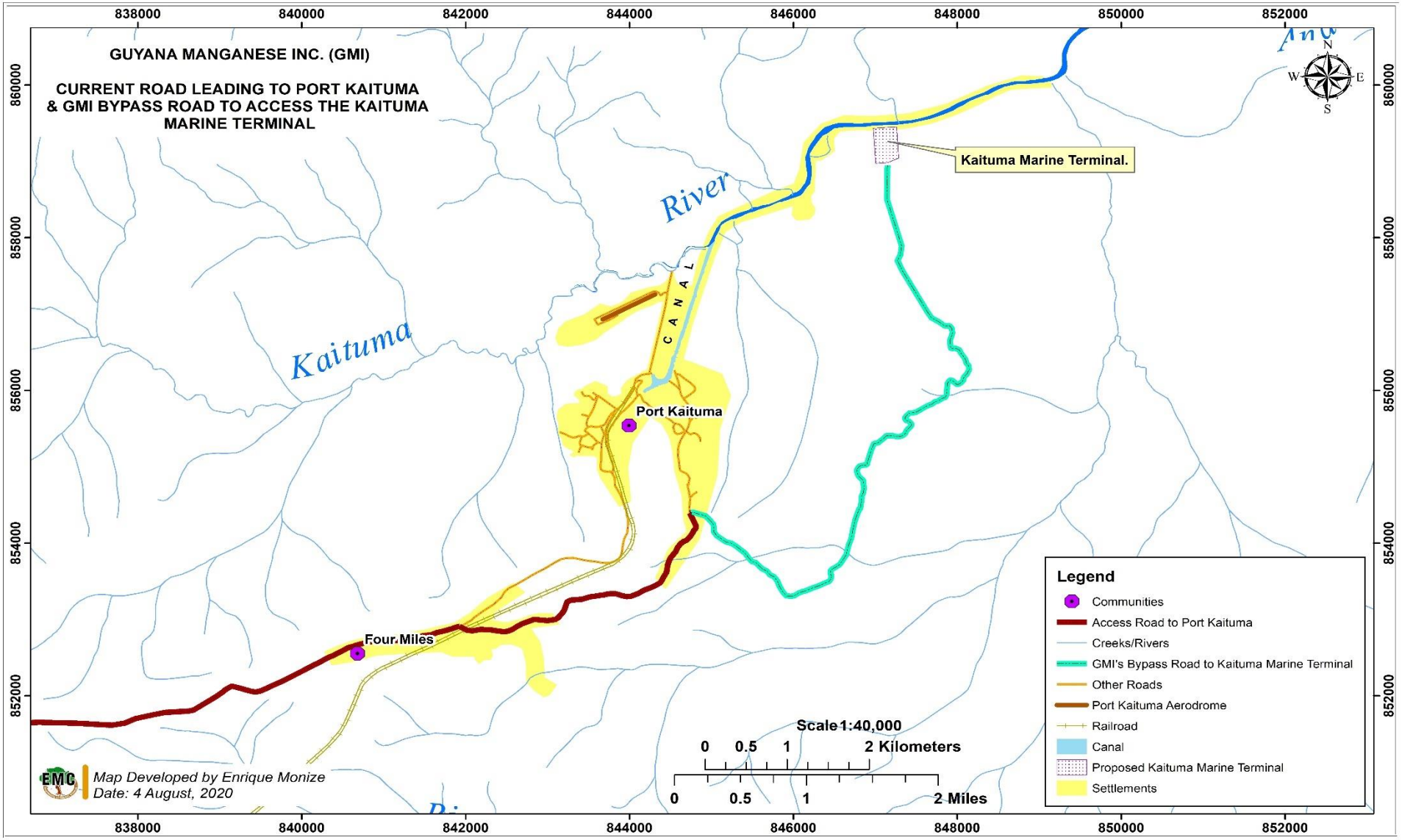


Figure 5-2: Public Roads Leading to Port Kaituma and Bypass Road Constructed by GMI

5.6 Ore Shipping

Three options were considered for the shipping of the manganese concentrates from the Kaituma Marine Terminal to the market or processing facility. These are outlined below:

- **Option 1: Shipping of the concentrate by barge to the mouth of the Berbice River** where a trans-shipment facility exists and which is being utiliseutilised by Bauxite Company of Guyana Inc. (BCGI) to transship its bauxite from barges to ocean going vessels.
- **Option 2: Shipping of concentrate by barge to the mouth of the Waini River** where GMI will establish a trans-shipment point from where the concentrate will be transferred to ocean going vessels.
- **Option 3: Ocean-going barges** will transport the concentrate directly from the Port Kaituma Marine Terminal to Brighton Port, La Brea, in Trinidad.

Option 1 was ruled out given the considerable distance from Port Kaituma to the mouth of the Berbice River. In addition, GMI would have had to work out an arrangement with BCGI to utilise this facility. Option 2 was also ruled out since a trans-shipment facility would have had to be established at the mouth of the Waini River, an additional cost to GMI. In addition, this option could have resulted in more environmental and safety risks, and the location would also be close to the Shell Beach Protected Area. Both Options 1 and 2 would have resulted in double handling of the concentrate which would have increased costs. As such, Option 3 was selected, given that it is the cheaper option, easier to execute, and would result in less environmental and safety risks.

5.7 Dredging of Shipping Waterways

Consideration was given to dredging of the Kaituma River and the Mora Passage access from the Barima River to the Waini Estuary to improve marine draft so as to improve transport logistics and facilitate the passage of the 3,000 tonnes laden barges. It was envisaged that this would utilise two dredges with an hourly capacity of 1,000 cubic metres operating on a 20 hour basis. This would have resulted in disturbance of the bed of the waterways and depositing of spoils on the banks, and would also incurred significant cost to GMI. Dredging of the Mora Passage to the Waini Estuary would also require the removal of approximately 500,000 cubic metres of spoil to be dumped mainly to flushing beyond the Waini Bar into the Atlantic Ocean. GMI decided to forego this plan and instead to load the barges with an amount of concentrate which will enable them to traverse the waterways using the existing draft, and scheduling trips to coincide with high tides. While this option may result in less concentrate being transported per load, it will result in savings to GMI and avoidance of environmental impacts associated with dredging.

5.8 Use of Explosives

During mining operations, once the softer materials are removed over the initial years, harder rocks will be encountered which will require disintegration to recover the ore. GMI considered the use of explosives or excavator-equipped jack hammers for this task. If jack hammers are to be utiliseutilised several will be required for continuous use and will be less effective in ensuring optimum productivity. There will also be continuous noise generation and safety risk to operators.

GMI has instead decided to utilise explosives to conduct blasting. The use of explosive will ensure maximum output and productivity. Explosive are currently being used in Guyana's mining sector and is heavily regulated with established procedures and requirements for the transport, storage and use which GMI would comply with. While the use of explosives could increase safety and environmental

risks these could be managed with tight security with and blasting being conducted by certified personnel.

5.9 Ore Washing Process

In selecting the processing plant, a jig option and a heavy media separation (HMS) option were considered. The HMS process depends on density to separate ores and gangue minerals. The recovery of the fine magnetic (magnetite) medium separated from product and the cost of magnetic medium are two concerns with this method. The jig system processes without magnetic medium loss and has low operating costs. In addition, the various parameters of the jigging process can be adjusted quickly. As such, after comprehensive consideration, the jig process was determined by GMI to be more suitable for the project.

5.10 Reuse of Process Water

GMI considered the options for both reuse and discharge of process water from the processing plant. Discharging the process water is the cheaper option since no treatment will be required. However, this will result in more water to be managed in the tailings pond and may also affect the water supply for the processing plant since the Pakera Lake is the main source of water and the recharge rate is heavily dependent on rainfall. As such, this option was ruled out.

GMI opted for recirculation of water so as to reduce the usage of water from the Pakera Lake and also reduce the pressure on the tailings pond since there will be less water to be managed. It will also guarantee a steady water supply for the project. However, it could result in a slight additional cost to GMI since the recirculated water will need to be treated by a flocculant prior to use. The tailings will be separated in the concentration basin by the use of flocculant and the concentrated residue will then be pumped to the tailings pond and the clean water recirculated for use. The flocculant that GMI plans to use in operation is anionic polyacrylamide which is commonly used in water treatment and it is estimated that the annual usage will be 50 tonnes. In addition, the backwater from the tailings pond will be pumped back to the processing plant for the usage by the jigging machines, rather than being discharged into the environment.

5.11 Tailings Pond Construction

In designing the project GMI considered the option of utilising the existing tailings pond rather than constructing a new tailings pond. This would have resulted in a slightly smaller footprint of the project. However, the structures of the old tailings pond have deteriorated and would require rebuilding. In addition, there is a significant amount of tailing material already within this pond, some of which is economically recoverable. The efficiency of moving materials between the processing plant and supplying water from the tailings pond to the processing plant was considered from the outset in selecting the location of the processing plant relative to the old tailings pond. These were the key factors which influenced the site selection of the tailings pond. In the period since the closure of the historic operations, persons have also encroached on the edges of the existing tailings pond by establishing small residences and farmlands but GMI has ensured that resettlement of these activities would be feasible prior to the final decision on the location of the tailings pond.

GMI has taken the decision to build a new tailings pond to the east and west side of the current tailings pond. This new tailings pond will have a capacity of 11.6 Mm^3 (million cubic meters) and equipped with spillways and stilling basins. The new tailings pond is designed to contain all the tailings over the life of the project and would be safer since it would have better capacity to manage and contain tailings,

and allowing for the recovery of water for reuse. More so, this option will allow for the manganese-rich resource present at the north edge of the old tailings pond, estimated to be 1,035,900 tonnes, to be recovered and processed.

5.12 Tailings Discharge

Tailings are to be deposited in a conventional manner – end of pipe discharge at 40% solids into the tailings pond. Optional tailings management strategies could include:

i. Discharge as a thick slurry- e.g. 60-70% solids. The benefits include a reduction of the tailings facility footprint, and the reduction of sand-slimes segregation in the tailings facility. The disadvantages of this would be the creation of eroding mounds of tailings and the high cost of producing the thick slurry and pumping to discharge locations.

ii. Dewater by filtration and dispose tailings by truck transport. The benefits of this strategy would be the creation of stacked tailings and the creation of a smaller tailings facility imprint and the enhanced recovery of process water. The disadvantages of this are significant – filtration of clay-containing material would be extremely costly, stacked tailings would be unstable and eroding in rainstorms, and this would leave an eyesore structure on closure.

iii. In future years, a portion of the tailings could be disposed into mined out pits. This would reduce the amount and footprint of tailings in the engineered facility. Disadvantages include the potential isolation of future resources in the pit base and walls and the generation of unconsolidated tailings slurry in a confined space which would represent a risk to people and wildlife.

None of these options represent economical or environmental benefits.

5.13 Airstrip Access Road

The existing access road to the Matthews Ridge airstrip and the communities further west passes very close to GMI's processing plant compound. Currently, vehicles of the community and the company use the same road leading to the airstrip. GMI considered upgrading this road, including resurfacing, widening and installing the necessary safety features such as signage. However, this would still result in the shared use of the roadway by the company and residents and which could present safety risks and congestion. This could be exacerbated during operation with the movement of mine haul trucks on the roadway as GMI commences mining at the deposits west of the processing plant.

Given such a scenario, GMI has decided to build a bypass road for community use and which bypasses the company operations. This will avoid congestion and minimise the safety risks that residents of the community may face if they continue to utilise the existing road. The new road which GMI has already constructed is much more improved than the existing roadway. In addition, there is a bypass road which is currently being constructed for trucks and other company traffic traversing to and from the Hill 9 mine. This will reduce the exposure of public traffic to GMI's traffic for another section of the road which leads to the airport. This rerouting of the access road and the bypass being constructed by GMI can be observed in Figure 5-3.

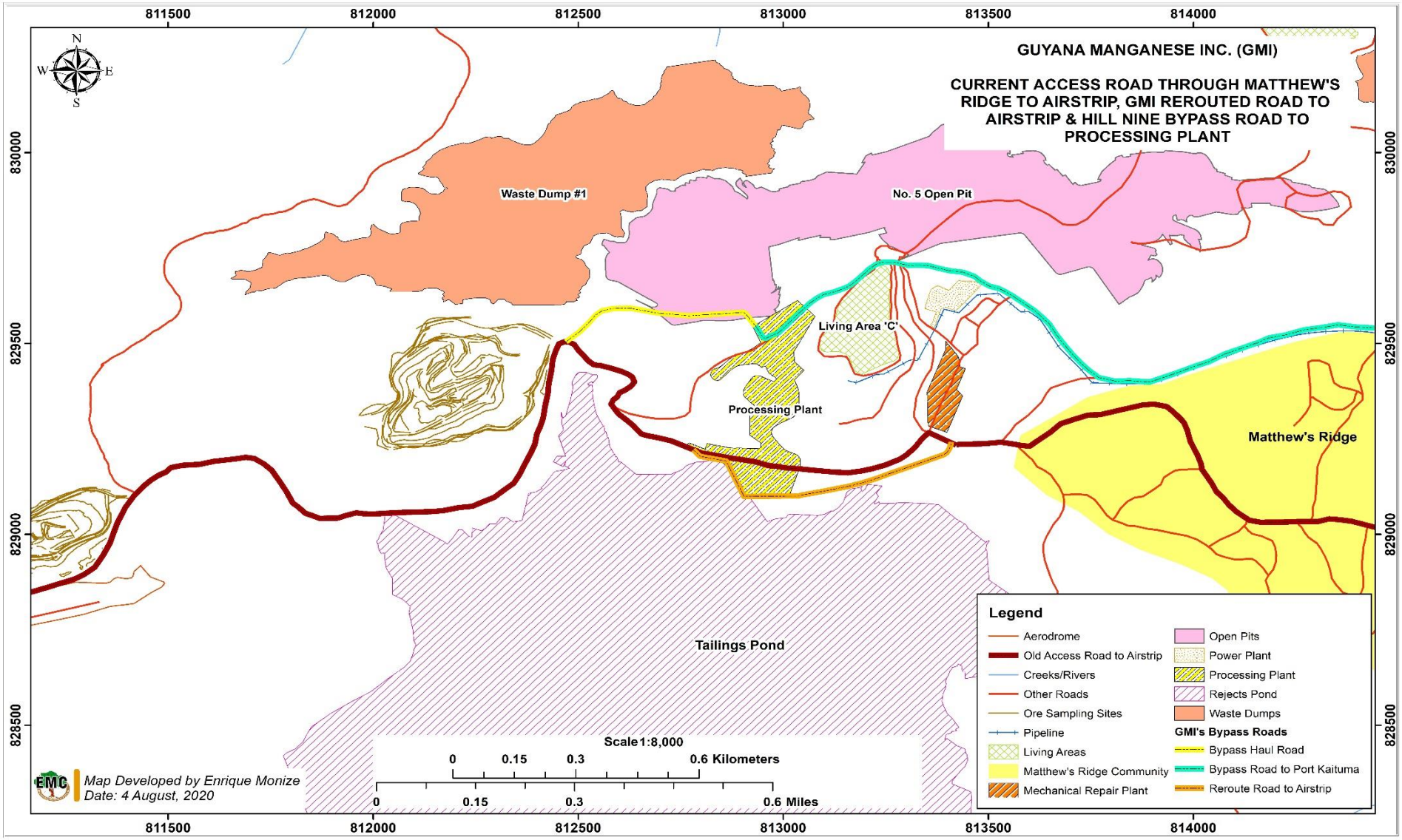


Figure 5-3: Old and Rerouted Access Road to the Airport and Bypass Road to Processing Plant from Hill 9

Chapter 6 - Stakeholder Identification and Consultation

This chapter introduces the process and strategy which guided stakeholder engagement throughout the preparation of the EIA. It also outlines the processes for identifying and engaging with stakeholders and presents the feedback and areas of concerns identified by these stakeholders for consideration in the EIA. It also presents an indication as to how these were addressed by the EIA.

6.1 Stakeholder Engagement in EIA Preparation

Stakeholder engagement in EIA preparation is a statutory requirement and is embedded in the Environmental Protection Act (1996). Indeed, Part IV of the Act makes provisions for the developer and the EIA preparation team to consult with members of the public, interested bodies and organisations. In addition, the Act outlines the specific timeframes for some of the steps of stakeholder consultations in the EIA preparation process. Prior to commencing preparation of the EIA, the Act requires the EPA to publish in at least one daily newspaper a notice of the project and make available a Project Summary to members of the public. This public consultation period lasts for a period of 28 days. The next statutory timeframe for public consultation occurs after the draft EIA has been submitted to the EPA. As part of this process, a notice is published in the newspapers that the draft EIA has been submitted and members of the public have 60-days to provide feedback on the draft document. Finally, the Act also requires the developer and the EIA team to provide members of the public, on request, copies of information obtained for the purpose of the EIA.

Apart from these statutory requirements, the EIA team considered stakeholder engagements as a critical element of the EIA preparation process. From the scoping period, stakeholder engagement supported the identification and assessment of potential impacts and the development of measures to mitigate these impacts. Stakeholder engagements were also a key component of managing the project risk because it familiarized local and central stakeholders of GMI's activities, the measures being undertaken to protect the environment, to provide a platform for concerns to be raised and to lay the foundation for a positive relationship between GMI and the local communities. Although affected by the COVID 19 pandemic, with the national restrictions instituted and the need to take all the necessary precautions, stakeholder engagement was done continuously throughout the EIA preparation process and it is recommended that this should continue during the implementation phase of the project.

6.2 Stakeholder Engagement Strategy

Stakeholders for the GMI project are diverse and generally, comprise local communities, national, regional and local government authorities and civil society organisations. The overall purpose of the stakeholder engagements was to build awareness of the GMI project and provide a platform for stakeholders to share their feedback throughout the EIA preparation process. The specific objectives of the strategy that guided stakeholder engagements led by the EIA team throughout the EIA preparation process were to:

- Inform stakeholders about project components and planned project activities.
- Initiate open dialogue between the EIA team and stakeholders to allow stakeholders to receive clarifications on the project and GMI's activities, and to share their views, concerns and expectations.
- Receive feedback from stakeholders on the main environmental and social concerns associated with the project components and project activities for inclusion and consideration in the EIA.

- Create a mechanism through which feedback from stakeholder engagements are shared with GMI so as to ensure that stakeholder engagements are meaningful and are considered in business deci sion-making.

The strategy consisted of the following key elements:

- Identification of stakeholders for engagement.
- Determining the methods and tools for engagement of different stakeholders throughout the EIA preparation process.
- Organisation of feedback received for consideration in EIA preparation. Feedback was also shared with GMI to support decision making and company-led stakeholder engagement particularly during the implementation phase of the project.

6.2.1 Stakeholder Identification

Stakeholder engagement commenced with identifying the stakeholders and groups of stakeholders who should be consulted and determining the phase in the EIA preparation process in which they should be consulted. Stakeholders included persons who were affected by project activities during the construction phase or are likely to be affected during project implementation (project-affected parties). These stakeholders may be affected either positively or negatively and directly or indirectly by the project. Stakeholders were also engaged who may have had an interest in the project or an influence over the project outcomes (other interested parties).[18] Based on these criteria, the following broad-based stakeholder groups were identified for consultation during the EIA preparation process:

- Government agencies at national (central), regional and local (district) levels.
- Private sector bodies and groups, including commerce – suppliers and businesses.
- Civil society organisations, including conservation, indigenous; faith-based; and women's groups.
- Local communities and indigenous villages (including representation from vulnerable communities and local land users such as miners, foresters and farmers).

Subsequently, a list of stakeholders to be engaged was developed taking consideration the stakeholder list provided by the EPA in the Terms and Scope; discussions with GMI to understand the scale and reach of operations during project implementation; desk research to determine the socio-economic context of Port Kaituma and Matthew's Ridge, and communities in proximity to the AoI of the project. The stakeholders who were consulted during the EIA process is presented in Table 6-1 below.

[18] Classification of stakeholders as *project-affected parties* and *other interested parties* is consistent with the World Bank's Environmental and Social Framework, Standard 10 Stakeholder Engagement and Information Disclosure.

Table 6-1: Stakeholders Consulted for EIA Preparation

Stakeholder Groups	List of Stakeholders Consulted
Government Agencies (National)	▪ Ministry of Natural Resources. ▪ Ministry of Communities. ▪ Ministry of Indigenous Peoples Affairs. ▪ Ministry of Public Health. ▪ Ministry of Public Infrastructure. ▪ Ministry of Social Protection. ▪ Guyana Forestry Commission ▪ Guyana Geology and Mines Commission. ▪ Civil Defence Commission. ▪ Guyana Lands and Surveys Commission. ▪ National Trust – Guyana. ▪ Guyana Water Incorporated. ▪ Maritime Administration Department. ▪ Transport and Harbours Department.
Government Agencies (Regional and Local)	▪ Regional Democratic Council for Region 1. ▪ Municipality of Mabaruma. ▪ Neighbourhood Democratic Council for Port Kaituma/Matthew's Ridge/Arakaka. ▪ Guyana Police Force (Mabaruma/Port Kaituma/Matthew's Ridge). ▪ Guyana Water Incorporated Field Offices (Port Kaituma and Matthew's Ridge). ▪ Guyana Forestry Commission Field Office (Mabaruma). ▪ Guyana Livestock Development Authority (Mabaruma). ▪ Port Kaituma District Hospital ▪ Pakera District Hospital
Local Communities and Indigenous Villages	▪ Matthew's Ridge. ▪ Port Kaituma. ▪ Wauna. ▪ Imbotero. ▪ Smith's Creek. ▪ Kamwatta. ▪ Bumbury. ▪ Morahwanna. ▪ Almond Beach. ▪ Four Miles. ▪ Eclipse Falls. ▪ St. Anselm. ▪ Three Brothers. ▪ Arakaka. ▪ Koberimo.
Private Sector and Civil Society	▪ Guyana Marine Conservation Society.

6.2.2 Methods and Tools

The stakeholder engagement strategy was designed to utilise various methods and tools throughout the EIA preparation process. At the outset, the type of engagement selected and the tools used during the engagement exercise depended both on the phase of the project during which the consultation was being undertaken as well as the stakeholder groups being targeted. The overarching objective was to employ methods and media to facilitate meaningful consultations with stakeholders to encourage the free sharing of information and views about the company and the project. The critical first step in all of the engagement exercises was to share information on the project to enhance stakeholders understanding on project activities and allow them to consider how they may be impacted (positive or negative). This led to the second step of the stakeholder engagement strategy, consultations. The consultations provided the stakeholders with the opportunity to engage actively with the EIA team to provide feedback on their concerns and to share recommendations. Finally, it is important to note that the methods and tools used to engage stakeholder from local communities within of proximate to the AoI were adapted based on restrictions put in place to respond to the global COVID-19 pandemic.

The stakeholder consultation process was executed using a three-pronged approach to reach all relevant stakeholders and to obtain feedback. The methods and tools used in these engagements were as follows:

- Scoping Phase
    - Public Meetings in Mabaruma, Port Kaituma and Matthew's Ridge utilising presentations, photographs, maps and discussions amongst stakeholders in plenary. These public meetings were convened following guidance from the EPA.
    - Written feedback on the project based on a Project Summary invited from the public via notice in the newspapers for submission to the EPA.
- EIA Preparation Phase
    - One-on-one meetings with central stakeholders, including government agencies, utilising presentations, photographs and maps. As requested, the EIA also shared additional project information including GIS shape files and photographs of the project locations with these stakeholders.
    - Interviews, including via the telephone, with key representatives of communities within or proximate to the AoI of the project.
    - Continuous and open two-way flow of information between the EIA team and stakeholders utilising emails and telephone calls.
- Disclosure Phase
    - Feedback on the draft EIA will be invited from the public for submission to the EPA.

Public meetings allowed for information sharing and consultations with broad-based stakeholder groups. One-on-one engagements, interviews and focus groups allowed for more in-depth and specific discussions and facilitated open and candid dialogue between stakeholders and the EIA team. Although these discussions were more focused, they also provided stakeholders with the opportunity to ask questions and receive clarifications on planned project activities. These engagements also

allowed the engagement team to obtain additional information on other resource use, if any, in or close to the proposed project site to identify possible conflicts.

6.2.3 Organisation and Reporting

A stakeholder registry was maintained for all stakeholder consultations and systematically documented, for record keeping, to preserve evidence and inputs, and to ensure the feedback is meaningfully considered in the EIA process. Accordingly, the outcomes from the stakeholder consultations were considered and incorporated, as relevant, into the EIA. The feedback and recommendations from the stakeholder engagement process was also shared with GMI to be used as a guide for future engagement processes particularly engagements to be led by the company during the implementation of the project. The process for organisation and reporting of the feedback collected from stakeholders is shown in Figure 6-1 below.

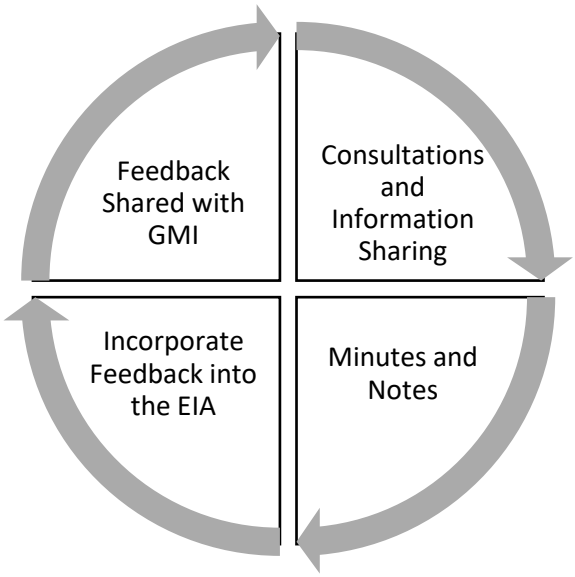


Figure 6-1: Mechanism Reporting and Incorporating Feedback from Stakeholder Engagements in the EIA

6.3 Stakeholder Engagement Processes

This section describes the processes undertaken for engaging different stakeholders in the EIA preparation process. In some instances, the processes undertaken were guided by the EPA. However, in other instances the EIA team adopted processes which were deemed to be most appropriate for the stakeholders being engaged.

6.3.1 Scoping Meetings

As required by the Environmental Protection Act, the EPA published a notice in a daily newspaper indicating that an application for environmental authorisation was submitted by GMI and the EPA had determined an EIA was required before the project can be implemented. The general public was given a 28-day timeframe in which to provide written feedback to the EPA on concerns or issues that need to be addressed in the EIA. Moreover, members of the public were directed to the EPA website or its office in Ganges Street, Sophia, Georgetown to obtain the project summary to be used as the basis of the written feedback.

In addition, within this 28-day period, the EPA recommended that GMI organise, host and document the outcomes of three public meetings in Mabaruma, Matthew's Ridge and Port Kaituma to afford the Region 1 public and other stakeholders the opportunity receive information on the project, receive clarifications, and share their concerns and recommendations. Flyers and printed notices, along with instructions on accessing a non-technical project summary, were developed and distributed by GMI in the surrounding communities. The flyer also indicated that the full project summary could be accessed via the EPA website, GMI offices in Mathew's Ridge, Port Kaituma and Georgetown, and from the Regional Democratic Council (RDC), Region 1 located in Mabaruma. Representatives from the EPA attended these three meetings as observers to process and to note the feedback provided by the participants.

The public meetings were chaired by GMI and featured a presentation on the project by the company. Photographs and maps were also displayed in hard copy around the venues of the meeting. Please see Appendix D1 for the flyer utilised to announce the scoping meetings, a copy of the agenda of the meetings, minutes of each meeting including pictures and the registration sheets.

6.3.2 Consultations with Agencies

One-on-one direct engagements were held with national (centralized) and regional agencies and institutions to gather information and opinions including concerns and recommendations. These include government offices with regulatory responsibility over various activities within the AoI of the project, infrastructure or navigation entities and a conservation based organisation working in Region 1.

The EIA team reached out directly to these agencies and institutions to request a meeting in order to introduce the project, receive any relevant baseline data that could be shared by the agency, and to receive feedback on potential impacts and mitigation measures. The meetings were organised at the convenience of the stakeholders and after each meeting was concluded there was an open channel of communication between the EIA team and the stakeholders utilising both email and telephone calls. Please see Appendix D2 for a copy of the letter which was dispatched by the EIA team requesting the meetings, a schedule of the meetings and minutes of each engagement.

6.3.3 Consultations with Local Stakeholders

Engagement with local stakeholders, including stakeholders within or proximate to the AOI of the project was the final critical element of stakeholder consultations. The initial design of these consultations included a variety of tools and fora namely:

- Visual media comprising of presentations, photographs and maps.
- Print media presenting summaries of key project components and planned project activities.
- One-on-one meetings with local authorities including the RDC, the NDCs, Village Councils and CDCs.
- One-on-one meetings with key services and utilities provider within Port Kaituma and Matthew's Ridge including the Hospitals, Police, and Guyana Water Inc.
- Focus Group Meetings on various planned project activities including ore transportation, project construction and infrastructure among others.
- Community Meetings with broad-based participation from interested community members.

- Rapid Social Assessment to establish a socio-economic baseline for the two project locations and Ecosystems Services Survey to collect data on resource use within the AoI. Data was intended to have been collected via questionnaire completed by a sample population of approximately 900 residents from Matthew's Ridge, Eclipse Falls, Four Miles, Arakaka, Port Kaituma and Canal Bank.

In anticipation of these meetings, the EIA team discussed its intention of conducting engagements with local stakeholders with the NDC during an initial meeting in January 2020 (EMC Personal Communication 15). Further, the team officially informed the Ministry of Indigenous Peoples Affairs (MOIPA) of the project during a one-on-one meeting and also requested guidance from the MOIPA on engaging with local indigenous stakeholders. Please see EMC Personal Communication 06 for a record of the discussions during that meeting.

However, none of these consultations could be conducted on account of the public health and safety requirements and restrictions arising as a result of the COVID 19 pandemic. Instead, the EIA team conducted telephone interviews with representatives of key local authorities and communities. In advance of the telephone interviews, one member of the EIA team telephoned the potential interviewee to introduce the EIA team, provide a status update of project and invite them to participate in a telephone interview at a time of their convenience. They were also invited to solicit views from local stakeholders on their views and concerns about the project. Moreover, the Toshao of Four Miles Village and the Chairman of the Eclipse Falls Community Development Council were invited to include their council members on the call. If the potential interviewee agreed to participate, a telephone interview was arranged during which the EIA team solicited information about the community as well as views and concerns about GMI or the potential impacts of the project. Where possible, questions were also emailed by the EIA team to the stakeholder. Structured questionnaires were also prepared and sent to local service provider including the Hospitals and Police soliciting information and their feedback. Please see Appendix D3 for records of these engagements.

The communities consulted during the EIA preparation process are shown in Figure 6-2.

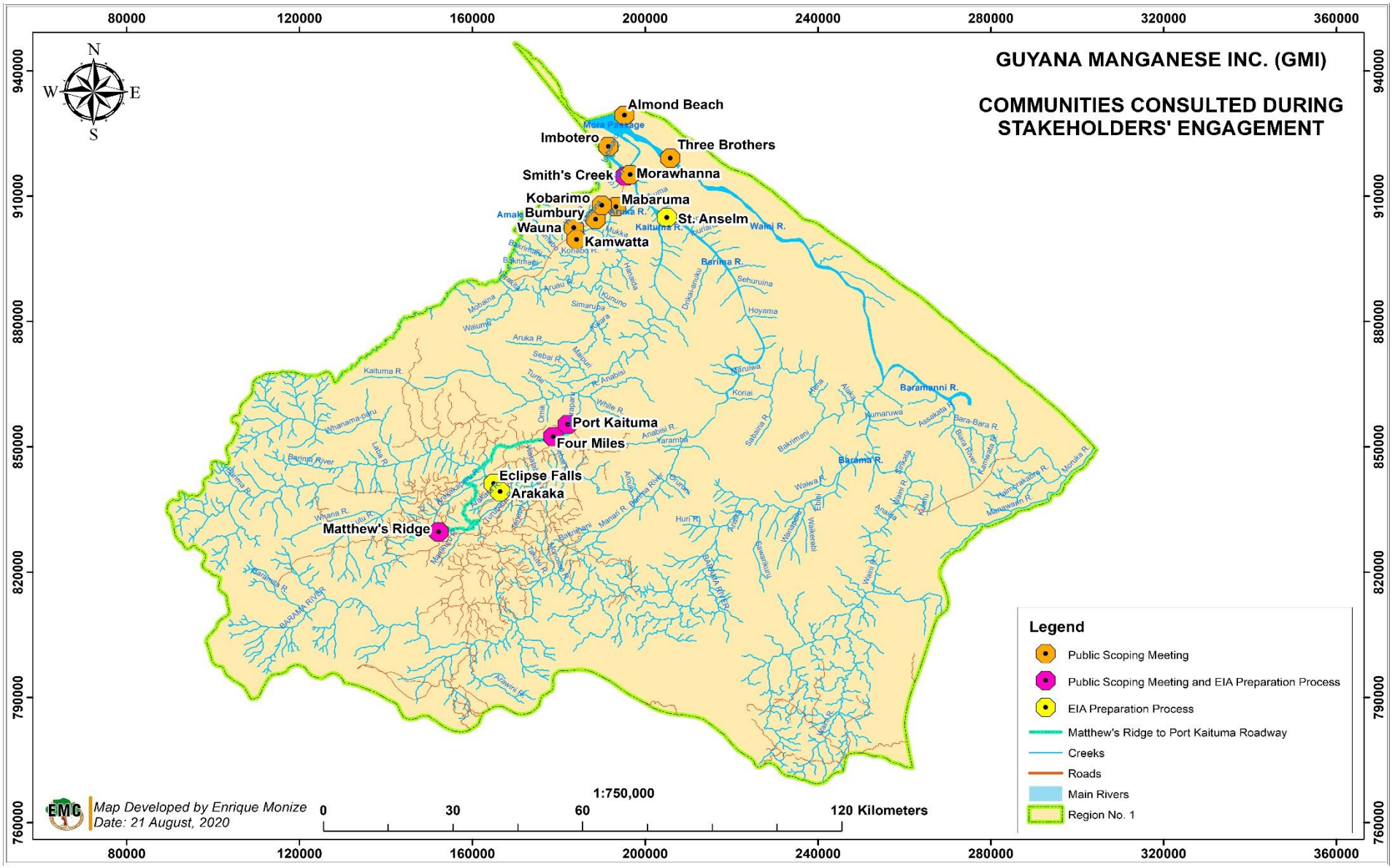


Figure 6-2: Communities Engaged during the EIA Preparation Process

6.4 Summary of Stakeholders Feedback

This section provides a summary of the key issues, comments and suggestions highlighted during the stakeholder consultation process and how the comments were incorporated and addressed in the EIA.

6.4.1 Scoping Meetings

During the scoping phase of the statutory EIA process, GMI hosted three public scoping meetings in Mabaruma, Port Kaituma and Matthew's Ridge. The purpose of these meetings was to inform the public about the project and to receive feedback as well as recommendations from stakeholders. Approximately 100 persons participated in these meetings. Stakeholders provided feedback on a wide range of issues including health and safety, water availability and water quality, economic impacts of the project, employment, project infrastructure and corporate social responsibility among others. In some instances, queries on planned project activities were directly posed to GMI and the company provided responses. These interventions are detailed in the minutes of the public scoping meetings presented in Appendix D1.3. Table 6-2 provides summary of issues raised at each meeting and where the comments were addressed in the EIA.

Table 6-2: Stakeholder Feedback from the Public Scoping Meetings and Incorporation into the EIA

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
Public Scoping Meeting in Mabaruma		
Economic Development	▪ The project was welcomed and expectations were shared of its positive contribution to the Region.	▪ Section 19.3.1 – Potential Impacts of Employment ▪ Section 19.3.7 – Potential Impacts of Economic Development and Community Well-Being
Employment	▪ Region 1 has skilled workers who can support the company's operations. ▪ The RDC received reports of employees' services being terminated without notice and without severance payments. ▪ Skilled residents from Kamwatta applied for jobs with GMI but were not successful. ▪ Will GMI consider hiring Venezuelans?	▪ Section 19.3.1 – Potential Impacts of Employment
Health and Health and Safety	▪ Does GMI have procedures for workers health and safety? ▪ Does the company provide PPEs to workers? ▪ Do employees have a medical examination before being hired? ▪ Workers health and safety should be prioritised. ▪ Proper and adequate accommodation should be provided for workers.	▪ Section 19.3.1 – Potential Impacts of Employment ▪ Section 20.2.6 – Occupational Health and Safety Risks ▪ Section 20.3.4 – Occupational Health and Safety ▪ Section 20.4 – Mitigation and Monitoring Measures (Health)

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
Transportation	▪ The bridge on which GMI trucks cross in Matthew's Ridge is narrow and this creates some unsafe conditions for pedestrians in particular children. ▪ The RDC received feedback that the roads in Matthew's Ridge and surrounding areas are impassable due to use by GMI's trucks. Similar complaints were also received about the road leading to the log pond area in Port Kaituma. ▪ Will GMI be supporting road repairs? ▪ Has GMI considered reintroducing the railway?	▪ Section 15.2.1.2 – Road Network in Matthew's Ridge ▪ Section 15.3.1 – Potential Impacts of Road and Wharf Rehabilitation and Construction ▪ Section 5.5 – Concentrate Transport from Matthew's Ridge to Port Kaituma
Waste Management	▪ Sanitation in Matthew's Ridge is a concern as there is no designated landfill or dump site.	▪ Section 16.2.2 – Waste Management in Matthew's Ridge
Water and Water Quality	▪ Will wash water contain any chemicals which could adversely impact the environment?	▪ Section 8.3.1.6 – Potential Impacts of Contamination from Process Water Discharge ▪ Section 12.3.2.2 – Terrestrial and Aquatic Fauna
Biodiversity	▪ Will discharges impact sea turtles?	▪ Section 12.2.3.2 – Areas of Biological Interest
Compensation	▪ Will there be compensation to affected workers in any eventuality?	▪ Section 22.7 – Grievance Mechanism
Stakeholder Engagement	▪ GMI should engage with local authorities and residents before making decisions on CSR initiatives. ▪ The RDC will be interested in reviewing the company's proposals for contributions to the Region.	▪ Section 19.3.7 – Potential Impacts of Economic Development and Community Well-Being ▪ Section 19.4 – Mitigation and Monitoring Measures (Socio Economic Environment) ▪ Section 22.6.7 – Stakeholder Engagement Plan
Corporate Social Responsibility	▪ GMI should consider donating a small waste compactor to Matthew's Ridge. ▪ GMI should consider providing scholarships to students similar to the GUYMINE scholars in Linden.	
Public Scoping Meeting in Port Kaituma		
Transportation	▪ GMI's equipment has damaged the road leading to the log pond and the movement of heavy equipment is dangerous to pedestrians in these communities, particularly the children. The company should repair the roads.	▪ Section 15.2.1.1 – Road Network in Port Kaituma

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
Water and Water Quality	▪ Will wash water be channeled to the tailings pond be discharged into the environment?	▪ Section 8.3.1.6 – Potential Impacts of Contamination from Process Water Discharge ▪ Section 16.3.1.1 – Mine Waste
Corporate Social Responsibility	▪ GMI should consider contributing to the development of the schools in the project locations. ▪ GMI should consider the construction of a secondary school and providing tertiary level scholarships to students from Region 1. ▪ Port Kaituma has significant challenges with accessing freshwater for domestic use and GWI drilled wells in the area but these wells are not operational. Will GMI invest in the water sector in Port Kaituma?	▪ Section 19.3.7 – Potential Impacts of Economic Development and Community Well-Being ▪ Section 19.4 – Mitigation and Monitoring Measures (Socio Economic Environment) ▪ Section 22.6.7 – Stakeholder Engagement Plan
Public Scoping Meeting in Matthew's Ridge		
Socio-Economic Development and Related Issues	▪ The project is welcomed as it is expected to contribute to economic and social development. The quality of life in Matthew's Ridge significantly declined following the closure of the manganese operations, including failure of agriculture efforts. Many persons pursued mining and as a result of the pork knockers' way of life the social situation within the community declined. ▪ Is GMI committed to the development of Matthew's Ridge during its operations?	▪ Section 19.3.7 – Potential Impacts of Economic Development and Community Well-Being ▪ Section 19.4 – Mitigation and Monitoring Measures (Socio Economic Environment) ▪ Section 22.6.7 – Stakeholder Engagement Plan
	▪ GMI was encouraged to ensure that workers respect the young girls in the village.	▪ Section 19.3.5 – Potential Impacts of Other Vulnerable Groups and Gender Impacts
Migration	▪ There are concerns about migrant workers coming into the village.	▪ Section 19.3.2 – Potential Impacts of Planned and Unplanned Migration for Employment
Housing	▪ Will GMI establish a housing scheme for migrant workers or will these workers be required to seek accommodation in the village?	
Land Use	▪ What measures are in place to resolve any land disputes between residents of Matthew's Ridge and GMI as there is no clear demarcation of the boundary of the company's operations and residential lands? Will GMI consider a mechanism	▪ Section 22.7 – Grievance Mechanism ▪ Section 22.5.4 – Land Acquisition and Resettlement

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
	whereby lands leased to the company but not used in the operations could be used by residents? ▪ It was recommended that GMI should identify the boundaries of its operations so that residents do not encroach on these areas.	
Resettlement	▪ Will residents who live proximate to the dumpsite (previous tailings pond) have to be relocated? ▪ Will relocated residents be compensated?	▪ Section 21.2.2 – Land Acquisition in Matthew's Ridge ▪ Section 22.5.4 – Land Acquisition and Resettlement
Transportation	▪ Much more work will be required on the public road between Matthew's Ridge and Port Kaituma to withstand frequent traversing by haul trucks.	▪ Section 15.3.1 – Potential Impacts of Road and Wharf Rehabilitation and Construction
Employment	▪ Will workers be unionized? ▪ What are the systems for seeking employment at GMI? ▪ There were reports of terminations and suspensions without justification. ▪ Will GMI have apprenticeship programmes? ▪ Will GMI consider waiving the requirement for job applicants to also provide a police clearance?	▪ Section 19.3.1 – Potential Impacts of Employment
Stakeholder Engagements	▪ It was recommended that monthly meetings should be held between representatives of GMI and the community to discuss and mutually agree to any corporate support projects prior to implementation.	▪ Section 19.4 – Mitigation and Monitoring Measures (Socio Economic Environment) ▪ Section 22.6.7 – Stakeholder Engagement Plan
Health and Health and Safety	▪ GMI will have more than 400 employees as this far exceeds the capacity of the hospital. Further, the hospital does not have the equipment or expertise to deal with industrial accidents or new diseases which migrants may introduce. ▪ Will workers be medically screened before beginning employment? ▪ Are workers provided with the required PPEs? ▪ Will GMI provide transportation for employees to and from work?	▪ Section 19.2.2.2 – Matthew's Ridge (Communities Profile) ▪ Section 20.2.6 – Occupational Health and Safety Risks ▪ Section 20.3.4 – Occupational Health and Safety ▪ Section 20.4 – Mitigation and Monitoring Measures (Health)

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
Blasting	▪ Will the blast radius encompass residences? ▪ Does the EPA have a standard which the company must satisfy when conducting blasting?	▪ Section 9.4 – Mitigation and Monitoring Measures (Soils and Geology) ▪ Section 14.4 – Mitigation and Monitoring Measures (Noise and Vibrations) ▪ Section 22.6.4 – Blasting Plan
Water Availability and Water Quality	▪ Hill 5 is located above one of the sources of water for the residents. Will the operations negatively affect availability of water to residents? ▪ The company's operations are affecting water availability in the village. GWI uses 250 gallons of water from the spring on a daily basis and this decreases the pressure going to the tank which supplies the village. ▪ Slush from two of the company's roads runs off into the well which results in that water being sometimes muddy.	▪ Section 8.3.4.1 – Potential Impacts of Sedimentation and Contamination from Surface Runoff ▪ Section 8.3.4.2 – Potential Impacts to Water Balance: Community Water Supply ▪ Section 8.3.4.10 – Potential Impacts of Community Water Supply
Risk Management	▪ Does GMI have a Disaster Response Management Plan?	▪ Section 22.8 – Emergency Response and Contingency Plan
Corporate Social Responsibility	▪ GMI should consider supporting the transport of pensioners from Matthew's Ridge to Port Kaituma on a monthly basis to do shopping. ▪ GMI was requested to support the rehabilitation of the roads in the community. ▪ GMI should consider donating street lamps to the community. ▪ GMI should consider contributing to the education sector by constructing a secondary school. ▪ GMI should consider providing technical/vocational training and work study opportunities for students. ▪ GMI should assist in providing fuel to the GWI pump which is used to extract water to be supplied to the village if there is a shortage.	▪ Section 19.3.7 – Potential Impacts of Economic Development and Community Well-Being ▪ Section 19.4 – Mitigation and Monitoring Measures (Socio Economic Environment) ▪ Section 22.6.7 – Stakeholder Engagement Plan

6.4.2 Consultations with Agencies

This section highlights the critical areas identified during the one-on-one meetings held with national, regional and local organisations during the EIA preparation process. The issues/concerns identified covered several critical areas including climate change; workers health and safety; employment; environmental impacts of the project and stakeholders engagement. During these meetings, questions were posed to the EIA team on operational issues which could be answered based on the planned project activities outlined in the Project Summary. All such queries and clarifications are documented in the notes of the one-on-one meetings presented in Appendix D2.3. Table 6-3 provides a summary per thematic issues and recommendations to be addressed in the EIA, as well as where they were addressed.

Table 6-3: Stakeholder Feedback from the One-on-One Meetings and Incorporation into the EIA

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
Guyana Forestry Commission		
Rehabilitation of Mined Out Lands	▪ The EIA should include a rehabilitation plan for the re-vegetation or reforestation of mined out lands.	▪ Section 22.6.5 – Closure and Decommissioning Plan
Project Infrastructure	▪ GFC considers loggers' access to interior roads as an essential factor in the overall productivity of the forestry sector and all roads constructed for the project should be open for public use. ▪ Will the EIA consider potential impacts of road construction and rehabilitation?	▪ Section 15.3.2 – Potential Impacts from Increased Traffic and Shared Use of Roads
Forest Reserve	▪ GFC will verify whether Barama Company Limited established a forest reserve within the project boundaries. If a reserve was established, GFC recommends that it remains intact throughout operations.	▪ Based on follow-ups by the EIA team with the GFC, no forest reserves were established within the project AoI.
Regional Democratic Council, Region 1		
Engagement with the RDC	▪ GMI has not directly engaged with the RDC to provide an update on the implementation of project activities in Matthew's Ridge and Port Kaituma. The Regional Chairman recommended frequent, periodic and direct engagements between the Council and the Company to provide progress updates and receive feedback/recommendations from the Regional administration.	▪ Section 19.4 – Mitigation and Monitoring Measures (Socio Economic Environment) ▪ Section 22.6.7 – Stakeholder Engagement Plan
Industrial Complaints	▪ The RDC has received multiple complaints about non-payment to employees and dissatisfaction with GMI's recruitment and dismissal procedures.	▪ Section 19.3.1 – Potential Impacts of Employment
Corporate Social Responsibility	▪ GMI has made commitments to road rehabilitation in Matthew's Ridge, and with respect to schools, water supply and health care which have not been fulfilled.	▪ Section 19.3.3 – Potential Impacts of Community

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
		Engagements and Expectations
Guyana Marine Conservation Society		
Biodiversity	▪ Potential impacts include the destruction of habitats, species migration and fragmentation as a result of deforestation which was required for the construction of the access road at Port Kaituma. Frequent trips by haul trucks may also disturb remaining biodiversity. ▪ The EIA should assess potential adverse impacts of the project on the Shell Beach Protected Area. ▪ The EIA should assess any impacts associated with increased mining, forestry and wildlife hunting as a result of the construction of the new access road in Port Kaituma. ▪ The EIA should assess potential impacts on riverine and marine biodiversity from dredging.	▪ Section 12.2.3.2 – Areas of Biological Interest ▪ Section 12.3.1 – Potential Impacts during the Construction Phase ▪ Section 12.3.2 – Potential Impacts during the Operational Phase
Water Quality	▪ Will the tailings pond be located in proximity to any waterways including any used by the community? ▪ The EIA should assess whether pumping water from the Pakera Lake will affect community use, including for fishing or recreational purposes.	▪ Section 8.2.1.2 – Swamps, Lakes and Tailings Pond
Socio-Economic Impacts	▪ The project is likely to have generally positive socio-economic impacts on the communities particularly regarding job creation. ▪ The EIA should present a profile of current economic activities of residents in the project locations. ▪ The EIA should consider potential impacts on local schools if workers move with their families and children to the project locations. ▪ The EIA should consider whether migration into the project locations will potentially impact the use of illicit drugs in these communities.	▪ Section 19.2.2 – Communities Profile ▪ Section 19.3.1 – Potential Impacts of Employment ▪ Section 19.3.2 – Potential Impacts of Planned and Unplanned Migration for Employment ▪ Section 19.3.7 – Potential Impacts of Economic Development and Community Well-Being
Transportation	▪ The EIA should consider potential impacts barging may have on traditional uses of the river, including its use for transport of produce from households and villages to market.	▪ Section 15.2.2 – River Transportation Network in the AoI ▪ Section 15.3.3 – Potential Impacts from River Transportation
Blasting	▪ Will residents of Matthew's Ridge be affected by blasting activities?	▪ Section 19.3.3 – Potential Impacts of

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
		Seismic Triggers from Blasting
Health	▪ The EIA should consider the potential health risks to residents of Matthew's Ridge and Port Kaituma as a result of migration of Guyanese and non-Guyanese.	▪ Section 20.3.6 – Social and Cultural Practices
Corporate Social Responsibility	▪ GMI should consider provision of medi-vac services for workers and community members. ▪ GMI should consider providing 24-hour medical support.	▪ Section 19.4 – Mitigation and Monitoring Measures (Socio Economic Environment) ▪ Section 22.6.7 – Stakeholder Engagement Plan
National Trust of Guyana		
Preserving Cultural Heritage	▪ If any elements of the old railway line still exist including at the bridge at Eclipse Falls, they not be dismantled. The Trust recommends putting these on display as a mark of the historical infrastructure and industrial heritage of the area.	▪ Section 18.2.2 – The Historical Socio-Cultural Context ▪ Section 18.3 – Impact Assessment (Cultural Heritage)
Civil Defence Commission		
Blasting	▪ Will there be negative impacts of dust, noise and vibrations to residents of Matthew's Ridge from blasting activities?	▪ Section 9.4 – Mitigation and Monitoring Measures (Soils and Geology) ▪ Section 14.4 – Mitigation and Monitoring Measures (Noise and Vibrations) ▪ Section 22.6.4 – Blasting Plan
Engagement with the RDC	▪ It was recommended that the GMI reach out and engage directly with the RDC, NDC and Regional Disaster Risk Committee to determine any specific requirements for emergency response for potential incidents at GMI. ▪ Direct engagement may also help GMI to identify whether it may be able to provide emergency response support to the Regional Disaster Risk Committee for other disasters, unrelated to project, in Region 1.	▪ Section 19.4 – Mitigation and Monitoring Measures (Socio Economic Environment) ▪ Section 22.6.7 – Stakeholder Engagement Plan
Ministry of Indigenous Peoples Affairs		
Approach to Community-Based Consultations	▪ The following approach to community-based consultations was recommended: ○ Engage directly with local authorities (Village Councils, Community Development Councils or Neighbourhood Democratic Councils)	The EIA team followed the guidance provided by the Ministry of Indigenous Peoples Affairs and subsequently, engaged

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
	of Matthew's Ridge, Port Kaituma, Eclipse Falls, Four Miles, and possibly Arakaka. ○ Engage directly with the Regional Administration of Region 1. ○ Liaise, if necessary, with the MOIPA's Management Development Officer for Region 1 prior to the visit. ○ Follow up with the MOIPA if any additional information or policy guidance is needed after the field visits were conducted. ○ Consider engaging the National Toshaos Council on the project.	directly with communities in the AoI.
Socio-Economic Impacts	▪ The project is likely to have generally positive socio-economic impacts on the communities particularly regarding job creation.	▪ Section 19.3.1 – Potential Impacts of Employment
Blasting	▪ The EIA should consider dust emissions associated with blasting activities and the potential impacts on nearby residents.	▪ Section 10.3.2 – Potential Impacts from Emissions of Particulate Matter
Health	▪ The EIA should consider long term impacts, including impacts on health and health and safety, of all mining activities on residents including on schools and health facilities. ▪ The EIA should make recommendations on preventing future bat infestations to prevent histoplasmosis outbreaks.	▪ Section 20.3 – Impact Assessment (Health Risk Assessment)
Transportation	▪ The EIA should consider how dredging and barging activities will impact local residents living along the Port Kaituma Canal in the short-term and in the longer term.	▪ Section 15.2.2 – River Transportation Network in the AoI ▪ Section 15.3.3 – Potential Impacts from River Transportation
Guyana Water Incorporated		
Water Quality and Water Supply	▪ There are concerns of potential contamination of surface water sources in Matthew's Ridge from wash water and tailings produced by the project. ▪ Dredging of the Kaituma Canal has the potential to temporarily suspend water supply to residents. Temporary suspension is likely to have significant negative impacts on the residents. ▪ GWI recommended that GMI closely engages the company on the schedule according to which dredging activities will be conducted.	▪ Section 8.3.1.6 – Potential Impacts of Contamination from Process Water Discharge ▪ Section 8.3.4.1 – Potential Impacts of Sedimentation and Contamination from Surface Runoff ▪ Section 8.4 – Mitigation and Monitoring Measures (Water)

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
		▪ Section 15.3.3 – Potential Impacts from River Transportation ▪ Section 22.6.7 – Stakeholder Engagement Plan
Ministry of Social Protection		
Employee Accommodation	▪ The MOSP indicated that, during an official visit to investigate the histoplasmosis outbreak, it was observed that the accommodation for Guyanese workers was in very poor conditions, particularly the sanitary facilities and was unacceptable for their health.	▪ Section 20.2.6.4 – Living Conditions
Expatriate Employees	▪ How many expatriate employees will be employed during the construction and operational phases of the project?	▪ Section 4.5 – Project Profile
Health and Safety	▪ The project is required to comply with the provisions of Occupational Health and Safety in all phases, including construction. ▪ GMI should ensure that a Health and Safety Policy and a Health and Safety Plan are in place to guide its operations. ▪ All workers should be trained in the requirements for health and safety for their jobs. The Ministry also conducts training free of cost. ▪ Deaths due to the histoplasmosis outbreak were due in part to appropriate PPEs not being used. ▪ GMI should conduct risk assessments of all activities prior to the commencement of work every day. ▪ GMI should also be registered with the Health and Safety Department.	▪ Section 20.3.4 – Occupational Health and Safety ▪ Section 20.4 – Mitigation and Monitoring Measures (Health)
Transport & Harbours Department and the Maritime Administration Department		
Project Infrastructure and Facilities	▪ Are any plans in place for use of the project infrastructure including the bypass road and marine terminal when the project has been completed in 13 years?	▪ Section 22.6.7 – Stakeholder Engagement Plan
Water Supply and Quality	▪ Will GMI's water consumption reduce water available to residents of Matthew's Ridge? ▪ Will any water contaminants be released as a result of ore washing?	▪ Section 8.3.4.2 – Potential Impacts to Water Balance: Community Water Supply ▪ Section 8.3.1.6 – Potential Impacts of Contamination from Process Water Discharge

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
Employment	▪ Will the Matthew's Ridge community have a sufficient number of local employees, particularly given that many persons in this village are also engaged in small-scale gold mining which may have higher earnings?	▪ Section 19.3.1 – Potential Impacts of Employment
Ministry of Natural Resources and the Guyana Geology and Mines Commission		
Project Infrastructure	▪ Project roads should be durable and bear the load of the haul trucks and a drainage system be installed.	▪ Section 15.4 – Mitigation and Monitoring Measures (Transportation) ▪ Section 22.6.7 – Stakeholder Engagement Plan
EIA Scope and Process	▪ Concerns were expressed that the EPA issued a Construction Permit prior to the preparation of an EIA and that construction onsite had significantly advanced.	The EIA assesses potential impacts throughout the project lifetime including the construction phase of the project.
Reclamation of Mined Out Areas	▪ The plan for the reclamation of the mined-out area should benefit from input from the local communities on the type of restoration work which should be conducted.	▪ Section 22.6.5 – Closure and Decommissioning Plan
Air Quality	▪ During the dry seasons, significant amounts of dust from vehicles traversing the road is generated and this has negative impacts on communities located close to the road.	▪ Section 10.3.2 – Potential Impacts from Emissions of Particulate Matter ▪ Section 10.3.5 – Cumulative Impacts ▪ Section 11.3.1.1 – Impacts and Risks of Increased Temperatures ▪ Section 15.3.2 – Potential Impacts of Increased Traffic and Shared Use of Roads
Transportation	▪ GMI should consider an alternative route/road for transport of ore from Matthew's Ridge to Port Kaituma to ensure safety for all road users.	▪ Section 5.5 – Concentrate Transport from Matthew's Ridge to Port Kaituma
Health	▪ Was a baseline health assessment done of persons who are occupationally exposed and non-occupationally exposed to manganese? This is particularly concerning as there have been reports of brain deformities, and other neurological impacts, of persons including children exposed to manganese during mining.	▪ Section 20.2.3 – Air Quality and Health ▪ Section 20.2.4 – Water Quality and Health ▪ 20.2.6 – Occupational Health and Safety Risks

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
Health and Safety	▪ River users must be made aware of the types of equipment, barges that the GMI plans to use, and its traffic frequencies along the Kaituma Canal so that traditional uses of the waterways, in particular persons using canoes or other small vessels, can continue safely. ▪ Safety signs should be installed along the roadway.	▪ Section 15.4 – Mitigation and Monitoring Measures (Transportation) ▪ Section 22.6.7 – Stakeholder Engagement Plan
Blasting	▪ There are concerns about the potential impacts of blasting.	▪ Section 9.4 – Mitigation and Monitoring Measures (Soils and Geology) ▪ Section 10.3.2 – Potential Impacts from Emissions of Particulate Matter ▪ Section 14.4 – Mitigation and Monitoring Measures (Noise and Vibrations) ▪ Section 22.6.4 – Blasting Plan
Water Quality	▪ Persons who live along the Canal Bank use surface water from the Kaituma Canal for domestic purposes. Previously, there have been significant challenges of turbidity which has negatively impacted the use of water from this source and dredging of the Kaituma Canal may amplify these impacts. ▪ Tailings should be properly managed to prevent the leaching of any heavy metals released during the washing process.	▪ Section 8.3.1.6 – Potential Impacts of Contamination from Process Water Discharge ▪ Section 8.3.2 – Cumulative Impact Assessment
Waste Ore	▪ How will waste ore/ore with low manganese content be managed?	▪ Section 16.2.2 – Waste Management in Matthew's Ridge ▪ Section 16.3.1.1 – Mine Waste
Land Use	▪ The EIA should include a property status map which shows the boundaries of the mining claims and leases which were issued by GGMC and other leases, such as agricultural leases, which were issued by other regulatory agencies to identify any possible land use conflicts. ▪ GMI's operations may open new land uses and support the development of small enterprises.	▪ Section 19.2.1 – Historical Overview of the Project Areas (Figure 19-1: Land Uses of the Wider Project Area) ▪ Section 19.3.2 – Potential Impacts of Planned and Unplanned Migration for Employment

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
Stakeholder Engagement	▪ GGMC expressed interest in being engaged and updated on the EIA and also to be included in stakeholder engagements when the findings of the EIA are being disclosed.	▪ Section 22.6.7 – Stakeholder Engagement Plan
Ministry of Public Health		
Health and Health and Safety	▪ During the visit to investigate the histoplasmosis outbreak, bat droppings removed from caves were disposed of in a valley and there were residents at the top of the hill. Susceptible communities should be flagged and actions should be taken to reduce the risks of additional illnesses of histoplasmosis. ▪ Will GMI put plans in place for regular health care, disease prevention and emergency response?	▪ Section 20.2.6.1 – Histoplasmosis Outbreak of 2019 ▪ Section 22.8 – Emergency Response and Contingency Plan ▪ Section 20.2.2.2 – The COVID-19 pandemic ▪ Section 20.4 – Mitigation and Monitoring Measures (Health)
Health and Safety	▪ During the visit to investigate the histoplasmosis outbreak, Guyanese workers were observed to be living in very poor conditions in an abandoned warehouse where cooking and sanitary conditions were deplorable.	▪ Section 20.2.6.4 – Living Conditions
Public Health Ordinance	▪ The provisions of the Public Health Ordinance be included in the EIA. ▪ EPA should consider making compliance with the Public Health Ordinance a part of the Environmental Permit.	▪ Section 20.1 – Administrative Framework (Health)
Biological Surveys	▪ Matthew's Ridge community has a history of vector borne diseases. In particular, mosquitoes that cause malaria, and the sand flies that cause leishmaniasis breed in Matthew's Ridge. Insects should be captured in the biological surveys which will be conducted for the EIA preparation.	▪ Section 12.2.3.1.2.2 – Terrestrial Fauna (Captures Terrestrial Macro-Invertebrates but does not include vectors)
Stakeholder Engagements	▪ There should be community meetings with residents to garner their perspectives on how GMI's operations would affect them. These consultations should include the residents of Matthew's Ridge and Canal Bank. Engagements should also capture the views of the small shop owners near to the old tailings pond.	▪ Section 19.4 – Mitigation and Monitoring Measures (Socio Economic Environment) ▪ Section 22.6.7 – Stakeholder Engagement Plan
Expatriate Employees	▪ How many expatriate workers are based at the project locations during the construction phase of the project?	▪ Section 4.5 – Project Profile
Water Quality	▪ Concerns were expressed about possible contamination of water used for domestic purposes and drinking including from pit latrines and other forms of sewage. It was	▪ Section 8.2.1.6 – Groundwater and Water for Domestic Purposes

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
	recommended that all biomarkers (like total coliforms, faecal coliforms and *E. coli*) be tested in the water quality analyses of water used for human consumption, in particular surface water sources such as springs.	▪ Section 8.2.3 – Port Kaituma Surface Water Hydrology and Quality
Corporate Social Responsibility	▪ Following the histoplasmosis outbreak, MOPH made several requests from GMI to improve the capacity of the Matthew's Ridge hospital including for laboratory supplies and equipment. Through a medical support programme between the Governments of Guyana and China, four Chinese doctors were requested to be stationed at Matthew's Ridge. Through the Chinese Embassy, an X-ray machine was requested. However, none of the requests were actioned.	▪ Section 19.2.2.2 – Matthew's Ridge
Ministry of Public Infrastructure		
Project Infrastructure	▪ The MOPI has received several reports of damage to roads and bridges in Matthew's Ridge caused by GMI's vehicles. ▪ Based on a previous meeting with GMI, it was determined that the axel loads of GMI's haul trucks will more than double the maximum weight capacity of the existing Matthew's Ridge to Port Kaituma road. ▪ MOPI's priority is ensuring that the wharf and project roads are safe structures.	▪ Section 15.2.1.2 – Road Network in Matthew's Ridge ▪ Section 15.3.2 – Potential Impacts from Increased Traffic and Shared Use of Roads
Engagement with the Ministry	▪ MOPI has expressed its interest in meeting with GMI to discuss plans for the upgrade of the Matthew's Ridge to Port Kaituma.	▪ Section 15.4 – Mitigation and Monitoring Measures (Transportation) ▪ Section 22.6.7 – Stakeholder Engagement Plan
Biodiversity	▪ The EIA should consider whether dredging is likely to have any adverse impacts on aquatic biodiversity in the waterways to be dredged.	▪ Section 12.3.1.2 – Terrestrial and Aquatic Fauna
Ministry of Communities		
Project Infrastructure and Facilities	▪ The MOC received several complaints about GMI's use of large boulders to fill potholes in Matthew's Ridge as these slip with vehicles, especially heavy trucks, traverse the road. ▪ GMI has not been satisfying its obligations under the Memorandum of Understanding with the NDC.	▪ Section 19.3.3 – Potential Impacts of Community Engagements and Expectations
Health and Safety	▪ The MOC observed some unsafe road practices including several stockpiles of	▪ Section 15.3.1 – Potential Impacts of

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
	road building materials at the intersection of the roads from Matthew's Ridge to Arakaka and Port Kaituma. The stockpiles were very high and affected visibility but measures were not in place for management of traffic to ensure safe road usage and crossing of the intersection. ▪ Does GMI intended to continue using the intersection for storage of road building materials?	Road and Wharf Rehabilitation and Construction
Waste Disposal	▪ The EIA should indicate where GMI intends to dispose of garbage in Matthew's Ridge and Port Kaituma.	▪ Section 16.3 – Impact Assessment (Waste) ▪ Section 16.4 – Mitigation and Monitoring Measures (Waste)
Water Quality and Water Availability	▪ What is the extraction versus recharge rates of Pakera Lake? ▪ Will wastewater or water contaminated by chemicals used during the washing process be discharged into the Pakera Lake?	▪ Section 8.3.4.1 – Potential Impacts to Water Balance: Processing and Industrial Water ▪ Section 8.3.1.6 – Potential Impacts of Contamination from Process Water Discharge
Biodiversity	▪ Will the volume of water extracted from the Pakera Lake have an adverse impact on the aquatic life of the Lake?	▪ Section 12.3.2.2 – Terrestrial and Aquatic Fauna
Blasting	▪ Concerns were raised regarding the distance from the mining sites to the community and how blasting could impact residents. ▪ The EIA should consider potential dust emissions from blasting activities.	▪ Section 9.4 – Mitigation and Monitoring Measures (Soils and Geology) ▪ Section 10.3.2 – Potential Impacts from Emissions of Particulate Matter ▪ Section 14.4 – Mitigation and Monitoring Measures (Noise and Vibrations) ▪ Section 22.6.4 – Blasting Plan
Reclamation and Closure	▪ The EIA should include a reclamation and closure plan.	▪ Section 22.6.5 – Closure and Decommissioning Plan
Storage of Explosives	▪ There are special requirements for the storage of explosives which should be followed including use of a special bond to be supervised by the Guyana Police Force	▪ Section 15.3.5 – Potential Impacts from Transportation of Explosives

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
	and that explosives and detonators must be separately stored.	
Scope of the EIA	▪ The EIA should include cumulative impacts of the project. ▪ The EIA should consider impacts in all project areas.	▪ Cumulative Impacts are considered for each resource assessed in Chapters 8 to 20 ▪ Section 2.3 – Study Areas/ Area of Influence
Guyana Lands and Surveys Commission		
Project Infrastructure	▪ What is the location of the airport relative to the active mining areas? A buffer area should be maintained between the airstrip and the active mine area so as to facilitate any future expansion of the airstrip.	▪ Section 15.2.3 – Matthew's Ridge Airstrip
Leases	▪ The EIA team should verify whether there are any overlapping leases within the prospecting area.	▪ Section 19.2.1 – Historical Overview of the Project Areas (Figure 19-1: Land Uses of the Wider Project Area)
Resettlement	▪ GLSC expressed concern that they were not engaged by GMI in the land acquisition and resettlement process of the persons residing at the site identified for the construction of the wharf in Port Kaituma. In particular: ○ GLSC would have to verify whether the resettled persons were squatting, had rights or tenure or had applied for a lease for the land on which they were living. ○ GLSC developed a Standard Operating Procedure (SOP) for land acquisition and transfer. This SOP should have been followed in the resettlement process. ○ A GLSC representative should have been present at the negotiations between the developer and the lessee.	▪ Section 21.4 – Mitigation and Monitoring Measures (Land Acquisition, Resettlements and Livelihoods)
Dredging	▪ GLSC is interested in being updated on the area where the dredged materials will be disposed.	▪ Section 16.4 – Mitigation and Monitoring Measures (Transportation)
Corporate Social Responsibility	▪ GMI should consider supporting an agricultural programme at the school in Matthew's Ridge.	▪ Section 22.6.7 – Stakeholder Engagement Plan
Employment	▪ What are the existing level of skills of the local workforce? Would most employees be considered as unskilled?	▪ Section 19.3.1 – Potential Impacts of Employment

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
	▪ The EIA should consider the possible pull-factors on labour into Matthew's Ridge when GMI becomes operational. It should also consider spin-off effects of road construction including potential for establishment of shops along the roadway.	▪ Section 19.3.2 – Potential Impacts of Planned and Unplanned Migration for Employment

6.4.3 Consultations with Local Stakeholders

This section highlights the critical areas identified during the one-on-one meetings held with national, regional and local organisations during the EIA preparation process. The issues/concerns identified covered several critical issues including health and safety; employment; environmental impacts of the project and stakeholder engagement. The notes of the discussions with the local stakeholders are presented in Appendix D-3.

Table 6-4 provides a summary per thematic issue and recommendations on issues to be addressed in the EIA, as well as where they were addressed.

Table 6-4: Stakeholder Feedback from the One-on-One Meetings and Incorporation into the EIA

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
Neighbourhood Democratic Council		
Road Safety	▪ There are significant quantities of machinery and scrap metal placed along both sides of the road leading to the log pond and this causes challenges for pedestrians, especially school children, when trucks use the access road to and from the log pond.	▪ Section 15.2.1.1 – Road Network in Port Kaituma
MoU between GMI and the NDC	▪ GMI and the NDC has entered into a Memorandum of Understanding (MoU) under which the NDC has waived road use tolls for GMI vehicles and GMI had agreed to rehabilitate internal roads in Matthew's Ridge. However, while the NDC has not been charging the toll, GMI has not followed through with road maintenance and repair in Matthew's Ridge (EMC Personal Communication 15). ▪ During a recent meeting of the NDC, a decision was taken to levy 50 percent of the toll on GMI's vehicles entering Port Kaituma because the company was not fulfilling the obligations of the MoU (EMC Personal Communication 17).	▪ Section 19.3.3 – Potential Impacts of Community Engagements and Expectations ▪ Section 22.6.7 – Stakeholder Engagement Plan
Employment	▪ Residents have complained that GMI had promised to have 50 percent of the workforce comprising Guyanese with a preference for workers from Region 1. The	▪ Section 19.3.3 – Potential Impacts of Community

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
	NDC Chair and the Regional Chairman discussed this issue with GMI and the company indicated that it is not yet operational.	Engagements and Expectations ▪ Section 19.3.1 – Potential Impacts of Employment
Perceptions of Local Stakeholders	▪ At the outset, the local communities were excited about GMI's operations and the opportunities it presented from Region 1. However, local perceptions have changed and many people express the view that GMI is taking resources from the Region and providing no direct benefits to the people.	▪ Section 19.3.3 – Potential Impacts of Community Engagements and Expectations
Water Contamination	▪ Dredging in the vicinity of the new turning basin has created concerns of water contamination of the Kaituma Canal. This water is used for drinking, washing and other domestic purposes.	▪ Section 8.3.1.6 – Potential Impacts of Contamination from Process Water Discharge ▪ Section 8.3.2 – Cumulative Impact Assessment
Displacement of Economic Activities	▪ GMI is constructing a road in Matthew's Ridge around the processing plant and the NDC received complaints that the road runs across the farming lands used by four households for planting permanent crops and cash crops.	▪ Section 21.2.2 – Land Acquisition in Matthew's Ridge
Regional Democratic Council, Region 1		
MoU between GMI and the NDC	▪ The Regional Chairman advised the NDC to engage GMI to discuss the decision to levy 50 percent of the toll for entry to Port Kaituma.	▪ Section 19.3.3 – Potential Impacts of Community Engagements and Expectations ▪ Section 22.6.7 – Stakeholder Engagement Plan
Road Maintenance	▪ The road leading to the Log Pond is frequently in poor condition and when it rains trucks become stuck. This provides significant hardship especially to young children who use this road to walk to school.	▪ Section 15.2.1.1 – Road Network in Port Kaituma
Stakeholder Engagement	▪ GMI has not taken any significant steps to inform residents in settlements along the river transport route of the project and the planned project activities. Information should be provided prior to project commencement and consistently thereafter. Alternative means to do this should be found even amidst the COVID-19 pandemic.	▪ Section 22.6.7 – Stakeholder Engagement Plan

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
Water Contamination	▪ The RDC received a report that GMI's activities were contaminating the Whanaparo Creek which ultimately discharges into the Barima River, which also supplies water to Eclipse Falls and Arakaka. The Whanaparo Creek is the main source of freshwater for two communities in the Matarkai Sub-District namely, Whana and Paro. ▪ It should be noted that some residents in Mabaruma still depend on the Barima River for freshwater for domestic purposes.	▪ Section 8.3.1.10 – Potential Impacts of Contamination of the Community Water Supply
Four Miles Village		
Road Safety	▪ There have been instances where vehicles belonging to GMI were travelling at high speeds and overturned on the roads in the village. Travelling at a fast speed also pose safety risks to pedestrians including young children. It was recommended that GMI institute a lower speed limit for its vehicles.	▪ Section 15.3.2 – Potential Impacts of Increased Traffic and Shared Use of Roads
Air Quality	▪ Significant quantities of dust were generated from vehicles traversing the road during the dry seasons and dust covers most surfaces inside homes close to roadways. It was recommended that GMI put a system in place for road wetting during the dry season.	
Corporate Social Responsibility	▪ Support was requested to provide a vehicle to the village, such as a bus, to help with transportation for students, pensioners and sick persons.	▪ Section 19.4 – Mitigation and Monitoring Measures (Socio Economic Environment) ▪ Section 22.6.7 – Stakeholder Engagement Plan
Eclipse Falls		
Employment	▪ It is expected the persons from the community will be hired by GMI when it becomes operational.	▪ Section 19.3.1 – Potential Impacts of Employment
Air Quality	▪ Vehicles passing through the community generate significant quantities of dust during the dry season. Dust is considered to result in sickness especially in children and hinders the collection of rainwater. It was recommended that GMI adopt measures to reduce dust levels during the dry season.	▪ Section 15.3.2 – Potential Impacts of Increased Traffic and Shared Use of Roads
Road Safety	▪ School children use the public roads and bridge which pass through the community and GMI should ensure that low speed	

Themes and Issues	Stakeholder Questions, Concerns and Recommendations	Consideration in the EIA
	levels are used when passing through the community.	
Water Quality	▪ The CDC indicated that the head of the Arakaparo Creek is located in Matthew's Ridge and lead to the Barima River which supplies freshwater to residents of Arakaka and Eclipse Falls. Any potential contamination of the creek will have adverse effects on these communities.	▪ Section 8.3.1.10 – Potential Impacts of Contamination of the Community Water Supply
Arakaka		
Employment	▪ It is expected the persons from the community will be hired by GMI when it becomes operational.	▪ Section 19.3.1 – Potential Impacts of Employment

Chapter 7 – Impact Identification, Assessment, and Mitigation

7.1 Impact Assessment Methodology

It is recognized that the project is neither technically complex nor inherently threatening to people or to the environment since most of the project's physical components are situated in "brownfield" locations.

GMI has been issued Construction Permits by the EPA for the:

- Mine Site (Matthew's Ridge) – the construction of the Processing Plant, Accommodation and Mess Hall, Office, Power Plant and Mechanical Repair Shop; the rehabilitation of existing buildings, and the construction/rehabilitation of roads and bridges; and
- Construction of the Kaituma Marine Terminal and Access Road at Port Kaituma.

As, while the EIA addresses construction related impacts, the main focus is therefore on the operational activities of the project. Impacts associated with closure and decommissioning of the project are also addressed.

The first step involved having a clear understanding of the operational activities of the project and the AoI of the project. The general project's AoI was determined to be all areas where project activities and interaction with communities will occur. This includes the project sites at Matthew's Ridge and Port Kaituma, and the land and river transport routes. The project's AoI is described in Section 2.3.

The second step was to predict potential impacts that might reasonably be expected to occur during the construction and operational phases of the project and their significance. Those considered to have significance will need to be managed, mitigation and/or monitored to reduce potential adverse impacts and enhance positive impacts.

The approach to the EIA involves a standard impact assessment methodology as outlined below:

Stage 1	Impact Identification – what could happen from the project's activities
Stage 2	Impact Assessment - how important are the issues identified
Stage 3	Mitigation and Management – what needs to be done to address adverse issues

7.1.1 Stage 1 - Impact Identification

The potential impacts of the GMI's project are those that change existing physical, ecological or socioeconomic conditions within the AoI and are negative or positive. Identifying potential impacts attributable to the project require an understanding of the receiving environment. This understanding was achieved from the baseline physical, ecological and socioeconomic conditions as described in Chapters 8 to 21 of this EIA. Further, an understanding of the project related activities was required, as is outlined in Chapter 4 of this EIA.

For this EIA, impacts are considered as positive or negative, direct or indirect, short-term or long-term, localised or local, regional and cumulative. Table 7-1 provides definitions for each type of impact used in the EIA.

Table 7-1: Definitions of Types of Impacts

Impact Type	Definition
Positive	An impact that results in a positive effect on the receiving environment or resource from activities performed at or by the project.
Negative	An impact that results in a negative effect on the receiving environment or resource from activities performed at or by the project.
Direct	An impact created as a direct result of the project.
Indirect	An impact which may be caused by the project, but will occur in the future or outside the project's AoI.
Short-term	An impact or activity that is expected to dissipate shortly after the cause ceases
Long-term	An impact or activity that is expected to continue for significant time after the cause ceases
Cumulative	The total impact to a particular resource anticipated to occur as a result of a combination of effects produced together with neighboring projects.
Localised	Impact which is limited to the project's AoI.
Local	Impact which extends outside the project's immediate AoI, but is contained within the general vicinity of the project.
Regional	Impact which has extended beyond the vicinity of the project's AoI.

7.1.2 Stage 2 - Impact Assessment

The approach to assessing impacts can be either qualitative or quantitative, depending on available information and historical site-specific experience. Both are important in normal impact analyses. However, considering that the project is not complex, employs well understood mining and processing methods, transports inert concentrates and will produce non-toxic mine waste, and the fact that it is not a new project, and the project sites are disturbed areas with existing activities, the impact assessment will adopt more of a qualitative approach.

The importance of an impact has been assessed by combining two impact elements:

- The **significance** of the impact on the resources should the impact occur; and
- The **likelihood** of that impact occurring.

In determining **the significance level**, consideration was given to the types of impacts from each project activity relative to existing baseline physical, environmental and socioeconomic conditions. This is described in Table 7-2.

Table 7-2: Impact Significance Level Descriptors

Significance Level to Potentially Impacted Physical, Ecological or Soci-oEconomic Resources				
Negligible	**Minor**	**Moderate**	**Major**	**Extreme**
Minimal impact in a localised area of little or no consequence.	Low impact in a localised or regional area with a functional recovery within one year.	Medium impact in a localised or regional area with a functional recovery of 1 to 5 years.	High impact in a localised or regional area with a functional recovery within 5 to 10 years.	Very high impact in a broad regional area or area of national significance with functional recovery in greater than 10 years, if at all.

In determining **the likelihood levels,** consideration was given to the probability of an identified physical, ecological or socioeconomic resource to be impacted by the project. The anticipated likelihood of occurrence of an impact was identified to range from Rare to Certain (Table 7-3).

Table 7-3: Impact Likelihood Levels

Likelihood of Impact to Physical, Ecological or Socio-Economic Resources				
Rare	**Unlikely**	**Likely**	**Almost Certain**	**Certain**
Highly unlikely to occur but theoretically possible.	May occur within the life of the Project or activity.	Likely to occur more than once during the life of the Project or activity.	Very likely to occur during the life of the Project or activity.	Expected to occur as a result of the Project or activity.

Impacts of routine and existing events are also included in the assessment considering nearby commercial activities as well as existing and future projected traffic on road and river corridors to be used by the project.

Utilising the outcomes of both the impact significance ranking and the identified likelihood of impact, the effect of each impact causing action on the receiving environment is evaluated. The risk level (or importance) is assessed by combining the significance column and the probability row in the following Risk Assessment Matrix (Table 7-4).

Table 7-4: Risk Assessment Matrix

		Significance				
		Negligible	**Minor**	**Moderate**	**Major**	**Extreme**
Likelihood	**Rare**	Low	Low	Low	Medium	Medium
	Unlikely	Low	Low	Medium	Medium	High
	Likely	Low	Medium	Medium	High	High
	Almost certain	Low	Medium	High	High	Critical
	Certain	Low	Medium	High	Critical	Critical

Note: Where the Significance of an impact is indicated to be positive, the corresponding risk will also be positive.

7.1.3 Stage 3 - Mitigation and Management

Adverse impacts having a **Negligible** significance level or posing a **Low to Medium Risk** based on the Impact Assessment do not require to be mitigated but do require to be managed. Impacts to be mitigated are those which have a **Moderate to Extreme** significance level and pose a **High to Critical** Risk. In such cases the approach will be to identify actions to avoid (remove or minimise the source of the impact by modifying project operations) or reduce (lessen the chances of adverse interaction between the project activities and receptions) the potential adverse impacts.

7.2 Presentation of Impact Identification, Assessment, and Mitigation

As required by the EIA's Terms and Scope, the administrative framework, baseline condition, impact assessment and mitigation and monitoring is described for each resource area and detailed in Chapters 8 to 21. Within the respective chapters, and in each resource area considered, cumulative impacts are also addressed where applicable. Cumulative impacts are likely to result from the project's activities in combination with existing and proposed project in the area and which could reasonable be considered to have a combined effect.

For each resource area considered, a Summary Table as identified in Table 7-5 is provided.

Chapter 22 provides the Environmental and Social Management Plan (ESMP) for impacts that need to be managed and mitigated. The ESMP also includes a Monitoring Plan, Emergency and Response and Contingency Plan, and Conceptual Rehabilitation and Closure Plan.

7.3 Hazard Identification and Assessment

Unplanned events can be both natural and man-made. For the purposes of this EIA, these are addressed in the Emergency Response Plan.

Table 7-5: Summary Table for Impacts and Mitigation Measures

Impact Producing Activity	Operational Controls and Regulatory Compliance	Anticipated Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			

Chapter 8 – Water Resources

This chapter describes the existing surface water hydrology and water quality for key project locations in Matthew's Ridge, and Port Kaituma, as well as waterways along the road linking Matthew's Ridge to Port Kaituma. It also describes the existing groundwater hydrology and quality in Matthew's Ridge. It then examines the potential impacts and risks which both planned and accidental discharges from project activities may have on the existing surface and ground water sources. Finally, measures to mitigate and manage these impacts and risks associated are outlined.

8. 1 Administrative Framework – Water Resources

Article 36 of the Constitution of Guyana declares the fundamental rights of Guyanese to having access to pure water. It states, "*the wellbeing of the nation depends on preserving clean air, fertile soils, pure water and rich diversity of plants, animals and ecosystems*." As a result, several legislations and institutions established by these laws provide for the governance and management of water resources.

8.1.1 General Legislations, Policies, Standards and International Agreements

Table 8-1 summarises the legislation, policies and strategies, standards, guidelines, codes of practice, and applicable international treaties, and protocols that are relevant to the planned project activities.

Table 8-1: Applicable Regulatory Framework, Standards, guidelines

Title	Description	Applicability to the Project
Legislation		
Water and Sewerage Act (2002)	Provides the framework for the overarching management of water resources in Guyana, and subject to existing rights, the ownership of water resources and the rights to use, abstract, manage, and control the flow of water, are vested in the State. The Act contains various provisions for the management of the freshwater resources, and established three institutions for realising its objectives: ▪ the National Water Council for policy development and implementation. ▪ the Hydrometeorological Service for licensing and monitoring of water-use, and impacts on quantity and quality of surface and groundwater. ▪ Guyana Water Incorporated (GWI) for the licensing and monitoring of potable water use and sewerage systems. The Act also outlines liabilities for offences related to access to records and information to the relevant authorities, the improper disposal of sewage, the pollution of waterworks, the diversion of water from streams and rivers, and water availability and water quality.	The project is required to apply to Hydrometeorological Department and GWI for licenses to develop and operate any boreholes, wells, water supply from groundwater or surface water abstraction as well as any other sources. In addition, authorisation required from the Hydrometeorological Department for diversions and abstractions of surface water. The project will also be subject to monitoring by the Hydrometeorological Department and will be required to keep and provide records of water abstraction, usage, and quality. GMI will also be required to register the existing wells with the Hydrometeorological Service. Licenses may be modified based on drought orders. The Project may also be subject to new policies and regulations made under the Act. Specifically, Guyana does not have a national water management policy. The Act provides for such as policy as part of the intended management framework for water resources. The expected content of the National Water Policy is to set out strategies, objectives, plans, guidelines and procedures to protect, sustain and conserve surface and ground water resources.
Environmental Protection Act (1996)	Provides for the management, conservation, protection and improvement of the environment and has provisions for the prevention or control of pollution. The Act also establishes the Environmental Protection Agency (EPA). The Act also requires that the EPA be notified of any discharge, its concentration, amount of	The EIA for the project should specifically address water resource degradation. The project may face liability for pollution including for clean-up, neutralise contaminant; restore water to the conditions prior to discharge; to pay for independent investigation and cost associated or restoration, and compensation to any person who suffers any loss or damage.

Title	Description	Applicability to the Project
	contaminant, the circumstances of the discharge, and actions taken or planned to restore the natural environment.	
Drainage and Irrigation Act (1940 with amendments)	Establishes the National Drainage and Irrigation Authority (NDIA) for ensuring that water resources are located, evaluated, conserved and utiliseutilised for the greatest national advantage through appropriate water management strategies and water use planning; to provide that the drainage and irrigation systems are operated in a sustainable manner; among others. The objectives of the Act are to (a) frame an institutional structure in terms of water resources management strategy and water use planning for the primary purpose of locating, evaluating, conserving and distributing water resources of the country for agricultural purposes.(b) establish the Authority as the regulatory and coordinating agency responsible for the operation, maintenance, control and management of the drainage and irrigation and flood control system and works and to effectively harmonise activities to enhance agricultural production; (c) ensure that the existing drainage and irrigation system and flood control and any new expansions that are made, are operated and maintained in a sustainable manner.	Whilst this act refers primarily to agricultural activities, the Project will need to take cognizance of activities along rivers e.g. Canal Bank, Kaituma and Barima Rivers and not hinder drainage and irrigation infrastructure, and water availability and quality for agricultural activities in these areas, including flood control mechanisms.
Sea and River Defence Act (1933 with amendments)	Provides for the maintenance, management and construction of sea defences. Under the Act, sea defence includes any dam, concrete, stone, timber, or other wall, or any construction as a protection of river banks against the erosive action of the river current.	The Project will need to take cognizance of activities along rivers, in particular, the Kaituma Canal and the Kaituma and Barima Rivers. The project will also require approval for river defence infrastructure and dredging. In addition, construction of the wharf will require approval.

Title	Description	Applicability to the Project
Maritime Zones Act (2010)	Regulates internal waters, sea, territorial sea, contiguous zone, the continental shelf and the exclusive economic zone) and the regulation of the activities in those areas. It also provides that the internal waters comprise the areas of the sea that are on the landward side of the baselines which form the inner limits of the territorial sea as well as all rivers, bays, historic bays, ports, harbours and waters lying landward of the baselines.	The project will need to take cognizance of river transportation and dredging activities and impacts on rivers, riverbeds and navigability. In addition, dredging and disposal of dredged materials will require approval under this Act.
Creeks Act (1888 with amendments)	Provides a mechanism for keeping creeks clear and free from obstruction.	The Act applies only to an identified list of creeks, none of which are located in the project locations. However, the Act gives the Minister the power to make an order bringing a particular creek under the Act.
Environmental Protection (Water Quality) Regulations (2000)	Provides for the protection of the sources of and quality of water is provided. The Regulations prohibit the discharge of effluents into inland or coastal waterways. Under the Regulations, environmental authorisation is required for the construction, installation, operation, modification/extension of facilities that discharge effluents. Requirements and guidelines on the discharge of effluents and disposal of sludge are provided. There are liabilities for the discharge of toxic effluent into the environment and also for the discharge of sewage.	The project is required to apply for an authorisation to discharge effluent and also register with the Agency. Require compliance with provisions of associated penalties for offences regarding effluent discharge parameter limits. Although parameter limits have not been set under these regulations, the EPA, in collaboration with Guyana National Bureau of Standards, prepared interim effluent discharge standards which will apply. The Regulations also require sampling, keeping records and submitting reports as well as notifying the EPA of any spill or accidental discharge of any effluent onto any inland or coastal waters. The Project shall be required to contain, cleanse the discharge or to recover substances in a manner satisfactory to the EPA. The EPA may recover all costs and expenses associated with the above.
Mining (Amendment) Regulations (2005)	Promotes enforcement of environmental standards in the sector and makes provisions for maintaining water quality. These regulations set out discharge limits for Total Suspended Solids and Turbidity from mining operations and other	The Regulations will apply throughout the project and GMI will be required to comply with parameter limits for discharges. GMI will be required to comply with the discharge limits for TSS and Turbidity set out in the regulations

Title	Description	Applicability to the Project
	measures relating to the management mining waste, water quality, etc. These regulations also require large and medium scale mining operations to obtain permits for use of poisonous substances such as cyanide.	Under the Regulation, Codes of Practices have been prepared to provide critical environmental management guidance to the industry in areas such as tailings management. However, these Codes are still in draft and not yet finalized and may apply to the project when they are final.
Policies and Strategies		
GWI Strategic Plan (2017 to 2021)	Outlines systems for supplying water to the various communities. This is done through two main sources namely, well water from 'A' and 'B' sand wells and surface water from rivers, creeks, springs and canals. These sources are recognized as having inherent characteristics which require respective treatment and monitoring to address the following parameters: pH, turbidity, colour, iron, aluminum, total coliforms and E. Coli etc.	The Project will have to ensure that water for domestic use meets the required standards set by GWI and appropriate treatment applied. GWI adopts Drinking Water Standards from the World Health Organization (further details below).
Guidelines and Standards		
Interim Guidelines for Industrial Effluent Discharge into the Environment (2002)	Sets out specific parameter limits to guide and monitor industrial discharge, human sewage and surface runoff from urban and agricultural land use among other activities. It should be noted, however, the standard states in its perambulatory scope that this standard does not apply to industrial operations of mining.	The EPA has not established parameters limits for water quality specific for large scale mining operations. However, EPA may stipulate parameter limits in environmental authorisations based upon these guidelines and/or international standards such as World Bank among others (see section below on international standards possibly applicable).
Guyana Geology and Mines Commission, Environmental Effects Program	Applies to large and medium-scale mining operations and is mandatory. The Code addresses all phases of the mining cycle and is dependent on an accurate description of the baseline conditions and an environmental impact assessment.	The EPA subsumes this task and requires water quality baselines, preparation of a site specific- environmental effects monitoring plan which specifies surface and ground water parameters to be monitored based upon identified environmental effects.
International Treaties and Protocols		

Title	Description	Applicability to the Project
International Finance Corporation (IFC)/World Bank Group Effluent Discharge Guidelines	The guidelines outline parameter limits for liquid effluent discharges from tailings impoundment, mine drainage, sedimentation basins, sewage systems and stormwater drainage which are typically considered applicable in mining projects. The guidelines also outline parameter limits for residual heavy metals so they pose no risk for significant adverse impact to aquatic biota or human use, are considered applicable to mining projects. However, if natural concentrations exceed these levels, the discharge may contain concentrations up to natural background levels. Concentrations up to 110 percent of natural background are acceptable if no significant adverse impact can be demonstrated.	In the absence of national effluent discharge standards for mining, the project may adopt these where applicable.
IFC Environmental Health and Safety Guidelines for Mining, and IFC Environmental Health and Safety General Guidelines	Provide technical reference on general and industry-specific examples of Good International Industry Practice. The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs.	The project may adopt these guidelines as applicable and practical to ensure good environmental, safety and health during construction and operations, including closure. These guidelines also inform the recommended management and mitigation measures.
WHO Drinking Water Standards	Provides guidelines and parameter limits for drinking-water quality (GDWQ) to promote the protection of public health.	The project may adopt these where applicable.
The Cartagena Convention for the Protection and Development of the Wider Caribbean Region	Aims to protect and manage the marine environment and coastal areas of the Wider Caribbean Region through its Protocols.	Protects against marine pollution from ships, pollution from dumping, and pollution from land-based sources or activities. Guyana ratified in 2010.

Title	Description	Applicability to the Project
Chinese Standards		
Chinese Code for Design of Outdoor Water Supply and Wastewater Engineering (GB50013-2006) and (GB50014-2016); Building Water Supply and Drainage (GB50015-2003) (2009); Pumping Station (GB50265-2010); Tailings Facilities (GB50863-2013)	This suite of codes was formulated to make the water supply engineering design conform to Chinese national principles, policies, laws and regulations, unify engineering construction standard, improve engineering design quality, meet customers' demand for water volume, quality and pressure and to achieve safety and reliability, advanced technology, economy and rationality, convenient management.	The project voluntarily adopts these specifications and compliance with the provisions for water supply system, surface water intake structures, pump house, water transmission and distribution, outdoor wastewater engineering, building water supply and drainage, pumping station and the design of tailings facilities.

8.1.2 Permissible Limits for Surface and Potable Water Quality

In 2002, the EPA in collaboration with the Guyana National Bureau of Standards, prepared Interim Effluent Guidelines[19] (herein after referred to as GNBS guidelines). The parameters applicable to this project are presented in Table 8-2. In addition, the project may also adopt, on a voluntary basis, International Finance Corporation (IFC)/World Bank Group Effluent Discharge Guidelines and Drinking Water Standards from WHO. The parameter values applicable to this project are also presented in Table 8-2.

Table 8-2: Water Quality Permissible Limits

Parameters	Acceptable Limits
Physio-Chemical Parameters (IFC/ World Bank Group Effluent Discharge Guidelines and Mining (Amendment) Regulations)	
pH	6 to 9
Temperature	< 40°C (degrees Celsius)
Total Suspended Solids (TSS)	50 to 100 mg/L (milligrams per liter)
Total Dissolved Solids (TDS)	250 to 500 mg/L
Dissolved Oxygen (DO)	6.5 to 8 mg/L
Oil and Grease	10 mg/L
Turbidity	50 NTU (Nephelometric Turbidity Unit)
Conductivity	150 to 500 µs/cm (microseimens per centimetre)
Residual Heavy Metals (IFC/ World Bank Group Effluent Discharge Guidelines)	
Arsenic (As)	1 mg/L
Copper (Cu)	0.3 mg/L
Iron (Fe)	2 mg/L
Manganese (Mn)	0.3 mg/L
Nickel (Ni)	0.5 mg/L
Lead (Pb)	0.6 mg/L
Zinc (Zn)	1 mg/L
Major Cations	
Calcium (Ca)	5 mg/L
Magnesium (Mg)	30 mg/L
Sodium (Na)	200 mg/L
Potassium (K)	8 mg/L
Major Anions	
Sulphates	250 to 500 mg/L
Sulfides	0.2 mg/L
Nutrients	
Cyanide (CN)	0.2 mg/L
Total Nitrogen	10 mg/L
Ammonia	10 mg/L
Nitrates	10 mg/L
Biological (WHO Drinking Water Standards)	
Faecal Coliform or E. Coli	Not detectable in a 100 millileter sample

[19] Guyana National Bureau of Standards. GYS 207: 2002. Guyana Standard. Interim guidelines for Industrial Effluent discharge into the environment.

Parameters	Acceptable Limits
Drinking Water Standards (WHO Drinking Water Standards)	
Apparent Colour	15 True Colour Units (TCU)
Turbidity	5 NTU
Iron	0.3 mg/L
Total Dissolved Solids	1,000 mg/L
Manganese	0.05 mg/L

8.2 Baseline Conditions – Water Resources

The baseline environment (or prevalent environmental status) of the study areas represent the current prevailing environmental conditions and existing levels of environmental sensitivity, pollution or degradation prior to the proposed development. The baseline information is therefore indicative of the current environmental status. Baseline information was gathered through site visits, desktop studies as well as field studies/investigations. In 2012, a hydrological baseline characterisation study[20] was conducted by Ground Structures Engineering Consultants (GSEC) for the property at Matthew's Ridge which was owned then by Reunion Manganese Incorporated (RMI). Baseline information was extracted from this study and updated with data collected in 2020, and supplemented by data provided by GWI, the Hydrometeorological Department, and supported by desktop studies.

The baseline information serves as a reference point to scientifically measure or professionally judge the future changes to the surface water environment based on impacts associated with the construction and operational phases of the project. Chapter 2 describes in detail the Project's AoI. For this chapter, the two main areas of concern are Matthew's Ridge and Port Kaituma, and inclusive of the Kaituma and Barima Rivers from Port Kaituma and through the Mora Passage to Waini Point. The existing surface and groundwater hydrology and quality baseline for these areas are presented in this section.

8.2.1 Matthews Ridge Hydrology and Water Quality

The topography of the Matthew's Ridge prospect area is rugged, with chains of steeply sloping hills, gullies, and peneplane tops. Elevations range from 34 to 200 meters above mean sea level. Rocks are highly weathered and exposed only along the resistant crest of ridge, river valley and roadside cuts. Soils are developed over depths ranging from less than one meter to over 10 meters[21]. Surface drainage strikes generally both north and south of Hills 1 to 9.

8.2.1.1 Rivers and Creeks

The Matthew's Ridge area is part of the Barima River watershed. As such, all of the major rivers and creeks within the Matthew's Ridge area are tributaries of the Barima River that run north east and north of Matthew's Ridge (Figure 8-3). Within a 10-kilometer radius of Matthew's Ridge are the Manikuru River and the Arakaka River and their tributaries. In addition, there are creeks which have been named as well as unnamed creeks, and small seasonal surface flows. In 2012, a Hydrological Baseline Report was prepared by RMI that focused on surface waterways proximate to the Matthew's Ridge project area. The surface water flows which were discerned during that baseline assessment were the Manikuru River, Fish Creek, Paro Creek and the Pakera Creek.

[20] Ground Structures Engineering Consultants. 2012. Reunion Manganese Inc Hydrological Baseline. Page 4,
[21] Zhonge Changtian International Engineering Co. Ltd. Volume 1: Feasibility Study Report. Bosai Minerals Group Co. Ltd. Matthews Ridge Project Guyana.

The Manikuru River (Figure 8-1) is fast flowing in an east-north-east direction before entering Barima River in vicinity of Arakaka. The source of the Manikuru River is approximately 3-kilometers south east of Hill 5. Fish Creek is approximately 6- to 7 kilometers northwest of the Matthew's Ridge community and the project areas. Paro Creek is 3 kilometers central north of the project site, with its source just north, and is among a network of stream flows heading north and away from Hill 5. Pakera Creek (Figure 8-2) is approximately 2.5 to 3 meters in width and has its source south of the tailings pond used by the manganese mining operations in the 1960s. The Pakera Creek is north flowing and then heads east into Pakera Lake on the outskirts of the Matthew's Ridge community and adjacent to the Pakera Settlement. The catchment areas of Fish Creek, Pakera Creek and Manikuru River are 3.5, 2 and 35.2 square kilometers respectively[22]. The Matthew's Ridge watershed and key surface water features are shown in Figure 8-3.

Figure 8-1: A Section of the Manikuru River

Figure 8-2: A Section of the Pakera Creek

[22] Ground Structures Engineering Consultants. 2012. Reunion Manganese Inc. Hydrological Baseline.

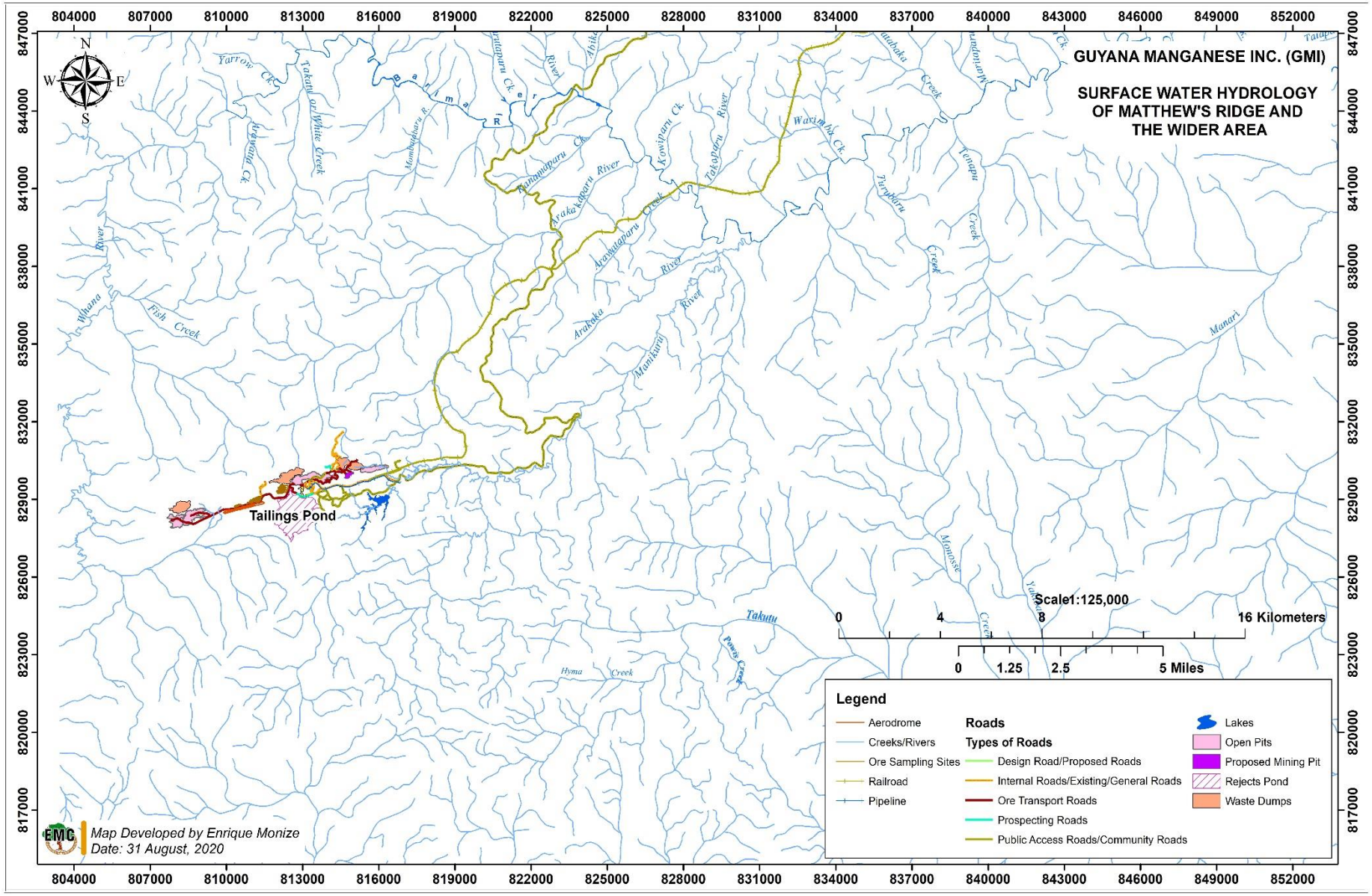


Figure 8-3: Surface Water Hydrology of Matthew's Ridge and the Wider Area

Table 8-3 and Figure 8-4 show the existing hydrological data available, measured for RMI in 2012 of the surface waters around the project area at Matthew's Ridge. The maximum and minimum flow rates have been inferred for Fish Creek, Pakera Creek and Manikuru River, using data from Eclipse Falls[23]. The mean monthly flow rates for these water bodies varied over the period January to December 2012 with the highest flows inferred in the months of January to July and in December. The lowest flows were as expected during the August to November periods. The maximum and minimum flow rates coincided generally with the bimodal wet and dry seasons of rainfall respectively in the area. It is expected that the flows are reflective of a combination of direct runoff from precipitation and groundwater flow to surface water bodies[24].

Table 8-3: Hydrological Features of Discernible Creeks in Matthews Ridge Area

Location	Average Velocity (meters/second)	Flow (cubic meters/second)	Longitudinal Slope
Paro Creek (SW 1)	0.05	0.09	0.033
Pakera Creek (SW 2)	0.18	0.02	0.009
Manikuru River (SW 3)	0.18	0.9	0.021
Pakera Outlet (SW 4)	0.3	0.17	0.011
Manikuru Main Outlet (SW 5)	0.8	2.19	0.183

Note: Pakera Outlet (SW 4) is the location at which the Pakera Creek discharges into the Manikuru River.

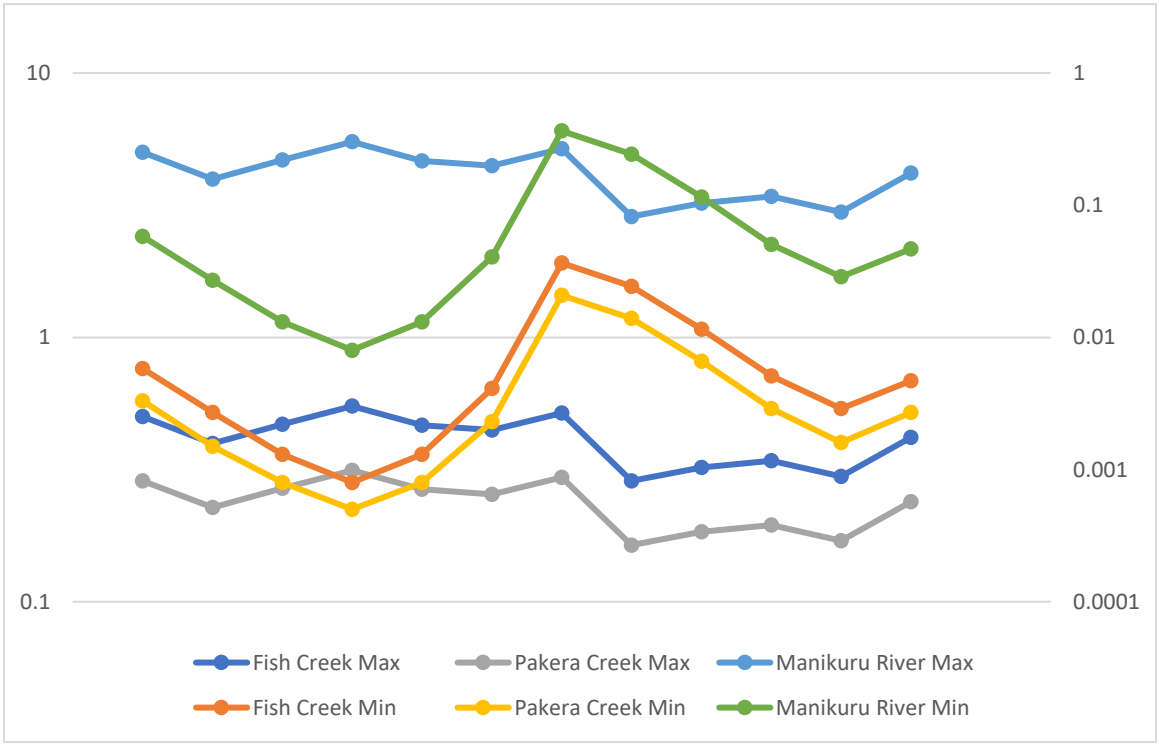


Figure 8-4: Maximum and Minimum Monthly Flow Rates Measured in 2012

[23] Ground Structures Engineering Consultants. 2012. Reunion Manganese Inc. Hydrological Baseline.
[24] Ibid

Runoff from several of the hills within the project area forms itself into small seasonal flooded creeks, swamps, and ravines. As part of the development of the hydrological baseline in 2012, flow rates, velocity, width and average depth of surface flows for Hills 3, 5, 6, 7 and 8 were measured between April and August 2012[25]. The locations where the measurements were undertaken are shown in Figure 8-5 and the findings of the hydrological analyses are presented in Table 8-4. The highest flows were observed at sample location Hill 8B, followed by Pakera Creek and Northern Prospect 2 based on measurements conducted in August 2012. The resulting flow rates are directly related to the quantity of water moving off the watershed into the stream channel influenced by precipitation, with increases during rainfall events and decreases during dry periods. However, the streams surveyed as well as others generally in the project area are probably reflective of a combination of both direct runoff from precipitation and groundwater flow to surface water bodies.[26]

Table 8-4: Hydrological Features of Surface Flows on Hills in the Project Areas

No.	Sample Location	Average Depth	Width	Stream Velocity	Flow Rate
		(meters)	(meters)	(meters/ second)	(cubic meters/ second)
1	Hill 8A	0.0396	3.0968	0.0701	0.0086
2	Hill 8B	0.0091	2.1336	0.1524	0.003
3	Hill 8C	0.125	2.4079	0.4115	0.1238
4	Hill 8A	0.6614	3.6576	0.2987	0.7226
5	Hill 7 Contact Water	0.0914	0.6096	0.0518	0.0029
6	Rail End	0.0091	1.143	0.3536	0.0037
7	Hill 6	0.3414	0.4816	0.0518	0.0085
8	Hill 5C 1	0.001	1.8776	0.2286	0.0004
9	Hill 5C 2	0.1219	1.524	0.32	0.0595
10	Northern Prospect	1.0668	4.2672	0.0518	0.2359
11	Northern Prospect 1	0.9373	1.524	0.0366	0.0522
12	Northern Prospect 2	0.2347	1.524	0.8931	0.3194
13	Hill 3	0.0914	0.9144	0.1524	0.0127
14	Pakera	0.6584	3.6576	0.1859	0.4477

[25] Ground Structures Engineering Consultants. 2012. Reunion Manganese Inc Hydrological Baseline.
[26] Ibid

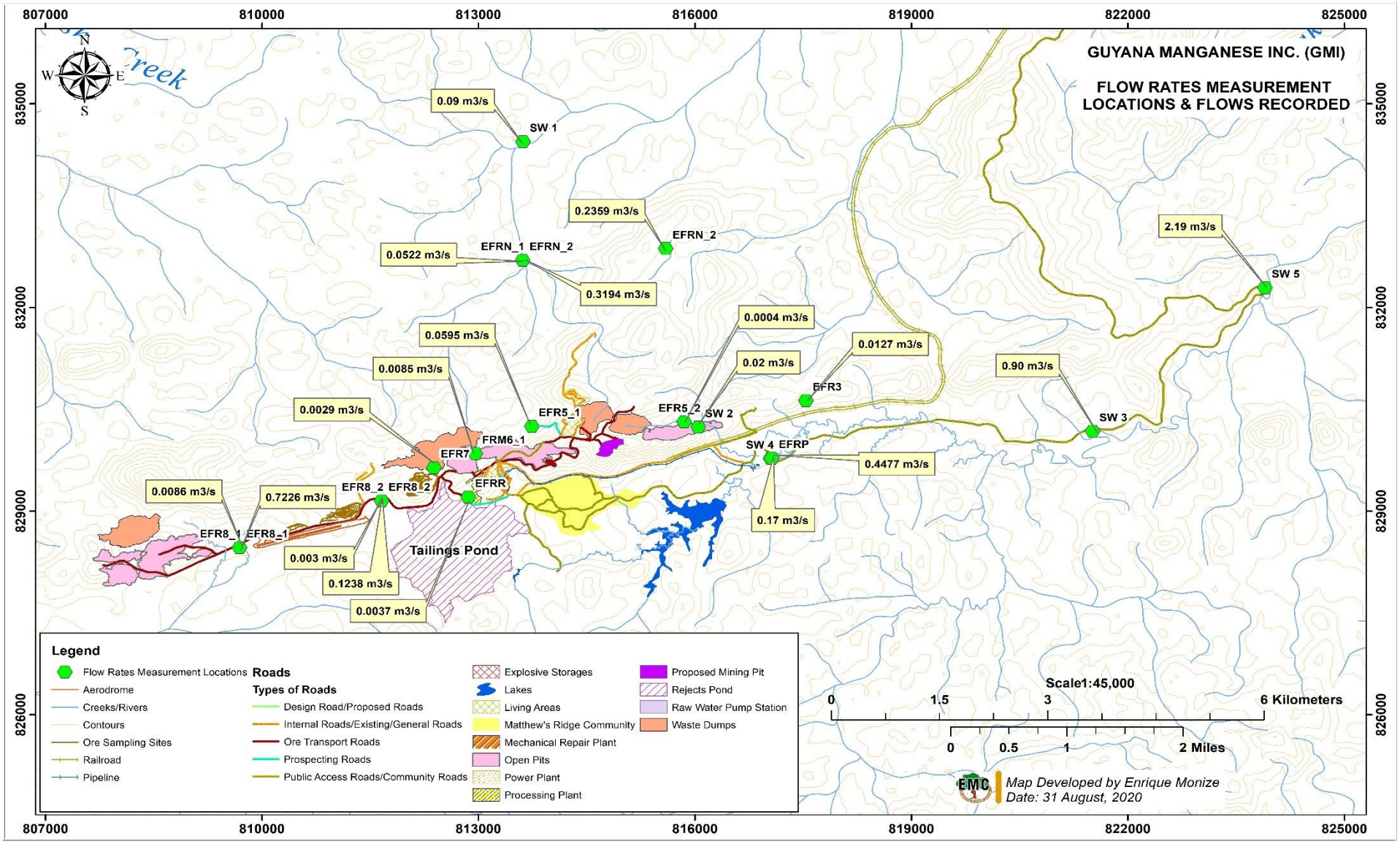


Figure 8-5: Flow Rate Measurement Locations

8.2.1.2 Swamps, Lakes and Tailings Pond

There are several man-made surface water bodies within the project area including the Hill 8 Swamp, Pakera Lake, Pump Station Intake Lake, the old tailings pond and an unnamed lake (Figure 8-3).

Pakera Lake (Figure 8-6) is one of the key components of the project as is the primary source of raw water supplied to the processing plant. Pakera Lake is a seasonal man-made lake resulting from a combination of a dam on the Pakera Creek (created in the early days of manganese mining) and overtopping of the Creek during the rainy season. During the dry season, the lake is a mostly a grassy depression with Pakera Creek flowing through it. Pakera Creek, as indicated earlier, originates south of the old tailings pond and flows through another smaller unnamed lake south of and adjacent to the old tailings pond. Pakera Lake is also fed by two other unnamed surface flows/creeks originating in higher grounds south of the project areas. Pakera Creek links Pakera Lake and the Pump Station intake lake, before exiting into the Manikuru River (Pakera Outlet). During the dry season, an estimated 34,600 cubic meters of water will be pumped from the Pakera Lake to support processing to compensate for lower water levels in the tailings pond as a result of increased evaporation.

The Hill 8 swamp (Figure 8-7) is located west of Hill 8 and north and northwest of the airstrip and is characterised by fluctuating water levels and is influenced by rainfall.

The Tailings Pond, shown in (Figure 4-9) is located just south of the Hill 5 pit. Based on the Feasibility Study,[27] the topography of the area is relatively flat with the highest elevation above sea level (AMSL) being 177 meters, and the lowest AMSL is 75 meters**.** The catchment area of the tailings pond is about 2.3 square kilometres. During the wet seasons, water stored in the Tailings Pond will be recirculated in the system and used for ore processing. The Tailings Pond was designed to hold maximum 24-hour rainfall events of 955 millimeters (tropical rainforest areas are typically 716mm). The surface area is 2.3 square kilometers with a depth of two meters and an elevation of 86 meters. The maximum water depth of the maximum possible flood in 24 hours is about 0.74 meters or by volume approximately 1,704,000 cubic meters.

The spillway will have a minimum freeboard height of 1.26 meters. The spillway is set west of the tailings pond. The spillway will have a depth of 2 meters, width of 20 meters, and a wall thickness is 400 millimeters. A stilling basin will be set downstream of the spillway and according to the terrain size will be 30 meters long, 25 meters wide and 3 meters high. The spillway and the basin are reinforced concrete structures. The total capacity of the tailings pond will be increased over the project lifetime and will ultimately be 12,080,000 cubic meters. GMI has not determined the water table profile of the tailings pond at the time of this study. However, based on groundwater elevation measured in 2012, water table depth is expected to range between 46 to 78 metres (see Table 8-13 and 8-14).

[27] Zhonge Changtian International Engineering Co. Ltd. Volume 1: Feasibility Study Report. Bosai Minerals Group Co. Ltd. Matthews Ridge Project Guyana. Zhonge Changtian International Engineering Co. Ltd. Volume 1: Feasibility Study Report. Bosai Minerals Group Co. Ltd. Matthews Ridge Project Guyana.

Figure 8-6: Pakera Lake

Figure 8-7: Swamp by Hill 8/North of Airstrip

8.2.1.3 Storm Water Drains

Several catch water ditches and open concrete drains (Figure 8-8) were constructed by GMI around the open pits, the waste dump and the industrial plant (processing, mechanical, power plants) respectively. These drainage features have 0.6 to 1 meter in width and depths of 0.6 meters. They are designed to capture surface flows and runoff in and around the mine and processing sites. The drains in the vicinity of the processing plant and power plant area discharge into the tailings pond. Storm water drains in the mine pits will discharge into the natural flows in the respective areas.

Figure 8-8: Storm Water Drains Constructed by GMI

8.2.1.4 Surface Water Quality

The baseline surface water quality analysis presented in this section was based on data from two sampling programmes. The first was conducted during the period 2011-2012[28] as part of RMI's work to develop a hydrological profile for the Matthew's Ridge project areas. The second was conducted by the EIA team in July 2020 to develop a surface water quality baseline for the project areas.

[28] Ground Structures Engineering Consultants. 2012. Reunion Manganese Inc Hydrological Baseline.

8.2.1.4.1 2012 Baseline Water Quality Assessment

The 2012 water quality sampling programme covered an extensive suite of physical and chemical parameters including heavy metals, nutrients and major anions and cations. Each parameter was sampled from 17 locations, shown in Figure 8-9.

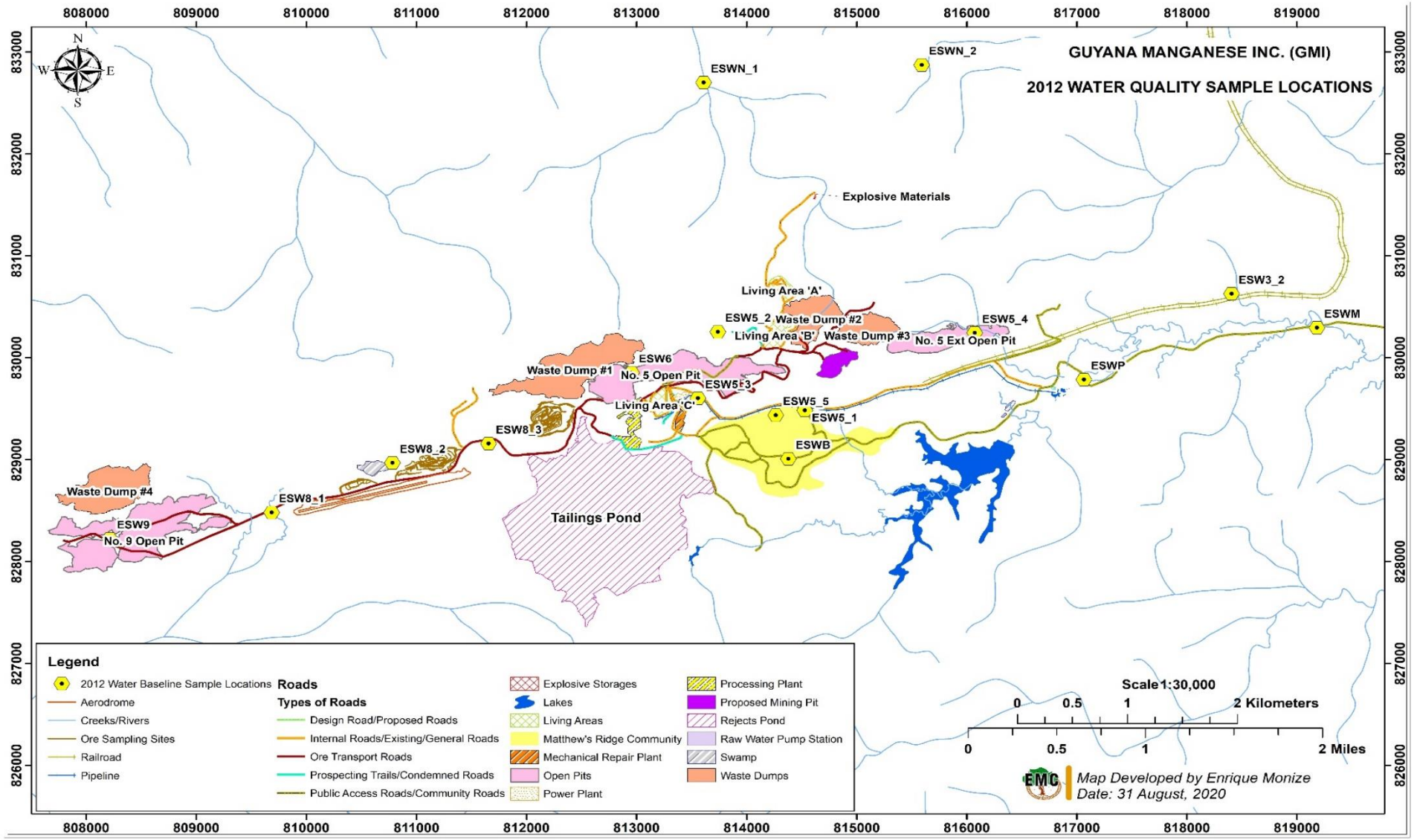


Figure 8-9: Water Quality Sampling Locations 2012

Physical Water Quality Parameters in 2012

Table 8-5 shows the results of the analysis of the physical parameters of surface water quality from the 2012 hydrological assessment.

Table 8-5: Baseline Water Quality of Surface Waters in Matthew's Ridge (2012)

Sample Locations	pH (5 to 9)	Total Suspended Solids (50 to 100 mg/L)	Turbidity (50 NTU)
Pakera	6.6	7	16
Dam	7	29	24
Hill 6	6.5	8	5
Hill 8A	6.4	10	19
Hill 8B	6.5	15	24
Hill 8C	6.5	8	9
Rail End	6.4	6	8
Hill 7 Contact Water	6.7	17	13
Hill 9	6.3	0	1
Hill 5 CE	6.7	-	8
Mile 23	6.6	35	36
Northern Prospect	6.6	14	18
Northern Prospect Bridge	6.4	-	12
Hill 3 WF	6.4	-	18

The results of the analysis showed that the pH values were within the acceptable range for all surface waters sampled and ranged from 6.3 – 7. All samples were within the range of 5-9 and 6-9 as set out by the IFC/World Bank Group Effluent Discharge Guidelines (herein after IFC guidelines) and the Guyana National Bureau of Standards (GNBS) Interim Effluent Guidelines[29] (herein after GNBS guidelines), respectively.

The results show that TSS and turbidity values vary among all sample locations but were all within the limits established by both the IFC and GNBS guidelines. TSS values ranged from 0 to 29 milligrams per liter and turbidity values ranged from 1 NTU to 36 NTU. Mile 23 and the Dam sample locations had TSS values in excess of 20mg/L. All surface waters sampled on Hills 1 to 9 were below 17 milligrams per liter, with the sample on Hill 9 returning 0 milligrams per liter. Turbidity values were highest at the dam and Mile 23 sample locations. These locations are influenced by small scale gold mining activities. The variations are expected and are influenced by the type of water source and the hydrological conditions of the sample locations, and possibly existing environmental and climatic conditions during the time of sampling.

Residual Heavy Metals

Table 8-6 shows the results of water quality analysis for residual heavy metals which were analysed as part of the 2012 hydrological baselines assessment.

[29] Guyana National Bureau of Standards. GYS 207: 2002. Guyana Standard. Interim guidelines for Industrial Effluent discharge into the environment.

Table 8-6: Baseline Water Quality Analysis for Residual Heavy Metals in Matthew's Ridge (2012)

Sample Locations	Arsenic (1 mg/L)	Copper (0.3 mg/L)	Iron (2 mg/L)	Manganese (0.2 mg/L)	Nickel (0.5 mg/L)	Lead (0.6 mg/L)	Zinc (1 mg/L)
Pakera	0.01	0	1.84	0.85	-	0.02	0
Dam	0.03	0.03	0.28	0.52	-	0.02	-
Hill 6	0.04	0.02	0.13	0.87	-	0.02	-
Hill 8A	0.02	0	4	1.46	0.01	0.03	0
Hill 8B	-	0	4.82	1.95	0.01	0.02	0
Hill 8C	-	0	1.45	0.34	0	0.02	-
Rail End	-	0	1.54	2.08	0	0.02	-
Hill 7 Contact Water	-	0.02	0.29	4.43	0.01	0.03	0
Hill 9	-	0	0.17	0.49	0.01	0.02	
Hill 5 CE	-	0.01	0.1	0.1		-	
Mile 23	0.03	0	1.74	0.47	0	-	0
Northern Prospect	-	0	1.69	0.2		-	-
Northern Prospect Bridge	0.01	0	1.64	0.09	0	0.01	-
Hill 3 WF	0.04	0	1.42	1.13	0.01	-	0

Based on the analysis, arsenic, copper, iron, manganese, nickel and lead were detected in the samples analysed. Zinc was not detected in any of the samples. In all samples trace elements except for manganese and iron, were within the limits established by IFC/World Bank standards. Manganese was above the stipulated limits in 15 of the 17 samples analysed. Samples taken at Hill 5 and Northern Prospect locations returned manganese levels that were within acceptable limits. Iron was above acceptable limits in two samples taken from surface flows on Hill 8.

These results highlight the background geological conditions with abundant manganese in the Project area. Manganese is typically found with iron, and occurs naturally in surface waters, the high values returned from the analysis may be a reflection of the existing natural conditions. Lead and arsenic were detected but were within the acceptable limits. While lead is an essential element for humans and other living organisms, adverse health effects such as impaired growth, skeletal abnormalities, reproductive deficits, and neurological effects among others, can result from over exposure.[30] These high values may be as a result of a combination of its natural occurrence, and run-off from loose aggregates of manganese used as a surface cover on road ways within the area, and possibly legacy of Acid Mine Drainage associated with previous manganese mining activities.

[30] World Health Organization. 2011. Manganese in Drinking Water; Background document for development of WHO Guidelines for Drinking-water Quality. WHO/SDE/WSH/03.04/104/Rev/1.

Major Cations, Anions, and Nutrients

Tables 8-7 to 8-9 presents the findings of the major cations, anions and nutrients which were analysed and detected in during the 2012 hydrological baseline assessment.

Table 8-7: Major Cations for Surface Flows Matthew's Ridge (2012)

Sample Location	Calcium (5 mg/L)	Magnesium (30 mg/L)	Sodium (200 mg/L)	Potassium (8 mg/L)
Pakera	2.73	2.42	1.53	0.53
Dam	3.46	5.09	2.35	0.28
Hill 6	0.75	1.84	1.74	0.04
Hill 8A	2.35	2.29	2.57	0.6
Hill 8B	2.99	3.13	3	0.25
Hill 8C	1.02	1.02	1.58	0.48
Rail End	1.03	1.6	2.92	0.35
Hill 7 contact water	1.68	2.35	3.51	0.58
Hill 9	0.61	0.74	2.32	0.39
Hill 5 CE	-	-	-	-
Mile 23	3.1	1.98	2.72	0.37
Northern Prospect	-	-	-	-
Northern Prospect Bridge	2.12	1.67	2.38	0.14
Hill 3 WF	1.5	1.77	2.54	0.19

Although the parameter values for major cations, anions and nutrients varied across the samples analysed, they were generally within acceptable limits. The resulting values are typical of surface waters due to the influence of natural weathering and erosion of exposed rocks and soils. Calcium is a major ion in natural waters and comes mainly from rocks, seepage, and also wastewater from mining. The concentration of calcium in surface water samples varies from 0.19 to 3.7 milligrams per liter. These values are well below WHO guidelines of 5 milligrams per liter. Magnesium is required as an essential nutrient for plants as well as for animals and a concentration of 30 milligrams per liter is recommended by WHO guidelines for drinking waters and the concentration of magnesium in Matthew's Ridge ranged from 0.74 to 5.79 milligrams per liter. Sodium represents one of the main ions dissolved in natural waters, when reacting with chloride ions forms rock salt (NaCl). The WHO guidelines for drinking water limits for sodium is 200 milligrams per liter and the concentrations of sodium at the sample locations were in the range of 0.36 to 4.21 milligrams per liter in surface water samples. The presence of potassium in the natural waters is very important since it is an essential nutrient element for plants. The concentrations of potassium are quite low in surface water samples ranging from 0.14 to 1.7 milligrams per liter.

Table 8-8: Major Anions for Surface Flows Matthew's Ridge (2012)

Sample Location	Sulphate (250 to 500 mg/L)	Sulfide (0.2 mg/L)	Cyanide (0.2 mg/L)
Pakera	0.84	0.18	0.003
Dam	10.92	0.36	0.003
Hill 6	0.26	0	0.003
Hill 8A	0	0.02	0.003
Hill 8B	-	0.01	0.008
Hill 8C	-	0.01	0.002
Rail End	-	0.01	0.005
Hill 7 contact water	-	0.02	0.003
Hill 9	-	0.01	0.004
Hill 5 CE	-	0.01	0.003
Mile 23	-	0.06	0.003
Northern Prospect	-	0.03	0.004
Northern Prospect Bridge	-	0.01	0.004
Hill 3 WF	-	-	-

The results for anions particularly cyanide, sulphates and sulphites indicate that all the values across all sample locations were also well within stipulated limits. Cyanide usage in any activity in the area is neither recorded nor is expected in this project. However, while it can be released into soils and waters from industrial activities including mining, it does occur naturally in soil and water[31].

Table 8-9: Nutrients for Surface Flows Matthew's Ridge (2012)

Sample Location	Total Nitrogen (10 mg/L)	Ammonia (10 mg/L)	Nitrate (10 mg/L)
Pakera	0.08	0.64	0.06
Dam	0.3	0.53	0.38
Hill 6	0	0.33	0.42
Hill 8A	-	0	0
Hill 8B	-	-	0
Hill 8C	-	-	0.04
Rail End	-	-	-
Hill 7 contact water	-	-	0.22
Hill 9	-	-	0.55
Hill 5 CE	-	-	0.69
Mile 23	-	-	0.07
Northern Prospect	-	-	0.12
Northern Prospect Bridge	-	-	0

[31] Mousavi et al. 2013. Determination of cyanide and nitrate concentrations in drinking, irrigation, and wastewaters. Journal of Research in medical Sciences vol 18(1). Pp 65-69.

Nutrients were all of very low values across the samples analysed. Nitrate ranged from 0 to 0.69 milligrams per liter. Nitrogen ranged from 0 to 0.87 milligrams per liter and ammonia ranged from 0 to 2.73 milligrams per liter. Nitrogen and ammonia were not analysed in the surface flows on Hills 3, 5, 6, 7, and 8.

8.2.1.4.2 2020 Baseline Water Quality Assessment

The 2020 baseline sample programme for Matthew's Ridge selected surface water flows within a 10-kilometer radius from the project area. This included surface flows for naturally occurring surface water bodies as well as surface flows intentionally created by the manganese mining operations in the 1960s. These sites were selected based upon a review of the 2012 water quality assessment programme, the location of the main water bodies, representative conditions and potential influence of mining operations and expected uses of the water body. A total of 11 surface water flows were analysed including the Manikuru River, Pakera Creek, Pakera Lake, the Lake and Creek located south of the tailings/rejects ponds, unnamed creeks/surface flows in vicinity of Hill 9, Hill 5 waste dump, Hill 5 Extension Waste Dump. The description of these sample points as well as the date and time samples are presented in Table 8-10. These locations are presented in Figure 8-10.

Table 8-10: Description of Water Sampling Locations

Sample Location ID	Sample Location	Coordinates	Date	Time (hrs)	Weather Condition
SW 13	Pakera Outlet	817211 830157	15/07/20	14:30	Sunny, Recent Rain
SW 14	Pump Station	816959 830041	15/07/20	14:45	Sunny, Recent Rain
SW 15	Pakera Lake at Dam	816502 829538	15/07/20	15:16	Rainy
SW 16	Swamp (Hill 9 Road)	809853 828882	16/07/20	10:00	Sunny
SW 17	Drain across Hill 9 Road (Draining Swamp)	809667 828791	16/07/20	10:12	Sunny
SW 18	Creek flowing across road at Hill 8	811817 829555	16/07/20	10:28	Sunny
SW 19	Ravine Hill 8/7	812499 830014	16/07/20	10:51	Sunny
SW 20	Discharge at Processing Plant Area	812913 829444	16/07/20	11:25	Sunny
SW 21	Hill 5 Reservoir	813912 830650	16/07/20	13:45	Recent Rain
SW 22	Hill 3 (Surface Flow)	816326 830644	15/07/20	15:28	Sunny
SW 23	Pakera Creek (South of Tailings Pond)	813379 828400	17/07/20	9:11	Sunny

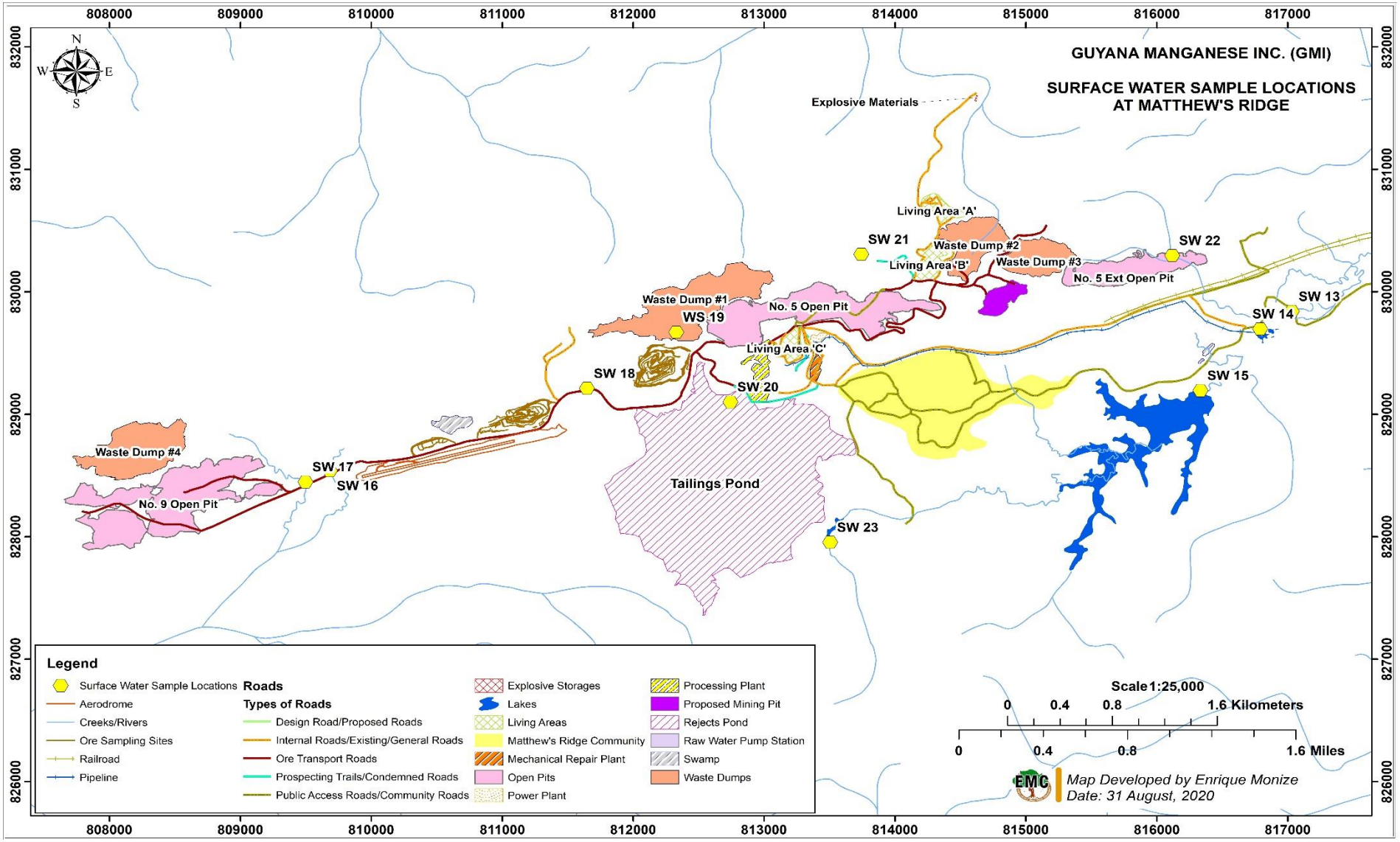


Figure 8-10: Surface Water Sample Locations within and around Matthew's Ridge

Parameters analysed for the surface waters were selected based on the following criteria:

- pollutants expected to be generated from planned project activities, specifically related to manganese mining;
- the baseline geological and environmental conditions of the area;
- the presence at elevated baseline concentrations determined in the 2012 water quality assessment; and
- potential for attenuating physio-chemical processes in surface waters.

As a result, physio-chemical parameters and trace metals in water were analysed for all 11 sample locations. The results of the analyses were compared with permissible limits from the GNBS, IFC and WHO Drinking Water Guidelines as outlined in Table 8-2. However, due to the restrictions of travel and public health and safety issues associated with the COVID-19 enforced at the time of the baseline survey resulted in limited sampling periods and allowed for only one round of water quality sampling, which was conducted during the wet season in July 2020. As a consequence, water quality analysis could not be done for both the wet and dry seasons. In addition, biological parameters were not measured because COVID-19 travel restrictions created logistical challenges of transporting samples from the sampling locations to the laboratory within the prescribed 24-hour holding period. As a result, biological parameters are presented based on water quality analyses conducted by GWI for its distribution network in Matthew's Ridge.

The EIA team utilised portable equipment which were used to measure the physical parameters *in-situ* at the selected sample points, given that conditions on-site allow for this to be conducted safely. Grab samples were collected from the sampling point for the parameters which could not have been analysed on-site and were conveyed to an accredited lab for analyses. Field analysis of water quality and collection of samples were guided by Standard Operating Procedures (SOPs) to protect the integrity of field analyses as well as sample collection and chain-of-custody protocols for delivery to the lab. The SOPs used for field testing and sample collection as well as further information on the mobile field-testing equipment are presented in Appendix E.

Physical Parameters

Table 8-11 shows the results of the physio-chemical parameters, including oil and grease, which were analysed for 11 of the sample locations in 2020. The Analysis Report from the laboratory for Oil and Grease is included in Appendix E1.

Table 8-11: Baseline Physio-Chemical Parameters for Surface Flows (2020)

Sample ID	Temp (<40°C)	pH (6 to 9)	DO (6.5 to 8 mg/L)	Turbidity (50 NTU)	Conductivity (150 to 500 µs/cm)	TDS (250 to 500 mg/L)	TSS (50 to 100 mg/L)	Oil and Grease (10 mg/L)
SW 13	29.5	6.431	2.17	33.6	73.7	31.7	25	0.08
SW 14	30.2	6.649	4.14	61.4	71	30.1	42	0.01
SW 15	30.6	7.062	7.44	25.4	60.1	25.2	16	0.11
SW 16	28.1	6.031	1.91	34.5	31.5	13.92	23	0.18
SW 17	27.5	5.979	1.77	23.2	31	13.96	18	0.02
SW 18	26.4	6.278	2.97	26.5	54.5	25	17	0.05
SW 19	31.3	7.46	6.62	147	192.1	83.6	61	0.1
SW 20	26.6	6.95	7.84	70.5	78.6	35.7	28	0.05
SW 21	27.6	7.19	8.04	69	63.3	28.4	41	0.04
SW 22	27.4	7.22	8.03	23.6	37.2	16.64	14	0.03
SW 23	28.6	6.35	6.69	18.2	68.9	30.1	12	0.01

Six of the parameters analysed (temperature, pH, TSS, TDS, Conductivity and Oil and Grease) were within or well below the acceptable limits for surface waters. These results are also typical for surface waters in forested areas of Guyana. Turbidity levels at four of the sample locations were in excess of acceptable limits, which can be explained due to increased sedimentation as a result of rainfall during sampling period. The highest levels were recorded at the pump station, Hills 8/7 Ravine, and the discharge from processing plant area. Construction was ongoing at the processing plant area with exposed soil and storm water flows captured and directed to discharge point at the location of the existing tailings pond. Hills 8/7 Ravine captures all surface flows from surrounding hills and the water level at time of sampling was low. The soil was also exposed due to deep water action cuts creating the natural ravine. The pump station lake captures storm water flows from surrounding hillsides, particularly from the southern end of Matthew's Ridge.

Residual Heavy Metals

Table 8-12 shows the results of water quality analysis for residual heavy metals. These parameters were analysed as part of the 2012 Hydrological Baseline Assessment. The Analysis Report from the laboratory is included in Appendix E1.

Table 8-12: Baseline Water Quality Analysis for Residual Heavy Metals in Matthew's Ridge (2020)

Sample Locations	Arsenic (1 mg/L)	Copper (0.3 mg/L)	Iron (2 mg/L)	Manganese (0.2 mg/L)	Nickel (0.5 mg/L)	Lead (0.6 mg/L)	Zinc (1 mg/L)
SW 13	ND	ND	2.3	2.4	0.01	0.01	0.01
SW 14	ND	ND	0.73	1.49	0.01	0.02	0.01
SW 15	ND	ND	0.68	0.07	ND	ND	0.03
SW 16	ND	ND	0.49	2.73	0.01	ND	0.02
SW 17	ND	ND	0.97	0.71	ND	ND	0.02
SW 18	ND	ND	ND	2.31	0.01	ND	0.03
SW 19	ND	ND	ND	7.34	ND	ND	0.01
SW 20	ND	ND	1.04	1.4	0.01	0.04	0.02
SW 21	ND	ND	0.59	0.18	ND	ND	0.01
SW 22	ND	ND	0.75	ND	0.01	0.02	0.02
SW 23	ND	ND	0.72	10.1	0.01	0.01	0.01

ND = Not Detected

Most of the heavy metals analysed were found to be within the acceptable limits. Unlike the results of the 2012 baseline assessment, arsenic and copper were not detected. Manganese was the exception with higher than acceptable limits in eight of the 11 sample locations. These levels represent the natural background levels resulting from erosion and sediment runoff. The roadways in and around Matthew's Ridge community and general project area are capped with manganese aggregate. This, coupled with exposed surface areas which would have be eroded by storm water flows during and after rainfall episodes, impact the surface water bodies in the project area. Although the acceptable limits for manganese in drinking water is 0.2 milligrams per liter, it is unlikely that the surface water flows in the project area will meet this standard due to prevailing geological conditions associated with the manganese deposits. Further baseline water quality monitoring and analysis (including capturing concentrations in the dry season) should be conducted prior to the operational phase to establish a comprehensive baseline manganese level for the surface flows in Matthew's Ridge.

8.2.1.5 Matthew's Ridge Groundwater Hydrology

Groundwater hydrology was based on the baseline hydrological assessment conducted for RMI in 2012[32]. As part of this assessment, five well nests were installed (Figure 8-11) and stratigraphy, water levels, hydraulic conductivity, and quality were assessed.

[32] Ground Structures Engineering Consultants. 2012. Reunion Manganese Inc. Hydrological Baseline.

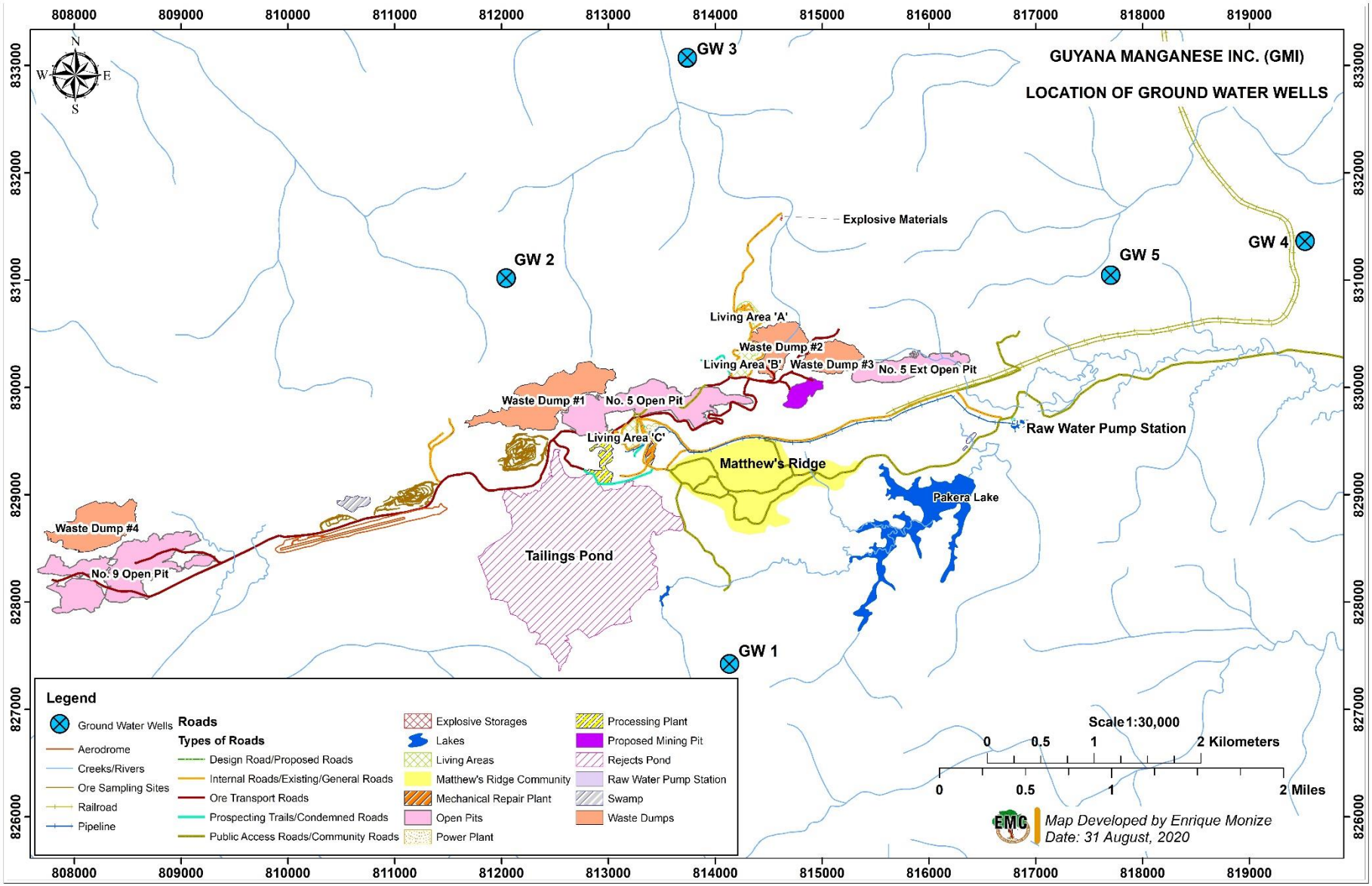


Figure 8-11: Ground Water Wells Assessed in 2012

The stratigraphic profile within the project area generally consists of a zone of residual soil which has been completely weathered to soil with no visible remaining structure of the rocks from which they were formed. There is laterite, present at some locations, and the residual soil is underlain by saprolite, which has undergone no strain. The saprolite is underlain by weathered rock or sap rock which constitutes the transition zone between saprolite and bedrock. The sap rock is underlain by a stratum of intact rock with no indication of weathering.

There is an absence of direct hydraulic connection between the overburden and bedrock strata. It was observed that groundwater levels in the overburden and bedrock differed at the same well nest. While no discernible confining layer was encountered at the interface between the saprolite and bedrock, the differing groundwater levels is indicative of the overburden stratum itself acting as a confining layer for groundwater flow in the bedrock. Ground water elevation is defined as the elevation of the ground water table above mean sea level[33]. Tables 8-13 and 8-14 show the various groundwater elevation.

Table 8-13: Ground Water Elevations A

Monitoring Well ID	Coordinates		Response Zone	Groundwater Elevation (meters)
	Easting (meters)	Northing (meters)		
GW1	814133.561	827422.591	Bedrock	78.138
GW2	812042.746	831017.046	Bedrock	60.423
GW3	813738.595	833071.096	Bedrock	46.795
GW4	819520.488	831362.242	Bedrock	52.274
GW5	817700.399	831044.774	Bedrock	76.329

Table 8-14: Ground Water Elevations B

Monitoring Well ID	Coordinates		Response Zone	Groundwater Elevation (meters)
	Easting (meters)	Northing (meters)		
GW1A	814133.357	827424.183	Saprolite	78.341
GW2A	812044.531	831016.838	Saprolite	60.876
GW3A	813739.243	833068.464	Saprolite	46.397
GW4A	819518.076	831364.448	Saprolite	52.143
GW5A	817701.743	831045.713	Saprolite	76.301

Groundwater levels for all wells in the overburden area were assembled with the associated well location data and a potentiometric map was developed for the overburden zone. The potentiometric map is representation of the “potentiometric surface” which is an imaginary surface that defines the level to which water in a confined aquifer would rise it was to be completely pierced with wells, and if the potentiometric surface lies above the ground surface, a flowing artesian well result. Contour maps and profiles of the potentiometric map (Figure 8-12 and 8-13)[34] were developed by extrapolation between points where groundwater elevations were recorded.

[33] Sacremento State, 2019. Water and Wastewater Glossary: Ground Water Elevation.
[34] Ground Structures Engineering Consultants. 2012. Reunion Manganese Inc. Hydrological Baseline.

Horizontal flow gradients in the overburden zone range from a low of 0.0463 in the north-western section of the area to a high of 0.127 in the north-eastern section.

Hydraulic conductivity tests (Tables 8-15 and 8-16) suggest that the overburden was determined to be relatively constant and ranged from a low of approximately 2.71E-05 centimetres per second to a high of approximately 6.38E-05 centimetres per second. The hydraulic conductivity of the bedrock was variable and ranged from approximately 1.94E-05 to 7.23E-05 centimetres per second. The variation of these values is indicative of flow in the bedrock being influenced by fracture frequency and spacing, the higher hydraulic conductivity being likely reflective of greater fracture frequency and spacing. Groundwater levels were recorded at all wells at approximately the same time to provide data on vertical and horizontal flow gradients.

Table 8-15: Hydraulic Conductivity of Groundwater Wells in the Bedrock Zone

Monitoring Well ID	Coordinates		Response Zone	Hydraulic Conductivity of Response Zone (centimeters/second)	Legend Colour (Figure 8-12)
	Easting (meters)	Northing (meters)			
GW1	814133.561	827422.591	Bedrock	4.17E-05	
GW2	812042.746	831017.046	Bedrock	1.94E-05	
GW3	813738.595	833071.096	Bedrock	2.47E-05	
GW4	819520.488	831362.242	Bedrock	7.23E-05	
GW5	817700.399	831044.774	Bedrock	3.29 E-05	

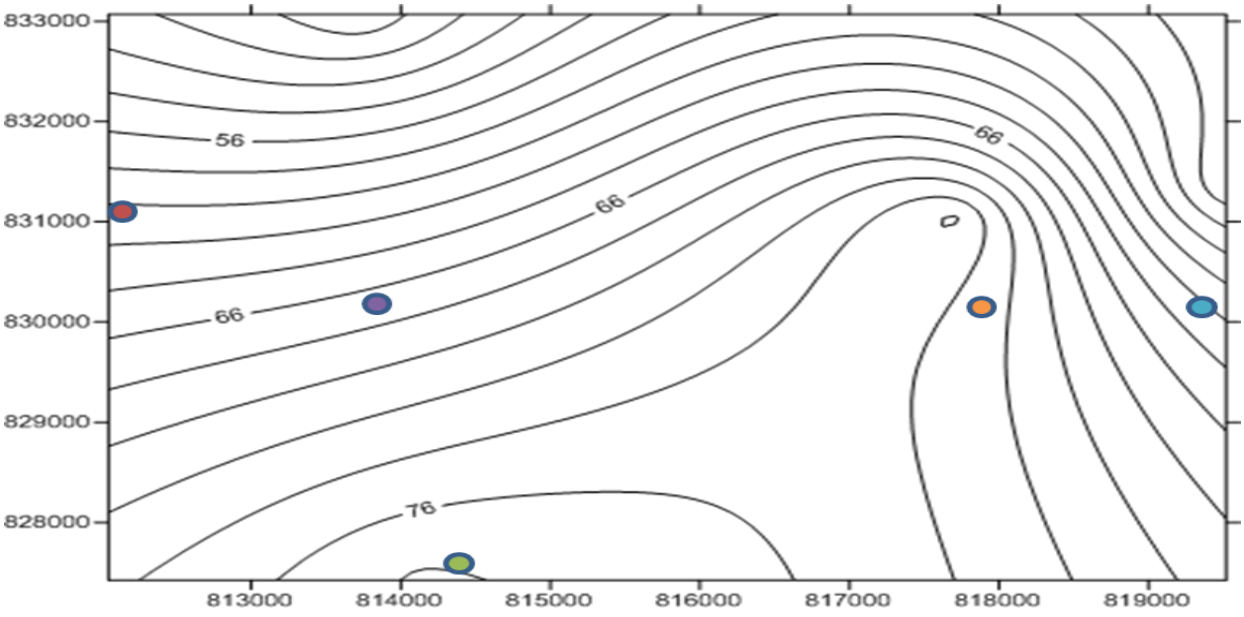


Figure 8-12: Potentiometric Map and Hydraulic Conductivity Ground Water Wells in the Bedrock Zone

Table 8-16: Hydraulic Conductivity of Groundwater Wells in the Saprolite Zone

Monitoring Well ID	Coordinates		Response Zone	Hydraulic Conductivity of Response Zone (centimeters/second)	Legend Colour (Figure 8-13)
	Easting (meters)	Northing (meters)			
GW1A	814133.357	827424.183	Saprolite	6.38E-05	
GW2A	812044.531	831016.838	Saprolite	2.58E-05	
GW3A	813739.243	833068.464	Saprolite	2.71E-05	
GW4A	819518.076	831364.448	Saprolite	4.52E-05	
GW5A	817701.743	831045.713	Saprolite	3.39E-05	

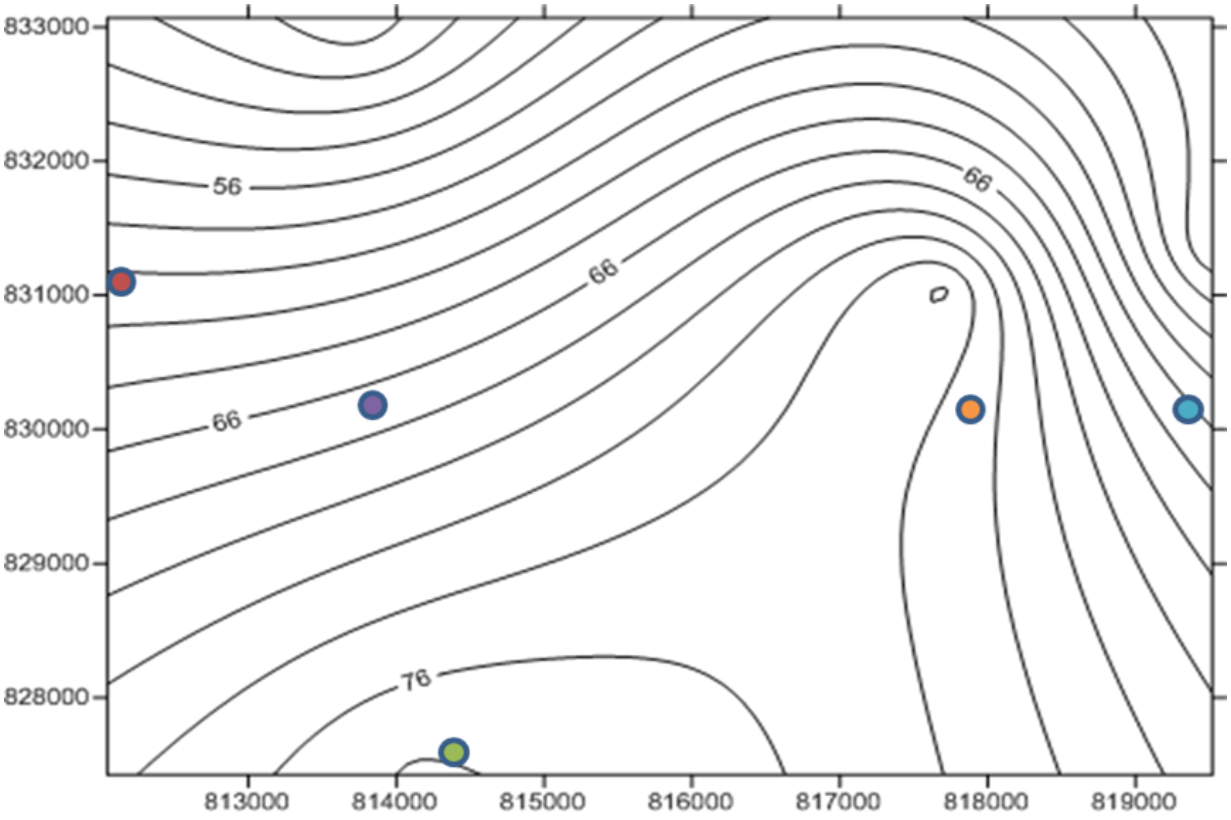


Figure 8-13: Potentiometric Map and Hydraulic Conductivity Ground Water Wells in the Saprolite Zone

8.2.1.6 Groundwater and Water for Domestic Purposes

GWI installed and commissioned the existing water supply system within Matthew's Ridge in 2001. It consists of a spring which gravity feeds water through 100-millimeter PVC pipes to three storage units with an overall capacity of 197.97 cubic meters. The water is then gravity fed through 100-millimeter PVC SDR 26 pipes into two separate distribution networks referred to as ˜low-line & high-line at different intervals. One of the systems is a concrete catchment/reservoir called "Industrial Yard" which collects water from three springs. The second is called Jacks and collects water from an additional three springs into above ground

tanks. The production of water from the springs is seasonal and varies at different periods of the year depending on the bimodal seasonality of the area (wet and dry seasons).

Two locations were sampled, namely the spring at Matthew's Ridge and an aquifer on Hill 3, as part of the baseline assessment of potable water quality conducted in 2012. Baseline assessments were also conducted by the EIA team in 2020. The results of these two baseline assessments are presented in Table 8-17 and the locations sampled are shown in Figure 8-14. Analyses were conducted in the same manner as with the surface water samples, with analyses for some parameters conducted *in-situ* utilising portable meters and others done at the lab. The Analysis Report from the laboratory is included in Appendix E1.

Table 8-17: Description of Potable Water Sampling Locations in Matthew's Ridge

Sample Location ID	Sample Location	Coordinates	Date	Time (hrs)	Weather Condition
GW 1	Piped Spring at Power Plant Area	813726 829984	16/07/20	13:18	Rainy
GW 2	Hill 3 Aquifer	812706 830972	16/07/20	14:30	Sunny

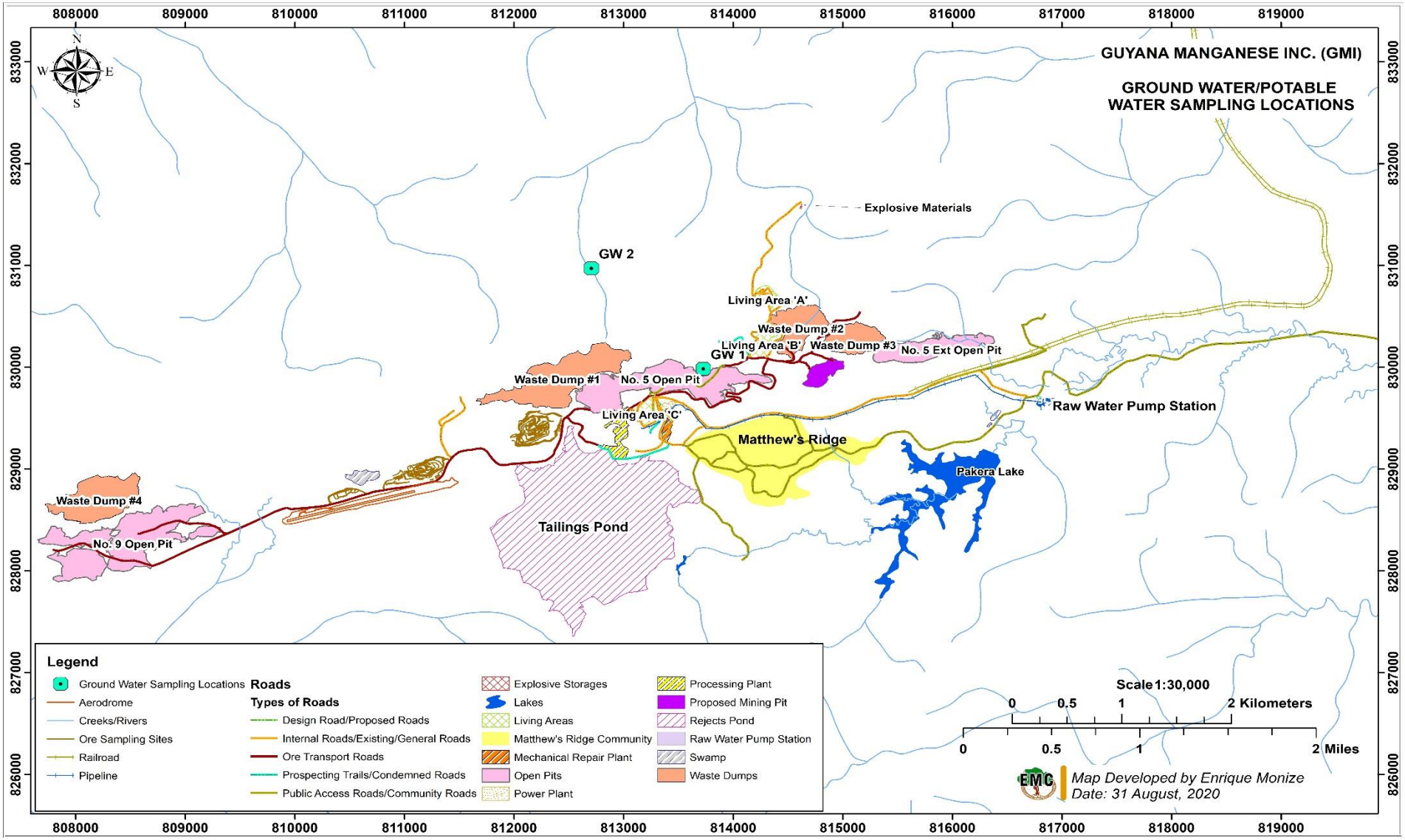


Figure 8-14: Potable Water Sample Locations

Table 8-18: 2012 and 2020 Baseline Potable Water Quality

Parameters	Acceptable Limits	2012		2020	
		GW 1	GW 2	GW 1	GW 2
Temp (^{0}C)	<28	-	-	26.9	26.7
pH	6 to 9	6.4	6.5	6.3	6.54
DO (mg/L)	6.5 to 8	-	-	6.94	3.46
Turbidity (NTU)	5	16	0	2.31	2.78
Conductivity (µs/cm)	150 to 500	-	-	64.4	158.4
TDS (mg/L)	250 to 500	-	-	23.9	72.6
TSS (mg/L)	50 to 100	7	2	2	5
Oil and Grease (mg/L)	2	-	-	0.05	0.04
Arsenic (mg/L)	1	0.06	0.02	ND	ND
Copper (mg/L)	0.3	0.01	0.01	ND	ND
Iron (mg/L)	2	0.31	0.13	0.97	1.16
Manganese (mg/L)	0.2	3.49	4.77	ND	3.91
Nickel (mg/L)	0.5	0.01	0.01	0.01	0.01
Lead (mg/L)	0.6	0.03	0.01	ND	0.01
Zinc (mg/L)	1	0.01	0	0.01	0.02
Sulphate	5	0.25	-	-	-
Sulfide (mg/L)	30	0.01	0	-	-
Cyanide (mg/L)	200	0.004	0.004	-	-
Calcium (mg/L)	8	3.71	15.24	-	-
Sodium (mg/L)	0.2	4.5	8.33	-	-
Potassium (mg/L)	0.2	1.52	0.13	-	-
Total Nitogen (mg/L)	10	0.08	-	-	-
Ammonia (mg/L)	10	0.12	-	-	-
Nitrate (mg/L)	10	0.08	0.05		

ND = Not Detected

Based on the analysis, levels for all physio-chemical parameters were well within the acceptable range limits established by the IFC and WHO guidelines. In particular, turbidity for the spring at Matthew's Ridge was lower in 2020 as compared to 2012.

With the exception of manganese, the values of all trace elements were within the acceptable limits. Although manganese was not detected in the sample collected for the spring at Matthew's Ridge, the levels were in exceedance of the permissible limits for the Hill 3 aquifer. This is of concern because high manganese levels in drinking water have been associated with a range of adverse health outcomes foremost of which are diminished intellectual performance of children including diminished IQs as well as increased hyperactive and oppositional behaviours. Iron levels were greater in 2020 than in 2012. However, Iron content of water, particularly groundwater, in Guyana are typically high and require treatment before consumption.

Major cations values were below 5 milligrams per liter for the spring at Matthew's Ridge. For Hill 3, all values were above 5.0 milligrams per liter with the exception of potassium; calcium being 15.24, magnesium 6.73 and sodium 8.33 milligrams per liter.

Results showed that cadmium, cyanide, antimony and selenium in the two ground water sources were below the WHO drinking water guidelines. The spring at Matthew's Ridge had the highest average value for arsenic (0.06 milligrams per liter) and had one of the highest values for lead (0.03 milligrams per liter) for all of the sampling points. Hill 3 had a value of 0.02 milligrams per liter for arsenic and 0.01 milligrams per liter for lead.

Following an engagement with GWI, information was shared with the EIA team on the results of water quality analysis for various points of the public water distribution system over the period 2018 to 2020. GWI's results align with the findings of the baseline water quality assessments for physio-chemical parameters. However, GWI also assessed biological parameters namely coliforms and *E.Coli* both of which exceeded safe levels during different testing periods. The results of GWI's water quality analyses are presented in Table 8-19.

Table 8-19: Potable Water Quality Analyses Conducted by GWI for Matthew's Ridge (2019 to 2020)

Location	Date Analyzed	pH (6.5 to 8)	Turbidity (<5 NTU)	Iron (<0.3 mg/L)	Chlorine	Apparent Colour (Clear, <100)	Total Coliforms (0 to 60 CFU)	E- Coli (0 CFU)	Conductivity (µs/cm)	TDS (mg/L)	Salinity (ppt)	Free Chlorine Residual (mg/l Cl)
Jacks 3 Spring	Jun 08, 2019	5.51	3.34	0.06	-	14	TNTC	TNTC	-	-	-	-
Jacks 3 Spring	Nov 06, 2019	5.66	0.21	0.02	-	0	TNTC	0	-	-	-	-
Jacks 3 Spring	Feb 25, 2020	5.46	0	0.06	-	0	3	0	64.40	30.30	0.03	-
Jack 3 Water Source (Stand Pipe)	Aug 20, 2019	5.91	0.24	0.03	-	-	TNTC	TNTC	-	-	-	-
Jack 3 Water Source (Stand Pipe)	Aug 20, 2019	5.91	0.24	0.03	-	-	TNTC	TNTC	-	-	-	-
Jack 3 Water Source (Stand Pipe)	Dec 09, 2019	6.02	0.49	0.03	-	1	-	-	-	-	-	-
Stand Pipe at Storage Tank	Oct 15, 2019	6.06	0.70	0.05	-	20		0	-	-	-	-
Stand Pipe at Storage Tank	Feb 26, 2020	5.36	0	0.06	-	0	0	0	67.40	31.70	0.03	0.40
Industrial Site Stand Pipe	Jun 08, 2019	-	-	-	0.30	-	8	0	-	-	-	-
Industrial Site Stand Pipe	Jun 14, 2019	5.80	6.05	0.07	0.40	39	1	-	-	-	-	-
Industrial Site Stand Pipe	Aug 20, 2019	5.84	0.34	0.00	-	-	-	-	-	-	-	-
Industrial Site Stand Pipe	Nov 06, 2019	6.08	0.34	0.04	0.30	12	TNTC	0	-	-	-	-
Industrial Site Stand Pipe	Dec 09, 2019	5.96	0.59	0.06	-	2	-	-	-	-	-	-
Industrial Site Stand Pipe	Feb 25, 2020	5.34	0	<0.02	-	0	0	0	80.30	37.80	0.04	0.30

TNTC – Too Numerous to Count

8.2.2 Matthew's Ridge to Port Kaituma Road Surface Water Hydrology and Quality

The public road between Matthew's Ridge and Port Kaituma either crosses or is aligned along the catchment area of several creeks and rivers (Figure 8-17). These include the Manikuru River, Arakaka River, Arakakaparu River, Kanamaparu River, Barima River (where it passes through the Eclipse Falls community), Abikabaru River, and several tributaries of the Kaituma River. Mean daily flow rates for the period 1968 to 1986 are available for Barima River at Eclipse Falls[35]. The mean daily flow rate is 49.24 cubic meters per second.

Five sites were sampled in the 2020 water quality assessment programme. These include a tributary of Barima River, the Barima River passing through the Eclipse Falls community (in the vicinity of the Eclipse Falls Bridge), the Arakakaparu River, the Manikuru River at Arakaka Junction, and a creek crossing road to Matthew's Ridge which flows into Manikuru River. The sampling locations as well as the time date and time at which the samples were taken are presented in Table 8-20 and the locations are shown in Figure 8-17. As previously mentioned, due to the restrictions of travel and public health and safety issues associated with the COVID-19 enforced at the time of the survey resulted in limited sampling periods and allowed for only one round of water quality sampling, which was conducted during the wet season in July 2020. As a consequence, water quality analysis could not be done for both the wet and dry seasons.

The EIA team utilised portable equipment which were used to measure the physical parameters *in-situ* at the selected sample points, given that conditions on-site allowed for this to be conducted safely. Field analysis of water quality and collection of samples were guided by SOPs. The SOPs used for field testing as well as further information on the mobile field-testing equipment are presented in Appendix E.

Figure 8-15: A Section of the Arakaparu River

Figure 8-16: A Section of the Barima River

[35] Ground Structures Engineering Consultants. 2012. Reunion Manganese Inc. Hydrological Baseline.

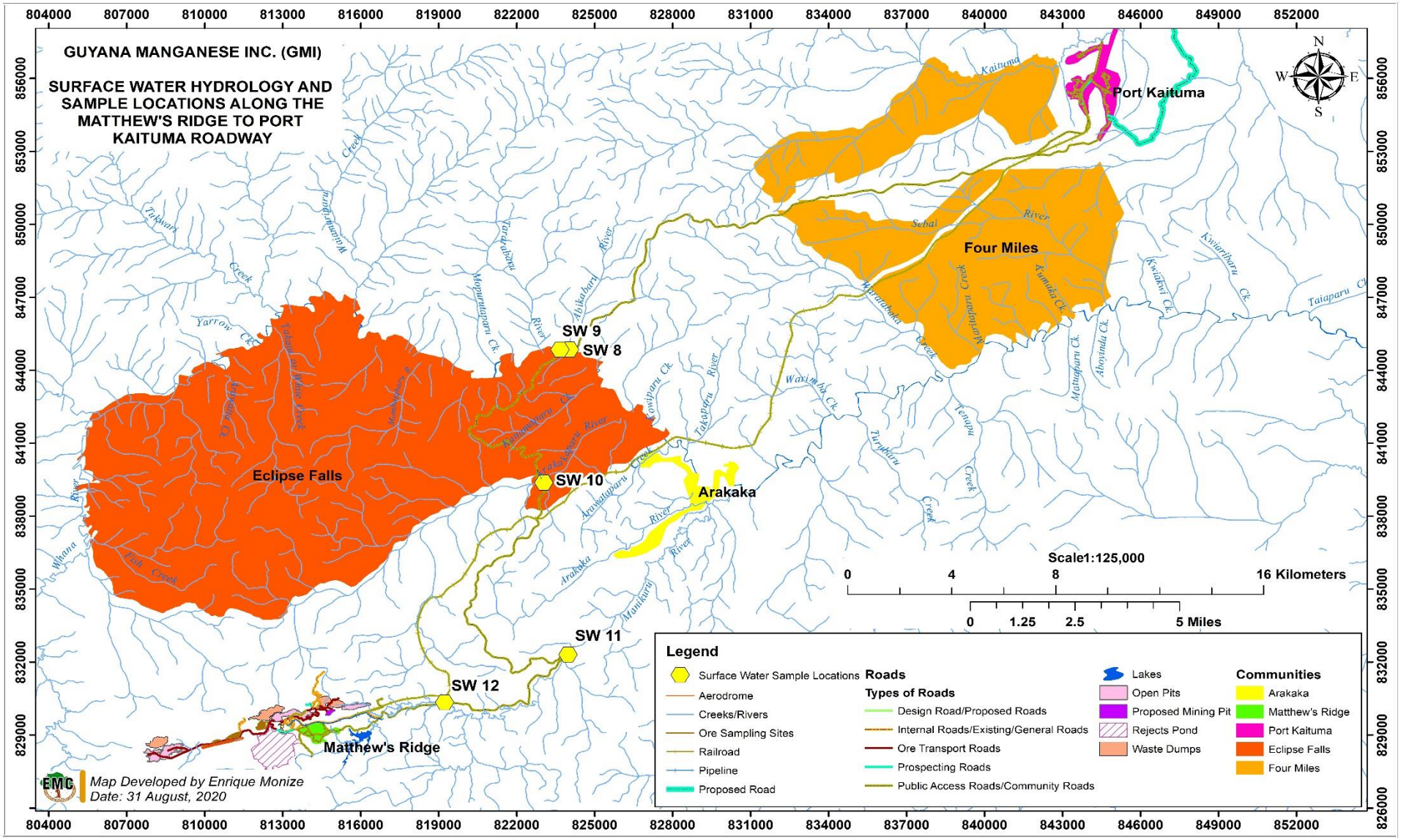


Figure 8-17: Surface Water Hydrology and Sample Locations along the Matthew's Ridge to Port Kaituma Roadway

Table 8-20: Details on Surface Water Sampling Locations along the Port Kaituma to Matthew's Ridge Road

Sample Location ID	Sample Location	Coordinates	Date	Time (hrs)	Weather Conditions
SW8	Creek before Eclipse Falls (Washbay)	824314 845182	15/07/20	10:03	Sunny
SW9	Barima River in the Eclipse Falls Community	823794 845133	15/07/20	10:30	Sunny
SW10	Arakaparu River	823138 839784	15/07/20	11:01	Sunny
SW11	Manikuru River at Arakaka Junction	824052 832654	15/07/20	11:39	Sunny
SW12	Creek Flowing from Rail-End into the Manikuru River	819362 830684	15/07/20	12:15	Sunny

Physio-chemical parameters, including oil and grease, were analysed for these sample points because the likely impacts on these surface waters may result from accidental spills of fuel and oil from vehicles traversing the roadway. Moreover, vehicles traversing the roadways proximate to these waterways may also impact physical parameters like turbidity, total dissolved solids and total suspended solids associated runoff from the laterite roads as well as dust. Table 8-21 presents the water quality results. The Analysis Report from the laboratory for Oil and Grease is included in Appendix E1. The results of these analyses were compared with permissible limits from the GNBS, IFC and WHO Drinking Water Guidelines.

Table 8-21: Water Quality Results along the Matthew's Ridge to Port Kaituma Road

Parameters	SW 8	SW 9	SW 10	SW 11	SW 12
pH (6 to 9)	6.5	6.8	6.09	7.09	6.82
Temperature (<40°C)	26.5	27.1	27.3	28.0	26.6
Turbidity (50 NTU)	8.14	58.7	74	148	45.2
Dissolved Oxygen (6.5 to 8 mg/L)	6.57	6.82	6.09	6.97	5.65
Conductivity (150 to 500 µc/cm)	41.6	52.5	56.2	68.6	47.0
Total Dissolved Solids (250 to 500 mg/L)	18.93	23.6	25.5	30.3	21.24
Total Suspended Solids (50 to 100 mg/L)	6	41	53	55	20
Oil and Grease (10 mg/L)	0.01	0.09	0.01	0.01	0.07

All parameters with the exception of turbidity, were within or well below the acceptable limits. As anticipated, higher turbidity levels were detected and resulted from sedimentation from runoff due to intermittent rainfall during the sampling period. In addition, the Barima River at Eclipse Falls and the Arakaparu River are also influenced by small scale mining activities upstream of these rivers.

8.2.3 Port Kaituma Surface Water Hydrology and Quality

The Marine Terminal is situated within the catchment area of the Kaituma River (Figure 8-9). The main surface waters include the Kaituma Canal (Figure 8-18), Kaituma River (Figure 8-19), and several unnamed creeks that are tributaries of the Kaituma River. The Kaituma Canal is an approximately 3-kilometer man-made canal that links the community of Port Kaituma to Kaituma River. The Marine Terminal is located on the right bank of the Kaituma River approximately 7-kilometers from Port Kaituma. However, this section of the River is also referred to by locals as the Kaituma Canal since it was modified (dredged and widened) at the time when the canal was created. The average depth of Kaituma River at the Marine Terminal site is 4.8 meters. Daily flow rate of the Kaituma River is approximately 40 cubic meters per second. Two small tributaries of the Kaituma River cross the haul road alignment (Figure 8-20). The surface water hydrology within and around Port Kaituma is shown in Figure 8-21.

Since the creation of the Kaituma Canal, more than 300 households have been erected on both banks creating a settlement commonly referred to as Canal Bank. According the Chairperson of the NDC for the Matarkai sub-district, in 2020, the population of Canal Bank was approximately 1,500. All of these residents depend on the water in the Kaituma Canal for domestic purposes including washing, bathing, cooking and in some instances, drinking (EMC Personal Communication 17). In addition, GWI sources water from a tributary of the Kaituma River to supply to approximately 700 residents in central Port Kaituma (EMC Personal Communication 07 and 17). In recent years, the water quality of Kaituma River has over the years been influenced by small scale gold mining activities in the area. According to GWI, contamination of surface flows had required the temporary cessation of water supply to residents of Port Kaituma (EMC Personal Communication 06). In addition, according to an article in the Stabroek News[36] dated July 16, 2018, the mercury concentration of the Kaituma River was found to be 0.016 milligrams per liter, approximately two and half times above the safe limit for drinking water set by the WHO (0.006 milligrams per liter).

Seven sites were selected to be part of the 2020 water quality assessment for Port Kaituma These include three creeks along the Port Kaituma bypass road which was constructed by GMI, two unnamed drainage canals bounding the marine terminal on the east and west, and upstream and downstream of the Marine Terminal on Kaituma River. The description of the surface water sampling locations is presented in Table 8-22 and the locations can be observed in Figure 8-21.

Table 8-22: Surface Water Sampling Locations in Port Kaituma

Sample Location ID	Sample Location	Coordinates	Date	Time (hrs)	Weather Condition
SW1	Kaituma Canal Upstream of Wharf	185131 859602	14/07/20	14:29	Overcast
SW2	Kaituma Canal Downstream Wharf	185622 859653	14/07/20	14:26	Overcast
SW3	Drain (Western Boundary of Wharf Site)	185207 859571	14/07/20	14:41	Overcast
SW4	Drain (Eastern Boundary of Wharf Site)	185546 859584	14/07/20	14:15	Overcast
SW5	Creek crossing the Wharf Site Bypass Road	186107 856098	14/07/20	15:56	Raining

[36]Stabrorek News, 2018. Mercury and the Kaituma River.

Sample Location ID	Sample Location	Coordinates	Date	Time (hrs)	Weather Condition
SW6	Surface Flow along Right Side of Bypass Road	183505 854070	15/07/20	8:45	Sunny
SW7	Reggy (Red G) Creek flowing across Bypass Road (Tributary of Kaituma Canal)	183465 854096	15/07/20	9:00	Sunny

Figure 8-18: Kaituma Canal

Figure 8-19: A Section of the Kaituma River in the vicinity of the Wharf Site

Figure 8-20: Small Creek Crossing the Bypass Road Alignment

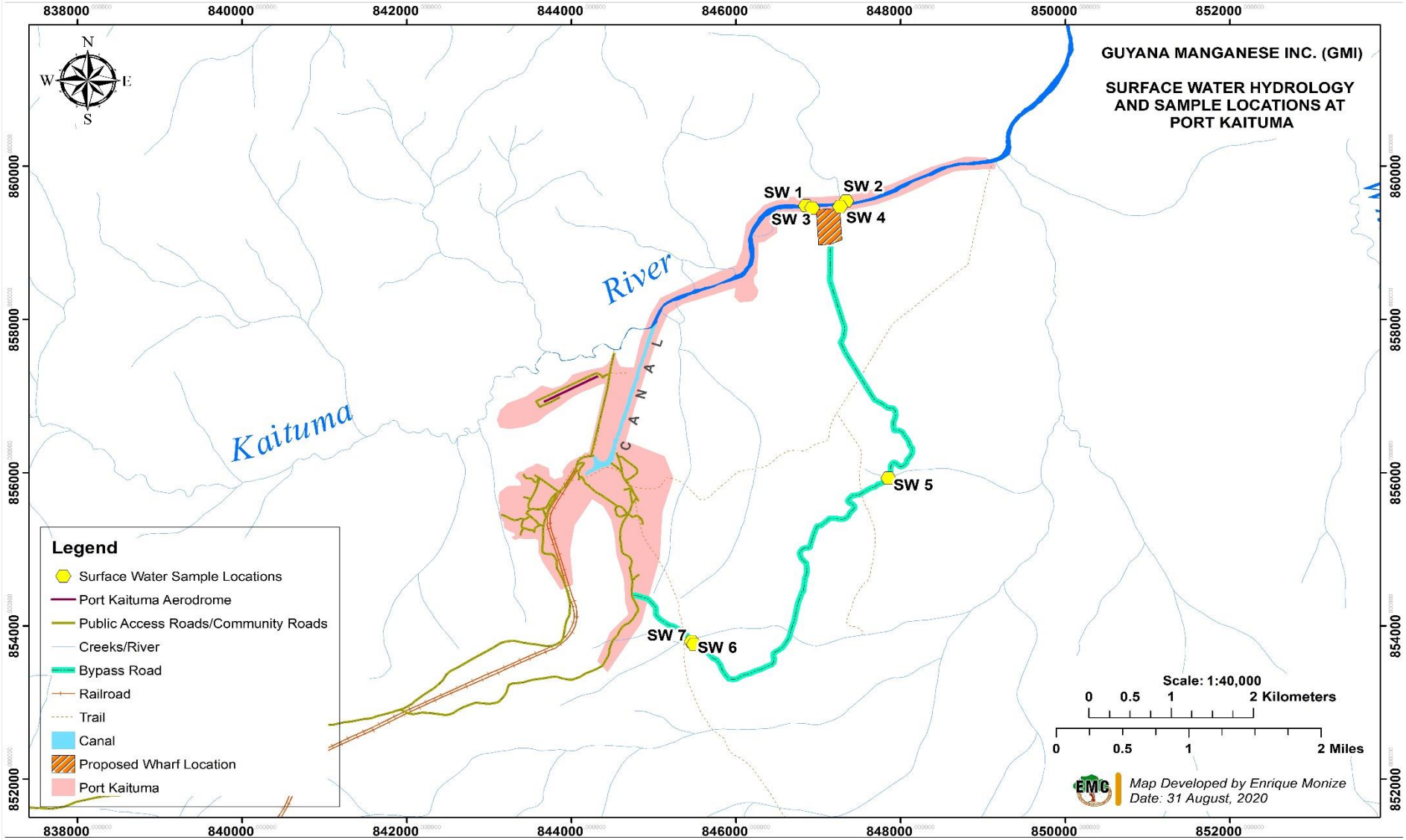


Figure 8-21: Surface Water Hydrology and Sample Locations at Port Kaituma

Physio-chemical parameters, including oil and grease, were analysed for these sample points because of the likely impacts on these surface waters may result from accidental spills and discharges of fuel and oil from vehicles and vessels traversing the roadway and waterway respectively. Moreover, runoff from roadways proximate to these waterways and the wharf site may also impact physical parameters like turbidity, total dissolved solids and total suspended solids associated. Unlike at Matthew's Ridge, it is not considered likely that GMI's activities in Port Kaituma will release effluent containing residual heavy metals and therefore, these parameters are not included in the baseline assessment. Table 8-23 shows the water quality results. The Analysis Report from the laboratory for Oil and Grease is included in Appendix E1. The results of these analyses were compared with permissible limits from the GNBS, IFC and WHO Drinking Water Guidelines.

Table 8-23: Water Quality Results for Port Kaituma

Parameters	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7
pH (6 to 9)	6.2	6.2	5.5	6.0	6.1	5.9	6.2
Temperature (<40°C)	29.2	28.8	29.5	29.3	29.4	26.8	25.1
Turbidity (50 NTU)	15.1	14.7	17	50.4	36.9	47	45
Dissolved Oxygen (6.5 to 8 mg/L)	4.71	5.81	1.01	4.73	5.86	2.03	4.65
Conductivity (150 to 500 µc/cm)	62.7	38.5	50.4	36.9	15.64	17	0.09
Total Dissolved Solids (250 to 500 mg/L)	26.4	16.33	21.29	15.64	20.35	20.32	17.38
Total Suspended Solids (50 to 100 mg/L)	11	12	14	17	16	35	22
Oil and Grease (10 mg/L)	0.29	0.29	0.34	0.09	0.001	0.001	0.001

All parameters measures were well within or below the acceptable limits.

In addition, GWI also shared results of water quality analyses which were conducted for surface water flows from a standpipe on the Canal Bank and for the Pump Creek Pump Station. These results are presented in Table 8-24 and show that coliforms and *E. Coli* were frequently in exceedance of the drinking water limits established by the WHO. Other critical parameters for drinking water quality such as colour and turbidity were also frequently in exceedance of WHO parameter limits.

Table 8-24: Potable Water Quality Analyses Conducted by GWI for Port Kaituma (2019 to 2020)

Location	**Date Analyzed**	**Appearance**	**pH** (6.5 to 8)	**Turbidity** (<5 NTU)	**Iron** (<0.3 mg/L)	**Apparent Colour** (Clear, <100)	**Total Coliforms** (0 to 60 CFU)	**E- Coli** (0 CFU)
Pump Creek Pump Station	Mar 15, 2019	-	6.65	12.9	0.82	158	TNTC	18
Pump Creek Pump Station	Mar 28, 2019	-	7.36	2.16	0.36	10	-	-
Pump Creek Pump Station	May 16, 2019	Brown with tiny particles	6.49	146.00	4.68	970	-	-
Pump Creek Pump Station	Jun 06, 2019	Brown with tiny particles	6.10	15.50	1.11	303	TNTC	7
Pump Creek Pump Station	Jul 17, 2019	Brown	6.11	17.00	1.69	303	TNTC	40
Pump Creek Pump Station	Aug 08, 2019	Brown with sediments	6.08	39.70	2.09	350	TNTC	TNTC
Pump Creek Pump Station	Aug 14, 2019	Slightly Brown	6.32	2.01	1.51	332	TNTC	TNTC
Pump Creek Pump Station	Sep 13, 2019	Brown with sediments	6.08	39.70	2.09	350	TNTC	TNTC
Canal Bank Stand Pipe	Sep 24, 2019	Clear	7.53	0.48	0.18	8	TNTC	0
Canal Bank Stand Pipe	Aug 14, 2019	Clear	7.45	0.18	0.18	3	0	0
Canal Bank Stand Pipe	Aug 27, 2019	Clear	7.41	0.47	0.12	20	TNTC	0
Canal Bank Stand Pipe	Feb 25, 2020	Slightly Brown	7.35	4.61		82	60	0
Canal Bank Stand Pipe	Mar 15, 2019	Clear	7.41	0.47	0.12	20	TNTC	0
Canal Bank Stand Pipe	Mar 28, 2019	-	6.39	5	0.66	76	TNTC	0

TNTC – Too Numerous to Count

8.3 Impact Assessment – Water Resources

This section assesses the potential impacts on, and associated risks to surface and ground water resources related to construction, operation, and closure of GMI's mining and related activities at Matthew's Ridge and Port Kaituma, including road and river transportation routes for concentrated products. The anticipated water demand by the various project activities as well as water sourcing are presented in Table 8-25 below.

Table 8-25: Project Activities, Water Demand and Potential Sources

Project Activities	Water Demand and Potential sources
Ore Processing at Matthew's Ridge	An estimated 1,258 cubic meters of water is required for processing of manganese ore on a daily basis. During the wet seasons, water will be recirculated from the tailings pond. Tailings retention dam annual capacity storage after processing is estimated to be 740,000 cubic meters. During the dry season, an estimated 34,600 cubic meters of water will be pumped from the Pakera Lake to support processing to compensate for lower water levels in the tailings pond as a result of increased evaporation. Three pumps are installed at the Pumphouse, each with a maximum extraction capacity of 200 cubic meters per hour. One pump will be for standby and will not be regularly operational.
Water for Industrial Purposes at Matthew's Ridge	Approximately 200 cubic meters of water will be required by the workshop on a monthly basis. In addition, approximately 1,347 cubic meters of cooling water is required which will be recirculated in the power plant. Four water tanks will be established around the compound, including in areas near to the powerhouse and mechanical workshops to provide water needed for industrial purposes. This water will be sourced from both the Pakera Lake and supplemented by rainfall.
Water for Domestic Purposes at Matthew's Ridge and Port Kaituma	Water being used for domestic purposes (including bathing, washing) by workers at Matthew's Ridge is pumped from a spring located at the bottom of Hill 5 aback the Guyana House and the GMI Office Buildings. The estimated daily demand of water from the spring are approximately 170 cubic meters during the dry season and 80 cubic meters during the wet season. To a lesser extent, water for domestic uses at Matthew's Ridge will be supplemented by water from GWI distribution network for drinking and cooking, amounting to 45 cubic meters. At Port Kaituma, potable water for domestic purposes is also supplied by rainwater which is stored in tanks. Drinking water is purchased from a local vendor who pumps water from a well.
Water for Firefighting and Road Wetting at Matthew's Ridge and Port Kaituma	The company has three water trucks, two based at Matthew's Ridge and one at Port Kaituma, which are used to support both road wetting and firefighting, each of which has the capacity for 20 cubic meters of water. At Matthew's Ridge, water may be sourced from the pump at the Pakera Lake, or any of the four water tanks located around the compound.

The potential impacts of the GMI Project's construction and operations on surface and ground water resources and quality at Matthews Ridge and along road transportation route to Port Kaituma are presented in Table 8-26. The relevant sources of the impacts and locations of potentially impacted water sources are also provided. In the identification of environmental impacts and risks of the planned project activities, the assessment of impact significance, and the recommendation of appropriate management and mitigation measures, due consideration has been given to the IFC's "Environmental, Health, and Safety General Guidelines; and the IFC's "Environmental, Health, and Safety Guidelines for Mining".

Table 8-26: Water Resources and Potential Impacts

Potential Impacts	Relevant Sources of Impacts	Location of Potentially Impacted Sources
Modification of water balance in the local surface water hydrological systems	Processing Plant; Operations at Matthew's Ridge	Pakera Creek and Lake Spring behind Guyana House Surface water bodies within a 5-kilometer
Modification and reduction of hydrologic flow due to percolation, subsidence and network of cracks and micro-cracks	Open mine pits and mining surface	Surface water bodies within a 5-kilometer radius of Hills 1 to 9
Slope failure of waste rock, overburden and ore stockpile disrupting surface flows	Waste dump, ore and overburden stockpiles	Surface water bodies in the vicinity
Sedimentation and storm water runoff resulting in contamination of surface water bodies	Mine and processing sites, project roads and marine terminal	Surface water bodies within a 5-kilometer radius
Acid Mine Drainage (AMD)	Open mine pits and mining surface	Surface water bodies within a 5-kilometer radius
Contamination from Effluent Discharges	Open pits and mine water discharge Discharges of sewage and sanitary wastewater Discharges from the Tailings and Water Retention Dam	Surface water bodies within a 5-kilometer radius
Contamination from solid and hazardous waste disposal	Littering and disposal of garbage within the AoI, Workshop at Matthew's Ridge	Surface water bodies within a 5-kilometer radius of project locations and components

Potential Impacts	Relevant Sources of Impacts	Location of Potentially Impacted Sources
Potential failure of the tailings pond dams during operations and after completion of mining activities	Tailings Pond Dam	Lake and creek south of Tailings Pond
Potential elevated manganese levels in surface waters used for drinking	Manganese mining and processing	Surface water bodies, in particular
Contamination due to accidental discharges/spills of untreated mine and processing water, hazardous materials and waste, solid waste	Accidental discharges of sewage Accidental discharges of fuel Breach or overtopping of the Tailings Pond Dam	Surface water bodies within a 5-kilometer radius of project locations and components Waterways intersecting the road transportation route in particular the Barima River Waterways along the river transport route (Kaituma Canal, Kaituma River, Barima River, Mora Passage)
Dewatering and lowering of water table	Mining pits below incline/closed loop	Aquifers within a 5 kilometer radius Water table in immediate vicinity and within a 10 kilometer or greater radius
Contamination due to seepage and inflow of untreated mine and processing water, and acid mine drainage	Seepage of mine water Seepage from waste dumps Seepage from Tailings Pond Dam Marine Terminal and Port Kaituma Access Road	Aquifers with immediate vicinity

8.3.1 Impact Assessment

Considering that the project is not complex, employs well understood mining and processing methods, transports inert concentrates and will produce non-toxic mine waste, and the fact that it is not a new project with the project sites being disturbed areas with existing activities, the impact assessment adopted primarily a qualitative approach, but supported where applicable by quantitative measures. However, management of water resources is especially important given that communities within the primary and secondary AoI of the project depend

on waterways which intersect with project components and project activities for domestic purposes.

8.3.1.1 Potential Impacts to Water Balance: Processing and Industrial Water

The processing plant was designed as a closed loop system whereby process water discharged into the tailings and water retention dam could be reused for manganese processing. A barge-mounted floating pump station will be installed in the tailings pond to pump water back to the processing plant at a capacity of 700 cubic metres of water per hour. On a daily basis, an estimated 1,258 cubic meters of water is required for processing of manganese. Process water will be treated and recycled for reuse by the plant. Supplemental water will be obtained from two sources, the Pakera Lake and the tailings pond. During the wet seasons, water will be recirculated from the tailings dam. The tailings pond is supplied by wash water discharged from the processing plant and by rainfall onto its open surface. GMI also plans to develop a drainage system to connect mine water discharge and storm water runoff from the processing plant as well as other parts of the facility to the tailings pond. The annual storage capacity of the tailings pond is estimated to be 740,000 cubic meters. As a result, it is not anticipated that additional processing water will be sourced elsewhere during the rainy seasons.

However, during the dry seasons, water will be pumped from the Pakera Lake to support manganese processing to compensate for lower water levels in the tailings pond as a result of increased evaporation and reduced rainfall. On a monthly basis during the dry season, it is anticipated that approximately 34,600 cubic meters of water will be pumped from the Pakera Lake. GMI has installed a pumphouse at the Pakera Lake comprising three pumps each of which has a maximum extraction capacity of 200 cubic meters per hour. One pump will be for standby and will not be regularly operational. As such, the maximum pumping capacity is not expected to exceed 400 cubic metres of water per hour from the Pakera Lake. The Pakera Creek is approximately 2.5 to 3 meters in width and has a total catchment of approximately 2 kilometers. The source and recharge rate of the Pakera Creek are not known. Based on the baseline assessment conducted in 2012, it is anticipated that the Pakera Creek is a seasonal water body with flow and total water available vary significantly with the bimodal rainfall patterns. Moreover, it is expected that there is also groundwater flow to this water body.

Four water tanks will be established around the compound, including in areas near to the powerhouse and mechanical workshops to provide water needed for industrial purposes. This water will be sourced from both the Pakera Lake and supplemented by rainfall. This will supply approximately 200 cubic meters of water that will be required by the workshop and approximately 1,347 cubic meters of cooling water for recirculation in the power plant. GMI will also extract water from the Pakera Lake for road wetting during the dry seasons and for firefighting, as needed but estimated use from these sources is not yet quantified. Given the significant volume of water required for processing and industrial purposes, in particular during the dry seasons when the flow of the Pakera Creek will be at its lowest, project activities have the potential to disrupt the water balance of the Pakera Creek and Lake. However, GMI intends to reduce, or even cease production activities during the dry season to maintain the equipment and focus on the transportation of ore from Matthew's Ridge to Port Kaituma. As such, potential impacts from the intensive extraction of water from the Pakera Lake are expected to be **negative, direct, short-term** and **localised**. In the absence of data on recharge rates and sources are not well known, the potential impact anticipated relating to the disruption to the water balance will be of **moderate significance** and will **unlikely** to occur during the project lifetime. As such, the project presents **Medium Risks** of disrupting the water balance of the Pakera Creek and Pakera Lake.

8.3.1.2 Potential Impacts to Water Balance: Community Water Supply

During the public scoping meetings in Matthew's Ridge in July 2019, residents raised concerns about the project and potable water supply in the community. Firstly, concerns were raised that GMI was mainly depending on, and would continue to depend on, GWI for potable water to be used for domestic purposes. Since then, GMI developed a spring located at the bottom of Hill 5 aback the Guyana House and the GMI Office Buildings and commenced pumping water from that spring for domestic purposes (including bathing and washing) by workers at Matthew's Ridge. Water for domestic purposes will also be supplemented by rainfall which will be captured in tanks located at the Matthew's Ridge facility. Potable water will be treated prior to use by filtration and chlorination.

The estimated daily demand of water from the spring are approximately 170 cubic meters during the dry season and 80 cubic meters during the wet season. The source of water for this spring or the recharge rate are not known but it is expected that it is seasonal and is fed by a combination rainfall, flows from groundwater sources and flows from other surface water bodies in the vicinity. In a scenario where the latter two assumptions hold true, it is possible that the secondary water bodies feeding the GMI spring also feed the springs used by GWI (which are also seasonal). Moreover, to a lesser extent, GMI will also be sourcing potable water for other domestic purposes (drinking and cooking) from GWI year-round (approximately 45 cubic meters per month). In these circumstances, potential impacts of project operations disrupting the community water supply are expected to be **negative, direct, short-term** and **localised** of **minor significance** but **likely** to occur during the project lifetime during prolonged dry seasons or periods of drought. As such, this presents **Medium Risks** of the project.

8.3.1.3 Potential Impacts of Acid Mine Drainage

There is potential for the formation of acid drainage and the associated mobilization of contaminants. Acid mine drainage (AMD) or acid rock drainage (ARD), primarily depends on the mineralogy of the rock material and the availability of water and oxygen. Acid drainage can be generated both during operations and after closure of the mine site. Areas where the earth has been disturbed may create acid rock drainage. AMD entering surface and groundwater can lead to low pH values and elevated concentration of dissolved metals and trace elements. AMD may be generated during construction and operation, and perhaps beyond closure. This AMD water can dissolve toxic metals and trace elements, such as copper, aluminum, cadmium, arsenic, lead, manganese, and mercury during construction and operations. AMD sources may include the waste dumps, open pits, pit walls, and tailings and may affect surface waters within vicinity of the sources. Given that the baseline conditions for some of the surface water and ground water sources show elevated levels of manganese, if AMD occurs there may be further increases of these existing levels, including other metals and trace elements. In the Mathew's Ridge area, the pervasiveness of the manganese bearing materials and the disturbed nature of the area due to previous mine activity may have already resulted in the baseline data collected being influenced by AMD. However, the results of the water quality survey conducted by the EIA team in 2020 have indicated that the pH level is neutral or very close to neutral, with none being acidic.

The potential for AMD was investigated analytically in the Pre-Feasibility Study done for RMI. A geochemistry program was initiated to define the acid rock drainage and metal leaching properties of both waste rock and jig reject samples. The waste rock program focused on the dominant rock types and weathering zones (saprolite and transition) from Hills 1, 3, 5, 7, and 9, with samples collected in 2013. Jig reject samples were comprised of composite samples from various hills and lithologies and represent slimes from the initial wash and jig rejects from the fine and lump tests, as well as associated decant waters and were collected from the site

by RMI staff in 2012 (slimes) and 2013 (jig rejects). All 29 samples of waste rock (n=20) and jig rejects (n=9) were submitted for static testing including chemical composition, acid base accounting, short-term leach test, and chemical testing of decant water. All testing was completed at SGS in 2012 and 2013. Based on the test results, all waste rock and jig reject samples, regardless of their lithology, exhibit similar solid chemistry trends including low calcium, high iron and high manganese values indicative of extensive weathering processes. Samples report minor total sulphur content (< 0.04 wt%), with most of the samples exhibiting higher sulphate sulphur values compared to the reactive sulphide sulphur, suggesting sulphides may have oxidized previously during the weathering process. As a result of weathering, samples also have minimal amounts of available neutralization potential ("NP") and low carbonate content (<0.07 wt% CO3). Results from the short-term leach test show that most lithologies, including the jig rejects, are not expected to leach metals at concentrations above International Finance Corporation (IFC) effluent guidelines (IFC, 2007) when the material is in contact with fresh water. However, the diorite saprolite lithology reported dissolved iron concentrations in leachate that exceed IFC guidelines in two of three samples tested; chromium and nickel concentrations are above IFC effluent criteria (2 mg/L total iron) in one sample and may be associated with suspended particles. Three jig reject decant water samples also report total iron greater than effluent guidelines and dissolved low iron concentrations; these samples also exhibit high total suspended solid values (TSS 49 to 1060 mg/L). With respect to bulk ARD potential, the diorite saprolite, phyllite transition and the jig rejects groups all have no potential to generate acid as defined by the guidance criteria of the Global Acid Rock Drainage Guide (GARD; INAP 2012), while both the phyllite and manganiferous phyllite saprolites have a potential to generate acid. However, because of low sulphide sulphur content in these latter materials, if ARD conditions were to be generated, they would be short in duration.[37]

Based on the detailed geochemical analysis conducted by Golder Associates Ltd., as detailed above, and the deep weathering profile that has been proven to dominate the local geology; it can be determined that the potential for AMD to develop is very low. This is due to the fact that most of the sulfides which may cause AMD have already been chemically removed by the prolonged oxidizing conditions which have prevailed during the deep weathering of the strata. This potential impact from ARD will have a **direct**, **negative, short-term** and **localised** effect on the surface water flows in the vicinity of the mines. The significance of the impact is **minor** and **unlikely** to occur during the life of the project. As such, AMD is a **Low Risk** of the planned project activities. However, if AMD were to occur, it can be mitigated with the implementation of appropriate measures the risk level can be maintained as **Low**.

8.3.1.4 Potential Impacts of Sedimentation and Contamination from Storm Water Runoff

Storm water from surface runoff from rainfall and natural drainage can include drainage from mine and processing plant sites, drainage collection ponds, material handling areas, raw material storage sites, and waste disposal areas, including waste rock and overburden dumps. Typically, storm water drainage is diffuse with many discharge points to the environment but GMI has instituted several measures to direct the flow of runoff and to manage runoff into surface water bodies.

Sedimentation resulting from the clearing of areas has the potential to reduce water quality in streams and creeks adjacent to cleared areas. The clearing of vegetation will reduce interception and may result in increased discharge to streams and creeks around the construction area and increased water levels in these streams and creeks. Increased water

[37] G Mining Services Inc, 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Appendix RSF B: GUMR-TM-13-08-08-Golder-Geochemical Characterization Waste Rock and Jig Reject

levels in the streams and creeks are unlikely to exceed typical wet season levels. These impacts will be mitigated by undertaking most of the construction activities, which may result in increases in storm water runoff, in the dry season.

Erosion of waste rock dumps can also cause sedimentation of surface water quality. Potential sources of sedimentation can also include the open pit areas, waste dump and overburden piles, haul roads and access roads, ore stockpiles, and vehicle and equipment maintenance areas. Waste rock disposal areas are located as close to mines as possible to minimise haulage costs, but if they are not properly sited, metal bearing element can be eroded into streams or other bodies of water (MINEO consortium, 2000[38]; Dasgupta, 2012[39]). When this occurs, the material may react with water and oxygen to release metals and other potentially undesirable elements into streams (Hudson, 2012)[40]. Due to erosion sediment can be deposited into surface waters. Minerals associated with deposited sediments may lower the pH of surface runoff thereby mobilizing heavy metals that can infiltrate into the surrounding subsoil or can be carried away to nearby surface waters (Sumi et al., 2001)[41].

GMI has installed storm water drains at its processing facility and compound facility at Matthew's Ridge. For example, the dimensions of the culverts under the stockyard of manganese concentrate are one meter for both width and height and this runoff is directed to the tailings pond. In addition, there are several intercepting drains surrounding the processing plant, the power plant and other areas in the Matthew's Ridge headquarters. These drains are six hundred millimetres in width and height and discharge is controlled. In the case of the drains surrounding the processing plant, all runoff is discharged to the tailings pond. Runoff from ore stockpile will also be intercepted and directed to the tailings pond. At the mine site, runoff from the overburden dumps will be collected by toe drains and directed to a sediment pond.

During periods of heavy rainfall the haul roads and access roads can become slushy and water with extremely high sediment loads can flow directly into nearby waterways. However, GMI plans to install turn out drains leading to vegetative areas which will assist in the trapping of sediments contained in the runoff.

Potential impacts from erosion and surface water runoff are expected to be **direct**, **negative, short-term** and **localised to** surface water flows in the vicinity of the waste dump, Hills 5, 5 Extension and 9, transportation and access roads within the project site. The combined significance of the potential impacts is **minor** and due to the measures put in place will therefore be **unlikely** to occur during project implementation. As such, these are associated with **Low Risks** of project activities.

At the Kaituma Marine Terminal GMI will install two runoff collection ponds to collect runoff from the ore concentrate storage and others areas and allow it to be settled prior to discharge. Storm water runoff could potentially adversely impact nearby waterways by increasing turbidity and total solids of the surface flows. However, based on the findings of the 2020 baseline assessment, water quality of rivers and creeks intersecting the roadways was generally acceptable. It is unlikely that GMI's overland vehicle fleet will significantly change these results given that only one return trip will be made daily by the hauling fleet for ore transportation from Matthew's Ridge to Port Kaituma during the wet seasons. In addition, dredging in the Kaituma Canal may temporarily increase the turbidity and suspended solids in the Canal. Given the

[38] Mineo Consortium. 2000. Review of potential environment and social impacts of mining.www.brgm.fr/mineo
[39] Dasgupta, A. 2012. Impact of mining on rural environmental and economy. A case study, Kota district, Rajasthan. International Journal of Remote sensing and Geoscience (IJRSG). v.2, pp.21-26.
[40] Hudson, T. 2012. Living with Earth, An Introduction to Environmental Geology. PHI Learning Private Limited.
[41] Sumi, L. and Thomsen, S. (2001) Mining in Remote Areas, Issues and Impacts. Mining Watch Canada/ Mines Alerte.

measures that are in place, it is anticipated that surface water contamination from runoff has potential impacts that are **negative, direct, localised** and **short-term**. Given the low vehicular density of GMI's overland ore transportation schedule, surface runoff from project activities of **negligible significance** but are **likely** to occur. This results in **Low Risks** of the project activities.

8.3.1.5 Potential Impacts of Contamination from Mine Water Discharges

The general project site is drained naturally into the streams and creeks within and around the project areas. Storm water runoff generally flows directly into surrounding waterways. However, the creation of the mining pits will intercept the surface water flow, which will result in water flowing into the pits. As mining within the pits progress deeper, ground water flow will also be intercepted, resulting in in-pit flow and accumulation. Rainfall will also accumulate within open mining pits. Discharges of unsettled water from the mining pits can result in water with high sediment loads flowing into waterways resulting in sedimentation and discolouration.

For the mining pits GMI will install perimeter drains around the pit to prevent the inflow of water. This water will then be directed to a collection/sedimentation pond. Water within the pits will be channeled into sumps located within the pits and allowed to settle for a short period before being pumped out of the pit. Pumps installed in the sumps will be used to dewater the pits by pumping water out of the pit to an external collection/sedimentation pond for further settlement. GMI plans to direct this water to the tailings pond so that it will contribute to the water supply for the processing plan. This will reduce the possibility of contamination from mine water discharge while increasing the water supply available to the company. Any mine discharge which will not be directed to the tailings pond will be discharged through settling ponds.

Discharging of unsettled water into the environment contributes to sedimentation and discolouration of the waterways. However, given the planned measures to be implemented by GMI, these impacts are expected to be **direct, negative, short-term** and **localised** of **moderate significance** and are **likely** to occur during the life of the project. These are therefore **Medium Risks** of project activities.

8.3.1.6 Potential Impacts of Contamination from Process Water Discharge

Process related effluent comprised mainly waste water from the wash plant, but can also include water which has contacted process materials or results from the production or use of raw material, intermediate product, finished product, by-product, or waste product or wastewater. It can also include blow-down water, effluent that results from plant cleaning or maintenance operations, and any effluent that contacts cooling water or storm water. In addition, it is also likely to include cooling water used to remove heat from equipment, process operations and materials including the power plant. Typically, spent cooling water would be combined with other effluent streams such as a tailings slurry discharge to the tailings pond or mine water stream, prior to discharge to the environment.

For effluent to be generated from the processing plant, GMI has opted for recirculation of the water rather than discharging so as to reduce the usage of water from the Pakera Lake and also reduce the pressure on the tailings pond since there will be less water to be managed. It will also guarantee a steady water supply for the project. At the processing plant, after the thickening process material consisting of manganese and rock slimes are pumped out as tailings. Water from the thickeners is flocculated and recycled to processing. The flocculant will clump together floating particles in the water to sink to the bottom. The concentrated residue will then be pumped to the tailings pond where it will be settled out and the clean water recirculated for use via a pump to be placed within the pond. The flocculant that GMI plans to

use in the operation is anionic polyacrylamide. Anionic polyacrylamides are widely used flocculants employed by industry and municipalities to assist in settling fine suspended solids from industrial process streams, wastewater and drinking water. This family of chemicals are proven to be non-toxic to both aquatic species and people. It is estimated that the annual usage will be 50 tonnes. The underflows from the jigging process will be pumped to the sedimentation basin to be located at the processing plant site. In addition, discharges from the tailings pond, if it occurs, will be seldom since the water from the pond will be reused. Any discharge from the tailings dam will have to meet the permissible water quality discharge limits.

Failure of the tailings dam can also result in effluent being discharged into the environment, which can contaminate nearby water bodies. Potential embankment failure mechanisms are primarily:

- Piping Failure resulting in Internal Erosion of an Embankment.
- Overtopping of an Embankment.
- Embankment Foundation Failure.

Piping failure along the embankment may occur as a result of a small leak eroding away embankment material and expanding a leakage pathway to permit a substantial discharge of water and suspended solids. The suspended solids would be both embankment material and fine manganese tailings. The tailings solids mobilized during a piping failure event will be fine-sized solids because the proposed tailings management strategy will be to discharge tailings from a pipe into the central region of the tailings facility. The coarse tailings will tend to segregate out in these central zones and the fines will migrate to the zones adjacent to the embankments. The unlikely loss of tailings containment caused by a piping failure in an embankment will result in the discharge of tailings water and fine tailings solids. Based on historical evidence, both are considered to be non-toxic.

Historical examples of the consequences of piping failure are known, for example, Omai Gold Mines tailings in Guyana in 1995 and Piney Point phosphate tailings which occurred in Florida in April 2021. A piping failure at the 10-meter-high Dam 5 during the final year of operations (when tailings quantities will be highest) was analysed to evaluate a potential worse case scenario. For such an event, a maximum 5 percent loss of contained tailings is estimated to be discharged and this is equivalent to approximately 0.7 million tons. Assuming 75 percent of these tailings would be released in 48 hours and the slurry density is 50 percent solids, the average maximum flow would be about 320 m^3/min. Downstream of Dam 5 is the Pakera Lake which would buffer the discharge flow and retain a large proportion of the suspended solids. The flow of the stream containing a much lower degree of suspended solids would continue in Pakera Creek and then to the Manikuru River. There exists small scale mining activities and the residuals of small-scale mining about two kilometers creek and river downstream distance from the tailings facility. The pathway of this tailings release is shown in Figure 8-22. Assuming that the Pakera Lake control structure remains intact, both flow volumes and degree of suspended solids will be substantially attenuated by the time the tailings water reaches the small-scale mining zones.

The most obvious effect of a dam failure would be the deposition of tailings solids and dam material over a wide area downstream of the dam. Coarse material would be distributed by turbulent flow near the dam – a sandy delta would be developed. Finer suspended solids would be dispersed laterally in the low-profile terrain downstream of dam in the streams and Pakera Lake. The relation of particle size and flow velocity to transport and deposition is shown in the Hjulström Curve presented in Figure 8-23.

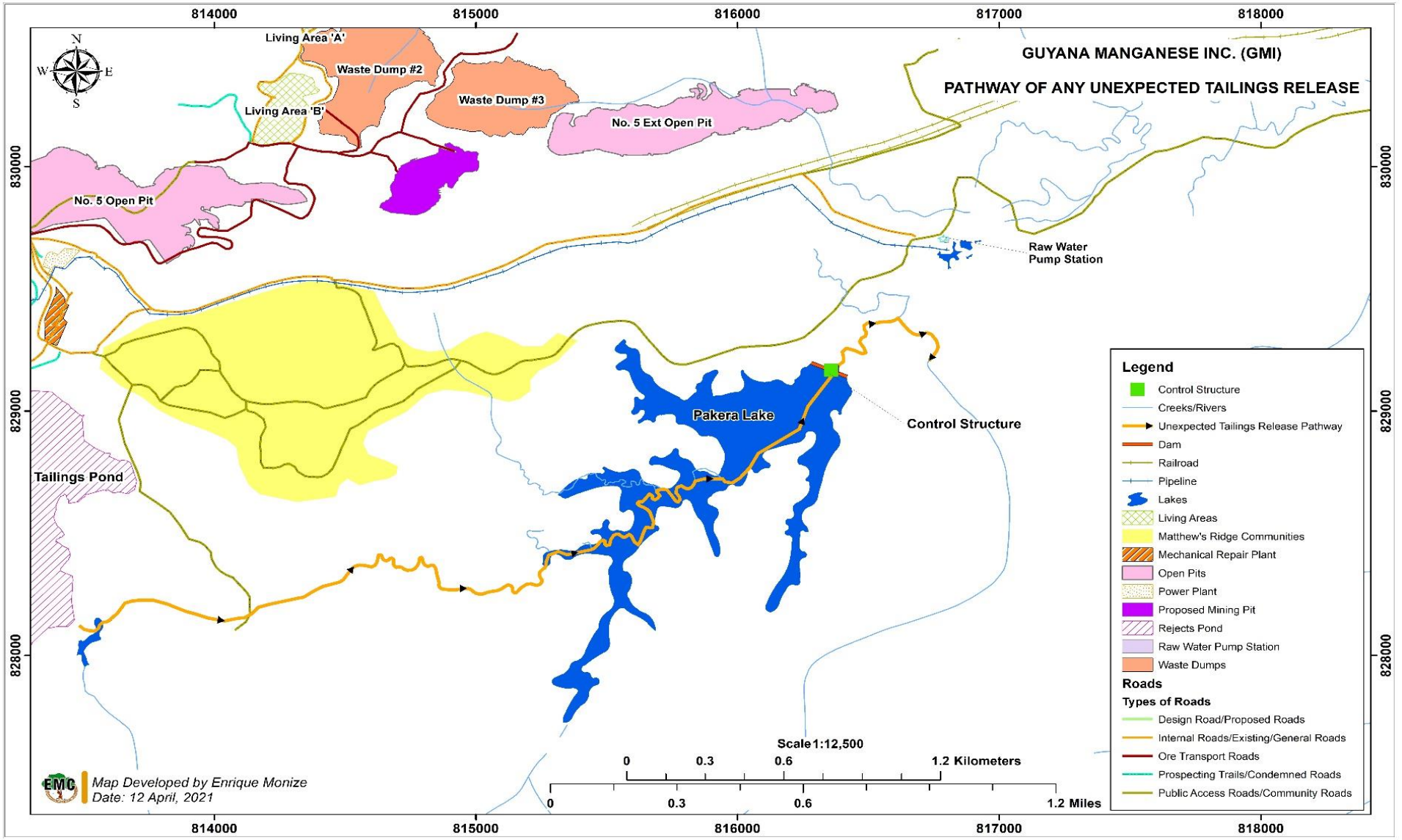


Figure 8-22: Pathway of Unplanned Tailings Release from Dam 5 in Final Year of Operation

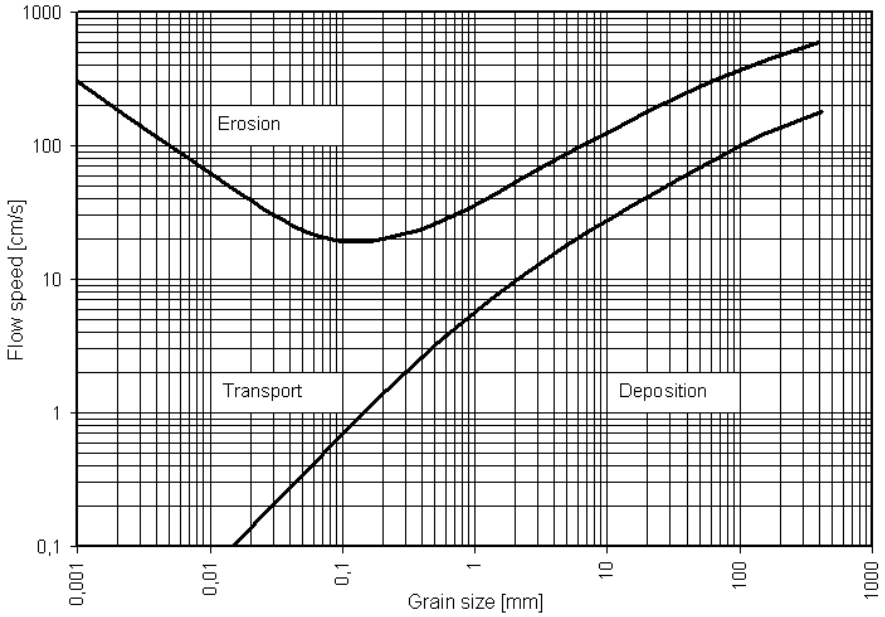


Figure 8-23: Hjulström Curve[42] Showing the Relation of Particle Behavior to Particle Size and Water Velocity

Overtopping and failure of the tailings dam is considered unlikely because GMI plans to construct a robust dam to retain the tailings. Computer iterations for dam stability under normal operations, considering the construction design and materials used, yield safe stability values of 1.20. Dam stability analysis was calculated using the total stress of Swedish Circle Method. Seismic parameters for input to the model are not available at present, and the seismic acceleration is calculated as 0.05 grams. According to the requirements of the Technical Code for Online Safety Monitoring System of Tailings Pond (GB51108-2015), GMI's tailings pond is Grade 3, and the safety monitoring level is Class II. The stable safety coefficient of normal operation, flood operation and special operation is greater than the corresponding minimum safety factor required by the standard. In addition, the foundation embankment zones are composed of naturally consolidated low permeability soils. Table 8-27 presents tailings volume and characteristics used to assess dam stability, Table 8-28 shows the materials parameters for stability calculation and Table 8-29 presents the results of the stability calculations for the tailings dam.

Table 8-27: Tailings Characteristics

	Quantity	Remarks
Raw Ore Scale (10^4 t/a)	200	
Tailings Pull (%)	58	According to the Mineral Processing Data
Annual Tailings Volume (104 t)	116	According to the Mineral Processing Data
Tailings Bulk Density (t/m3)	1.5	Empirical Value

[42] Hjulström curve describes the relationships between erosion, transportation, and deposition of sediments. Based on this logarithmic plot, it is possible to determine whether a waterway will erode, transport, or deposit the sediment depending on the particle size and water velocity.

Table 8-28: Parameters of Materials Used in Stability Calculation

Indices / Materials	Natural Density (g/cm^3)	Saturation Density (g/cm^3)	Buoyant Density (g/cm^3)	Shear Strength (Overwater) c(KPA)	Shear Strength (Overwater) φ(°)	Shear Strength (Underwater) c(KPA)	Shear Strength (Underwater) φ(°)
Tail Silty Soil	2.00	2.10	1.10	9.8	28.00	8.00	25.00
Foundation Soil	1.90	2.0	1.0	25.0	26.0	20.0	24.0
Damming Earth-Rock Mixtures	1.95	2.05	1.05	10.00	28.00	8.00	26.00

Note: Φ - Angle of Friction

Table 8-29: Results for Stability Calculation of Tailings Dam

Dam Crest Elevation (m)		86
Tailings Pond Rank		Grade 3
Normal Operation	Stage (m)	84
	Ks	1.35
	Specification Values	1.20
Flood Operation	Stage (m)	84.74
	Ks	1.21
	Specification Values	1.10
Special Operation	Stage (m)	84
	Ks	1.15
	Specification Values	1.05

In addition, compaction test, shear strength test and consolidation test have been conducted for several soil samples. The results of the compaction test are shown in Figure 8-24 and the sheer strength and consolidation tests of materials is presented in Table 8-30.

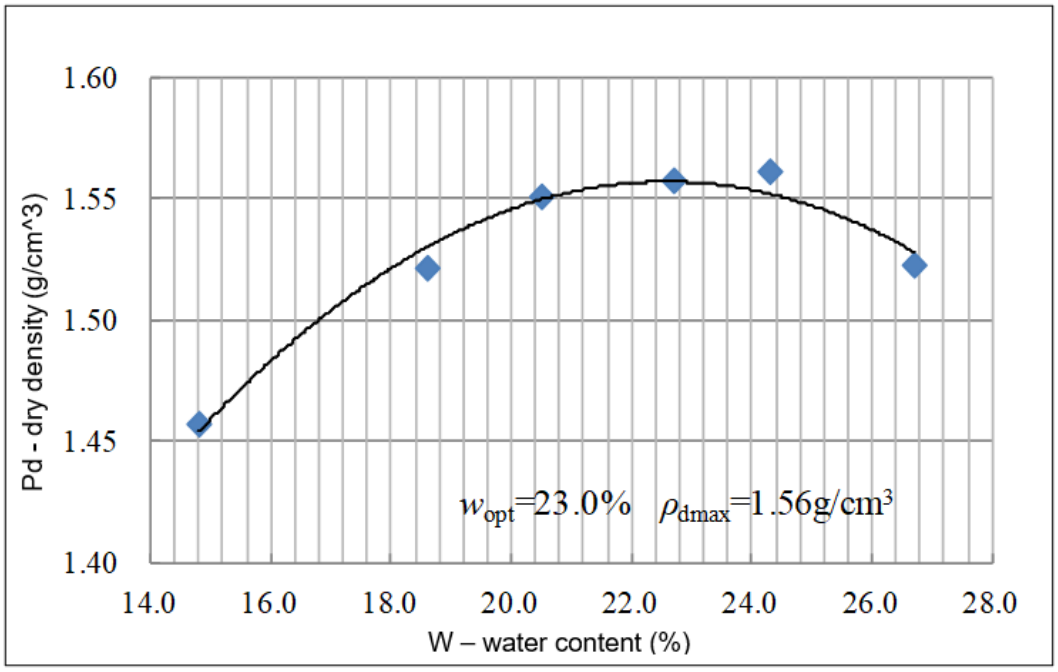


Figure 8-24: Relationship Curve of Water Content and Dry Density of Soil

Table 8-30: Sheer Strength and Consolidation Test

Project: Guyana Manganese project																							Date : 2019-03-01						
Drill hole #	Soil Sample #	Sampling status	Physical property of soil		Limit moisture content				90% compaction degree							95% compaction degree							Particle composition						
			Water content	Specific gravity of solid particles	Liquid limit	Plastic limit	Plasticity Index	Liquidity Index	Water content	Density	Dry density	Cohesion	Angle of friction	Coefficient of compressibility	Compression modulus	Water content	Density	Dry density	Cohesion	Angle of friction	Coefficient of compressibility	Compression modulus	Coarse sand 0.5-2	Medium sand 0.25-0.5	Fine sand 0.075-0.25	Silt sand 0.05-0.075	Coarse silt 0.01-0.05	Fine silt 0.005-0.01	Clay <0.005
			%		%	%			%	g/cm^3		KPa	°	MPa-1	MPa	%	g/cm^3		KPa	°	MPa-1	MPa	%	%	%	%	%	%	%
1	60101	Disturbed	21.9	2.8	35.6	21.1	14.5	0.06	32.5	1.86	1.40	23.1	23.1	0.277	7.16	28.9	1.91	1.48					25.0	4.7	9.0	6.8	9.2	15.2	30.1
1	60102	Disturbed	20.9	2.8	33.9	19.8	14.1	0.08	33.2	1.86	1.40	33.0	24.7	0.227	8.68	30.2	1.93	1.48			0.192	9.65							
1	60103	Disturbed	20.5	2.8	36.1	20.1	16.0	0.02	31.2	1.83	1.39			0.156	12.73	30.6	1.93	1.48	32.9	27.6	0.110	17.09							
2	60201	Disturbed	21.2	2.8	38.5	22.4	16.1	-0.07	33.0	1.86	1.40					27.8	1.89	1.48					34.0	4.0	7.7	5.7	11.5	10.4	26.7
2	60202	Disturbed	22.0	2.7	37.4	22.8	14.6	-0.05	31.5	1.84	1.40	43.8	17.9	0.221	8.86	28.5	1.90	1.48											
2	60203	Disturbed	21.1	2.7	40.5	22.5	18.0	-0.08	32.8	1.86	1.40	33.4	24.9	0.126	15.46	29.6	1.92	1.48	24.3	27.5	0.110	16.75							
3	60301	Disturbed	21.6	2.8	39.2	23.5	15.7	-0.12	30.7	1.85	1.42					27.5	1.89	1.48			0.143	13.06	17.7	2.6	6.0	4.0	16.0	25.4	28.3
3	60302	Disturbed	20.6	2.8	41.7	24.1	17.6	-0.20	33.6	1.85	1.38			0.256	7.77	30.2	1.92	1.47	32.8	26.4	0.115	16.21							
3	60303	Disturbed	23.6	2.8	42.2	26.1	16.1	-0.16	34.1	1.88	1.40	32.5	21.8	0.224	8.74	30.2	1.92	1.47	36.8	25.1	0.190	9.79							
4	60401	Disturbed	21.8	2.8	41.5	22.3	19.2	-0.03	33.5	1.85	1.39	50.1	23.8	0.333	6.02	29.6	1.92	1.48	37.3	27.8	0.291	6.44	11.3	3.4	7.0	5.3	7.7	28.3	37.0
4	60402	Disturbed	26.6	2.8	43.4	25.1	18.3	0.08	33.0	1.86	1.40			0.112	17.66	29.3	1.92	1.48			0.100	18.68							
4	60403	Disturbed	25.0	2.8	40.5	24.4	16.1	0.04	32.2	1.85	1.40			0.359	5.49	28.9	1.91	1.48			0.263	7.08							
5	60501	Disturbed	28.8	2.8	52	26.6	25.4	0.09	34.8	1.88	1.39					30.1	1.93	1.48			0.160	11.80							
5	60502	Disturbed	29.1	2.8	49.4	24.4	25.0	0.19	32.1	1.85	1.40	64.7	23.0	0.181	11.04	28.3	1.90	1.48	42.2	27.4	0.130	14.53							
5	60503	Disturbed	27.5	2.8	47.5	26.1	21.4	0.07	32.1	1.85	1.40	40.8	23.0	0.122	16.29	30.4	1.93	1.48	40.0	27.9	0.127	14.84	12.3	6.0	12.7	20.8	7.6	9.0	31.6
6	60601	Disturbed	27.8	2.7	43.1	27.9	15.2	-0.01	31.7	1.84	1.40			0.211	9.29	31.2	1.94	1.48	37.2	25.2	0.132	14.01							
6	60602	Disturbed	24.9	2.8	42.6	26.4	16.2	-0.09	33.6	1.87	1.40	38.7	20.5	0.137	14.41	27.7	1.89	1.48			0.131	14.16							
6	60603	Disturbed	26.9	2.8	45	27.3	17.7	-0.02	34.5	1.88	1.40			0.111	17.78	29.9	1.93	1.49	38.1	25	0.173	10.75	4.0	2.3	9.7	13.2	25.5	14.3	31.0
7	60701	Disturbed	25.3																										

GMI will also implement a manned 24-hour monitoring station at the dam to monitor piezometric pressures, water levels, signs of displacement and to carry out water releases via the spillway as necessary. In addition, there will be an online safety monitoring system of tailings pond which includes monitoring of surface displacement of dam body, monitoring of reservoir water level and monitoring of rainfall. The online monitoring system will be verified by personnel monitoring. Risks are considered to be greatest during unusual circumstances such as a 1 in a 1000-year storm event in combination with a blocked spillway.

A facility-specific Operation, Maintenance and Surveillance (OMS) Manual will be developed as a key component of the tailings management framework. The OMS manual will be regularly reviewed and likely revised several times during the ongoing construction and operation phases of the facility's life cycle, as well as beyond. The minimum review period will be one year. The OMS will ensure that performance objectives are met and that current and potential risks of the tailings pond are identified and addressed. A team will be tasked with the responsibilities for monitoring and maintenance of the tailings facility.

During closure of mining operations, it may be necessary to expand the spillway so that it is sized to handle any 1 in a 1000-year storm event and to accommodate the absence of organized and continuous monitoring that will be conducted during operations.

Effluent discharges, whether accidental or planned discharged, have potential to increase the background concentration of manganese, other residual heavy metals, trace elements, and physical parameters in surface waters in the vicinity of the processing plant and the tailings pond. Given the measures in place, the manner in which tailings will be discharged into the facility and the constant reuse of the water from within the pond will render dam failure unlikely. Nevertheless, if it does occur, measures are included in the Emergency Response Plan to address this. This impact from effluent discharges will be **direct**, **negative**, **localised** and **short-term**. These impacts are expected to be of **moderate significance** and are **unlikely** to occur during the life of the project. These are therefore **Medium Risks** of project activities.

8.3.1.7 Potential Impacts of Contamination from Waste Generated

Waste generated by the project, if not properly collected, stored and disposed of, can result in contamination of the waterways. This includes solid, liquid and hazardous waste. Chapter 16 details the potential impacts and management measures relating to waste management.

Liquid waste will include sanitary discharges from washrooms, discharges from kitchens, and storm water runoff from waste holding and disposal areas. Sanitary discharges, including discharges from septic systems have the potential to further increase the biological load (coliforms and *E. coli*) of surface waters which are already high and in exceedance of safe consumption limits in both Matthew's Ridge and Port Kaituma. This is particularly important in Port Kaituma given that residents of Canal Bank rely on water from the Kaituma Canal for domestic purposes. At Matthew's Ridge there are community water supply sources located in close proximity to project areas which can also be affected. Discharge of wastewater from to surface water may impair surface water quality by causing changes to physical, chemical and biological properties within the receiving waters. However, GMI intends to construct all septic tanks based on GNBS guidelines and install fat/grease traps to filter discharges from kitchen areas. Further, periodic water quality monitoring will be done to determine if GMI activities is contaminating waterways. As a result, potential impacts associated with contamination of surface waters from liquid waste disposal are **negative, direct, localised** and **short-term** of **moderate significance** and will be **unlikely** to occur. This results in **Medium Risks** of the project activities.

During the operational phase of the project, GMI will establish pits into which all project generated solid waste will be disposed at Matthew's Ridge and Port Kaituma. Runoff from these pits can enter waterways, resulting in contamination. As a result, these pits should be situated at an appropriate distance from surface water flows so as to prevent contamination. Waste should be disposed into the pits on a regular basis and not stockpiled for prolonged periods. GMI's has instituted a no-littering policy for all project vehicles traversing the Matthew's Ridge to Port Kaituma road during both the construction and operational phases of the project and at the project sites. As a result, potential impacts associated with contamination of surface waters from solid waste disposal are **negative, direct, localised** and **short-term** of **minor significance** and will be **unlikely to** occur. This results in **Low Risks** of the project activities.

During the construction and operational phases of the project, various types of hazardous waste will be generated including waste oil, used oil filters and oily rags among others. Most of these waste will be generated by the company's workshop at Matthew's Ridge. GMI will designate special storage areas at Port Kaituma and Matthew's Ridge to collect and store waste oil and other hazardous waste. There are potential impacts of spills of hazardous waste into surface water bodies. However, these potential impacts are entirely mitigable if appropriate measures such as storing hazardous waste in an impervious bunded secondary containment area, draining used filters before disposal, following proper collection and handling procedures, and clean up spills immediately and using appropriate methods. As a result, potential impacts associated with contamination of surface waters from hazardous waste management disposal are **negative, direct, localised** and **short-term** of **minor significance** and small spills will be **likely** to occur. This results in **Medium Risks** of the project activities.

8.3.1.8 Potential Impacts of Contamination due to Accidental Discharges/Spills

Surface water quality may be negatively impacted by discharges and accidental spills during construction and operation of the mine and associated facilities in Matthew's Ridge and Port Kaituma if the following accidental discharges were to occur:

- Large-scale spills of fuel while in transit along the river transportation route potentially impacting residents in the primary AoI located in Port Kaituma and the Canal Bank, and in settlements located along the tertiary AoI (St. Anselm, Lower Kaituma, Aruka Mouth, Smith's Creek and Morahwanna) who depend on the Canal and Rivers for water or their livelihoods. In addition, accidental discharge of fuel could have adverse impacts on aquatic biodiversity in particular in the vicinity of the Mora Passage which is being considered as a protected area.
- Large-scale spills of fuel while in transit into waterways adjacent to the road transportation route potentially impacting residents in the primary AoI located in Port Kaituma, Canal Bank and Matthew's Ridge and in settlements located along the secondary AoI (Eclipse Falls and Arakaka) who depend on these waterways, in particular the Barima River, for water or their livelihoods.
- Large-scale spills of fuel in storage at Port Kaituma and Matthew's Ridge into proximate waterways affecting GMI staff as well as residents of settlements in the primary AoI.
- Large scale spills of other hazardous materials (oils, grease and coolants) while in transportation of storage at Port Kaituma and Matthew's Ridge.
- Accidental discharges of sewage from stationary septic systems at Port Kaituma and Matthew's Ridge into proximate waterways affecting GMI staff as well as residents of settlements in the primary AoI.

- Accidental discharges of sewage from the barge while moored or in transit potentially impacting residents in the primary AoI located in Port Kaituma and the Canal Bank, and in the residents of settlements located along the tertiary AoI (St. Anselm, Lower Kaituma, Aruka Mouth, Smith's Creek and Morahwanna) who depend on the Canal and Rivers for water or their livelihoods.
- Breach or overtopping of the tailings pond resulting in contamination of proximate waterways in Matthew's Ridge.
- Accidental discharges of large quantities of hazardous waste, such as waste oil and grease, from consolidated storage areas into waterways within the entire project AoI.

However, GMI has instituted a range of measures to prevent any of these potential impacts from occurring. These measures are fully detailed in Section 8.4 below. Nonetheless, these potential impacts will be **direct**, **negative, local** and **long-term** of **moderate significance**. Given the mitigation measures in place, these potential impacts will **rarely** occur during the project lifetime. As such, contamination of waterways from accidental discharges are a **Low Risk** of project activities.

8.3.1.9 Potential Impacts of Contamination by Manganese

Given the geology of Matthew's Ridge, manganese occurs in naturally high levels in the water supply. However, exceeding safe water concentrations of manganese in the water supply are likely to result in several adverse health outcomes foremost of which are impaired intellectual capacities of young children. The levels of manganese in all surface waters tested in Matthew's Ridge exceeded permissible limits but these water bodies are not used by residents for drinking. However, manganese levels at the Hill 3 aquifer also exceeded the safe levels established by the WHO of 50 micrograms per liter or 0.05 milligrams per liter and may be due to exposure and historic disturbance of the manganese ore. Project activities that expose the manganese ore may also increase the concentration of manganese in surface water flows in Matthew's Ridge some of which are used by GWI for community water supply. In particular, a spring in proximity to Hill 5 is used by GWI to supply water to the community and the spring aback Guyana House which is used by GMI may also be considered exposed. The water flow from the mining pit will be accumulated in the tailings pond or a designated water pond for settling. Dams surrounding the tailings pond, and drainage around the mining pit will be built to prevent the water from contaminating the surface water which is used by the community. The manganese level in the surface water will be monitored regularly. High levels of manganese in drinking water will have potential impacts that are **negative, direct, long-term** and **localised.** Given the serious toxicology impacts of prolonged exposure, these potential impacts will be of **major significance** and are **likely** to continue during the project lifetime. Potential for adverse health impacts of prolonged environmental exposure from high levels of manganese in the water supply are **High Risk** with or without planned project activities.

Solid manganese ore may be released into surface water bodies if project vehicles transporting ore are involved in accidents. This potential impact is amplified for project barges transporting ore across riverine and marine routes. Manganese ore will be transported in a solid state and any loss of ore in transit will disperse in the water column and sink. Moreover, the manganese ore is poorly soluble to insoluble in water making bioaccumulation in aquatic flora and fauna improbable. Also, only relatively small quantities of ore (maximum of 3,000 tons) will be barged per trip thereby further reducing risks of adverse impacts to surface water quality. As such, potential impacts of surface water contamination from unplanned releases of solid manganese ore are **negative, direct, long-term** and **localised**. However, these potential impacts are of **negligible significance** and are expected to **rarely** occur. As such, this is a **Low Risk** of the project.

8.3.1.10 Potential Impacts of Contamination of the Community Water Supply

Based on the interview with the Chairperson of the Eclipse Falls CDC during the stakeholders' engagement, contamination of the Barima River resulted in significant hardships for the community as the Barima River is one of the primary sources of water used by residents for domestic purposes such as washing and bathing. The same is true for the residents of Arakaka. In this regard, the Chairperson raised concerns about GMI's planned project activities for tailings management potentially causing contamination to the Arakakaparu River. According to the CDC Chairperson, the head of the Arakakaparu River is located in Matthew's Ridge and ultimately discharges into the Barima River. The CDC Chairperson indicated that GMI had already been engaged on this issue and informed the local authorities that the spillway for the tailings pond was not located in proximity to the head of the Arakakaparu River (EMC Personal Communication 20). During the 2020 baseline water quality assessment the team verified that the head of this River was north of GMI's project footprint in Matthew's Ridge and therefore, not in proximity to the tailings pond. However, it is located along the public roadway connecting Matthew's Ridge to Port Kaituma and physio-chemical parameters of water quality was assessed during the 2020 baseline assessment (as seen in Table 8-21) and all parameters were within or close to the permissible limits.

Further, according to the interview with the Regional Chairperson of Region 1, residents of Wana and Paro, two communities west of Matthew's Ridge, believed that GMI's activities during the construction phase was contaminating the Wanparo Creek which supplied these communities with water used for all domestic purposes including drinking. The Whanaparo Creek ultimately discharges into the Barima River and this was also a cause for concern (EMC Personal Communication 18). Based on the findings of the 2020 baseline assessment, this Creek was outside the AoI at Matthew's Ridge and as a consequence, GMI's activities could not have been contributing to the contamination of this Creek. During the public scoping meeting in Matthew's Ridge, residents also raised concerns about road slush from the company's vehicle adversely impacting the community water supply. In addition, concerns were also raised on possible impacts to a spring on Hill 5 which is one of GWI's sources for community water supply. GMI will install turnout drains along all roadways to allow for storm water runoff and these will be directed away from any adjacent waterways. Potential impacts associated with contamination of the water supply are expected to be **direct, negative, localised** and **short-term** of **moderate significance**. In addition, contamination to the Arakakaparu River, Wanaparo Creek and the Hill 5 spring will occur **rarely** during the project lifetime. As such, contamination of these community sources of water are **Low Risks** of the project.

8.3.1.11 Potential Impacts of Dewatering and Lowering of Groundwater Table

When an open pit intersects with water table groundwater flows into the open pit. The mine development will result in dewatering, which in turn will result in a decreased groundwater level. The approximate decrease in the groundwater level around the decline is estimated between 8 to 20 meters. Boreholes in the vicinity of the mining pits are likely to be affected. However, mining below the closed loop/decline is not expected until year 4 of the operations. Moreover, only Hills 5, 5 Extension, and 9 will be mined in the first 7 years and Hills 1, 3, 7 and 8 becoming operational in year 8 of the project.

This impact is expected to be **direct**, **negative**, **localised** and **short-term**. The significance of the impact is **minor** and is **unlikely** to occur during the life of the project and combined with its moderate significance pose a **Low Risk** of project activities.

8.3.1.12 Potential Impacts of Reduced Surface Flow Rates due to Percolation, Subsidence and Network of Cracks/Microcracks

Blasting and opening of pits at the proposed mines at Hills 9, 5 and 5 Extension during the first few years, and subsequent mine development at Hills 1, 3, 7, and 8 in years 8 to13 of the project, including the process of extraction of overburden and ore, may result in fracturing of creek beds, and surface rocks in and around the vicinity of the activities. Localised depression may result adding to tension and shearing due to flexure of underlying rock strata. These changes in the permeability around cracking zones and subsidence depressions, may result in percolation of water downwards into the underlying strata, and also disrupt and divert the flow of surface water. This therefore can influence the availability of water and flow rates of creeks and streams in the catchment area.

This impact is anticipated to be **direct**, **negative, localised** and **short-term**. The significance of the impact is **minor** and the likelihood of this impact occurring is **rare** but theoretically possible. However, with appropriate engineering designs and measures the impact can be prevented or mitigated and the risk therefore posed by this impact is expected to be **Low.**

8.3.1.13 Potential Impacts of Groundwater Contamination due to Seepage and Inflow of Untreated Effluent

The waste dumps, mine pits and the rejects/tailings pond typically are sources of inflow to groundwater due to seepage. However, because of the impermeability of the saprolite layer this would not likely occur at Matthew's Ridge. In the tailings/rejects pond the effluent flow of tailings thickener is estimated at 195.3 tonnes per day, with a density is 13.59 percent, and a slurry flow of 1437.1 cubic meters per hour. Effluent density is estimated at 40 percent with bottom tailings slurry flow at 400.8 cubic meters per hour. The yield of overflow water of thickener is approximately 948.85 cubic meters per hour, which will flow back to the turbid circulation water pool by gravity. The rejects pond flux is controlled by the hydraulic conductivity of the tailing material, which is in the order of 1.94E-0.5 to 7.23E-0.5 centimetres per second. There is very low chance of vertical flow or seepage of tailings/rejects water into groundwater. Seepage will be controlled by the permeability of the base, which is lower than the porous sands of tailings/rejects. The seepage from the rejects pond would therefore be limited due to the impermeable nature of saprolite and also controlled by moisture release from the material, which contains 5 percent moisture.

This impact may be **direct, negative, localised** and **short-term** of **minor** significance in that the geology of the soil (impermeable saprolite) will result in almost zero seepage. This impact is **unlikely** to occur during the life of the project and combined with its **minor significance** pose a **Low**-**Risk** associated with the project.

8.3.2 Cumulative Impact Assessment

As discussed above, the project is expected to periodically discharge water into the nearby surface water bodies and the potential impacts of these discharges are discussed above. Currently, there are no other existing or planned projects within or proximate to the AoI which will discharge water into these waterways, except for discharges from residences within the communities. Further downstream from Matthew's Ridge the water quality in streams are affected by mining activities, such as the Manikuru River. However, all discharges from GMI are expected to meet the established water quality discharge limits. As a consequence, no cumulative impacts are anticipated for water discharges in Matthew's Ridge.

At Port Kaituma, discharges from small-scale gold mining sometimes significantly contaminate surface waters and require residents to temporarily discontinue use of waters from the Canal and its tributaries because of elevated mercury concentrations as well as elevated turbidity levels. However, Government agencies like the Guyana Geology and Mines Commission (GGMC) and GWI have worked to address this situation and ensure that the water is safe for consumption. Project activities related to dredging of the Kaituma Canal in the vicinity of the Marine Terminal may also potentially increase the turbidity of some sections of the Kaituma Canal requiring temporary discontinuation of these waters for domestic purposes. The potential contamination from upstream small-scale gold mining activities and dredging of the Kaituma Canal occurring at the same time is expected to significantly elevate turbidity levels. These impacts are **direct, negative, short-term, cumulative** and **localised** of **minor significance** and are expected to **rarely** occur making them **Low Risks**. In addition, residents also practice rain water harvesting, which provides an alternative source of water. Further, GMI intends to conduct dredging in a manner which will result in minimal impacts to the water quality available to residents. However, if the water quality is affected by GMI operations the Company will work with the relevant authorities to ensure water is available to residents.

At Matthew's Ridge, GMI will source water to be used for domestic purposes from the spring aback Guyana House as well as limited quantities from the GWI distribution system which supplies water to most of the residents of Matthew's Ridge. The water sources used by GMI and GWI are seasonal surface water flows which are associated with lower flows during the dry seasons. During prolonged dry seasons or drought conditions, the combined use of water by GMI and the Matthew's Ridge community of water supplied by GWI may result in water shortages. Potential water shortages during prolonged dry seasons may be augmented if the springs used by GMI and GWI share the same source. Potential impacts of shortages of water to be used for domestic purposes are **direct, negative, short-term, cumulative** and **localised** of **minor significance** and are **unlikely** to occur making them **Low Risks**.

During the operational life of the project, GMI will have exclusive access to water withdrawals from the Pakera Lake for industrial purposes, fire-fighting and road wetting and therefore no cumulative impacts are anticipated for the use of water for industrial purposes by the project.

8.4 Mitigation and Monitoring Measures – Water Resources

The overriding strategy for the Project is to prevent or minimise any water resources and quality impacts that would place any environmental burden on the watershed and river system, as well as on stakeholders including the communities. As a result, in addition to the mitigation measures mentioned under the respective impacts above, GMI will implement the following measures to mitigate risks of pollution:

- Establishing 24-hour monitoring station will be at the tailings pond to monitor piezometric pressures, water levels, signs of displacement and to carry out water releases via the spillway as necessary.
- Developing storm water drains around key project components including stockpiled areas, the processing plant and power plant.
- Maintaining existing drainage structures and constructing new drainage features, where necessary on all project roads.
- Constructing and rehabilitating septic systems in compliance with the guidelines from the GNBS.
- Creating secondary containment structures or bunds for fuel storage tanks/bowsers affixed with oil/water separators for drainage of these containment areas.
- Collecting runoff in settling ponds, including at the processing plant, mine sites and the Kaituma Marine Terminal.

- Designing the processing plant as a closed loop system of water to treat and reuse as much process water as possible thereby reducing the water demanded for processing as well as the effluent generated.
- Designing the foundation of the processing plant and other critical project components to minimise erosion.
- Installing concrete drains to channel storm water runoff from the processing plant and other operational areas into the tailings pond to reduce sedimentation and erosion. This also prevents soil from becoming a contaminant of runoff.
- Managing the drainage and discharge of storm water runoff on haul roads to minimise sedimentation.
- Installing concrete-lined storm water trenches and slope stabilization.
- Maintaining topsoil/organic matter stockpiles; and grading, scarifying, and re-vegetation of road ROWs, exploratory roads, and other temporarily cleared areas.
- Ensuring compliance with safe operational practices of all project vehicles.

In addition, GMI should implement the following management and mitigation measures. The measures presented herein were informed by the IFC's "Environmental, Health, and Safety General Guidelines", and the IFC's "Environmental, Health, and Safety Guidelines for Mining". These should include:

- Develop a water quality monitoring programme, in partnership with GWI, to regularly monitor manganese levels in the Matthew's Ridge community water supply. If manganese levels exceed safe consumption levels, GMI should work with GWI to make an alternative source of drinking water available for community members.
- Monitor water quality for physio-chemical and biological parameters and trace metals on a monthly basis. This should include frequently monitoring of water sources at high risk of contamination including the Hill 5 spring, GMI's spring and upstream and downstream of operations at the Canal Bank, among others.
- Ensure that the quality and quantity of effluent streams to be discharged to the environment, including overall mine works drainage and discharges from the tailings pond are managed and treated to meet the applicable effluent discharge guideline values of the GNBS, IFC or WHO guidelines, as applicable.
- Prepare and implement programmes for ore and waste geochemical characterization methods for proper routing of Potentially Acid Generating (PAG) materials and Acid Reduction Detection (ARD).
- Prepare an Erosion and Sediment Control Plan and ensure that it captures:
    - Maintaining natural features, including vegetation, terrain, watercourses and similar resources should be preserved or installed, wherever possible.
    - Restricting topsoil removal from the any areas outside the active mining areas on Hills 1 to 9.
    - Putting measures in place to ensure that stockpiled topsoil and other organic matter is protected from rainfall.
    - Phasing site clearing operations to prevent large increases in sediment loads of discharge.
    - Installing sediment traps and screens to control run-off and sedimentation from active mining and developed areas.
    - Designing a drainage system for spoil piles to minimise erosion and storm water runoff including such measures as a soil containment berm around the stockpiles.
    - Examining one or a combination of erosion control blankets, geotextile fabrics and seeding to control erosion.
    - Undertaking efforts to minimise 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.

- Prepare and implement a Water Management Plan which should feature:
    - Establishing a water balance (including probable climatic events) for the water required by the project for processing as well as other industrial and domestic purposes and the recharge rates of surface water bodies particularly the Pakera Creek, Pakera Lake and spring used by GMI for domestic water.
    - Minimising the impact to natural systems by managing water use, avoiding depletion of aquifers, and minimising impacts to water users. This should also include consideration of the water balance of aquifers prior to dewatering activities.
    - Instituting measures to minimise the amount of make-up water required by the processing plant.
    - Developing systems to monitor water consumption by the project on a monthly basis.
- Engage with GWI before conducting any future dredging activities in the Kaituma Canal.
- Install and maintain oil and grease traps/separators or sumps at refueling facilities, workshops, fuel storage depots, and containment areas, and spill kits.
- Establish bunded secondary containment areas for the storage of all hazardous materials and hazardous waste.
- Provide training for employees on proper collection, handling and management measures for hazardous waste.
- Field-test the procedures of the emergency response plan for clean-up of any accidental discharges from the operations.
- Monitor water consumption of project activities.
- Monitor of the physical integrity of the waste rock and stockpiles periodically.
- Engage with communities and local authorities to determine whether there are any adverse impacts from the company operations to water resources in the project footprint at Matthew's Ridge and Port Kaituma.
- Implement a Grievance Mechanism to receive any complaint regarding impacts to water resources.
- Consider options for improved tailings management throughout the lifetime of the project. If warranted, as a result of monitoring, the following modifications to operating procedures could be considered:
    - Increase in slurry discharge density from 40% solids (higher densities lessen fine-coarse particle segregation and the generation of slime ponds) by changing the thickening methods in the plant.
    - Frequent relocation of tailings discharge points within the facility.
    - Discharge of tailings from embankments – this could increase embankment stability by removing pond water from the edge of the embankment.
    - Deposit a fraction of tailings in one or more mined-out pits. The use of a mined-out pit for tailings disposal. This is an acceptable strategy and was practiced by Omai, Guyana in 2004. However, it may be limited at Matthew's Ridge by the potential to sterilize mineral resources and the expected need to construct and operate a water treatment plant.

Table 8-30: Summary of Impacts and Mitigation Measures

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
Surface Water Quality								
Project Operations	Compliance with Mining Act and GGMC Codes of Practice; Water and Sewerage Act, GGMC Environmental Effects Programme, EPA permit, IFC guidelines,	Disruptions of the water balance of surface water hydrological systems to be used by the project	Negative, Direct, Short-Term, Localised	Moderate	Unlikely	Medium	Establishing a water balance of project use of water compared with capacity and recharge rates of local hydrological systems.	Monitor water consumption of project activities and minimise make-up water required for ore processing
Land clearing for mine development; roads, storm water	Compliance with Mining Act and GGMC Codes of Practice; Water and Sewerage Act, GGMC Environmental Effects Programme EPA permit, IFC guidelines,	Potential run-off and sedimentation adversely impacting water quality	Negative, Direct, Short-Term, Localised	Minor/neg ligible	Unlikely	Low	Diversions; installation of skimmers/oily water separators Collection of runoff and retention in settling/mine water pond. Implementation of the Project Erosion Prevention and Sediment Control Plan Management of drainage and storm water runoff on	Monthly monitoring of water quality in accordance with the Water Management Plan which will include a water quality monitoring programme to ensure that controlled discharges meet quality standards defined by the Guyana EPA and IFC guidelines

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
							haul roads to minimise sedimentation. Maintenance of topsoil/organic matter stockpiles, and grading, scarifying, and re-vegetation of road ROWs, exploratory roads, and other temporarily cleared areas.	
Mine pits blasting and excavation of overburden and ore, stockpiles, waste rock dumps	Compliance with Mining Act and GGMC Codes of Practice; Water and Sewerage Act, GGMC Environmental Effects Programme EPA permit, IFC guidelines	Modification of hydrologic flow, increased percolation, subsidence, decreased water levels. Slope failure of waste rock and ore and overburden stockpiles disrupting surface flows	Negative, Direct, Localised	Minor	Rare	Low	Assessment and development of water balance plan to determine and manage modification of hydrologic flow.	Monitor water consumption of project activities. Periodic monitoring of the physical integrity of the waste rock and stockpiles.
Development and operation of mine pits, waste dumps,	Compliance with Mining Act and GGMC Codes of Practice; Water and Sewerage	Acid mine drainage and elevated metals in surface flows, creeks	Negative and Direct and Localised	Minor	Unlikely	Low	Implementation of Erosion Prevention and Sediment Control Plan	Monitor in accordance with Erosion Prevention and Sediment Control Plan

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
and rejects pond	Act, GGMC Environmental Effects Programme EPA permit, IFC guidelines	and streams in vicinity of mine pits, waste dump, and rejects pond						
Effluent discharge from mines and processing plant; Effluent discharge and from Rejects/Tailings pond	Compliance with Mining Act and GGMC Codes of Practice; Water and Sewerage Act, GGMC Environmental Effects Programme EPA permit, IFC guidelines	Contamination and elevated turbidity, manganese, heavy metals in surface flows creeks, streams in vicinity of mine pits, processing plant, and rejects pond; Tailings overflow of effluent into creeks and streams and elevating levels of manganese, heavy metals and other contaminants	Negative and Direct and Localised	Moderate	Likely	Medium	Treat and reuse effluent; development of probabilistic water balance; construction and operation tailings pond with sufficient freeboard; Installation and maintenance of supernatant pond pump back/recycling system to return reclaim water to processing plant; Installation of embankment seepage interception, collection, and return systems on rejects pond; maintenance of spillways, diversion ponds;	Regular monitoring of rejects pond water quality to ensure that controlled discharges are within the EPA and IFC limits.

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
							development of mine closure plan	
Mining and Blasting	Compliance with Mining Act and GGMC Codes of Practice; Water and Sewerage Act, GGMC Environmental Effects Programme EPA Permit	Environmental exposure to manganese in drinking water	Negative Direct, Long Term, Localised	Major	Likely	High	Development of a water quality monitoring programme to measure manganese levels in community drinking water supply Engagement with GWI	
Accidental Discharges and Spills	Compliance with Mining Act and GGMC Codes of Practice; Water and Sewerage Act, GGMC Environmental Effects Programme EPA permit, IFC guidelines	Spills of fuel and oil contaminating and elevating oil and grease levels in creeks, rivers within mine site, Port Kaituma Marine Terminal, and along road and river transportation routes	Negative Direct, Long-Term and Local	Moderate	Rare	Low	Implementation of Emergency Response and Contingency Plan Secondary containment and engineered spill prevention and control measures; preventative maintenance,	Inspection programs of equipment and machinery; monitor in accordance with monitoring plan.
Operations at mine and associated facilities	Compliance with Mining Act and GGMC Codes of Practice; GGMC Environmental Effects	Litter and solid waste clogging creeks, streams, and drains in and around mine	Negative, Direct and Localised	Minor	Unlikely	Low	Implementation of Waste Management Plan	Monitoring in accordance with Waste Management Plan and the Water Management Plan

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
	Programme EPA permit, IFC guidelines	site, processing plant, rejects pond, roadways, marine terminal at port Kaituma, Kaituma canal, river, and Barima River and Mora Passage.						
Transportation of manganese concentrates	Compliance with Mining Act and GGMC Codes of Practice; GGMC Environmental Effects Programme EPA permit, IFC guidelines	Unplanned releases of solid manganese concentrates into creeks, streams along road and river transportation routes (Kaituma Barima, Waini Rivers)	Negative, Direct, Long-Term, Localised	Negligible	Rare	Low	Adherence with safe practices for operating project vehicles.	
Groundwater Quality								
Mine pits excavation of overburden and ore	Compliance with Mining Act and GGMC Codes of Practice; Water and Sewerage Act, GGMC Environmental Effects Programme EPA	Dewatering and lowering of ground water levels and water table	Negative, Direct and localised	Minor	Unlikely	Low		Monitor on accordance with Water Management Plan; Monitoring of the water levels and quality in the boreholes onsite in

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
	permit, IFC guidelines							order to monitor fluctuations
Effluent discharge from mines and processing plant and seepage from rejects pond	Compliance with Mining Act and GGMC Codes of Practice; Water and Sewerage Act, GGMC Environmental Effects Programme EPA permit, IFC guidelines	Contamination and elevated levels of manganese, heavy metals due to seepage from mine pits, waste dump, rejects pond into groundwater	Negative, Direct and Localised	Minor	Unlikely	Low	Adherence to Operational Controls Consider options for improved tailings management	Monitor the quality of groundwater well in vicinity of tailings during first year of operations. Monitor the water level and quality of the boreholes located down-gradient of rejects pond Sampling frequency weekly-monthly and as needed
Accidental Spills	Compliance with Mining Act and GGMC Codes of Practice; Water and Sewerage Act, GGMC Environmental Effects Programme EPA permit, IFC guidelines	Seepage into groundwater resulting in elevated levels of oil and grease	Negative, Direct and Localised	Minor	Unlikely	Low	Implementation of the Emergency Response and Contingency Plan Ensure spill response kits, portable floating booms etc are readily available	Monitor on accordance with Water Management Plan
Availability of Potable Water	Compliance with Mining Act and GGMC Codes of Practice; Water and Sewerage	Low extraction/dem and rates	Negative, Direct and Localised	Negligible	Rare	Low	N/A	Monitor rate of extraction.

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
	Act, GGMC Environmental Effects Programme EPA permit, IFC guidelines							
Cumulative Impacts								
Ongoing small-scale gold mining proximate to Port Kaituma	Compliance with Mining Act and GGMC Codes of Practice; Water and Sewerage Act, GGMC Environmental Effects Programme EPA permit, IFC guidelines	Combined contamination of surface waters in and around creeks within 10 km of the Kaituma Marine Terminal	Negative, Direct, Short-term Localised, Cumulative	Minor	Rare	Low	Implement measures to control runoff from the Marine Terminal, Collaboration with GWI, EPA and the NDC in advance of future dredging activities	Monitor on accordance with Water Management Plan
Extraction of water from the spring behind Guyana House	GGMC Environmental Effects Programme EPA permit,	Water shortages during prolonged dry season or droughts	Negative, Direct, Short-term Localised, Cumulative	Minor	Unlikely	Low	N/A	Monitor rate of extraction. Engagement with GWI on water use during prolonged dry seasons or drought conditions

Chapter 9 - Soils and Geology

This section describes the baseline geological, topographical and soil conditions principally at the Matthew's Ridge mine sites based on extensive work undertaken by both Reunion Manganese Incorporated (RMI) and GMI. Baseline conditions are also provided for the soil conditions for the access road and marine terminal at Port Kaituma and for other project components at both locations. This section assesses potential impacts and risks to soils and geology from the planned project activities and project components and proposes measures which can be implemented to mitigate the risks which the project presents to the environment.

9.1 Administrative Framework – Soils and Geology

Table 9-1 summarises the legislation, policies, strategies, and international treaties that are relevant to the planned project activities.

Table 9-1: Legislation, Policies, Strategies and International Treaties

Title	Description	Applicability to the Project
Legislation		
Environmental Protection Act (1996)	Provides for the management, conservation, protection and improvement of the environment, the prevention or control of pollution, and the sustainable management of natural resources (including soils) and other related issues.	The project is expected to discharge tailings into a water retention and tailings dam and will also have to appropriately dispose of Wash Plant spoils. As such provisions on the Act for EIAs to identify, describe and evaluate impacts of the project including, inter alia, on soils and estimate contaminants, residues and emissions of pollutants to the soil are relevant to this section.
Mining Act (1989 with amendments)	Provides for prospecting and mining of metals, minerals and precious stones and for regulating their transport among other things.	GMI will be required to obtain a Mining License from the Guyana Geology and Mines Commission (GGMC) before commencing activities for stripping and mining.
Mining Regulations and Amendments (No. 1 of 1984, No. 9 of 1984, No. 1 of 1994, No. 1 of 2003, No. 3 of 2003, and No. 1 of 2005)	Sets out, inter alia, requirements for environmental management including with relation to the management of mining waste, reclamation of mined out lands, and management of project machinery including dredges.	GMI will be required to adhere to the requirements of the Regulations for open pit design, blasting, mining practices, management of mine waste and plans for reclamation, including topsoil storage and progressive reclamation on the mine site.

Title	Description	Applicability to the Project
International Guidelines and Standards		
Global Acid Rock Drainage Guide (GARD)	Provides guidance on the prediction, prevention, and management of drainage produced from sulphide mineral oxidation.	The geochemistry of the rocks in the mining areas were assessed to determine potential for sulphide mineral oxidation (acid mine discharges).

9.2 Baseline Conditions – Soils and Geology

9.2.1 - Port Kaituma

In the period after the manganese mines were closed there was significant gold mining and logging activities in the larger Kaituma - Matthew's Ridge area. All of these activities depended on the use of the Kaituma River and canal for logistics and transport. Over time, the expansion of the settlement has encroached on the area around the Canal where the previous shipping port was located, making it inaccessible and unsuitable for use as a major bulk shipping terminal now. As such GMI is establishing a new wharf facility on the right bank of the Kaituma River downstream of the historic terminal.

9.2.1.1 Geomorphology

The area around the Port Kaituma settlement and new wharf site is defined mainly by the large drainage basin and floodplains that border the Kaituma River. The settlement and the new wharf site are both located directly on the right bank of the river approximately 64 kilometers from its confluence with the Barima River. The floodplain is approximately 3 kilometers wide along the course of the channel with the river generally being in the middle of the floodplain. Parallel to the flood plains, roughly 1.6 kilometers inland on either side of the river the elevation rises to create the limit of the catchment area. This rise in elevation is gentle and gradual. The area within the drainage basin and floodplain is dominated by dendritic drainage patterns. The Kaituma River itself is a major waterway, running for more than 96 kilometers from its confluence with the Barima River. Its drainage basin and floodplains are mature and very well developed. There are small gentle rolling hills within and along the catchment of the drainage. Outside of the floodplain there are steeper hills which are elongated, capped with laterite or have saprock close to the surface making it weather resistant and resulting in higher relief.

9.2.1.2 Lateritic Profile

The tectonically stable nature of the Guiana Shield has resulted in prolonged deep weathering profiles being developed in virtually all of the shield. This deep weathering has resulted in the creation of typical laterite profiles. These profiles have duricrust (referred to as "Katchcow") and detritrial material resulting from the cementation of iron oxides. This cemented iron oxide material is resistant to erosion and over time becomes topographic highs. These hardened materials and surfaces are the basis for virtually all the roadways and road construction in the region. Under certain geologic conditions the development of a laterite profile may result in the formation of ore deposits. In the Kaituma area no such deposits have been identified.

9.2.1.3 Soil

The project components at Port Kaituma are located on two different types of soil. The project components and the types of soil on which they are located are outlined in Table 9 – 2.

Table 9-2: Project Components and Soil Types

Key Project Components	Mapping and Geomorphic Units*	Soil Class**	Land Capability Classification*
Port Kaituma			
A section of the access road	2d – red yellow podzolic soils and red latosols, heavy textured phase	Hapludoxs, Dystrochrepts	I and II
Kaituma Marine Terminal (Wharf)	3a – bog soils, peat and muck phases, deep pegasse	Sulfohemists, Medisaprists	III
A section of the access road			

* According to the soil units and capability identified by the United Nations Food and Agriculture Organisation (FAO) as presented in the National Land Use Plan
** According to the classification developed by the United States Department of Agriculture (USDA) as presented in the National Land Use Plan

Table 9-3: Summary of Soil Characteristics

Map Unit	Texture	Depth	Drainage	Fertility	Erosion Hazard	Limitations
2d	SC-C	Deep to Very Deep	Well	Low	None to Slight	Fertility (Slight Erosion)
3a	Organic	Deep	Very Poor	Extremely Low	None	Drainage. (Toxicity-(Acs), Fertility)

Source: National Land Use Plan (2013)

According to the National Land Use Plan, the key characteristics of these soils are as follows:

- **2d** – This mapping unit is an association of two soils (hapludoxs and dystrochrepts) which occur at lower elevations with a rolling to gently undulating topography. They occur extensively in north-west Guyana, particularly in Region 1 along the Barama, Barima and Waini rivers as well as in the Puruni river basin. The soils are deep to very deep, well drained, friable sandy loams to clays that have low fertility but have favourable physical properties that could be ameliorated by appropriate land management that would have to include soil conservation in areas with rolling topography. The land cover is forest.

- **3a** – These organic bog soils known as ‘pegasse’ occur as coastal back-swamps and are most extensive in north-western Guyana, west of the Pomeroon River where they can extend 65km inland, although they also occur in patches behind the rest of the coastal plain. The soils are

organic accumulations of peat and other organic matter occasionally interlayered with clay and can be as deep as 9m. They are very acidic and have extremely low fertility. Drainage, fertility and acid sulphate toxicity are the main limitations to agriculture. The land cover is mainly natural vegetation of grassland and swamp forest with characteristic ite palms.

Figure 9-1 shows the key project components and the soil types on which they occur at Matthew's Ridge and Port Kaituma

9.2.1.3.1 Topsoil Clearing

The access road to the new wharf facility being constructed at Port Kaituma is 9.7 kilometers long. There previously existed an old tractor road extending approximately 5 kilometers along this alignment to the new wharf site. This old 5-kilometer tract was upgraded and 4.7 kilometers of new road was constructed. The width of the road is 8 meters. During the upgrade and construction of this road it was not practical to remove the topsoil as the area was very swampy and the entire length of the road required filling to raise the road surface above the flood level. The widening along the 5 kilometers section of old road saw 4 meters of topsoil being covered along the sides. The 4.7 kilometers of new road construction covered topsoil all along its length. The total volume of topsoil covered by this road work is approximately 11,520 cubic meters. The fill material for this road came from the existing laterite pits in the area. Some of the fill material also came from the excavation of the river bank to create draft so that vessels may dock at the site.

The wharf site is 4 hectares (9.88 acres) in total. A significant portion of this along the river will be excavated to create a turning basin and wharf. At this location there will be ancillary facilities such as scale house, housing, security huts, stockpiles, equipment storage, loading facility etc. Based on the site plan for this facility, approximately 75 percent of the total area will either be excavated or covered by development.

9.2.1.3.2 - Existing Levels of Contamination / Degradation

The new wharf site at Port Kaituma was not previously developed except for some small artisanal activity along the river bank by local residents. As such there is no significant existing contamination or degradation at that site.

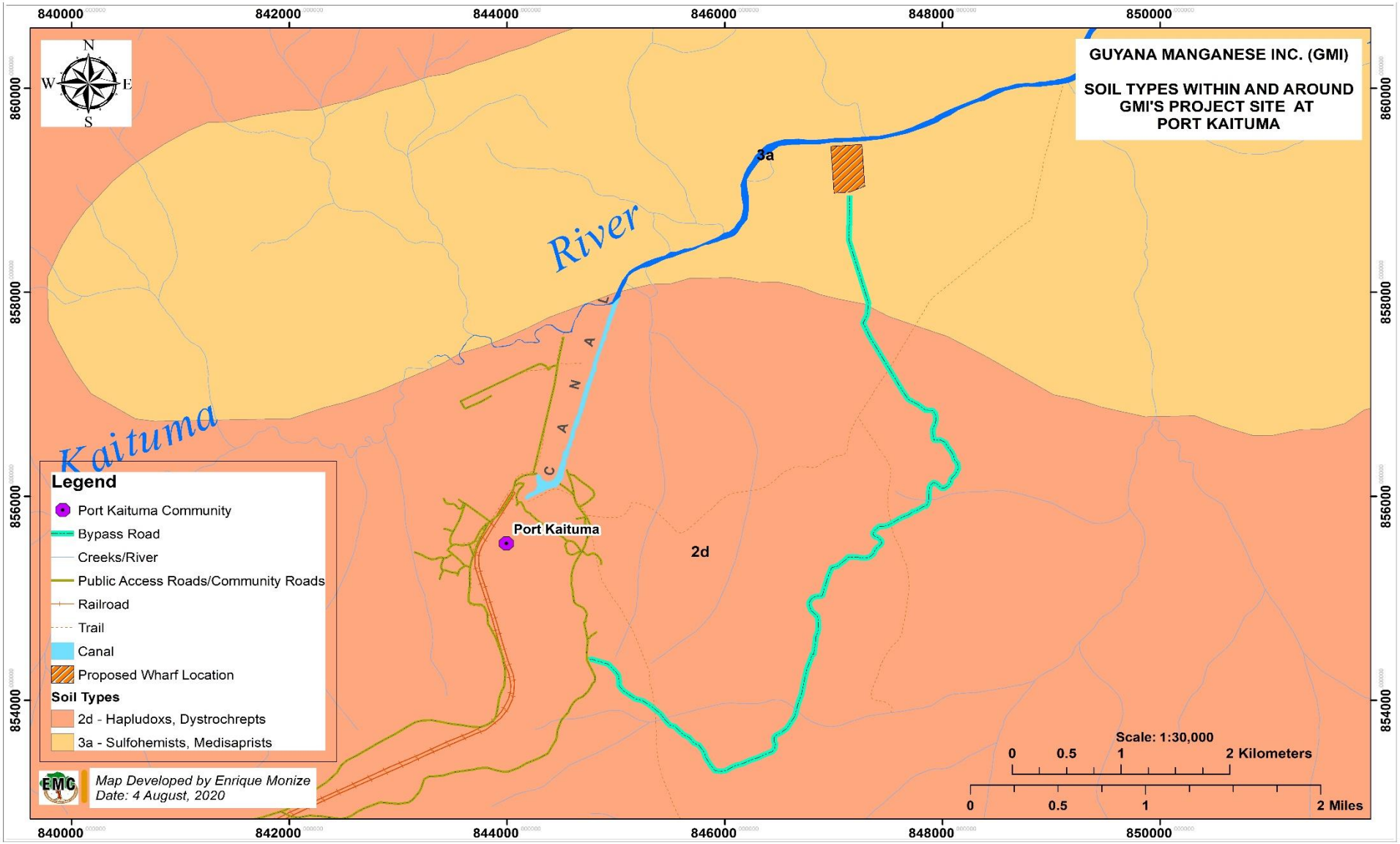


Figure 9-1: Soil Types and Project Components in Port Kaituma

9.2.1.4 Topography

Port Kaituma and the new wharf site are located on the right bank of the Kaituma River. The area is mostly flat and located in the drainage basin of the river. The surrounding areas have low relief, being typically less than 15 meters higher than the river bank. There are a few scattered hills with elevations of 50 meters above the river bank, these are the laterite capped hills. The area is mostly covered by fluviatile sediments and has been washed flat due to its location in the drainage basin of the river.

Figure 9-2 presents a topographical map that shows the elevation patterns at the wharf site and the wider Port Kaituma area.

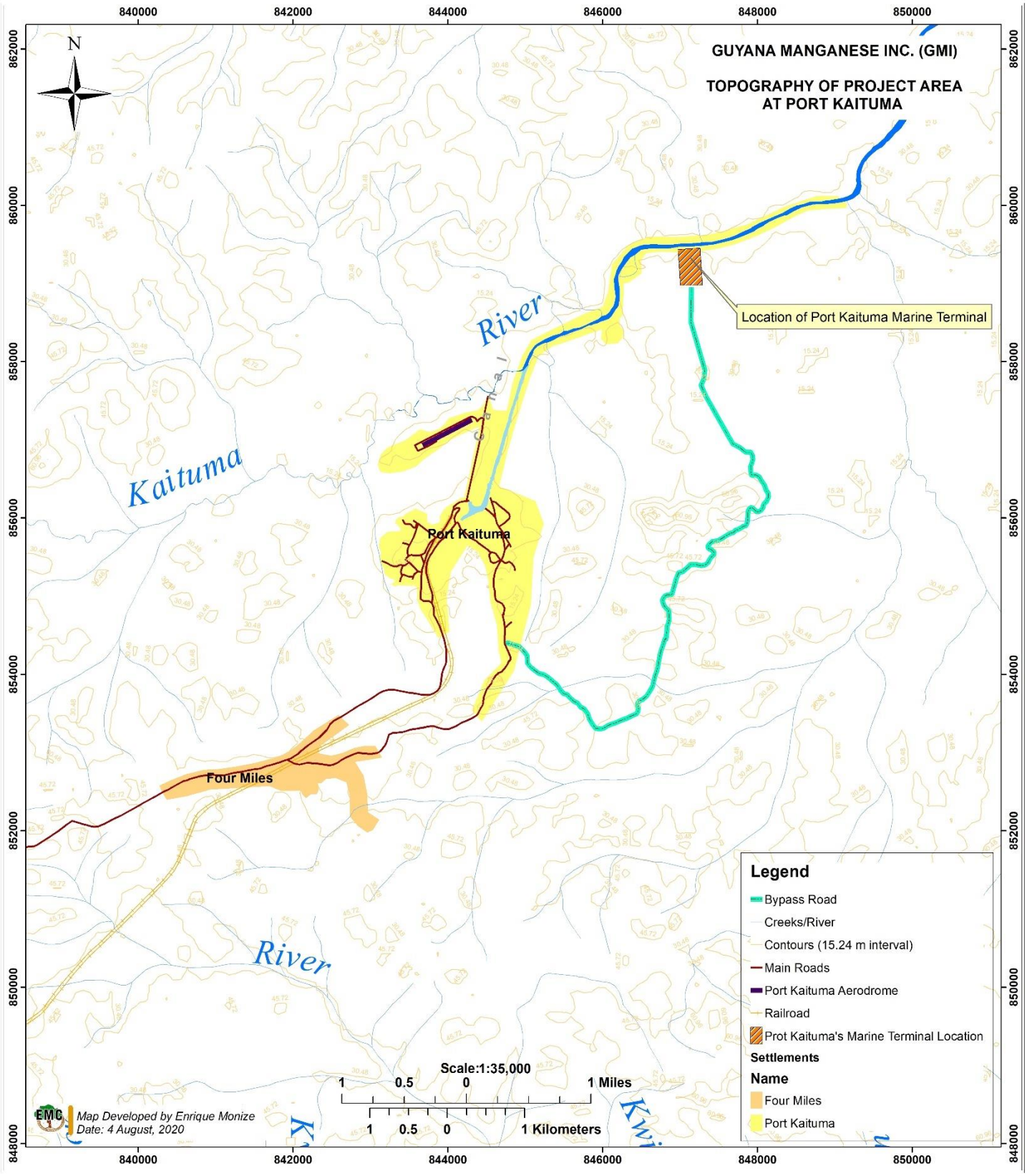


Figure 9-2: Topographic Map – Port Kaituma

9.2.2 Matthew's Ridge

The Matthew's Ridge Manganese deposit exploration began in the 1950s with numerous trenches, boreholes, geological surveys and prospecting activities. Subsequently, Manganese Mine Management Limited engaged in exploration and mining operations at the Matthew's Ridge Manganese deposit. The general occurrence of the deposit was found to be related to a series of nine hills stretching along 15 kilometers, oriented east - west and numbered from the east as Hills 1 through 9. In 1962, mineral resources were estimated at 3,265.9 thousand tons of manganese concentrate. Five of the nine hills, in the current Prospecting Licenses 2 and 3, were actively mined from 1961 to 1967. When extraction ceased in 1968, the known resources base was reported to be approximately 907,200 tonnes of 37 percent recoverable manganese concentrate. No mine closure or reclamation activities were undertaken. In 1985, the Guyana Geology and Mines Commission (GGMC) and the Democratic People's Republic of Korea (DPRK) established five new boreholes totaling 326 meters. The findings of this exploration increased the resource base to 3.6 million tonnes of 33.4 percent recoverable manganese concentrate.

From 2010 to 2012, Reunion Manganese Incorporated (RMI) undertook substantial exploration activities within all nine hills. Their work comprised of; 130 trenches totaling 12,429 meters and over 15,000 trench samples; 735 diamond drill holes totaling 47,570 meters and 24,207 core samples; 283 reverse circulation holes totaling 17,332 m and 11,536 samples; and magnetic survey along lines totalling 114.5 kilometers. In addition, 365 points were sampled in 100-meter by 50-meter grid in the detritic deposits, and 119 points were sampled in a 50-meter by 50-meter grid in the tailings pond using a Banka drill. In 2013 as part of their due diligence, GMI conducted a quality assessment/ quality control exercise of RMI's exploration activities and results. GMI determined that the work completed was credible and could be used as the basis of a resource assessment and understanding the geology of the deposit. GMI commissioned a Feasibility Study Report[43] which drew significantly on the work conducted by RMI to establish the geological baseline of the mining areas. As a consequence of the extensive works done by RMI and GMI, this baseline section draws significantly from the Feasibility Study Report prepared by GMI and the Pre-feasibility Study prepared by RMI. The RMI Pre-Feasibility Study, by G Mining Services Incorporated and Golder Associates Limited in particular, conducted extensive investigative and analytical data from lab and field analyses. The data used in that study was certified by ISO and NI 43-101 standards. This certified data is what is utilised in this chapter.

9.2.2.1 Geomorphology and Stratigraphy of the Mine Sites

9.2.2.1.1 Geomorphology

Generally, the geomorphology of the area consists of a rugged topography and chains of steeply sloping hills, gullies and peneplained tops. Abrupt changes in elevation are related to lithology and geological structures. Rocks are highly weathered and are exposes only along the resistant crest of ridge, river valley and road side cuts. Soils are developed in relation to the topography from depths of less than one meter to over ten meters. Drainage patterns are sub-dendritic as a result of the strings of ridges.

The Matthew's Ridge Manganese deposit is located in the northwestern part of the Guyana shield and underlain by Greenstone belt Lower Proterozoic rocks of the Barama Group of the Barama-Mazaruni Supergroup. In the Barama Group the oldest rocks are believed to be the Tenapu Formation (Williams et. al. 1967)[44], consisting of mafic rocks such as amphibolites, chlorite schists and pillow basalts, with

[43] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3.
[44] Williams, E., Cannon, R.T. & McConnell, R.B., 1967, The Folded Precambrian of Northern Guyana Related to the Geology of the Guiana Shield: Geological Survey of British Guiana; Records Volume 5, 60 p.

subordinate lenses of psammitic rocks and rare phyllites. Locally ultramafic zones such as serpentinites and talcose rocks occur, possibly representing komatiitic flows or sills (Gibbs & Barron 1993)[45]. In some areas these are overlain by more differentiated volcanics. In the central and lower Barama River Gibbs (1978)[46] describes overlying calc-alkaline flows, tuffs and sub-volcanic porphyry stocks (Arawanta Formation), while in the western part of the main Barama Group belt calc-alkaline rocks, including stratiform shoshonitic hornblende-porphyries occur (Gibbs & Barron, 1993)[47]. In the central part of the main Barama Group Belt mafic rocks are covered by sediments of the Matthews Ridge/Pipiani Formations. Webber (1952)[48], describes this as a sequence of dark coloured Lower Quartzites (~200 meters), red to brown to purple Lower Phyllites (~300 meters), pale to greenish sericite schist (~200 meters), and then the Upper Quartzite lens swarms in phyllites, including manganiferous zones (~300 meters), before the Upper Phyllite (~600 meters). At least some of the material that now looks like quartzite may originally have been chert.

The Barama Group is conventionally subdivided in three formations: the Arakaka Formation at the top, followed by the Matthews Ridge Formation, underlain by the Tenapu Formation. The manganese mineralization at Matthews Ridge is confined to the MRF, which is principally a low metamorphic grade, predominantly sedimentary sequence of fine-grained clastic (pelitic) and chemical nature. The manganese mineralization at Matthew's Ridge is clearly related to lateritic weathering of a complex geological sedimentary succession. The source of manganese is calcareous magnesia-rich rocks in the basic sequence. The Arakaka Formation, which may be the lateral equivalent of Webber's Upper Phyllite zone, consists of phyllites and mudstones, with subordinate quartzites and chlorite schists. At the eastern end of the main Barama Group outcrop in the Tassawini area tuffaceous zones as well as quartzites occur in the upper parts of the sequence. The overlying 2 to 3 kilometers thick Kokerite Formation (Gibbs, 1978)[4] is exposed extensively in the lower Barama and is dominated by clastic meta-sediments / greywackes, including volcaniclastic conglomerates and some fine-grained igneous rocks.

[45] Gibbs, A.K., and Barron, C.N., 1993, The Geology of the Guiana Shield: Oxford Monographs on Geology and Geophysics No.22
[46] Gibbs, A.K., 1978, Field Report on the Barama River Section: Geological Survey of Guyana. Unpublished Report AKG 1/78, 58p.
[47] Gibbs, A.K., and Barron, C.N., 1993, The Geology of the Guiana Shield: Oxford Monographs on Geology and Geophysics No.22
[48] Webber, B.N., 1952, Manganese Deposits in the Northwest District, British Guiana: Geological Survey of British Guiana, Bull. 23.

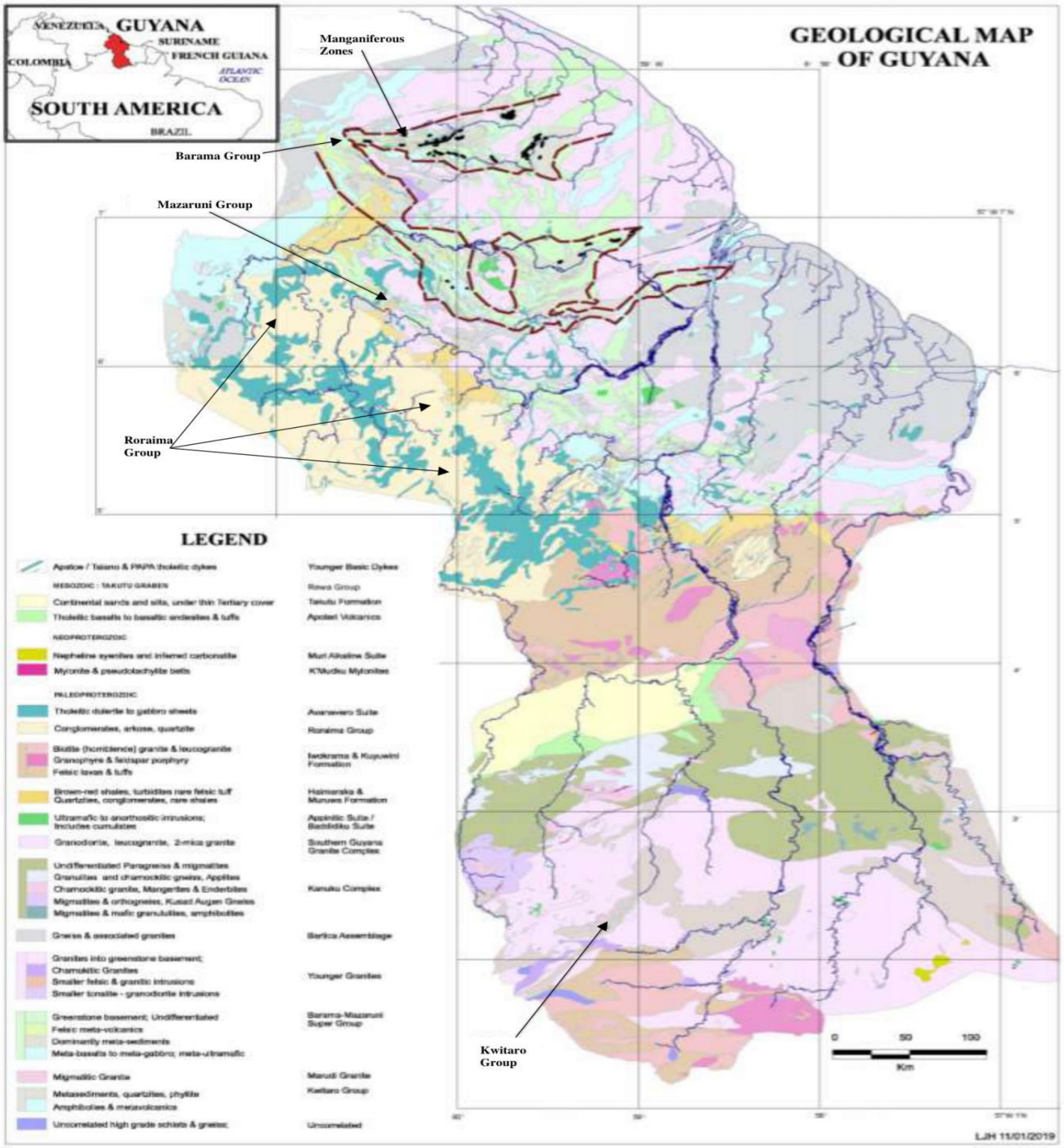


Figure 9-3: The Barama Group of the BMS

9.2.2.1.2 Stratigraphy[49]

The Matthews Ridge Formation (MRF) is a typical sedimentary sequence extending 20 kilometers from the southwest to northeast. Geological mapping by RMI indicates that the MRF is flanked to the south by pyroclastic rocks (tuffs and agglomerates) and to the north by coarse clastic sediments (greywackes and arenites). The major strata in MRF were identified as follows:

- *Massive Manganese Formation (MMF)*: When thicker manganiferous beds are encountered, they were named "massive manganiferous formation" (MMF), with typical thickness from 1 to 3 meters. Contact between MMF and an upper phyllitic unit is usually sharp.
- *Banded Manganese Formation (BMF):* This formation has an estimated thickness of 10 to 15 meters, characterized by well-stratified interlayered phyllite and manganese-rich beds. Manganese oxide is concentrated in the manganese-rich beds and is clearly distinguishable. The phyllite beds are sub-millimeter and continuous. BMF is very easy to identify and continuous in the deposit. It can serve as a standard layer for stratum and tectonic interpretation.
- *Manganiferous Phyllite (MPHY)*: When the phyllites contain a reasonable proportion of manganese-rich material (5 percent manganese) either as thin beds or fracture filling, RMI created the name "manganiferous phyllite". The MPHY transitionally contacts with the non-mineralized and more strongly mineralized phyllite. The mineralized units consist of phyllites containing various proportions of beds composed of manganese oxides/hydroxides. The frequency of beds and their thickness is highly variable, ranging from a few millimeters to several decimetres. Typically, the MPHY is less than 10 meters thick.
- *Phyllite (PHY)*: The phyllites are the most abundant lithology of the MRF. They are mostly purple in colour, but also grey, cream and white, finely bedded with slight to strong cleavage, locally manganous as thin beds or fracture filled with manganese oxides and hydroxides. This unit is obviously derived from the sedimentation of very fine-grained clastic material as claystones or siltstones. Bedding is very thin, distinguishable only by slight color differences between beds. Phyllite is divided into upper phyllite (UPHY) and lower phyllite (LPHY). This UPHY unit is estimated to be more than 100 meters thick, contains no manganiferous beds and is considered to be barren. The lower phyllite (LPHY), is estimated to be more than 75 meters thick, forms the basement of the sedimentary sequence, and contains thin and very local manganiferous and occasional chert beds.
- *Chert:* The chert members are usually seen as discrete beds, stratiform and stratabound, varying in thickness from a few centimetres to a few meters. They are usually light grey, but also purple and bluish, usually very fractured and present in much smaller proportion than the manganous beds. The rock is aphanitic, composed essentially of quartz. The cherty beds are not marker beds and have little lateral continuity as they are a competent unit and affected by boudinage. These rocks show little reaction to weathering, but act as hosts to manganous minerals because of the abundant space created by their brittle fracturing.

The extensive mafic and ultramafic intrusives underlying and intruding the entire MRF sedimentary sequence have been classified mainly as diorite. The diorite formation age is younger than the sedimentary MRF sequence. These rocks are usually massive, dark grey-green, finely crystalline to porphyritic, appearing in both cross-cutting and concordant contacts with the sediments, i.e. dykes and sills. The porphyritic minerals are usually euhedral feldspars, which weather to white clay. In thin-section, these rocks show no deformation, having the original igneous panidiomorphic granular texture well preserved, and are weakly altered (chloritization, saussuritization, amphibolization and microclinization). The diorites weather intensively to orange-colored clays often with manganous oxides filling fractures, forming boulders from "onion skin" exfoliation. The weathering of these rocks

[49]G Mining Services Inc, 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Section 7.2.

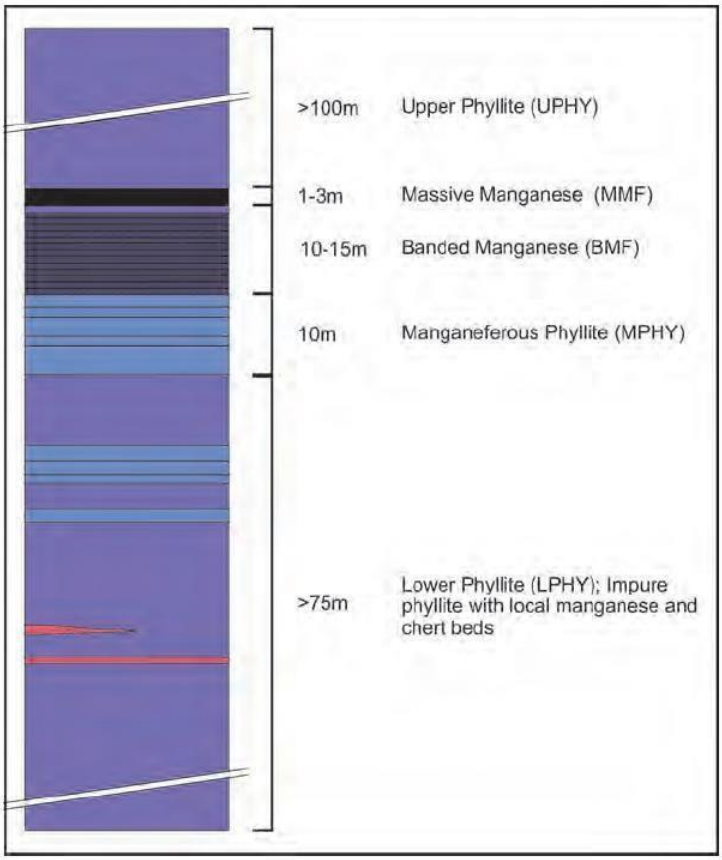
can be so intense as to cause bauxitization, as observed on Hill 1 and Hill 5. Figures 9 – 4 to 9 – 7 provide examples of the MMF, BMF and phyllite strata which are found at the Matthew's Ridge. The lithostratigraphic interpretation of the Matthews Ridge deposits is presented in Figure 9 – 8.

Figure 9-4: MMF- Formed by Indistinct Manganese Oxide and Hydroxide Minerals on Hill 5

Figure 9-5: BMF - Banded Manganese Formation on Hill 5

Figure 9-6: Alternating Bands of Braunite (Black) and Spessartite-Rich Purple Phyllite Forming Typical BMF Protore

Figure 9-7: Folded Chert Beds with Manganese Oxides/Hydroxides Intercalated with Phyllites (Hill 5W)



Source: Goulet (2012)

Figure 9-8: Schematic Stratigraphic Column of the MRF

9.2.2.2 Lateritic Profile

The formation of manganese deposits at Matthew's Ridge is closely related to manganese enrichment due to intense weathering in the late Tertiary. The lateritic profile for the mine sites is subdivided into: Duricrust and its detrital equivalents: nodular material and/or colluvium, Mottled Zone, Saprolite, and the Saprock or Transition Zone. The profile is the result of progressive weathering and leaching of the underlying rock formation.

The duricrust marks the ultimate level of development for the profile, where seasonal meteoric water stopped flowing, allowing the cementing of the pisolitic material previously formed into an indurated mass. This horizon is often the surface of peneplains and is the first to be attacked by erosion – usually "holding" the topography because of its nature. The existence of duricrust horizons is considered important because it indicates the lateritic profile was well developed and capable of leaching manganese from the protorocks and depositing it elsewhere in the profile.

The existence of bauxitized diorite occurrences suggest that the weathering process lasted long enough for the thorough leaching of the profile, probably associated with a former peneplain. A complete profile is observed in few locations, like at Hill 1, where an in-situ manganiferous duricrust was observed.

9.2.2.3 Soil

The project components at Matthew's Ridge are located on three different types of soil. The project components and the types of soil on which they are located are outlined in Table 9 – 4.

Table 9-4: Project Components and Soil Types

Key Project Components	Mapping and Geomorphic Units*	Soil Class**	Land Capability Classification*
Matthew's Ridge			
Processing Plant	1e – reddish brown lateritic of low base status	Dystrochrepts, Kanhaplustults	III
Tailings and Water Retention Dam (Rejects Pond)			
Waste Dump #1			
Power Plant			
Mechanical Repair Shop			
Hill 5 and Hill 9 Open Pits			
Bypass Road			
A section of raw water pipeline			
Pump Station	2f – lithosols acidic rock phase	Ustorthents, Kanhaplustults	IV
A section of raw water pipeline			
Explosives Storage Area			
Living Areas			
Waste Dumps #2 and #3			
Hill 5 Ext Open Pit			
Waste Dump #4	1d – red yellow podzolic soils	Dystrochrepts, Endoaquults	III

* According to the soil units and capability identified by the United Nations Food and Agriculture Organisation (FAO) as presented in the National Land Use Plan
** According to the classification developed by the United States Department of Agriculture (USDA) as presented in the National Land Use Plan

Table 9-5: Summary of Soil Characteristics

Map Unit	Texture	Depth	Drainage	Fertility	Erosion Hazard	Limitations
1e	CL-C	Very Deep	Well	Low to Medium	None to High	Fertility, Erosion Potential
2f	GL-ZC	Very shallow	Well to Excessive	Very Low	High	Fertility, shallow depth, steep slopes
1d	SC-C	Shallow to Deep	Well	Low	Slight to High	Severe erosion potential, fertility
2d	SC-C	Deep to Very Deep	Well	Low	None to Slight	Fertility (Slight Erosion)
3a	Organic	Deep	Very Poor	Extremely Low	None	Drainage. (Toxicity-(Acs), Fertility)

Source: National Land Use Plan (2013)

According to the National Land Use Plan, the key characteristics of these soils are as follows:

- **1e** – This unit describes soils derived from basic rocks occurring on ridges and isolated mountains that occur scattered in an arc from the upper Demerara, through the lower Potaro and Mazaruni Rivers, across the central Cuyuni River to the upper Waini River in Region 1. The soils are very deep, well drained clay loams to clays with some gravels and patches of very gravelly and shallow soils. They have a land capability classification of III and therefore, have a low to medium fertility but on steeper slopes are often very gravelly with a high erosion hazard if forest cover were to be removed. The low fertility and erosion potential are the main limitations.

- **2f** – This is one of the most extensive soil mapping units occurring in large areas of southwest Guyana including the southern Pakaraima Mountains, the Kanuku Mountains and the Sierra Acarai at the southern border with Brazil. The unit also occurs scattered in the interfluves of the Rewa, Essequibo, New and Corentyne rivers as well as in the upper Barama and Barima Rivers in North-West Guyana. They have a land capability classification of IV and therefore, are considered non-agricultural lands. The main limitations of this unit are low fertility, shallow depths and steep slopes.

- **1d** – These soils occur extensively in the North-West of Guyana in relatively large blocks, particularly between the Mazaruni and Cuyuni Rivers and north of the Cuyuni River. The soils are shallow to deep, well drained loams over often gravelly clays with low fertility. Due both to the nature of the soils and to the often dissected nature of the terrain, the soils have a high erosion hazard which, with the low fertility is the main limitation. The main land cover is forest.

Figure 9-9 shows the key project components and the soil types on which they occur at Matthew's Ridge.

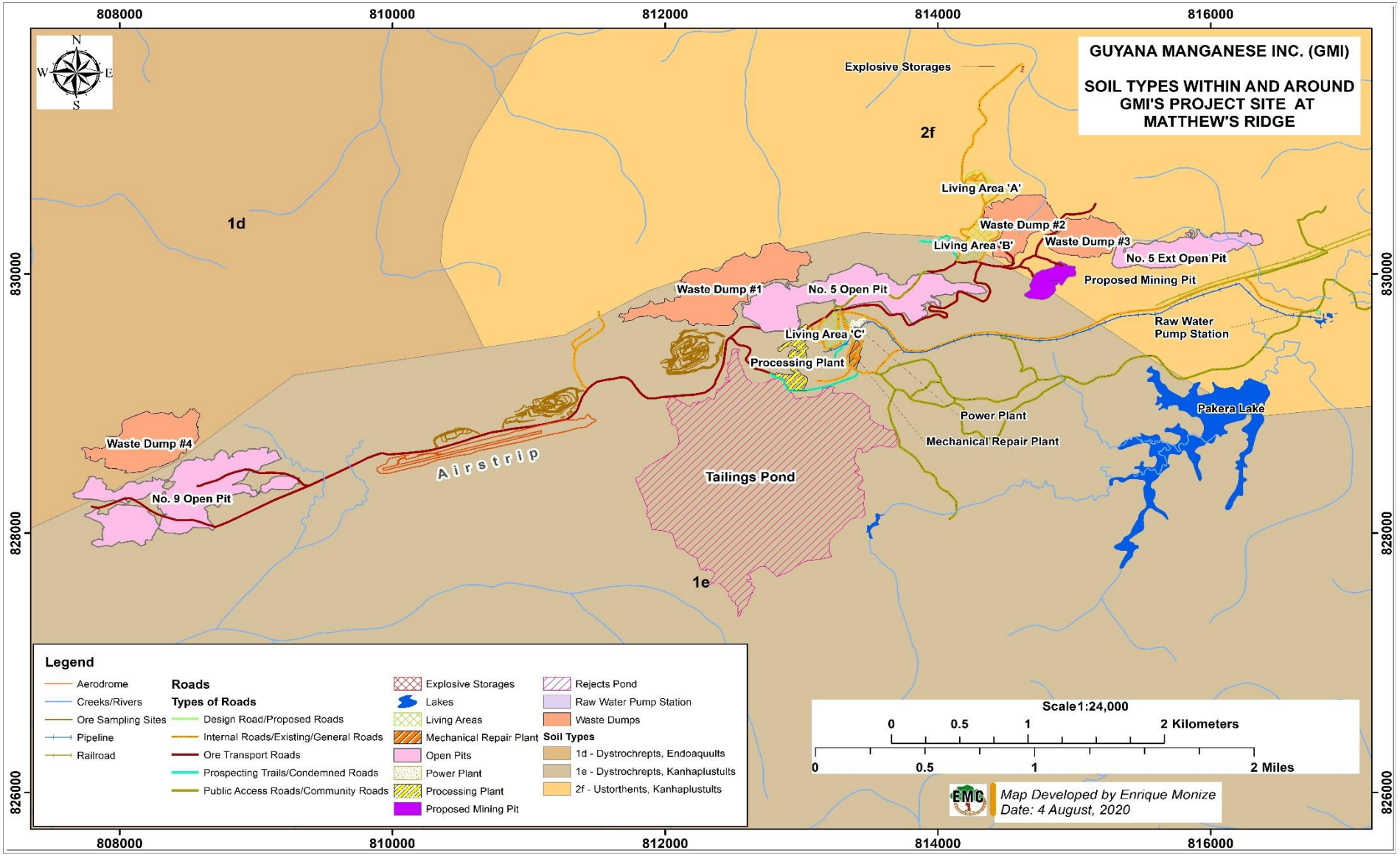


Figure 9-9: Soil Types and Project Components in Matthew's Ridge

9.2.2.3.1 Soil Quality[50]

In the Pre-Feasibility Study commissioned by Reunion Manganese Incorporated, soil quality was investigated along the 15-kilometer strike of the ore body. They assessed the potential for acid Mine drainage (AMD), metal leaching and chemical composition of materials across the project area. Chemical composition was determined through whole rock trace element analysis to determine the content of major rock forming elements and trace metals respectively. Metals were tested for by inductively coupled plasma - mass spectrometry (ICP - MS), with concentrates extracted by the use of strong acids. Mercury was tested for by cold vapor atomic absorption spectroscopy (CVAAS). Whole rock analysis for major metals was done by borate fusion / x-ray fluorescence (XRF). From all samples tested, nine elements were below the limit of detection, including uranium and tungsten. Gold, cadmium, cobalt and selenium were mostly below the limit of detection. The results showed that silicon, manganese, iron and aluminum predominated in the sediment samples. Mercury, arsenic, lead, cadmium and selenium were among the toxic elements tested. All samples tested were below the respective limits for these elements in soil based on the guidelines of the International Finance Corporation.

The potential of geologic material to oxidize and generate acidic drainage is evaluated through acid-base accounting (ABA). This test was conducted following the modified Sobek Method (MEND, 2009) and included determination of the following parameters: Paste pH, Total sulphur by LECO furnace (ASTM E 1915) method, sulphide and sulphate sulphur, total carbon and carbonate by LECO furnace and Bulk neutralization potential (1996 modified NP procedure MEND 2009). The analysis shows that most of the sulphur has already been oxidized during the deep weathering process under the tectonically stable conditions that have prevailed since the younger intrusives of 500 million years ago. Due to this deep weathering profile most of the carbonate minerals have been leached away resulting in a very low neutralization potential.

Metal leaching potential was done by Shake Flask Extraction (SFE). Samples were subjected to short term tests using a modified version of the shake flask extraction (ASTM D3987). Leachate from the SFE was analysed by ICP - MS for the following parameters: aluminum, antimony, arsenic, boron, beryllium, bismuth, calcium, cadmium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, potassium, selenium, silicon, silver, sodium, strontium, thallium, tin, titanium, tungsten, uranium, vanadium, zinc and yttrium. Mercury was tested for using ICP - atomic fluorescence spectrometry. The final leachate solutions were also subjected to analysis for pH, alkalinity, conductivity, chlorine, sulphate (SO_4). All samples tested were below the respective limits for these lechates in soil based on the guidelines of the International Finance Corporation.

9.2.2.3.2 Soil Strength - Geotechnical analysis

There were two detailed geotechnical investigations conducted in RMI's Pre-Feasibility Study. The first was conducted around the processing facility area and the second along the haul road connecting Matthew's Ridge to Port Kaituma.

Processing Site[51]

At the processing site, a hydraulic excavator was used to establish four pits for sample collection for geo-technical analysis. The samples from these four test pits were evaluated for the following criteria; liquid limit, plastic limit, plasticity index, water content and grain size distribution. Pits 1 and 4 were in

[50] G Mining Services Inc, 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Appendix RSF B: GUMR-TM-13-08-08-Golder-Geochemical Characterization Waste Rock and Jig Reject
[51] G Mining Services Inc, 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Appendix INF B: GUMR-TM-13-05-22-Golder-Process Plant Preliminary Geotechnical Investigation PFS

the same area since the profile revealed at location 1 was not suitable for investigation. The pit revealed that the area was used previously for stockpiling and the residual material was 4.5 meters deep. This residual material did not have the required characteristics to be considered for load bearing. As such another pit was located approximately 30 meters south of the Pit 1 and was labeled as Pit 4. At Pit 4 there was one meter of superficial material and then in-situ material. Pit 2 was in the proposed location for the central processing facility. Surficial material was only 0.7 meters deep and then there was still in-situ material. This pit did not encounter any ground water to a depth of 4.1meters. Pit 3 was located in the area identified for the construction of the manganese silos. At this location there was 1.5 meters of silt before encountering in-situ material. Water seepage was encountered at a depth of 3.4 meters.

The recommendations were that no foundations be placed on the unconsolidated surficial material to prevent differential settlement. The foundations were recommended to be placed from the top of the in-situ material with large coverages to spread the load so as to reduce settlement. It is expected that none of the foundation works will be below the water table. The summary of results is shown below in Table 9-6 and the location of four test pits are as shown on Figure 9-10.

Table 9-6: Geotechnical Parameters of Samples from Processing Plant Locations[52]

Pit	Depth (meters)	Liquid Limit (Percent)	Plastic Index (Percent)	Water Content (Percent)	USCS Classification
Pit 1	0.30 to 0.60	58	22	42	MH
Pit 2	2.00 to 2.30	50	34	39	MH
Pit 3	1.50 to 1.80	51	24	35	CH
Pit 4	3.00 to 3.50	52	26	27	CH

[52] G Mining Services Inc, 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Appendix INF B: GUMR-TM-13-05-22-Golder-Process Plant Preliminary Geotechnical Investigation PFS, Page 2

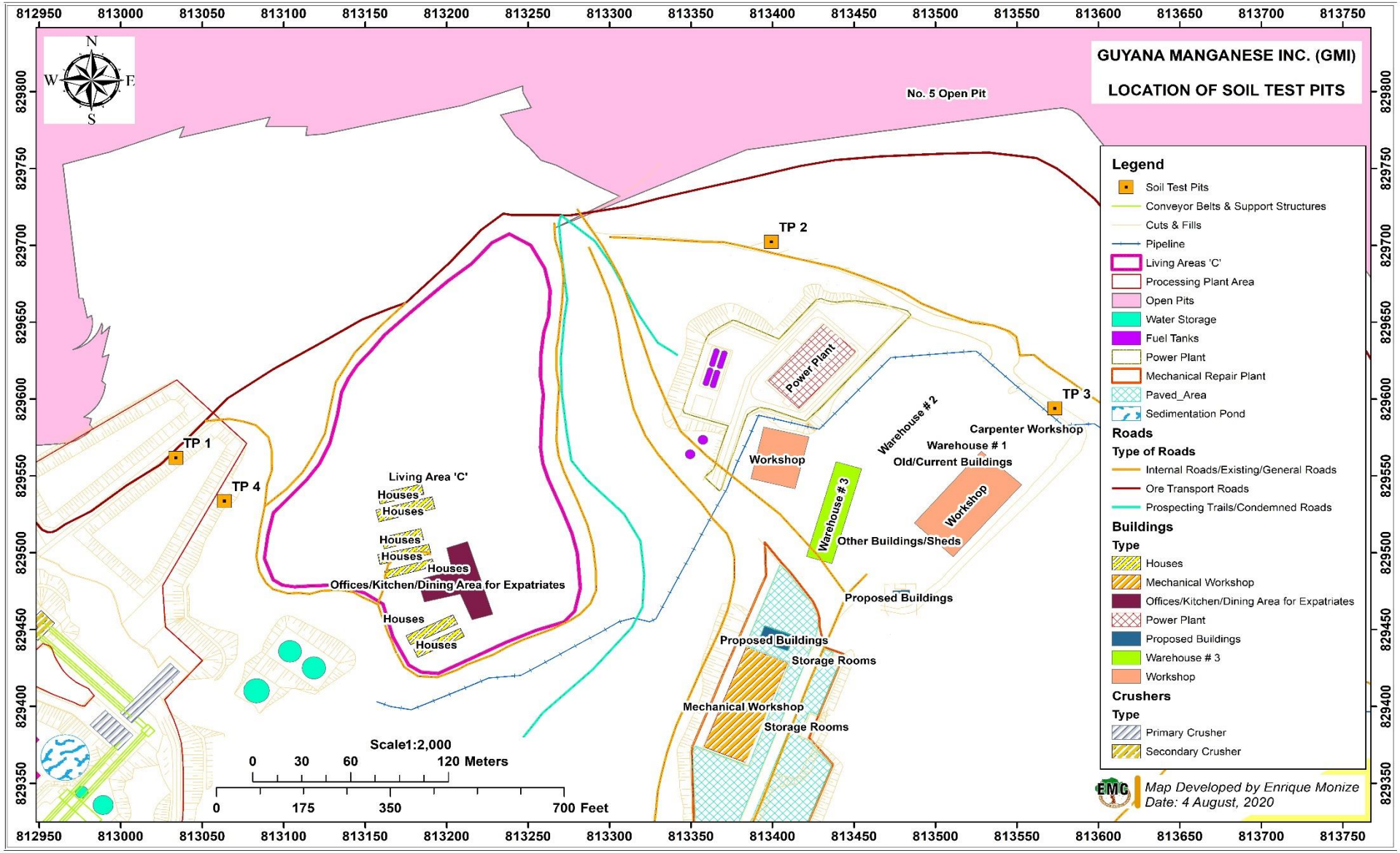


Figure 9-10: Location of the Test Pits

Haulage Road[53]

The site conditions in the area of the existing mine facilities and abandoned rail alignment consist of jungle vegetation on an undulating topography consisting of hills with small creeks and swampy areas in the valley floors together with a crossing of the Barima River. The abandoned rail alignment was developed to the east and north of the existing mine facilities by constructing a series of embankment fills and cuts. The subgrade of the proposed alignment will be comprised of native saprolite or saprock in the cut sections and saprolite fill in the fill sections.

As a result of the lack of locally available aggregate for construction of the haul road pavements, a nontraditional pavement design was also developed as part of the scope of work. The design optimizes the use of local materials and simplifies the construction methods. A variety of tests were completed on the native laterite material to determine its suitability as a pavement component, on a preliminary basis. Table 9-7 shows a summary of the material type and potential applications.

Table 9-7: Summary of Aggregate and Soil Applications[54]

Material Type	Potential Applications
Saprolite	Bulk Material for embankment fills and widenings
	Subgrade material for pavements
Laterite	Subbase material for pavements
Rock (Granite - Diorite/Gneiss)	Rock fill for fills in wet areas
	Aggregate for concrete
	Base Material for pavements
	Aggregate for surface treatment or asphalt
	Rip Rap for erosion protection
Sand	Fine Aggregate for concrete
	Filter material

Fifteen samples of saprolite were collected from the cut slopes and laboratory classification tests were carried out to determine the material properties of the subgrade and cut slopes. The results of the Atterberg limits testing of eight saprolite samples are summarized below. Standard Proctor compaction testing was also completed on four of the saprolite samples to determine the material's moisture-density relationship.

[53] G Mining Services Inc., 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Appendix INF C: GUMR-TM-13-07-17-Golder-Preliminary Aggregate and Soil Investigation and Transportation Corridor Assessment
[54] G Mining Services Inc., 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Appendix INF C: GUMR-TM-13-07-17-Golder-Preliminary Aggregate and Soil Investigation and Transportation Corridor Assessment, Page 3

Table 9-8: Summary of Atterberg Limits - Saprolite Samples[55]

	Atterberg Limits		
	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
Average	51	33	18
Minimum	43	26	9
Maximum	69	45	33

Table 9-9: Summary of Moisture Density Relationships - Saprolite Samples[56]

	Standard Proctor Compaction Test			
	Maximum Dry Density (kg/m^3)	Maximum Wet Density (kg/m^3)	Optimum Water Content (%)	In Situ Water Content (%)
Average	1705	1983	25	31
Minimum	1398	1839	8	6
Maximum	1952	2104	34	49

Laterite pits are currently in operation to obtain materials for local road construction and repair activities. Additional laterite was encountered in recent road cuts south of the existing pits. These materials have potential application as a pavement component material for haul road construction. Seven samples of laterite were sent to Golder's laboratory to complete water content, grain size distribution analyses, Atterberg Limit, Standard Proctor Compaction, and California Bearing Ratio (CBR) tests. CBR testing on laterite was completed with varying quantities of cement or lime additives and allowing the samples to cure to determine the effectiveness of stabilization.

The results of the Atterberg limits testing of six laterite samples are summarized in Table 9 - 10 below. Standard Proctor compaction testing was also completed on four of the laterite samples to determine the material's moisture-density relationship, the results are shown in table 9-11 below.

Table 9-10: Summary of Atterberg Limits - Laterite Samples[57]

	Atterberg Limits		
	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
Average	43	31	12
Minimum	38	28	8
Maximum	47	37	17

[55] G Mining Services Inc., 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Appendix INF C: GUMR-TM-13-07-17-Golder-Preliminary Aggregate and Soil Investigation and Transportation Corridor Assessment, Page 4
[56] G Mining Services Inc., 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Appendix INF C: GUMR-TM-13-07-17-Golder-Preliminary Aggregate and Soil Investigation and Transportation Corridor Assessment, Page 4
[57] G Mining Services Inc, 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Appendix INF C: GUMR-TM-13-07-17-Golder-Preliminary Aggregate and Soil Investigation and Transportation Corridor Assessment, Page 6

Table 9-11: Summary of Moisture Density Relationships - Laterite Samples[58]

	Standard Proctor Compaction Test			
	Maximum Dry Density (kg/m^3)	Maximum Wet Density (kg/m^3)	Optimum Water Content (%)	In Situ Water Content (%)
Average	1623	2002	24	21
Minimum	1513	1914	16	15
Maximum	1875	2186	27	27

The in-situ water content of the laterite materials is typically at or less than the optimum moisture content based on the results of the Standard Proctor Compaction Tests. Using the results of the Standard Proctor Compaction tests to determine optimum water contents of each material a series of CBR tests were performed. The results are summarized in table 9-12.

Table 9-12: Summary of the California Bearing Ratio Testing - Laterite Samples[59]

Sample	California Bearing Ratio Test					
	Cement / Lime Content (%)	Compaction Effort	Unsoaked		Soaked	
			Water Content (%)	Bearing Ratio (%)	Water Content (%)	Bearing Ratio (%)
Lat 2/ Lat 3 Mix	0	Standard	26.3	3	29.7	7
Lat 2/ Lat 3 Mix	5% Lime	Standard	27.7	19	30.6	28
Lat 2/ Lat 3 Mix	3% Cement	Standard	33.7	18	36.7	37
Lat 2/ Lat 3 Mix	0	Modified	28.3	117	26.6	14
Lat 5/ Lat 1 Mix	3% Lime	Modified	18.3	61	33.0	16
Lat 5/ Lat 1 Mix	5% Lime	Modified	18.0	84	31.5	45

Notes:

- Bearing ratios provided are for 5.0 millimeters penetration
- Standard compaction uses 2.49 kilograms hammer, 305 millimeters drop height, 3 soil layers and 56 blows/layer.
- Modified compaction uses 4.54 kilograms hammer, 457 millimeters drop height, 5 soil layers and 56 blows/layer
- Lime and cement were allowed 72 hours to cure/mellow.
- Soaked bearing ratios are taken after 96 hours of immersion.

From the six CBR tests which were completed on the laterite samples the following conclusions are provided:

- For the standard compaction untreated case the bearing ratio increased from the unsoaked case to the soaked case indicating that the Laterite may have a natural pozzolanic property.

[58] G Mining Services Inc, 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Appendix INF C: GUMR-TM-13-07-17-Golder-Preliminary Aggregate and Soil Investigation and Transportation Corridor Assessment, Page 6

[59] G Mining Services Inc, 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Appendix INF C: GUMR-TM-13-07-17-Golder-Preliminary Aggregate and Soil Investigation and Transportation Corridor Assessment, Page 6

- The standard compaction lime and cement cases yielded similar soaked and unsoaked bearing ratios. Since lime is typically cheaper than cement, lime is considered to be the preferred stabilization treatment.
- The untreated, modified compaction, with reduced moisture content trial yielded the highest unsoaked bearing ratio values. The untreated, modified compaction soaked trial yielded a significant decrease in bearing ratio indicating that some form of stabilization treatment is preferable to mitigate potential damage in saturated conditions.
- The soaked bearing ratios are higher for the treated cases indicating that the materials continue to cure/mellow between 72 hours and 7 days.
- Improved results generally result from using a high degree of compaction at a water content 5-8% below optimum water content. The strength gain is highly sensitive to degree of compaction and water content.
- The results suggest that where the lime stabilization option is selected, strict control on field compaction and placement water content will be needed during construction to avoid post-construction performance problems during mine service.

9.2.2.3.3 Topsoil Clearing

The total volume of topsoil to be removed is not easily quantifiable as there are areas that have previously been stripped for extraction of ore. There are also areas where the topsoil was previously covered or removed for development. There are now no easily identifiable stockpiles of topsoil from historic operations to be quantified. Table 9-13 below gives the calculated parameters of the pits.

Table 9-13: Parameters of the Open Pits[60]

No.	Location	Pit Number	Closed level Elevation (m)	Pit bottom elevation (m)	Area of closed level (m^2)	Area of pit bottom (m^2)	Conceptualized radius of closed level (m)	Conceptualized radius of pit bottom (m)	Inferred ground water level (m)	Bottom elevation of saprolite (m)	Top elevation of bedrock (m)
1	Hill 1	Pit1-1	112	76	16,970	602	130	25	52	80	40
2		Pit1-2	112	94	8,630	986	93	31	52	90	60
3	Hill 3	Pit3-1	52	31	12,700	725	113	27	65	40	25
4		Pit3-2	88	82	1,240	434	35	21	74	60	35
5		Pit3-3	63	39	15,970	2,945	126	54	74	50	40
6		Pit3-4	63	27	31,400	3,334	177	58	74	60	50
7	Hill 5	Pit5ext-1	198	183	10,300	1,226	101	35	70	150	100
8		Pit5-1	162	132	26,930	1,861	164	43	68	130	120
9		Pit5-2	90	54	35,000	788	187	28	66	80	60
10		Pit5-3	72	54	9,400	1,097	97	33	66	50	45
11	Hill 7	Pit7-1	81	51	10,500	1,760	102	42	68	65	55
12	Hill 9	Pit9-1	105	84	14,600	524	121	23	67	60	60
13		Pit9-2	105	75	20,000	1,656	131	41	66	90	80
14		Pit9-3	129	111	6,000	1,261	77	36	67	110	80
15		Pit9-4	81	42	20,500	941	143	31	66	80	50
16		Pit9-5	81	45	32,000	2,800	179	53	67	70	50

[60] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 4.2, Page 139

Taking the total combined perimeter of the planned open pits (272,140 square meters) and assuming all areas have 0.2-meter topsoil cover, we can estimate a maximum volume of 54,428 cubic meters topsoil. This volume is distributed between the seven (7) clusters of open pits. There will be nine (9) waste dumps developed to accommodate the storage of topsoil and overburden. The total volume of waste material available for backfill is 19.7 million cubic meters.

The soil characteristics as defined in section 9.1.2.3 - Soils indicate that the soils in the Mathew's Ridge area are very low in fertility, this suggests that the quality of topsoil derived from them may be poor.

9.2.2.3.4 Existing Levels of Contamination/ Degradation

Tailings from the previous manganese mining operation remain in the open pit into which it was discharged during the 1960s. Although unregulated residences were subsequently erected in proximity to the tailings pond, there has been no alternative use of the tailings area. The average grade of ore in the tailings open pit, the mineral compositions in the tailings pond and the quantity of ore contained therein are further discussed in Sections 9.2.2.6.3 and 9.2.2.7. As part of this project, GMI intends to rehabilitate this tailings pond and include it as part of the tailings and water retention dam being constructed. GMI will also be reprocessing a significant volume of the old tailings to produce concentrate based on improved technology and economics. Based on the soil quality work discussed above and detailed in the RMI Pre-feasibility study there is no existing contamination that meets or exceeds the International Finance Corporation guidelines of 2007.

There is significant existing land degradation in Mathew's Ridge as a result of the historic mining by AMC and their departure without any mine rehabilitation being done. There are several open pits and a tailing pond which were left abandoned. The removed topsoil from that mining activity is not identifiable now.

9.2.2.4 Topography

The topography of the mining area is rugged, and the altitude of the mining area varies from 34 to 235 meters above sea level. The geomorphic features of the area are rugged terrain, steep hillsides, gully and quasi plain covering areas. The abrupt change of altitude is related to the lithology and geological structure. Rocks are highly weathered, but only exposed along the ridge's anti-erosion tops, valleys and cuttings. Depth of soil development varies from less than 1 to more than 10 meters.

Figure 9-11 presents a topographical map that shows the elevation patterns at the mine site and the wider project area.

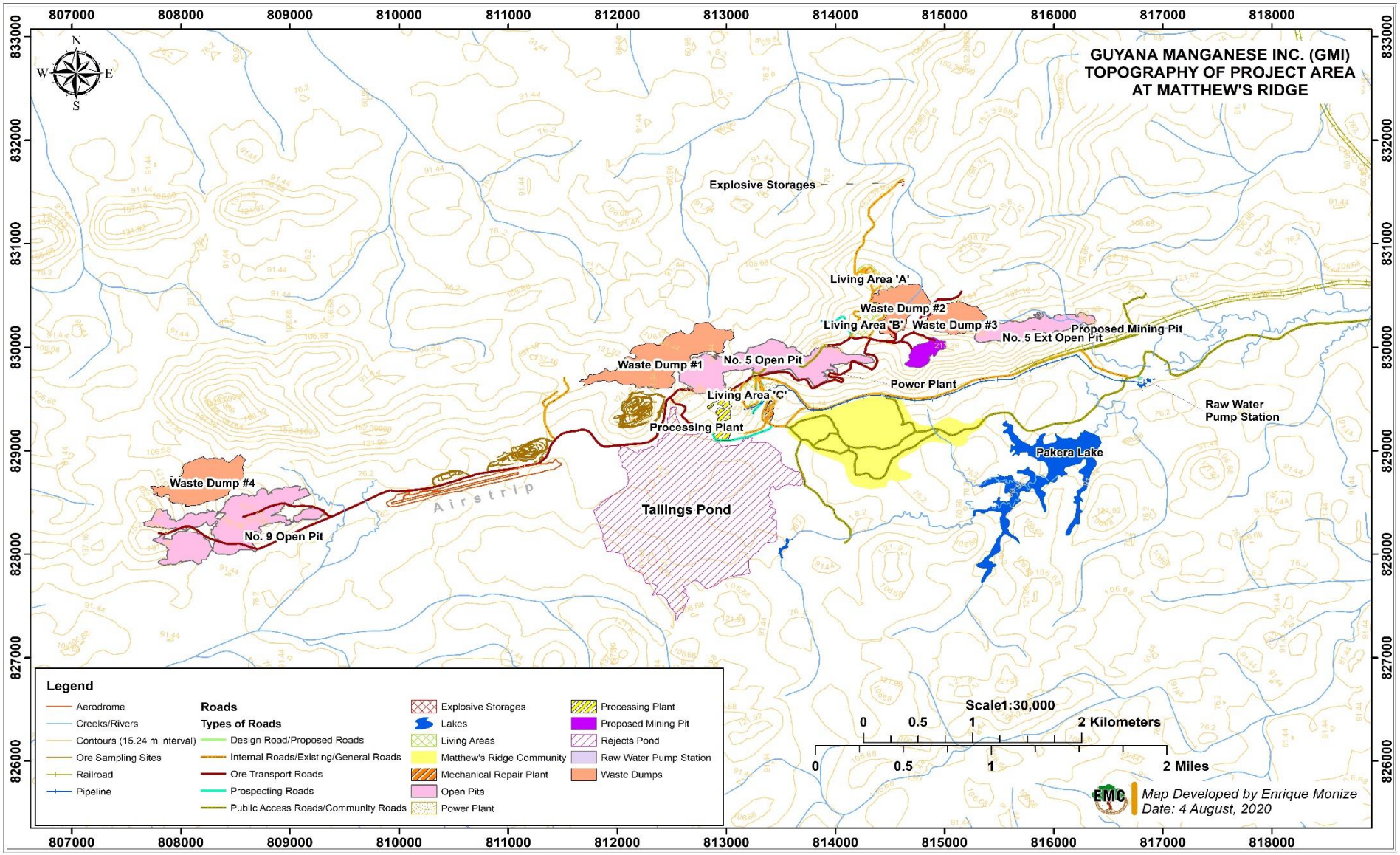


Figure 9-11: Topographic Map – Matthew's Ridge

9.2.2.5 Geologic Structure[61]

In the Matthews Ridge region, doleritic intrusives of both the Older Basic Intrusive and Younger Basic Intrusive Group occur. Apart from dykes, dolerite sills occur in conformity with the bedding of the country rock. At the centre of the basinal sequences, the low-metamorphic grade sediments and volcanics, known as the greenstones of Guyana, are found. These low-metamorphic grade rocks are openly folded and lenticular in shape at the regional level. At the local level, the beds show various levels of steepening, even overturning and thrusting, depending on the rheology of the rocks and the forces in the Trans- Amazonian orogeny (2,400 Ma to 2,000 Ma) to which they were subjected.

Although local structural discontinuities were observed, deformation along the Matthews Ridge deposits generally shows the same structural characteristic, in accordance with the intensity of deformation, orientation of structure and kinematic histories. Two main phases of deformation are recognized and both modified the position of the mineral deposits. The first phase of deformation is associated with a ductile - brittle style of deformation, whereas the second phase is characterized by a brittle style of deformation.

The MRF rocks are assembled along narrow belts occupying and holding positive topographic reliefs up to 150 meters above sea level in elevation and formed exclusively by sediments. These belts seem to be “floating” on and are flanked to the north and south by mafic intrusives with batholitic dimensions. The sediments are folded inside “keels” and axial planes are usually subparallel to the strike of the belts, causing the repetition of units across the strike.

9.2.2.5.1 Fold Structure

The orientation of the bedding along the Project Footprint and Arakaka, trends east-west (averaging N081) and shows various dip orientations as it is affected by tight folding. Fold structures are characterized by an east-west oriented axial surface dipping to the south, moderately to gently inclined (35 to 60 degrees) and locally recumbent. Fold hinges plunge gently at 15 degrees to the east. Tight anticline fold structures are typically characterized by south limb dipping at a relatively low angle (40 degrees), whereas the northern limb dips at a high angle (75 degrees) (Figure 7.13). Folds of the sedimentary beds are characterized by thickening in the hinge zone and thinning in the flanks.

Folds of the sedimentary beds are characterized by thickening in the hinge zone and thinning in the flanks. This is interpreted as being the product of a first phase of deformation, which had considerable impact on the mineralization as it is repeated several times by the folding. The same manganese beds were thickened by the anticline and syncline fold structures, which generally had axial planes dipping south 40 degrees, trending east to northeast. Anticline and Syncline Axial Traces along the Matthews Ridge Deposit are shown in Figure 9-12.

The regional structure in the northern E-W belt consists of a large scale re-folded syncline. The fold pattern is undoubtedly complicated by thrusts.

[61] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew’s Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3

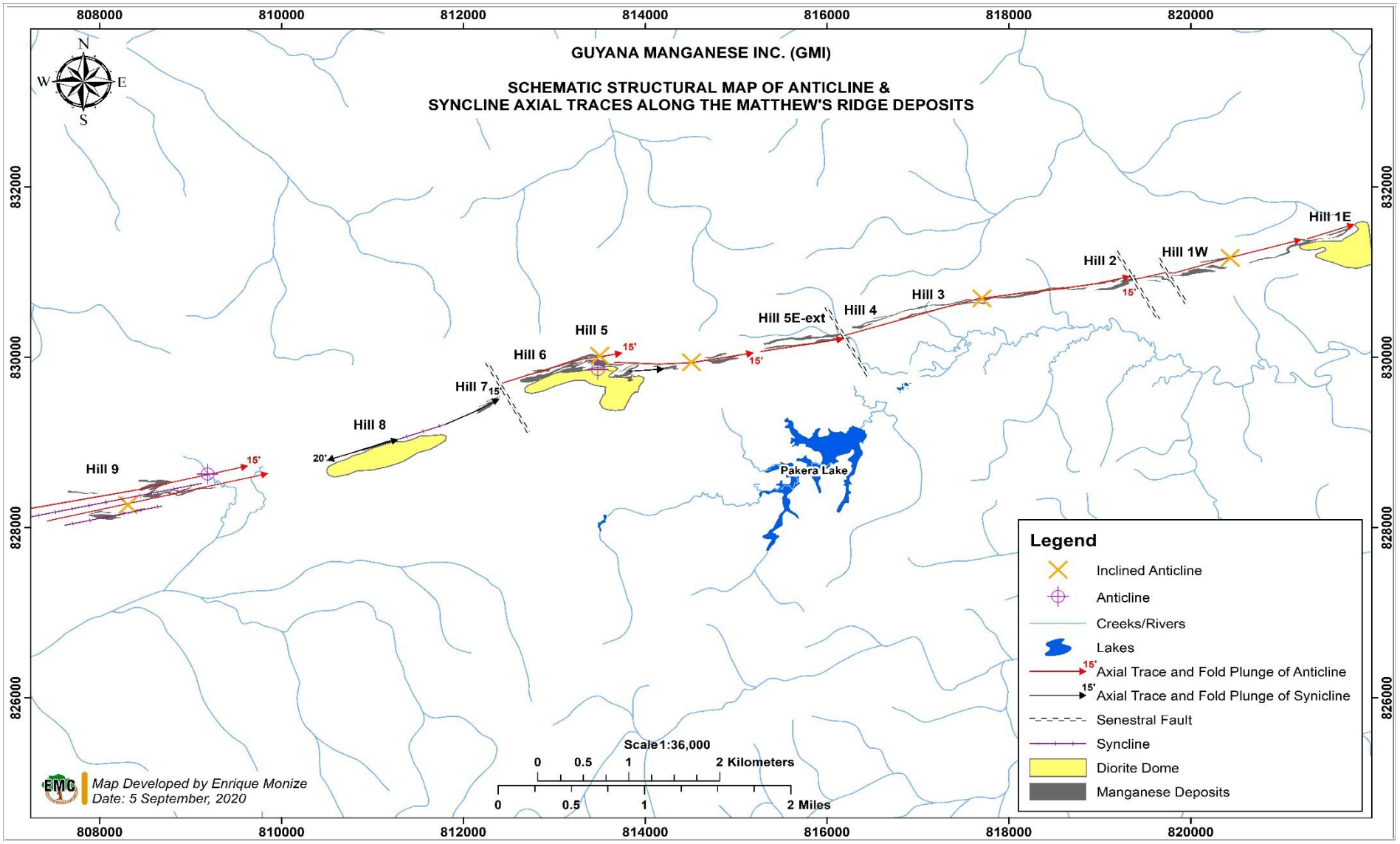


Figure 9-12: Schematic Structural Map of Anticline and Syncline Axial Traces along the Matthews Ridge Deposits

Fracture Structure

The second phase of deformation is characterized by late brittle structures and is considered to have less impact on the mineralization, but has a certain damaging effect on the ore. Associated structures are characterized by a north to northwest oriented steeply dipping west cleavage. At a larger scale, more important displacement along these structures is observed along a typically north-northwest sinistral fault, which displaces manganese mineralization. These larger structures are well outlined by topographic depression between Hill 5ext and Hill 2, as well as from Hill 2 to Hill 1W and create an *en-echelon* displacement of the Arakaka mineralized units. At the local scale, apparent sinistral movement along these faults, typically less than 10 centimeters, displaces the mineralized units.

Late normal faulting is also present, characterized by down dip striation on the mirror fault plane, which indicates a normal sense of movement, typically less than 2 meters of vertical displacement. Although these late brittle structures have minimal displacement, they are important as they could express sudden shifts of mineralized beds.

Metamorphism

Rocks at Matthew's Ridge show mineralogy and textures typical of a low to medium metamorphic grade environment. The phyllites usually show very poorly developed platy minerals along cleavages. In addition, there were observations of what was called "spotted slate", consisting of cummingtonite-bearing spessartite hornfels, probably related to contact metamorphism with diorite intrusions. Regional metamorphism at Matthews Ridge was considered to be within the lower greenschist facies. Braunite was formed in the primary or hydrothermal to metamorphic environment, likewise hausmannite and bixbyite. Spessartite is clearly linked to the metamorphic event, while rhodochrosite appears to be a hydrothermal phase or related to low metamorphism domain, together with quartz veinlets. The veinlets and veins of quartz, quartz + rhodochrosite, +/- calcite, +/- dolomite and kaolin are ubiquitous, and underline a hydrothermalism associated with deformation (quartz-carbonate microveining along braunitic beds is the most important feature of this event because it caused the introduction of external silica in the mineralized units).

9.2.2.6 Geology of the Deposits[62]

Using the classifications suggested by Holtrop (1965)[63], the Matthews Ridge deposits are of "mantle" and "nodular" types hosted by mineralized lateritic profile formed after a protore deposited as bedded manganese-rich sediments in a marine environment ("hydrogenous" according to (Nicholson, 1992)[64]. They would be classified by both Nicholson (1992) and Swindell and Harrison (2009)[65] as "supergene-enriched deposits".

The manganese mineralization at Matthews Ridge is clearly related to lateritic weathering of a complex geological sedimentary succession, which was metamorphosed, tectonically deformed, modified by igneous activity and partially obliterated by intense hydrothermalism. As previously discussed, these manganese-rich sediments are mainly composed of manganiferous phyllite, banded manganese formation and massive manganese formation. In the Feasibility Study Report for this

[62] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3
[63] Jan Fokke Holtrop; The manganese deposits of the Guiana shield. Economic Geology; 60 (6): 1185–1212.
[64] Nicholson, K., 1992, Contrasting Mineralogical - Geochemical Signatures of Manganese Oxides: Genesi s to Metallogenesis: Economic Geology, v. 87, p. 1253–1264.
[65] Ed Swindell and Peter Harrison, 2009. Supergene-enriched manganese deposits in West and Central Africa. Ferrous metals symposium - Geological Society of South Africa.

project, the Matthews Ridge deposits are grouped in four types: saprolitic, detritic, transition and tailings.

9.2.2.6.1 Saprolitic Deposits

These saprolitic deposits consist of the mineralized rocks in the saprolite horizon of the lateritic profile. These rocks are characterized by intense weathering and the development of mineralogy typical of meteoric water flow. The degree of weathering is directly dependent on the history of the profile and systematically decreases with depth. At the depths where the weathering was not thorough and consistent, there is a “transition” zone characterized by the so-called “saprocks”, immediately above the contact with fresh rocks/protore.

Figure 9-13 below is one of the geological sections showing the distribution of mineralized and non-mineralized units in the weathered profile, identifying the limit between the saprolitic zone and fresh protore material. They also illustrate the strong deformation affecting the mineralized sequence and the irregular nature of the dioritic intrusions.

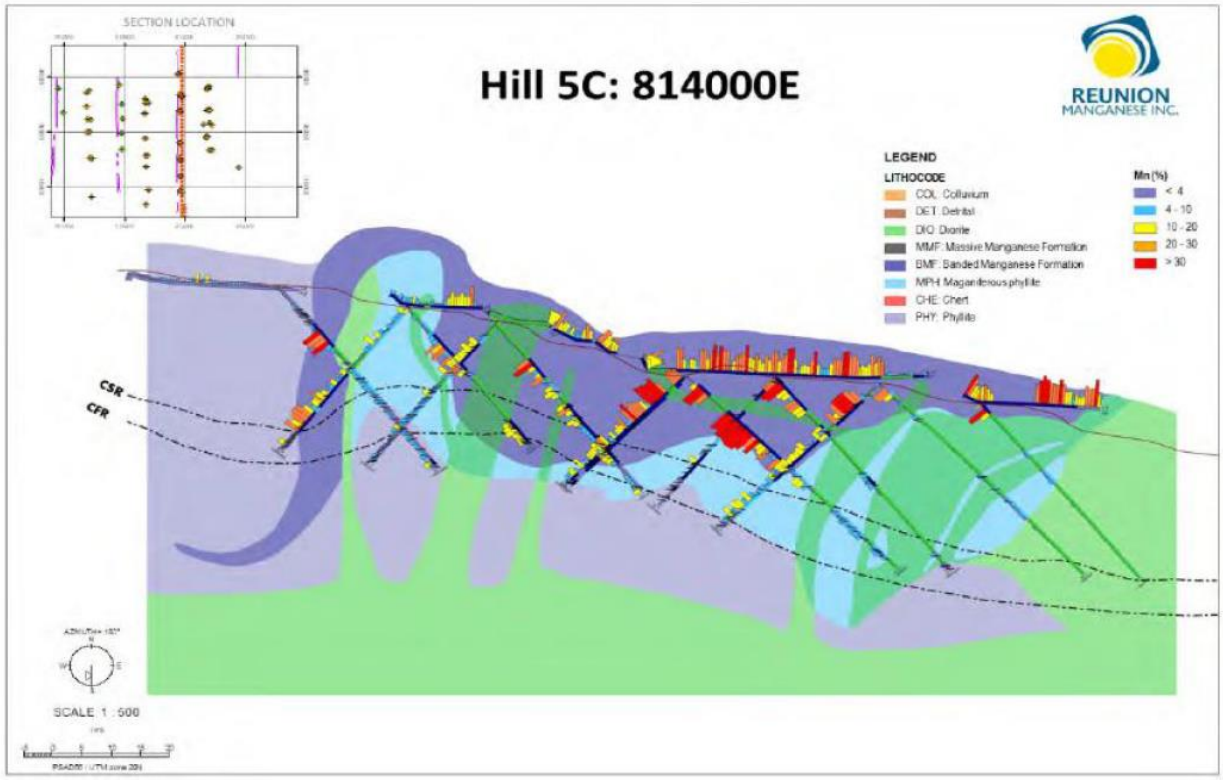


Figure 9-13: Geological Section along UTM Easting 814000E on Hill 5C

In addition, the Hill 5 to Hill 9 exploration determined that a large proportion of high-grade saprolitic ore was mined out in the 1960s and many transitional ores remained in several mining-pits. However, Hill 1 to Hill 4 were undisturbed and remained in their original lateritic profile.

9.2.2.6.2 Detritic Deposits

The detritic or “nodular” deposits form blanket-like colluvium over the saprolitic rocks, usually on hill tops and flanks and highly dependent on the degree of erosion forming the local topography. There are two types of detritic material:

- Manganiferous pisolites generated from the breakdown of the duricrust horizon that once capped the lateritic profile. The pisoids or nodules are usually fairly loose, cemented by soil clays, show spherical shapes with concentric layers, ranging in diameter from a few millimeters to a few centimeters (Figure 9 - 10). The topographic control of these deposits is the result of the formation of hard, relatively insoluble capping of cemented pisolites rich in manganese hydroxide at the top part of the lateritic profile. Cryptomelane appears in detrital samples and its more weathered form appears sporadically as the series Cryptomelane-hollandite.
- Manganiferous fragments from the physical breakdown of mineralized saprolitized rocks and duricrust. These fragments are of irregular shape and can reach sizes of a few centimeters to over one metre (boulder).

Figure 9-14: Detritic Nodular Material on the Surface at Hill 1, including Fragments of Duricrust

The distribution of detritic deposits in the various prospect areas varies considerably, depending on the completeness of the weathered profile, erosional level and previous mining activities. Nodular detritic material is abundant and well preserved on Hills 1 to 4, but largely mined-out on the crest of Hills 5 to 9, where it is found mostly on the hill flanks. The average thickness of the detritic deposit in the exploration area is shown in Table 9-14.

Table 9-14: Description of Detrital Surfaces Created for Each Hill[66]

Target Hill	Number of Detritic Regions	Average Thickness (meters)
Hill 1	3	1.65
Hill 3	4	0.75 to 1.11
Hill 5	14	1.54
Hill 5 Ext	5	1.54
Hill 7	6	1.64
Hill 8	1	1.19
Hill 9	3	1.32 to 1.68

9.2.2.6.3 Tailings Deposits

The tailings deposits at Matthews Ridge consist of fine-grained manganesiferous rock fragments deposited in a shallow valley downstream from the previously used processing plant, much like an artificially created alluvial deposit. Most of the fragments are angular and less than 1 centimeter in length.

9.2.2.7 Ore Characteristics: Mineral Composition, Texture and Structure[67]

9.2.2.7.1 Mineral Composition of the Ore

The partially weathered rocks still contain manganese silicates / carbonates, albite and chlorite, while the highly weathered saprolite carry manganese and iron oxyhydroxides (OHMn, OHFe) and abundant clay minerals. The X-ray diffraction ("XRD") analysis and petrography work by Costa (2012)[68] reveals that the manganese silicates braunite [$MnMn^{3}+6SiO^{12}$, $Mn^{2}+Mn^{3}$] and spessartite [$Mn^{2}+3Al^{2}(SiO^{4})^{3}$] are primary manganese minerals. Spessartite is typical of phyllitic rocks ("PHY") while braunite is a main constituent of the black beds of the banded manganese formation ("BMF") units, in this case alternating with spessartite/rhodochrosite-rich beds. The competent braunitic beds have a significant rheological contrast with the incompetent phyllitic bands, showing brittle and ductile deformation, respectively, the results produce boudinages and prominent quartz-filled tensional micro fractures orientated perpendicular to the braunitic beds. Braunite appears to be the most stable primary mineral, beside hausmannite and bixbyite, which are rare. Spessartite is quite unstable, originating a plasma of OHMn and OHFe (as veinlets of goethite) (Costa, 2012). It always occurs as micrometric crystals, with rounded shape due to the typical dodecahedral morphology invariably surrounded by such cryptocrystalline OHMn, like a diffuse opaque cloud. Spessartite seems to be a major source for the formation of OHMn at Matthews Ridge. Rhodochrosite [$MnC0^{3}$] is the primary manganese carbonate, changing quickly into OHMn and producing voids (i.e. porosity), but it does not appear to be abundant,

[66] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3. Page 95
[67] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3.4
[68] Isabel Costa et al, 2015. Petrographic and Chemical Characterization of Concrete Deterioration Products. SGEM2015 Conference Proceedings, Book1 Vol. 2 (pp.511-518)

except in certain units of phyllitic rocks. The key minerals forming the saprolitic deposits are OHMn of weathering origin: birnessite [(Na,Ca,)Mn7O^{14} 3H_2O], todorokite [(Mn,Ca,Mg)Mn^{3}+4O7 H_2O], cryptomelane-hollandite [K(Mn+2,Mn+4)8O^{16}] and lithiophorite, but pyrolusite and nsutite are less frequent. These minerals form manganese-rich beds (Banded manganese formation - BMF and massive manganese formation - MMF units), nodules and fracture filling. They are black, opaque micro to cryptocrystalline and intergrown with each other.

9.2.2.7.2 Texture and Structure of Ore

Structures of manganese ore mainly include banded structure, massive structure, loose detritic structure and phyllitic structure. With the deepening of weathering, the ore becomes looser. Most of ore textures are mainly opaque microcrystalline to cryptocrystalline. The geochemical tests completed to date demonstrate that there are no variation trends in chemical composition between the various hills or for each lithology and weathering horizon, such that material from each area is generally homogeneous and can be handled in the same manner.

Figure 9-15: Typical Structure and Texture of the Ore Materials[69]

9.2.2.7.3 Chemical Components of the Ore

As previously discussed, according to bearing lithology, the ore in Matthew's Ridge can be divided into four types; especially massive manganese formation, banded manganese formation, manganiferous phyllite and phyllite. Moreover, for practical and industrial utilization purposes, the deposits are grouped in three types: saprolitic, detritic and tailings. The chemical components of the ore in the open-pit boundary of Matthews Ridge are shown in Tables 9 – 15 to 9 – 23 below and the following components were measured:

- Manganese (Mn)
- Silicon Dioxide (SiO_2)
- Aluminimum Oxide (Al_2O_3)
- Iron (Fe)
- Phosphorous pentoxide (P_2O_5)

[69] G Mining Services Inc, 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Section 13.3 Page 13.3.

Table 9-15: Ore Components in the Open Pits of the Matthew's Ridge Deposits[70]

Hill	Average Grade of Ore (Percent)				
	Mn	***SiO_2***	***Al_2O_3***	***Fe***	***P_2O_5***
Hill 1	12.70	43.89	15.86	7.62	0.116
Hills 2, 3, 4	13.78	47.35	14.72	5.43	0.084
Hill 5 Ext	15.51	47.42	12.97	4.85	0.121
Hills 5, 6	14.65	47.18	13.02	5.21	0.124
Hill 7	16.23	35.37	15.80	6.44	0.188
Hill 8	12.85	48.02	13.47	5.48	0.077
Hill 9	15.02	34.91	17.74	6.88	0.120
Tailings	17.78	32.67	16.82	8.47	0.091
Average	14.75	43.04	14.93	5.96	0.12

Table 9-16: Average Grade of Ore at Different Elevations in the Hill 1 Open Pit[71]

Elevation (Meters)	Average Grade of Ore (Percent)				
	Mn	***SiO_2***	***Al_2O_3***	***Fe***	***P_2O_5***
160 to 154	19.47	22.44	13.14	14.70	0.185
154 to 148	14.23	25.83	14.75	15.58	0.185
148 to 142	14.88	24.15	15.79	13.42	0.181
142 to 136	14.50	30.23	17.35	9.10	0.140
136 to 130	13.22	35.76	17.78	7.93	0.119
130 to 124	12.15	42.91	17.13	7.22	0.098
124 to 118	11.57	50.39	15.49	6.76	0.089
118 to 112	11.86	54.68	13.87	6.09	0.100

[70] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3.4.2. Page 97
[71] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3.4.2. Page 98

Elevation (Meters)	Average Grade of Ore (Percent)				
	Mn	***SiO_2***	***Al_2O_3***	***Fe***	***P_2O_5***
112 to 106	12.09	55.44	13.60	5.98	0.120
106 to 100	12.06	55.24	13.78	5.97	0.116
100 to 94	12.81	56.95	13.30	6.39	0.125
94 to 88	12.93	54.71	12.88	7.68	0.152
88 to 82	13.27	57.62	13.00	6.95	0.106
82 to 76	14.17	61.95	12.87	5.19	0.110
Average	12.70	43.89	15.86	7.62	0.116

Table 9-17: Average Grade of Ore at Different Elevations in the Hill 3 Open Pit[72]

Elevation (Meters)	Average Grade of Ore (Percent)				
	Mn	***SiO_2***	***Al_2O_3***	***Fe***	***P_2O_5***
135 to 129	15.85	36.27	16.70	7.80	0.041
129 to 123	14.00	40.85	17.11	6.07	0.040
123 to 117	13.11	40.93	17.45	5.85	0.042
117 to 111	12.88	42.79	17.07	6.22	0.052
111 to 105	12.42	45.84	16.70	6.27	0.056
105 to 99	12.45	46.68	15.86	6.15	0.074
99 to 93	12.32	48.79	15.04	5.98	0.087
93 to 87	12.85	49.62	14.45	5.71	0.102
87 to 81	13.92	48.32	14.20	5.48	0.103
81 to 75	14.59	47.26	13.73	5.16	0.101
75 to 69	14.73	48.50	13.25	4.63	0.097

[72] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3.4.2. Page 99

Elevation (Meters)	Average Grade of Ore (Percent)				
	Mn	***SiO_2***	***Al_2O_3***	***Fe***	***P_2O_5***
69 to 63	14.92	48.53	13.32	4.53	0.096
63 to 57	14.96	48.67	13.35	4.40	0.093
57 to 51	15.42	50.15	12.84	4.33	0.096
51 to 45	16.44	50.02	12.30	4.15	0.094
45 to 39	17.37	48.03	12.16	4.10	0.095
39 to 33	17.13	48.80	13.00	4.46	0.111
33 to 27	17.91	60.82	13.21	4.38	0.115
Average	13.78	47.35	14.72	5.43	0.084

Table 9-18: Average Grade of Ore at Different Elevations in the Hill 5 Ext Open Pit[73]

Elevation (Meters)	Average Grade of Ore (Percent)				
	Mn	***SiO_2***	***Al_2O_3***	***Fe***	***P_2O_5***
234 to 228	11.06	36.84	15.65	13.64	0.164
228 to 222	12.68	42.28	15.73	9.66	0.167
222 to 216	12.70	42.86	16.79	8.21	0.147
216 to 210	12.43	43.37	15.84	7.77	0.136
210 to 204	12.03	47.99	14.92	6.33	0.111
204 to 198	11.63	49.90	14.66	5.74	0.085
198 to 192	11.30	53.08	14.00	5.37	0.072
192 to 186	11.61	54.72	13.84	5.83	0.087
186 to 180	11.34	56.15	13.19	6.19	0.080
180 to 174	11.64	51.34	12.94	7.72	0.129
174 to 168	11.40	47.58	12.93	7.82	0.138
168 to 162	14.42	44.96	12.84	6.56	0.137

[73] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3.4.2. Page 100

Elevation (Meters)	Average Grade of Ore (Percent)				
	Mn	***SiO_2***	***Al_2O_3***	***Fe***	***P_2O_5***
162 to 156	14.76	46.40	12.64	5.62	0.142
156 to 150	13.79	49.79	12.73	5.33	0.152
150 to 144	13.15	52.13	12.70	4.95	0.159
144 to 138	13.49	52.25	12.45	4.73	0.157
138 to 132	14.55	49.62	11.99	5.22	0.157
132 to 126	15.66	49.92	12.38	4.63	0.139
126 to 120	17.04	47.64	12.67	4.58	0.131
120 to 114	17.84	45.98	12.38	4.24	0.122
114 to 108	18.94	43.66	12.36	3.81	0.111
108 to 102	18.74	43.80	12.29	3.79	0.108
102 to 96	18.16	45.80	12.21	3.84	0.111
96 to 90	17.50	47.37	12.29	3.86	0.112
90 to 84	16.23	46.93	12.34	4.09	0.136
84 to 78	16.60	45.27	12.24	4.17	0.140
78 to 72	16.35	46.89	12.47	4.13	0.134
72 to 66	16.22	45.83	12.44	4.01	0.115
66 to 60	16.37	46.59	12.37	3.68	0.098
60 to 54	15.44	48.46	12.60	3.64	0.097
Average	15.51	47.42	12.97	4.85	0.121

Table 9-19: Average Grade of Ore at Different Elevations in the Hill 5 Open Pit[74]

Elevation (Meters)	Average Grade of Ore (Percent)				
	Mn	***SiO_2***	***Al_2O_3***	***Fe***	***P_2O_5***
234 to 228	11.32	41.80	15.03	6.09	0.128
228 to 222	11.32	43.55	15.03	6.09	0.128
222 to 216	11.32	46.02	15.03	6.09	0.128
216 to 210	11.32	46.22	15.03	6.09	0.128
210 to 204	15.63	51.43	13.42	4.71	0.125
204 to 198	16.88	52.50	12.52	4.23	0.115
198 to 192	17.31	52.01	12.38	4.10	0.111
192 to 186	16.24	51.00	12.82	4.03	0.109
186 to 180	14.88	49.77	13.33	4.29	0.106
180 to 174	14.71	46.69	13.08	4.51	0.109
174 to 168	15.51	44.60	12.66	4.47	0.116
168 to 162	15.36	46.52	12.96	4.61	0.123
162 to 156	16.32	43.46	12.65	4.64	0.118
156 to 150	15.49	44.98	12.30	5.29	0.117
150 to 144	14.13	44.19	12.85	7.21	0.145
144 to 138	12.93	44.01	13.86	7.91	0.157
138 to 132	13.12	43.96	14.06	7.43	0.138
132 to 126	12.84	46.52	14.38	7.41	0.148
126 to 120	12.54	48.86	13.69	6.37	0.137
120 to 114	13.38	48.97	13.23	5.59	0.127
114 to 108	14.11	48.16	13.19	5.30	0.126

[74] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3.4.2. Page 101

Elevation (Meters)	Average Grade of Ore (Percent)				
	Mn	***SiO_2***	***Al_2O_3***	***Fe***	***P_2O_5***
108 to 102	14.67	47.64	12.95	5.03	0.128
102 to 96	15.07	46.72	12.63	4.87	0.120
96 to 90	15.64	46.90	12.59	4.71	0.108
90 to 84	15.74	47.33	12.72	4.26	0.108
84 to 78	15.39	48.75	12.74	4.21	0.114
78 to 72	14.45	50.09	12.97	4.36	0.129
72 to 66	13.57	50.78	12.90	4.31	0.135
66 to 60	13.02	51.58	12.84	4.16	0.133
60 to 54	14.11	49.59	12.29	3.42	0.106
Average	14.65	47.18	13.02	5.21	0.124

Table 9-20: Average Grade of Ore at Different Elevations in the Hill 7 Open Pit[75]

Elevation (Meters)	Average Grade of Ore (Percent)				
	Mn	***SiO_2***	***Al_2O_3***	***Fe***	***P_2O_5***
180 to 174	8.01	34.12	17.46	10.85	0.180
174 to 168	10.43	37.50	18.50	9.35	0.134
168 to 162	10.12	41.28	18.17	8.34	0.140
162 to 156	10.79	45.94	16.27	8.02	0.139
156 to 150	11.77	43.07	15.88	8.53	0.198
150 to 144	11.90	44.67	15.52	7.89	0.187
144 to 138	13.82	38.56	16.49	7.12	0.183
138 to 132	15.76	33.78	16.79	6.77	0.186
132 to 126	16.83	31.43	16.91	6.62	0.189

[75] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3.4.2. Page 102

Elevation (Meters)	Average Grade of Ore (Percent)				
	Mn	***SiO_2***	***Al_2O_3***	***Fe***	***P_2O_5***
126 to 120	16.65	32.16	16.97	6.53	0.188
120 to 114	16.14	34.25	16.55	6.33	0.185
114 to 108	16.35	35.02	15.92	6.51	0.189
108 to 102	16.71	35.36	15.47	6.73	0.195
102 to 96	16.78	35.28	15.44	6.34	0.196
96 to 90	16.81	36.39	14.73	5.94	0.191
90 to 84	17.32	35.51	14.53	5.44	0.187
84 to 78	16.56	37.62	14.26	5.24	0.184
78 to 72	22.96	28.91	13.83	5.21	0.192
72 to 66	23.24	28.31	13.90	5.33	0.190
Average	16.23	35.37	15.80	6.44	0.188

Table 9-21: Average Grade of Ore at Different Elevations in the Hill 8 Open Pit[76]

Elevation (Meters)	Average Grade of Ore (Percent)				
	Mn	***SiO_2***	***Al_2O_3***	***Fe***	***P_2O_5***
117 to 111	10.74	49.56	13.64	4.63	0.043
111 to 105	12.45	46.29	13.55	6.01	0.057
105 to 99	12.50	45.98	14.29	6.91	0.069
99 to 93	12.97	47.71	13.35	6.32	0.090
93 to 87	13.02	48.67	13.10	4.96	0.090
87 to 81	13.19	48.70	13.19	4.56	0.079
81 to 75	12.86	50.04	13.40	4.41	0.069
Average	12.85	48.02	13.47	5.48	0.077

[76] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3.4.2. Page 103

Table 9-22: Average Grade of Ore at Different Elevations in the Hill 9 Open Pit[77]

Elevation (Meters)	Average Grade of Ore (Percent)				
	Mn	***SiO_2***	***Al_2O_3***	***Fe***	***P_2O_5***
162 to 156	19.67	23.15	20.19	7.21	0.143
156 to 150	16.05	25.29	21.52	8.20	0.154
150 to 144	18.03	25.29	20.08	7.73	0.144
144 to 138	18.64	26.88	19.46	6.97	0.131
138 to 132	18.67	27.71	18.54	6.92	0.122
132 to 126	17.50	29.71	18.40	7.54	0.133
126 to 120	16.24	30.15	18.61	8.05	0.130
120 to 114	15.55	33.40	18.49	8.00	0.121
114 to 108	15.17	33.76	18.25	7.99	0.106
108 to 102	14.58	34.51	18.38	7.49	0.096
102 to 96	13.03	36.29	18.06	7.15	0.096
96 to 90	12.99	35.86	17.93	7.66	0.103
90 to 84	13.91	35.26	17.34	6.70	0.119
84 to 78	15.13	35.54	16.49	5.93	0.132
78 to 72	14.36	39.84	16.32	5.53	0.130
72 to 66	13.91	41.30	16.25	5.49	0.132
66 to 60	13.03	42.50	16.42	5.57	0.128
60 to 54	13.05	44.72	16.02	5.28	0.127
54 to 48	13.00	46.54	15.66	5.06	0.125
48 to 42	13.61	44.52	15.86	5.49	0.126
Average	15.02	34.91	17.74	6.88	0.120

[77] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3.4.2. Page 103

Table 9-23: Average Grade of Ore at Different Elevations in the Tailings Open Pit[78]

Elevation (Meters)	Average Grade of Ore (Percent)				
	Mn	***SiO_2***	***Al_2O_3***	***Fe***	***P_2O_5***
144 to 138	21.07	26.73	18.88	8.14	0.081
138 to 132	26.06	20.13	16.46	8.05	0.089
132 to 126	25.22	21.42	16.53	8.84	0.105
126 to 120	20.32	24.90	16.78	8.74	0.113
120 to 114	20.05	24.16	16.24	9.04	0.118
114 to 108	19.18	25.83	16.09	8.75	0.117
108 to 102	17.43	29.50	16.09	8.40	0.118
102 to 96	18.03	30.90	16.34	8.62	0.112
96 to 90	20.56	29.73	16.17	8.54	0.107
90 to 84	20.78	30.42	15.64	8.59	0.094
84 to 78	15.41	35.02	17.64	8.36	0.081
78 to 72	12.84	38.29	19.40	8.18	0.071
72 to 66	11.10	42.06	19.42	8.29	0.067
Average	17.78	32.67	16.82	8.47	0.091

9.2.2.8 Resources Base

GMI prepared an initial mineral resource estimate for the Matthews Ridge manganese deposits, which has been tested by drilling, trenching and test pits. The resource evaluation is considered as a reasonable representation of the mineral resources found in the Matthew's Ridge deposit. The resource estimate was prepared in accordance with the Standards on Mineral Resources and Reserves from the Canadian Institute of Mining, Metallurgy and Petroleum (CIM). According to the requirements of the mining process, the total amount of resources to be mined in the 13-years of the mine life and overburden resulting from each of the open pits is estimated at each section of Matthew's Ridge manganese deposit is shown in Table 9 – 24.

[78] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3.4.2. Page 104

Table 9-24: Open Pit Content at Matthew's Ridge[79]

Open-pit	Ore Tonnage (kilotons)	Waste Tonnage (kilotons)	Total (kilotons)
Hill 1	1,755.96	1,475.87	3,231.83
Hill 3 (Hill 2,3,4)	4,725.17	7,116.38	11,841.55
Hill 5 Ext	3,657.74	5,804.76	9,462.50
Hill 5 (Hill5,6)	5,622.70	6,512.85	12,135.55
Hill 7	1,219.62	1,658.88	2,878.50
Hill 8	236.35	380.33	616.68
Hill 9	5,153.61	5,178.34	10,331.95
Tailings	1,064.40	-	-
Total	**23,435.55**	**28,127.41**	**50,498.56**

9.3 Impact Assessment – Soils and Geology

This section assesses the potential impacts of Mining by Open Pit method, and the risks associated with these impacts on planned project activities and project components. It includes an assessment of the key-mining related hazards to which project activities and project components are vulnerable.

Table 9-25: Open Pit Mining Impacts and Related Hazards Considered in the Assessment

Observed and Projected Changes to soil and rock Characteristics	Mining Related Hazards	Vulnerable Project Components
Land Degradation	Erosion Removal and loss of Topsoil Acid Mine Drainage Subsidence Mine Rehabilitation/Legacy Issues	All Project Components
Change in Topography	Landslide Flooding	All Open Pits Waste Dumps Pipe Line Some Roads/ Ramps
Seismic triggers from blasting	Fly Rock Ground Vibration Liquefaction Landslide	All Open Pits Waste Dumps Reservoir dam Tailings Dam
Pollution	Contamination	All Project Components

9.3.1 Potential Impacts of Land Degradation

In the context of GMI and the planned mining activities for this project, there will be multiple expressions of land degradation with potential to result in removal of topsoil and erosion, land

[79] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3.6.2. Page 111

subsidence, contribute to acid mine drainage and create challenges for rehabilitation after mining has ceased. Many of these are unavoidable due to the nature of open pit mining. There is also a direct impact on the water resource in the area of impact as a result of land degradation processes.

9.3.1.1 Erosion

Erosion is the action of surface processes that removes soil, rock, or dissolved material from one location on the Earth's crust, and then transports it to another location. The particulate breakdown of rock or soil into clastic sediment is referred to as physical or mechanical erosion; this contrasts with chemical erosion, where soil or rock material is removed from an area by its dissolving into a solvent (typically water), followed by the flow away of that solution.

There will be, in total, seven clusters of open pits and nine waste dumps for this project. These will be located at various points along the 15-kilometer strike of the ore body at Matthew's Ridge. A total of approximately 23,500 kilotons of ore will be extracted for processing and shipment and a total of approximately 28,200 kilotons of overburden will have to be stored in the waste dumps. From the technical work commissioned by RMI for the open pits it was determined that slopes in saprolite less than 40 meters high can be designed to have an angle of 45 degrees overall. Slopes in saprolite greater than 40 meters can have an overall slope of 42 degrees. The inter ramp angle can be 45 degrees, a 5-meter wide bench should be placed at the 40 meters depth and every 20-meter interval thereafter. Pit slopes in sap rock will have the same angles as in saprolite. Maximum ramp and road gradients will be 10 percent. For the waste dumps it was determined that dumps with ramps going up will all have the same ramp design factors. The other factors being the overall slope angle 21.9 degrees, 3-meter lift offsets, 3-meter lift heights, maximum height of 30-meter, locations to be away from surface water flows. Dumps in valleys will have an overall slope angle of 37 degrees since the material will be dumped from a higher elevation than 3-meter. The minimum safety factor resulting from these designs are 1.1, most of the slopes will have a safety factor of 1.3.[80]

Most of the foreseen erosion in the case of this project will be physical and mechanical. After deforestation of the areas, establishment of roads, open pits, stockpiles and waste dumps; erosion by wind and water will most certainly occur until slopes are stabilized mechanically or by use of vegetation. This can be qualitatively determined from the volumes, spread and overall slope angles being recommended for the pits and waste dumps. The removal of vegetation and dewatering of the pits will promote erosion of the dried-out material by wind and surface water. The waste dumps will be similarly devoid of vegetation for some period, exposed to the sun, become dry and then subject to erosion by wind and surface water. The movement of equipment will also cause erosion by the vibrations they generate, by materials sticking to the wheels or tracks and by material being blown away from the drag force as they traverse the roadways. Impacts from erosion are **negative, direct, localised** and **long-term** of **moderate significance** and will **certainly** occur, making it a **High Risk** of this project.

9.3.1.2 Loss of Topsoil

Topsoil is the upper, outermost layer of soil, usually the top 5 to 10 inches (13 to 25 centimeters). It has the highest concentration of organic matter and microorganisms and is where most of the biological soil activity occurs. Topsoil is composed of mineral particles, organic matter, water, and air. Organic matter varies in quantity on different soils. The strength of soil structure decreases with the presence of organic matter, creating weak bearing capacities. The structure becomes affected once

[80] G Mining Services Inc., 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Appendix MIN B: GUMR-TM-13-05-23-Golder-Pit Slope Design PFS

the soil is dewatered. The soil's volume substantially decreases. It decomposes and suffers wind erosion.

The open pits will see removal of approximately 54,500 cubic meters of topsoil over the thirteen years of the mine development. The new wharf site and its access road will see the loss of approximately 11,500 cubic meters of topsoil. The project has a progressive reclamation plan that will see backfilling and reapplication of topsoil as each successive pit is exhausted.

For this project topsoil has to be removed, stockpiled and then used in reclamation and mine rehabilitation. The period for which it has to be stockpiled will vary based on the progression of the mine plan, but it will be in timeframes of years and not in months. As a result, the topsoil while stockpiled will be eroded resulting in loss of volume and it will deteriorate and lose the characteristics that make it topsoil, as the material in the lower levels of the stockpile will be unable to sustain topsoil processes under those conditions. Topsoil by definition is at the top and exposed to the atmosphere (aerobic), putting topsoil in a stockpile for a prolonged period destroys the deeply covered portion of the topsoil by compaction and creating an anaerobic condition. The topsoil will however return to its natural state when redistributed and natural processes are promoted and allowed to be reestablished. The loss of topsoil in terms of volume and destruction of its characteristics while stockpiled is **negative, direct, localised, short-term** of **minor significance** but **certain** to occur. As such, it is **Medium Risk** of this project.

9.3.1.3 Acid Mine Drainage

Acid mine drainage (AMD) is the outflow of acidic water from metal mines. Acid rock drainage occurs naturally within some environments as part of the rock weathering process but is exacerbated by large-scale earth disturbances characteristic of mining and other large construction activities, usually within rocks containing an abundance of sulfide minerals. Areas where the earth has been disturbed may create acid rock drainage. This liquid often contains toxic metals, such as copper or iron. These, combined with reduced pH, have a detrimental impact on the aquatic environment. There is also a direct effect on the characteristics of the soil as this acidic flow passes over or through. The soil classification at the wharf site in Port Kaituma is of significance as the soil there has an acidic nature that combined with AMD can be exacerbated. In the Matthew's Ridge area, the pervasiveness of the manganese bearing materials and the disturbed nature of the area due to previous mine activity may have already resulted in the baseline data collected being influenced by AMD. However, all of the water samples analysed by the EIA team in 2020 have been neutral or very close to neutral and none have been acidic (See further details in Chapter 8 Water Resources).

The potential for AMD was investigated analytically in the Pre-Feasibility Study done for RMI. A geochemistry program was initiated to define the acid rock drainage ("ARD") and metal leaching ("ML") properties of both waste rock and jig reject samples. The waste rock program focused on the dominant rock types and weathering zones (Saprolite and Transition) from Hills 1, 3, 5, 7, and 9, with samples collected in 2013. Jig reject samples were comprised of composite samples from various hills and lithologies and represent slimes from the initial wash and jig rejects from the fine and lump tests, as well as associated decant waters and were collected from site by RMI staff in 2012 (slimes) and 2013 (jig rejects). All 29 samples of waste rock (n=20) and jig rejects (n=9) were submitted for static testing including chemical composition, acid base accounting ("ABA"), short-term leach test, and chemical testing of decant water. All testing was completed at SGS in 2012 and 2013.[38]

Based on the test results, all waste rock and jig reject samples, regardless of their lithology, exhibit similar solid chemistry trends including low calcium, high iron and high manganese values indicative of extensive weathering processes. Samples report minor total sulphur content (< 0.04 weight percent), with most of the samples exhibiting higher sulphate sulphur values compared to the reactive

sulphide sulphur, suggesting sulphides may have oxidized previously during the weathering process. As a result of weathering, samples also have minimal amounts of available neutralization potential ("NP") and low carbonate content (<0.07 weight percent).

Results from the short-term leach test show that most lithologies, including the jig rejects, are not expected to leach metals at concentrations above IFC effluent guidelines (IFC, 2007) when the material is in contact with fresh water. However, the diorite saprolite lithology reported dissolved iron concentrations in leachate that exceed IFC guidelines in two of three samples tested; chromium and nickel concentrations are above IFC effluent criteria (2 milligrams per liter total iron) in one sample and may be associated with suspended particles. Three jig reject decant water samples also report total iron greater than effluent guidelines and dissolved low iron concentrations; these samples also exhibit high total suspended solid values (TSS 49 to 1060 milligrams per liter).

With respect to bulk ARD potential, the diorite saprolite, phyllite transition and the jig rejects groups all have no potential to generate acid as defined by the guidance criteria of the Global Acid Rock Drainage Guide (GARD; INAP 2012), while both the phyllite and manganiferous phyllite saprolites have a potential to generate acid. However, because of low sulphide sulphur content in these latter materials, if ARD conditions were to be generated, they would be short in duration.[81]

Based on the detailed geochemical analysis conducted by Golder Associates Ltd., as detailed above, and the deep weathering profile that has been proven to dominate the local geology; it can be determined that the potential for AMD to develop is very low. This is due to the fact that most of the sulfides which may cause AMD have already been chemically removed by the prolonged oxidizing conditions which have prevailed during the deep weathering of the strata.

Impacts of AMD are **negative, direct, localised, short-term** of **minor significance** and **unlikely** to occur. As such, it is a **Low Risk** of this project.

9.3.1.4 Subsidence

Subsidence is the sudden sinking or gradual downward settling of the ground's surface with little or no horizontal motion. The definition of subsidence is not restricted by the rate, magnitude, or area involved in the downward movement. It may be caused by natural processes or by human activities. The former includes various natural events such as earthquakes, soil compaction, erosion, sinkhole formation, and adding water to fine soils deposited by wind. The human activities include compaction, subsurface mining or extraction of underground fluids, e. g. petroleum, natural gas, or groundwater.

In this project there will be a number of factors contributing to subsidence. There will be significant dewatering of the open pits. As the pits are advanced the groundwater flow will change as the hydrostatic pressures are reduced due to the removal of the waste and ore material. This will cause the water table to drop as groundwater flows freely and increasingly into the open pits. The resulting dewatered pore voids will collapse under the weight of the overlying material. Table 9 - 11 shows the final elevations of the pit floors and the relative ground water levels. Many of the pit floors will progress below the groundwater level.

Subsidence will also occur along the haulage roads as trucks traverse them. This will be due to the weight and vibrations being applied, by the trucks and other equipment, to the underlying soil. Trucks are transporting 35 tons and weigh almost 15 tons unladen. The gross weight of a loaded truck will be approximately 50 tons. In all instances the roads themselves are made by the application of capping

[81] G Mining Services Inc, 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Appendix RSF B: GUMR-TM-13-08-08-Golder-Geochemical Characterization Waste Rock and Jig Reject

material to create the driving surface. This coverage ranges from 0.5 to 2 meters and contributes its own weight to causing the underlying soil to be compacted and subside.

There will be waste dumps, stockpiles and facilities related to the processing production process that will see areas being loaded with varying weights. Waste dumps will be in the millions of tons. Stockpiles relating to production and shipment of ore will be in the hundreds of thousands of tons.

The construction of water storage, fuel storage and other mineral processing facilities will all be in the thousands of tons. These loads will contribute to subsidence at their respective locations. Subsidence may increase the possibility of landslides occurring. In this project due to the nature of open pit mining potential impacts of land subsidence are expected to be **direct, negative, localised** and **short-term** of **minor significance** and **certain to occur**. As such, it is a **Medium Risk** of this project**.**

9.3.1.5 Mine Reclamation

Mine reclamation is the process of restoring land that has been mined to a natural or economically usable state. Although the process of mine reclamation occurs once mining is completed, the planning of mine reclamation activities occurs prior to a mine being permitted or started. Mine reclamation creates useful landscapes that meet a variety of goals ranging from the restoration of productive ecosystems to the creation of industrial and municipal resources. Modern mine reclamation minimises and mitigates the environmental effects of mining. As part of the life cycle of an open pit mine, completed pits must undergo rehabilitation. When mining ends, operators must restore the land to its approximate original contour (AOC) or leave the land graded and suitable for a “higher and better” post-mining land use (PMLU) that has been approved. Acceptable post-mining land uses include commercial, residential, recreational, agricultural or public facility improvements. In some instances, due to a variety of factors or circumstances, open pit mines around the world have been left without adequate rehabilitation being done. These unrehabilitated mines lead to legacy issues and may become generational problems socio - economically as well as environmentally.

A detailed mine rehabilitation plan will be drafted in consultation with regulatory bodies and stakeholders. According to the Pre-feasibility Study of RMI and Feasibility Study of GMI, there will be in general; progressive mine reclamation with each pit being rehabilitated as it becomes exhausted. Because of the removal of ore from the topographic highs it will not be possible to restore the area to its original form. However, the waste material will be used to backfill and recontour so as to prevent standing bodies of water. Topsoil will be replied to foster rapid revegetation. All slopes will be graded so as to reduce any risk of landslides and erosion. All of the unnecessary roads will be rehabilitated after closure unless otherwise requested by the locality. The tailings pond will be dewatered, graded and covered with topsoil.

Potential for legacy issues from unrehabilitated mines are **direct, negative, localised** and **long-term**. However, with the present level of environmental awareness and regulation it is **unlikely** that this impact will occur, but it is of **extreme significance**. As such, it is a **High Risk** of this project**.**

9.3.2 Potential Impacts from Changes in Topography

Topography is the study and description of the physical features of an area, for example its hills, valleys, or rivers and the representation of these features on maps. Topographic maps depict the relief of an area also and shows drainage. There are also anthropological features represented on topographic maps. Changes in topography have implications for virtually all contiguous physical systems as it literally means a change in the form of the land. The hills which bear ore deposits form parts of various watersheds along its 15-kilometer strike length. These hills also have influence on the convection air currents in the area and will have some effect on the precipitation. The stripping of the

overburden, establishment of haulage roads, creation of waste dumps, creation of open pits with benches and ramps will all change the natural topography of the project area. Some changes in topography will be very small, such as establishment of haulage roads along slopes while others, such as the creation of extensive open pits to remove millions of tons of ore material, will leave permanent, significant changes in the natural landscape. Especially with open pit mining the issue arises due to the removal of the ore body, the harvested volume of material most times cannot be replaced to restore the original topography. This total restoration is impractical as it will often require more effort than the mining of the ore body as well as the associated cost. Most times the aim is to dewater, recontour to allow drainage and revegetate or make the area usable as required by the locality. The effect of the change in topography on the hydrogeology will be dealt with in the respective chapter. The global effect of the cumulative impacts of anthropological changes of earth's topography has been of such a scale for such an extensive period as to almost defy quantitative assessment. However, qualitatively we know of the significance and the impacts arising from topographic change and must plan accordingly.

9.3.2.1 Landslide

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope. Landslides are a type of "mass wasting," which denotes any down-slope movement of soil and rock under the direct influence of gravity. The term "landslide" encompasses five modes of slope movement: falls, topples, slides, spreads, and flows. These are further subdivided by the type of geologic material (bedrock, debris, or earth). Almost every landslide has multiple causes. Slope movement occurs when forces acting down-slope (mainly due to gravity) exceed the strength of the earth materials that compose the slope. The causes include factors that increase the effects of down-slope forces and factors that contribute to low or reduced strength. Landslides can be initiated in slopes already on the verge of movement by rainfall, changes in water level, stream erosion, changes in ground water, earth tremors, disturbance by human activities, or any combination of these factors. It should be noted that, in some cases, landslides may also involve other types of movement, either at the inception of the failure or later, if properties change as the displaced material moves downslope. Landslides can be classified into different types on the basis of the type of movement and the type of material involved. In brief, material in a landslide mass is either rock or soil (or both); the latter is described as earth if mainly composed of sand-sized or finer particles and debris if composed of coarser fragments. The type of movement describes the actual internal mechanics of how the landslide mass is displaced: fall, topple, slide, spread, or flow. Thus, landslides are described using two terms that refer respectively to material and movement (that is, rockfall, debris flow, and so forth). Landslides may also form a complex failure encompassing more than one type of movement (that is, rock slide—debris flow).

All open pit mines are subject to several forms of landslide; the GMI project is no exception. There are waste dumps, stockpiles, roadways, dams and open pits with significant depth and an overall recommended high angle of slope. There will also be drilling and blasting taking place as the pits progress to depth. The use of explosives will amplify the risks of landslides occurring. There will also be changes to the surface and subsurface water regime which will have implications for potential landslides. Landslides may range from the movement of a few kilograms of material to the movement of millions of tons.

By the end of the project, there will be 9 waste dumps with a combined twenty million cubic meters of material reaching up to 30 meters in height. These will be a combination of saprolite, saprock and rock. The angles of the ramps and overall slopes as determined by Golder Associates Ltd. are 10 degrees and 21.9 degrees respectively. These angles have been qualitatively assessed and should reduce the risk of landslides.

There will be seven clusters of open pits reaching depths of forty meters, these pits will begin in the soft saprolitic material and progress down to the sap rock and fresh rock. The angles in the soft material is the same as in the waste dump and in the fresh rock the overall angle is 42 to 45 degrees.[82] These angles were also quantitatively arrived at by tests carried out by Golder Associates Ltd. The old pit walls left from the abandoned works of AMC have been well preserved over the fifty years of being exposed to the weathering conditions. This lends credence to the recommended slope angles of this mine plan. Landslides may also occur along the embankments of the haulage roads under the influence of the weight and vibrations of the traffic. The possibility of landslides may be increased by subsidence and by the presence of certain geological features such as fractures.

Potential impacts of any scale of landslide would be a **direct, negative, localised** and **long-term**. However, with careful monitoring and design parameters any landslides should be **minor in significance** but are still **likely** to occur given the many factors which may act as triggers. As such, this a **Medium Risk** of this project.

9.3.2.2 Flooding

Flooding is the submergence of land that is usually dry. This project will see significant changes to the topography of the area. Especially to the watersheds, run off channels and general surface water systems. There will be the creation of nine waste dumps holding a total of approximately 20 million cubic meters of material. These dumps will change the surface water runoff patterns. There will also be channels created to direct the flow of rainfall away from the pits and the groundwater from the dewatering of the pits. All of these changes to the surface flows may result in flooding under heavy rainfall if the channels are not adequate or the rainfall beyond the design capacity.

There are several locations where roads cut across natural drainages and aqueducts have had to be installed. These may collapse under the weight of traffic or become blocked. Any restriction to these structures will result in flooding. There has been a dam installed across Pakera Lake to establish a reservoir to provide process water. There have also been 7 dams surrounding the tailings pond, with the maxium height of 10 meters. These will be earth-rock dams with concrete interception ditch. The downstream slope was calculated to be 1:2.5 and upstream slope 1:2. The dams have monitoring and release structure to supply the pump station and also to regulate the water level in the tailings pond. If there is any failure to the dams there will be flooding.

There are several of the open pits that will progress below the water table. These will require the creation of the sump and pump system to keep the pit dry. In the event of the pump failing and or heavy rainfall there will be flooding of the open pits. For the pits that will not reach below the water table there is only rainfall to consider as a cause of flooding. There will be channels around the top of the pit to prevent surface flows entering the pit. There will be pumps available to drain these pits in the event of excessive rainfall.

Potential impacts of flooding are **direct, negative, localised** and **short-term.** With careful monitoring and design parameters any flooding should be **minor significance** and **unlikely** to occur given the systems in place. As such, these potential impacts are **Low Risk** of this project.

[82] G Mining Services Inc, 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Appendix MIN B: GUMR-TM-13-05-23-Golder-Pit Slope Design PFS

9.3.3 Potential Impacts of Seismic Triggers from Blasting

In the blasting operations, fragmentation is the most important output. Fly rock, ground vibration, air blast, and environmental effects are detrimental effects of blasting operations. Identifying and ranking the risk of blasting operations is considered as the most important stage in project design. Typically, blasting operations in mining projects are used for rock fragmentation. Therefore, fragmentation control in blast operations is dependent on the explosion design and its impact on productivity. This is a challenge for explosive engineers due to numerous variables such as; blast pattern, amount of explosive energy in the blast hole and the variety of explosion initiation methods and their impact on the properties of explosion propagation. There is also variability in the mechanical properties of the host rock. In surface mines, only 20 to 30 percent of the energy produced is used for compression and movement of the rock mass: the remaining energy often produces unwanted environmental effects and explosive effects, such as excessive air pressure, ground vibration, fly rock, dust production, and back break. The inherent hazards and dangers associated with blasting are apparent and have been well studied and documented globally. At the project site the structural geology has established a series of sedimentary packages which have been extensively deformed, covered and/or underlain by soft material at surface and fresh material at depth.

The extensive deformation that characterizes most of northern Guyana makes for a weakened subsurface and host rock. Notwithstanding the low-grade metamorphism that has taken place, it would be reasonable to say that the sedimentary packages form a nonconformity with the underlying rock, these being zones of weakness susceptible to movement.

9.3.3.1 Flyrock

The Institute of Makers of Explosives (IME) has defined flyrock as the rock propelled beyond the blast area by the force of an explosion (IME, 1997)[83]. Flyrock comes in different sizes and shapes, ranging in mass from a few ounces to several tons. Flyrock is always a major concern for the blaster. Flyrock from surface blasting operations has caused serious injury and death to employees and other persons. Flyrock management and control has become an indispensable part of blast design. Upon initiation of an explosive charge in a blasthole, a detonation wave travels through the explosive charge column. The velocity of detonation is a function of explosive characteristics, confinement, and charge diameter. When an explosive charge is detonated in a blasthole, very high pressure is exerted on the wall. The wall of a blasthole could experience transient pressure of about 500,000 pounds per square inch for emulsion-type explosives. This high pressure causes expansion of the blasthole, crushing of the rock in the immediate vicinity, growth of cracks beyond the crushed zone, and generation of a seismic wave and air blast. The gases from the detonation products enter into the tensile-fractured spaces and resume their expansion work causing propagation of cracks. Gas pressurization then causes the fragmented rock mass to burst out from the bench. If there is excessive local gas pressurization, flyrock could be generated.

Flyrock is caused by a mismatch of the distribution of explosive energy, type of confinement of the explosive charge, and mechanical strength of the rock. Factors responsible for creating this mismatch include:

- Abrupt change in the rock resistance due to presence of joints; cracks; layers of mud, silt, or soft material in the host rock; differential weathering of rocks near an outcrop; faults and slip planes; back breaks, overhangs, and uneven highwall face;

[83] IME [1997]. Glossary of Commercial Explosives Industry Terms. Safety Publication No. 12, Institute of Makers of Explosives, 1120 Nineteenth Street, NW, Suite 310, Washington, D.C. 20036-3605, pp. 16.

- High explosive concentration leading to excessive localised energy density due to migration of explosive charge into fissures, caverns, voids, and mud seams;
- Deviation of blast holes from the intended direction causing a reduction in burden or spacing;
- Insufficient or improper stemming leading to stemming ejection and bench-top flyrock;
- Inappropriate or poor blast design.

For this project the drilling and blasting will be done on 6-meter benches, undertaken with 89millimeter holes (3.5 inches). Saprock material and an estimated 20 percent of the saprolite material will require blasting. The blast pattern parameters are presented in Table 9 - 26.

Table 9-26: Blast Pattern Parameters[84]

Drill Pattern	Units	Saprolite Pattern	Saprock Pattern
Explosive type		Emulsion	Emulsion
Explosive density	gram per cubic centimeter	1.20	1.20
Hole Diameter (D)	meters	0.089	0.089
Burden (B)	meters	3.50	3.50
Spacing (S)	meters	4.20	4.20
Subdrill (J)	meters	0.50	0.50
Stemming (T)	meters	3.50	2.10
Bench height (H)	meters	6.00	6.00
Blasthole Length (L)	meters	6.50	6.50
Pattern Yield			
Bulk density	tons per bank cubic meter	1.65	2.09
BCM/hole	bank cubic meters per hole	88	88
Yield per hole	tons perhole	146	184
Yield per meter drilled	tons per meter drilled	22	28
Blasting			
Explosive column (LE)	meters	3.00	4.40
Powder Factor	kilograms per ton	0.15	0.18

This mine is projected to consume more than 2.7 million kilograms of emulsion explosive material over the life of the mine.[85] This represents a very intensive and sustained blasting program probably with multiple blasts per week. Given that the blasting will occur inside the lower levels of the open pit the walls of the pit themselves will act as shields. Also, with careful control and adherence to the regulation and best practices the blasts should be executed within safety parameters.
Regulations include amongst other things that the local community be given advance notice and an alarm is sounded to warn of the blast. The majority of the open pits will be further away from the central Mathew's Ridge settlement. This will put the settlement outside the danger zone of the blasts.

Potential impacts of flyrock are expected to be **direct, negative, localised** and **short-term**. Depending on the size of the fly rock it can vary in significance from **negligible** to **minor**. The likelihood of occurrence depends on the blast design, which would factor in as best as possible the structural and mechanical properties of the materials involved, ideally there should be no fly rock. As such, these impacts are **unlikely to occur,** making these potential impacts a **Low Risk** of this project.

[84] G Mining Services Inc, 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Section 16.6.1. Page 16 -25
[85] G Mining Services Inc, 2013. Pre-Feasibility Study, Matthew's Ridge Manganese Project, Guyana. Section 16.6.1.3 Page 16 -28

9.3.3.2 Ground Vibration

Blasting is one of the most fundamental stages in open pit mining. A good fragmentation and a minimum ground vibration are characteristics of a successful drilling and blasting operation. Fragmentation and displacement of broken rocks accounts for only 20 to 30 percent of the total amount of explosive energy used. Utilising large amounts of explosives during charging can result in unwanted scenarios. Blasting operations may impose excessive noise and vibration on communities. Excessive levels of structural vibration caused by ground vibration from blasting can result in damage to, or failure of, structures. The intensity of ground vibration depends on various parameters which can be categorized into two classes: controllable and uncontrollable parameters. Controllable parameters are mainly related to explosive characteristics and blast hole design parameters, which can be changed by mine administrations. The other parameters, which are natural and uncontrollable, are related to geological conditions, rock characteristics and the subsurface structure of the area. Ground vibrations are generally quantified by means of particle velocities at particular ground locations. Currently, the most widely accepted single measurement of ground vibration considered potentially damaging is Peak Particle Velocity (PPV). PPV is defined as the speed by which earth particles move or pass a particular site. PPV can be related to the weight of the explosive charge and its distance to the recording site through the application of a simple power law formula.

This mine will see the use of 2.7 million kilograms of emulsion explosives. The long term and regular use of explosives in the same area of deformed rocks with unconformities may have influence on other impacts such as subsidence and landslides. There are critical structures which are particularly susceptible to mechanical failure from ground vibrations. These structures are the Pakera reservoir dam, the tailings dam, the process water pipe line and the slopes of the open pits / waste dumps.

Some of the open pits are close enough to the Mathew's Ridge settlement that vibrations may reach them buildings there. In Mathew's Ridge many buildings and structures are located on stilts and on the slopes of hills and other unstable foundations. If any significant vibrations reach the settlement repeatedly there may be structural failure of the buildings there. The geotechnical investigations done by both RMI and GMI have been used to calculate the blast pattern parameters which should be within safety limits. Potential impacts of ground vibrations are **direct, negative**, **localised** and **short-term.** These potential impacts are **certain** to occur, under ideal conditions the significance is likely to be **negligible** to **minor.** As such, these potential impacts are **Low Risk** of this project.

9.3.3.3. Blast Induced Liquefaction

Liquefaction refers to the process by which water-saturated, unconsolidated sediments are transformed into a substance that acts like a liquid, often in an earthquake. As a result of this liquid behavior the surface collapses, usually catastrophically. Blasting produces seismic waves similar to an earthquake and under certain conditions may induce liquefaction if certain PPVs are achieved below the water table. This phenomenon is called blast induced liquefaction. If the soil is saturated by water, a condition that often exists when the soil is below the water table or sea level, then water fills the gaps between soil grains ('pore spaces'). In response to soil compressing, the pore water pressure increases and the water attempts to flow out from the soil to zones of low pressure (usually upward towards the ground surface). However, if the loading is rapidly applied and large enough, or is repeated many times (e.g. earthquake, blasting) such that the water does not flow out before the next cycle of load is applied, the water pressures may build to the extent that it exceeds the force (contact stresses) between the grains of soil that keep them in contact. These contacts between grains are the means by which the weight from buildings and overlying soil layers is transferred from the ground surface to layers of soil or rock at greater depths. This loss of soil structure causes it to lose its strength (the ability to transfer shear stress), and it may be observed to flow like a liquid.

Many of the open pits in this project will require extraction by blasting to occur at or below the water table. There will also be the water against the retention dams of the Pakera reservoir and tailings dam. The waterways that are intersected by the roads will also have characteristics similar to the dams. At all of these places the soft material is wet, saturated or close to saturated. These structures will be vulnerable to blast induced liquefaction if the PPVs reaching them are too great. This risk may increase the possibility of flooding, subsidence and landslides. Potential impacts of blast induced liquefaction are **direct, negative, localised** and **long-term.** However, it is **unlikely** to occur and will be of **minor significance** making it a **Low Risk** of the project activities.

9.3.3.4 Landslides

Landslides were discussed previously under Change in Topography, the classification remains the same. They may be also triggered by the ground vibrations or blast induced liquefaction mentioned above. Nonetheless, the impact ratings associated with landslides will not change.

9.3.4 Potential Impacts of Pollution and Soil Contamination

Pollution may potentially result from the operation activity in the form of litter and fuel spills. During construction and operation earth-moving vehicles, generators, batching plants and other machinery are utiliseutilised extensively on site. These machines may leak fuel and/or oil. This fuel / oil will then infiltrate into the soils of the area impacting on the surrounding environment. Inevitably, with people working on site, litter is generated.

There is a fuel bay with spill containment at the main processing site and at the wharf site in Port Kaituma. There are fuel service trucks to handle equipment in the mine areas. Nonetheless equipment will operate along the roadways, around the open pits and at the new wharf site. There is the risk of any piece of equipment having a fuel or oil spill due to mechanical failure or rupture of hydraulic lines. This project will have more than sixty pieces of heavy-duty equipment deployed within the project area. These trucks will also be using the roads to Port Kaituma and the new wharf facility there. Any spillage or seepage of fuel/oil will cause contamination to the soil and may also enter the surface or groundwater systems. These impacts are **direct, negative, localised** and **long-term**. However, these impacts are **unlikely** to occur provided that equipment is well maintained, such a spill would be of **minor significance** making it a **Low Risk** of this project.

9.3.5 Cumulative Impact Assessment

There are no existing or proposed activities in the project AoI which require significant earthworks such as excavation or processing of soils or ore. In both Matthew's Ridge and Port Kaituma, small- and medium-scale gold mining activities involve soil excavation well outside of the AoI of the project. The construction of the bypass road in Port Kaituma increased access to lands for pork-knocking which is practiced with a few individuals who own metal detectors and therefore, do not cause significant disturbance of the soils. In addition, small-scale agriculture activities within the vicinity of the project were relocated in Matthew's Ridge. Although small-scale crop cultivation commenced on the periphery of the bypass road in Port Kaituma, they are no mechanized and therefore potential impacts related to compaction, erosion and pollution are not anticipated to occur.

However, ancillary activities of the project which involve the construction of bypass roads in Matthew's Ridge and Port Kaituma as well as the maintenance and rehabilitation of the Matthew's Ridge to Port Kaituma public road required the extraction of laterite from pits within the Matarkai sub-district. Laterite from these sources were already being extracted by the two contractors engaged by the Government, through the Ministry of Public Infrastructure, in particular to maintain the Matthew's Ridge to Port Kaituma public road. GMI will continuously utilize laterite from these pits during the operational phase

of the project for road maintenance. It is likely that Government contractors will also utilize laterite from these pits for road works. Increased extraction of laterite from these pits to support GMI's road works may potentially contribute to the depletion of these resources throughout the project lifetime and may require the identification and establishment of new laterite pits. This potential impact is expected to be **direct, negative, long-term, cumulative** and **localised** of **minor significance** and are **likely** to occur. Potential impacts related to the depletion of existing laterite pits throughout the project lifetime are **Medium Risks**.

9.4 Mitigation and Monitoring Measures – Soils and Geology

The overriding strategy for the Project is to prevent or minimise impacts on the soils and geological conditions as well as on stakeholders including the communities. As a result, GMI has put the following measures in place to mitigate risks identified above:

- Stockpiling of topsoil at various locations across the nine waste dumps areas. In addition, these stockpile areas will be monitored monthly to check for changes in conditions.
- Putting measures in place to manage risks associated with AMD including:
    - Controlling runoff from exposed ground with the careful placement of flow retarding barriers.
    - Putting measures in place to channel water generated from mine dewatering into the Tailings and Water Retention Dam to be used in the process.
    - Using a flocculant to treat water to be discharged from the processing plant into the Tailings and Water Retention Dam which will have a buffering or neutralizing effect on the discharge.
    - Containing process water in the Tailings and Water Retention Dam with minimal discharges into the environment, only as needed, via a spillway.
- Adhering to the relevant mine design parameters, such as the layout of mine workings and the geometry and strengths of slopes and pit characteristics so as to mitigate risks of subsidence and landslides.
- Using techniques to stabilize or retain slopes including mechanical means via use of cement, limestone or other chemical agents; diverting and controlling surface runoff; and designing mines with a safety factor of 1.1 to 1.3; and using terracing methods.
- Conducting periodic inspections to ensure that drainage systems and pumps are fully functional.
- Monitoring the water levels in the Tailings and Water Retention Dam on a 24-hour basis and creating a spillway to allow for emergency drainage.
- Putting measures in place to prevent soil contamination by hazardous waste including:
    - Ensuring that all hazardous materials and waste are stored on impervious surfaces within secondary containment.
    - Ensuring that there are suitable drips trays for refueling and oil changes.
    - Using appropriate vehicles for river and road transportation of fuel.
    - Refueling and oil change should take place in designated workshop areas. If maintenance at field locations are unavoidable, appropriate drip containers will be used the site will be cleaned up appropriately.
    - Training workers in proper fuel handling and management measures.

In addition, GMI should implement the following measures to mitigate and monitor the risks:

- Manage and reduce risks of topsoil loss by implementation of the following measures:
    - Strip topsoil to a maximum depth of 200 millimeters.
    - Ensure that topsoil stockpiles are kept as small as possible in order to prevent compaction and the formation of anaerobic conditions, typically around 1 meter thick or less.

  - Store topsoil stockpiles for the shortest possible timeframes.
  - Restrict handing of topsoil when moisture content exceeds 12 percent.
  - Ensure that topsoil stockpiles are kept separate from subsoils.
  - Store topsoil and other soil materials in bermed area on the higher lying areas of the footprint area. Topsoil should not be stored in any storm water run-off channels or any other areas where it is likely to cause erosion, or where water would naturally accumulate.
  - Optimize the mine plan to have stripping, extraction of ore and backfilling done in such a way as to minimize the exposure of material to erosion
  - Use topsoil to progressively backfill mined out areas thereby allowing for the re-growth of the seed bank contained within the topsoil.
  - Use natural or manufactured fertilizers to invigorate the topsoil when redistributed.
  - Put measures in place to prevent wind erosion of the stockpiles.
  - Stockpiles susceptible to wind erosion are to be covered during windy periods.
- Manage and reduce risks of AMD by implementation of the following measures:
  - Test soil and rock on an annual basis for AMD and NP as the mine progresses and material from depth becomes accessible.
  - Audit mine residue deposits, including water return dams, waste rock dumps, tailings storage facilities annually to ensure that best practices are being followed throughout the mining operation.
  - Limit ground exposure, surface area and duration, wherever possible.
  - Ensure that ore stockpiles at the Kaituma Marine Terminal are contained to prevent runoff from entering the Kaituma Canal.
- Manage and reduce risks of subsidence associated with project activities by implementation of the following measures:
  - Conduct monthly visual inspections to detect significant instances of subsidence.
  - Control of the rate of dewatering of the mine and the area affecting the strata surrounding the mine workings.
  - Design consideration of the structural, lithological and geotechnical characteristics of the overburden and inter-burden
  - Minimize any conditions that may cause increased loading or changes to the stress environment surrounding the mine workings.
- Manage and reduce the risks of landslides by continuous visual and instrumental monitoring of all slopes for erosion and landslide indications. At critical points devices must be installed to detect seismic movements and vibrations.
- Dewatering of material to reduce plasticity and hydrostatic pressures along slopes.
- Consider the use of vegetation for slope stabilization, prevention of erosion.
- Prepare a Blasting Plan before blasting operations including provisions for:
  - Designing blast patterns based on geotechnical data within a high safety factor and adhering strictly to the blast design.
  - Blasting should only be done under the control of a certified and experienced expert.
  - Installing instruments to detect flyrock PPV and seismic impacts each time blasting is conducted.
  - Minimising PPV at critical points including the Mathew's Ridge settlement, at the Pakera reservoir dam, at the tailings pond dam, on the slopes of waste dumps and on the saprolite/saprock sections of open pit slopes.
  - Adjusting the blast pattern if fly rock is observed or PPV values are too high at critical points.
  - Engaging with residents to determine whether any significant adverse impacts of blasting are being experienced such as PPV, noise and dust emissions.

- Ensure that spill kits are available to clean up accidental spills from earthmoving machinery or other project vehicles. These kits should be well-marked and workers should be trained in their use.
- Employ soil wetting techniques to prevent it from becoming dry and being lost to the wind.
- Limit traffic on disturbed, storage and reclaimed areas.
- Limit the double handling of material.
- Ensure that there is progressive reclamation throughout the life of the mine with annual monitoring to check on the status continuous mine rehabilitation.
- Undertake measures to be taken to mitigate the risks of non-rehabilitation of the mine including the development of the mine Closure and Decommissioning Plan in keeping with the national regulations to demonstrate that closed out Matthew's Ridge and Port Kaituma facilities will represent minimal long-term deleterious legacies. The Plan should be updated as the operations progress.

Table 9-27: Summary of Impacts and Mitigation Measures

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management / Mitigation	Monitoring
			Type	Significance	Likelihood			
Soils and Geology								
Open Pit Mining	GGMC Mining Reg, EPA Mining Reg, GARD Reg	Erosion	Negative Direct, Long Term, Localised	Moderate	Certain	High	Adherence to Operational Controls	Continuous
		Removal/ Loss of Top soil	Negative Direct, Short Term, Local	Minor	Certain	Medium	Adherence to Operational Controls	Monthly
		Acid Mine Drainage	Negative Direct, Long Term, Local	Minor	Unlikely	Low	Adherence to Operational Controls	Annual analysis of soil and rock
		Subsidence	Negative Direct, Long Term, Local	Minor	Certain	Medium	Adherence to Operational Controls	Monthly
		Lack of Reclamation	Negative Direct, Long Term, Local	Extreme	Unlikely	High	Adherence to Operational Controls	Annually
		Land Slide	Negative Direct, Short Term, Localised	Minor	Likely	Medium	Adherence to Operational Controls	Continuous
		Flooding	Negative Direct, Short Term, Localised	Minor	Unlikely	Low	Adherence to Operational Controls	Weekly
Blasting	GGMC Mining Reg,	Fly Rock	Negative Direct, Short Term, Localised	Negligible/ Minor	Unlikely	Low	Adherence to Operational Controls	Continuous when blasting commences

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management / Mitigation	Monitoring
			Type	Significance	Likelihood			
	EPA Mining Reg, GPF Reg	Ground Vibration	Negative Direct, Short Term, Localised	Negligible/ Minor	Certain	Low	Adherence to Operational Controls	
		Liquefaction	Negative Direct, Short Term, Localised	Minor	Unlikely	Low	Adherence to Operational Controls	
Pollution	EPA Reg, GEA Reg, GGMC Reg	Contamination	Negative Direct, Short Term, Localised	Minor	Unlikely	Low	Adherence to Operational Controls	Continuous
Cumulative Impacts								
Road Construction, Rehabilitation and Maintenance	GGMC Regulations, EPA	Depletion of existing laterite pits	Negative Direct, Long Term, Localised, Cumulative	Minor	Likely	Medium	Engagement with Ministry of Public Works and GGMC on road works	

Chapter 10 - Air Quality

This chapter outlines the baseline ambient air quality levels existing at the locations of the key project components as well as receptors within or proximate to the project's AoI. The baseline levels include recordings of primary data collected by the EIA team. It also assesses potential impacts of possible air pollutant emissions from planned project activities to proximate receptors. Finally, it proposes a suite of mitigation and monitoring measures which should be followed to manage risks associated with air pollution.

10.1 Administrative Framework – Air Quality

Table 10-1 summarises the legislation, policies, strategies, and international treaties that are relevant to the planned project activities.

Table 10-1: Legislation, Policies, Strategies and International Treaties

Title	Description	Applicability to the Project
Legislation		
The Environmental Protection Act (1996)	Provides for the management, conservation, protection and improvement of the environment and has provisions for the prevention or control of pollution including air pollution. The Act also established the Environmental Protection Agency.	Sets out requirements for consideration of air emissions as well as offences for air pollution that results in adverse effects.
Environmental Protection (Air Quality) Regulations (2000)	Establishes general provisions for air emission for activities. The Regulations also authorize the EPA to set specific permissible emission levels.	Requires submission of an application for activities generating air emissions/pollution. EPA has not established emission limits under this Act, but has been recommending compliance with established international guideline.
International Standards and Guidelines		
World Health Organization Air Quality Guidelines	Offers guidance on threshold limits for key air pollutants that pose health risks and provide a reference for setting air pollution targets at regional and national levels to improve air quality. The guidelines were most recently updated in 2005.	Air quality limits that the project may adopt
IFC Environmental, Health and Safety Guidelines (Mining and General)	Provides technical reference documents with general and industry-specific examples of Good International Industry Practice. The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by	The project may adopt these guidelines and permissible limits

Title	Description	Applicability to the Project
	existing technology at reasonable costs.	
Air Quality Index (Environmental Protection Agency, Victoria, Australia)	Creates an Air Quality Index against which mean pollutant levels may be compared and categorised.	The project may adopt these permissible limits.

10.2 Baseline Conditions – Air Quality

The EIA team undertook measurements to characterize the ambient air quality conditions for the project locations in Matthew's Ridge and Port Kaituma as well as for nearby receptors. The sampling locations were selected based on two principal criteria which were the location of key project components from which emissions may be generated and at locations where receptors were proximate to these planned project activities. At the dates of the assessment, construction of the new project facilities at Matthew's Ridge were approximately 80 percent completed. Minimum, maximum and mean air quality values were identified for four pollutant gases and three particulate emissions most likely to be emitted during the project implementation. The gases measured were carbon dioxide (CO), sulphur dioxide (SO_2), Nitrogen Dioxide (NO_2) and volatile organic compounds (VOCs) while the particulates measures were $PM_{2.5}$, PM_{10} and TSP. Particulates were measured for 1-hour twice per day and each of the gases were also measured twice daily for durations of 15 minutes each. At each sampling point, the air quality meters were placed about 1.5 meters (5 feet) from ground level to simulate the average height of the human nose. It should be noted longer measurement periods (up to 24-hours for particulate emissions) were initially included in the air quality survey plan. However, the duration of the field exercise to collect baseline data was curtailed because of national and other safety restrictions for the COVID-19 pandemic, including the curfew. This restricted the duration of the field sampling exercise and subsequently, the duration for which each test was run. However, the number and location of the sampling points were not influenced by the COVID-19 restrictions.[86] In addition, air quality was measured in 2012 as part of an environmental baseline study commissioned by Reunion Manganese Incorporated (RMI) for sampling locations in Matthew's Ridge and these results are also presented in this section.

10.2.1 Permissible Emissions Levels

The EPA has not established any permissible air quality limits. However, recognised international organisations have established air quality standards which are relevant to the project and which may be adopted on a voluntary basis. These include ambient air quality standards from WHO and the Environmental Protection Agency of Victoria, Australia as seen in Table 10-2. In addition, the occupational exposure limits were established by OSHA of the United States Department of Labour for a range of substances and those relevant to this project are also presented in Table 10-2.

[86] Additional information on the methodology employed including the Standard Operating Procedure which guided baseline data collection and a description of the equipment used are presented in Appendix F.

Table 10-2: Air Emissions Levels from International Organizations

Parameters	Acceptable Limits
Air Quality Standards (World Health Organization)	
Sulphur Dioxide (SO_2)	20 micrograms per cubic meter ($\mu g/m^3$) – 24 hour mean 500 $\mu g/m^3$ – 10-minute mean
Nitrogen Dioxide (NO_2)	40 $\mu g/m^3$ – annual mean 200 $\mu g/m^3$ – 1 hour mean
Particulate Matter ($PM_{2.5}$)	10 $\mu g/m^3$ – annual mean 25 $\mu g/m^3$ – 24 hour mean
Particulate Matter (PM_{10})	20 $\mu g/m^3$ – annual mean 55 $\mu g/m^3$ – 24 hour mean
EU Council Directive 80/779/EEC	
Total Suspended Particulates (TSP)	150 $\mu g/m^3$ – 24 hour mean
Air Quality Standards (Environmental Protection Agency, Victoria, Australia)	
Particulate Matter ($PM_{2.5}$)	62 $\mu g/m^3$ or greater – 1 hour mean that indicates poor air quality
Particulate Matter (PM_{10})	80 $\mu g/m^3$ or greater – 1 hour mean that indicates poor air quality
Carbon Monoxide (CO)	34 milligrams per cubic meter (mg/m^3) or greater – 1 hour mean that indicates poor air quality
Occupational Exposure Limits (Occupational Safety and Health Administration, US Department of Labour)	
Manganese Compounds (as Mn)	5 mg/m^3 – Maximum 0.2 mg/m^3 – 8 hour time weighted average
Manganese Fume (as Mn)	5 mg/m^3 – Maximum 0.2 mg/m^3 – 8 hour time weighted average
Particulates (Dust)	15 mg/m^3 – Maximum 10 mg/m^3 – 8 hour time weighted average
Sulphur Dioxide (SO_2)	13 mg/m^3 – Maximum 5 mg/m^3 – 8 hour time weighted average
Nitrogen Dioxide (NO_2)	9 mg/m^3 – Maximum 2 mg/m^3 – 8 hour time weighted average
Carbon Monoxide	55 mg/m^3 – Maximum 25 mg/m^3 – 8 hour time weighted average

10.2.2 Meteorological Conditions

Key meteorological data such as precipitation, air temperature, humidity, barometric pressure, evaporation and wind speed are detailed in Chapter 11 using data collected from the Hydrometeorological Department as well as baseline data collected by Reunion Manganese Incorporated over July 2011 to July 2012 in Matthew's Ridge. A summary is provided here:

- Overall, precipitation levels are higher at Port Kaituma as compared to Matthew's Ridge throughout the year. Based on the data available, total annual rainfall of at least 2,000 millimeters had a 69 percent probability of occurring in Port Kaituma, but only a 33 percent probability of occurring in Matthew's Ridge.

- Mean temperatures ranged from 26.33°C to 32.26°C but highs of 43.68°C and 40.89°C were observed in the dry season in Matthew's Ridge.
- Mean net radiation ranged from 149.39 to 216.86 watts/m^2/day and given Guyana's tropical climate, the mean net radiation at Matthew's Ridge was positive and was consistently higher during the dry seasons as compared to the wet seasons.
- Mean humidity was higher in the wet seasons.
- Atmospheric pressure was approximately 100 kilopascals throughout the year and this is the level of atmospheric pressure which typically prevails at sea level.
- Evaporation was highest during the dry seasons with all dry season months.
- Mean winds speeds peaked in July 2011 with 2.78 meters/second (6.2 miles per hour) which is considerably lower than average wind speeds which are reported to prevail at other locations along Guyana's coast. This may be attributed to Matthew's Ridge relatively inland location. However, maximum wind speeds reached 15.12 meters/second (33.8 miles per hour) in July 2011 and was greater than 13.4 meters/second (30 miles per hour) in September and October 2011. Wind directions are typically east to south-east.

10.2.3 Matthew's Ridge Air Quality

10.2.3.1 2012 Air Quality Measurements

Baseline noise levels were measured for 10 sampling points within the Matthew's Ridge project footprint. Sampling points were established at Hills 1 to 9 and the office location of the project site at Hill 5. Measurements were recorded over a 12-month period from July 2011 to June 2012 and only one parameter, PM_{10}, was measured, given the remote location of the project and in the absence of industrial development in the vicinity, combustion-derived compounds such as sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and carbon monoxide (CO) were deemed negligible within the project footprint and were not considered for baseline monitoring[87]. Mean annual concentrations of PM_{10} at each of these sites were 40.9 µg/m^3. However, variations were observed on a monthly basis and the maximum values were recorded in March and June 2012 with 41.2 µg/m^3 while a minimum of 40.6 µg/m^3 was recorded in July 2011. Monthly variations in PM_{10} measurements across all sampling locations is presented in Figure 10-1.

According to the Air Quality Index developed by the EPA of Victoria in Australia, it was determined that 1-hour measurements of PM_{10} that were lower than 40 µg/m^3 were indicators of "good air quality" while measurements between 40 to 80 µg/m^3 were indicators of "moderate air quality". Given that all values were consistently above 40 µg/m^3, the air quality within the Matthew's Ridge project footprint in 2012 may be categorized as "moderate".

[87] Ground Structures Engineering Consultants. 2012. Reunion Manganese Inc. Environmental Studies and Permitting Report.

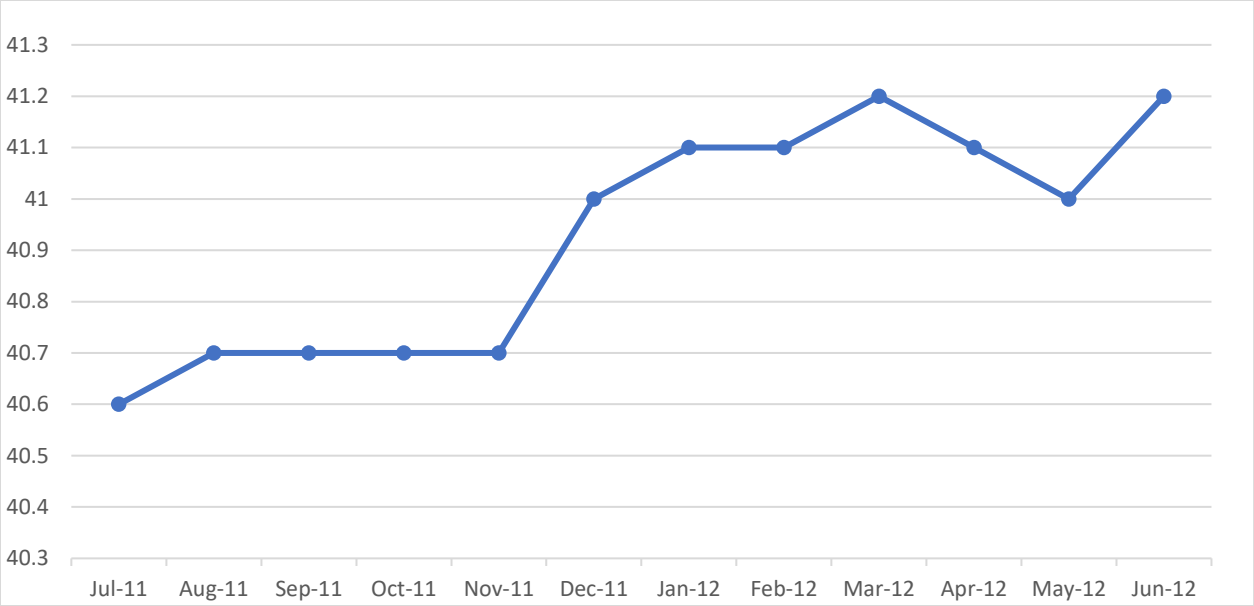


Figure 10-1: PM $_{10}$ Concentration (µg/m^3) in the Measurements Conducted Over the Period July 2011 to June 2012

10.2.3.2 2020 Baseline Air Quality Assessment

The 2020 baseline assessment comprised of six sample points within Matthew's Ridge representing key components of the planned project footprint and in the Matthew's Ridge community as follows:

- Hills 5 and 9. These two sampling locations are within the footprint of the active mine area and are within the project AoI. These deposits will be mined within the first seven years of the project;
- GMI's power plant and workshop, located approximately 1 km meters from the centre of the Matthew's Ridge community. The closest residents are situated approximately 300 meters to the east and 150 meters to the south. This sampling location is also within the project AoI.
- GMI's pump station which is located approximately 1 km from the centre of Matthew's Ridge community. The closest residents are located approximately 400 meters away. This sampling location is also within the project AoI.
- GMI's new processing plant which is located approximately 1.5 km meters away from the centre of the Matthew's Ridge community. The closest residents are situated approximately 300 meters east. This sampling location is also within the project AoI.
- The *Shel Nic Nel* Hotel which is located in the central Matthew's Ridge community. This is the only sampling point in Matthew's Ridge which is not located directly within the project AoI but is considered a receptor proximate to the project areas.

The six sampling points are shown in Figure 10-2. The results of the 2020 baseline air quality assessment are presented in Table 10-3.

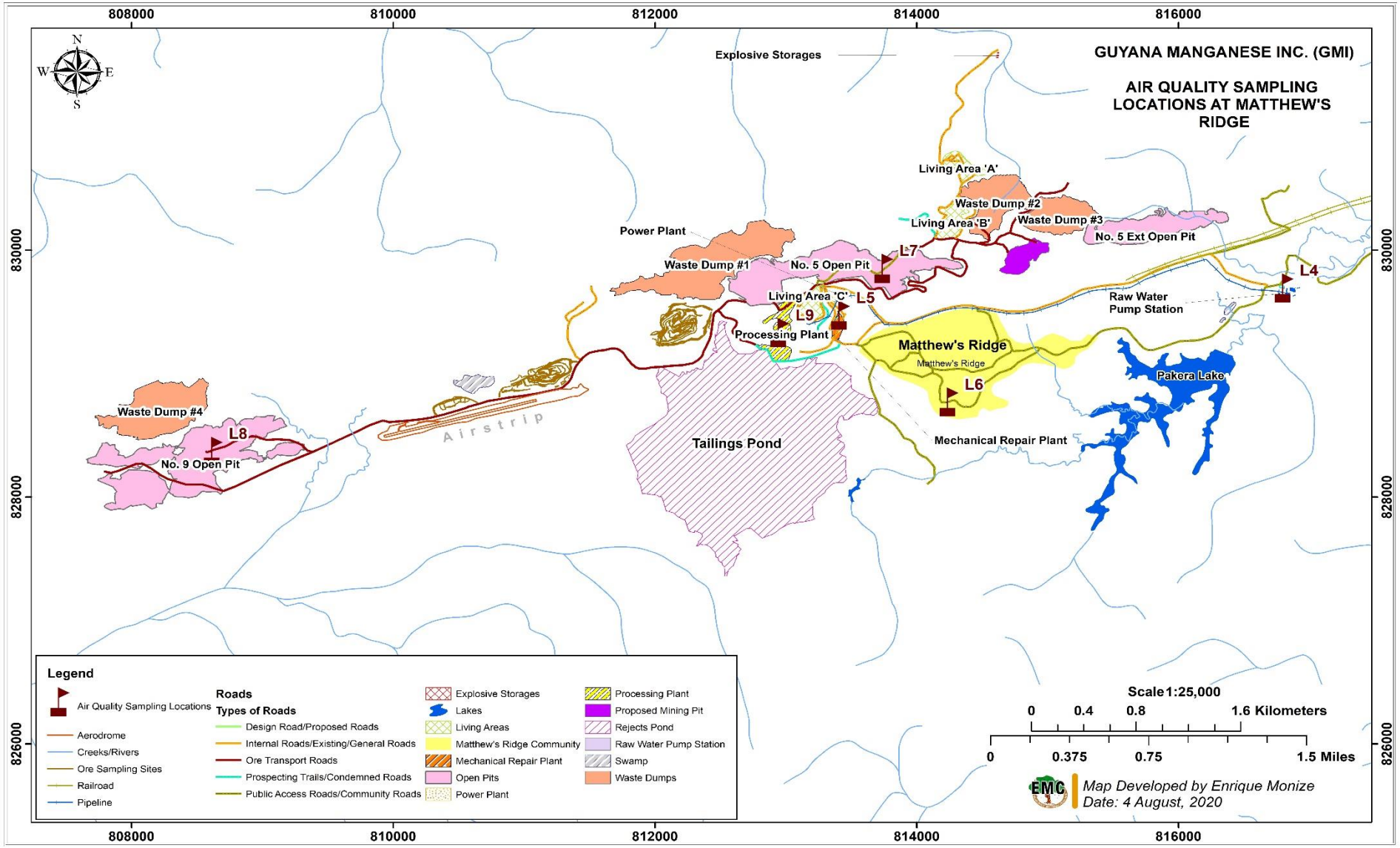


Figure 10-2: Air Quality Sample Locations in Matthew's Ridge (2020 Baseline Assessment)

Table 10-3: Results of the 2020 Baseline Air Quality Assessment

Locations	Date	Time (hrs)	Particulates 1-hour mean (µg/m³)			Gases: 15-minute mean (mg/m³)				Observations
			$PM_{2.5}$ (40)	PM_{10} (80)	TSP (150)	VOCs	CO (34)	NO_2 (0.2)	SO_2 (0.5)	
Pump Station	July 15, 2020	14:55	18.4	62.4	65.2	11	0.69	0.041	0	*Weather:* Overcast with intermittent showers *Sources:* Light traffic on adjacent public road
	July 16, 2020	14:13	11.0	43.5	47.6	3.5	2.6	0.066	0	
Power Plant/ Workshop	July 15, 2020	16:55	16.1	62.5	72.1	8.7	3.4	0.13	0	*Weather:* Raining *Sources:* Construction machinery, light traffic
	July 16, 2020	15:30	14.0	92.5	114.2	3.2	1.4	0.068	0	*Weather:* Raining *Sources:* Construction machinery, heavy traffic
Processing Plant	July 16, 2020	12:41	11.1	48.8	51.7	19.4	0.2	0.092	0	*Weather:* Sunny *Sources:* Light traffic
	July 17, 2020	10:08	10.0	45.4	48.1	4.8	3.1	0.047	0	*Weather:* Sunny *Sources:* Light traffic, machinery
Hill 5	July 16, 2020	08:08	9.3	43.4	45.3	5.8	0	0.083	0	*Weather:* Overcast *Sources:* Light traffic
	July 17, 2020	11:29	10.0	52.7	60.7	3.5	0	0.040	0	*Weather:* Sunny *Sources:* Light traffic
Hill 9	July 16, 2020	10:03	9.6	43.4	46.9	3.9	0.3	0.073	0	*Weather:* Intermittent rain and windy *Sources:* Natural sources
	July 17, 2020	08:40	11.1	85.8	91.4	9.0	0	0.049	0	
Matthew's Ridge Community	July 15, 2020	20:32	18.1	138.4	189.2	6.5	2.6	0.13	0	*Weather:* Foggy *Sources:* Generators, light traffic
	July 17, 2020	05:55	17.4	261.0	1669.8	4.2	1.1	0.10	0.26	*Weather:* Heavy fog *Sources:* Generators, ATVs

The measurements for the $PM_{2.5}$ and PM_{10} were compared to the Air Quality Index from the Environmental Protection Agency of Victoria, Australia[88] which categorizes emissions with 1-hour mean measurements as follows:

- Good: $PM_{2.5}$ levels lower than 25 µg/m^3; PM_{10} lower than 40 µg/m^3.
- Moderate: $PM_{2.5}$ levels between 25 to 50 µg/m^3; PM_{10} levels are between 40 to 80 µg/m^3.
- Poor: $PM_{2.5}$ levels between 50 to 100 µg/m^3; PM_{10} levels are between 80 to 120 µg/m^3.
- Very Poor: $PM_{2.5}$ levels between 100 to 300 µg/m^3; PM_{10} levels are between 120 to 300 µg/m^3.
- Hazardous: $PM_{2.5}$ levels greater than 300 µg/m^3; PM_{10} greater than 300 µg/m^3.

As seen in Table 10-3, all sampling locations recorded $PM_{2.5}$ well below the 62 µg/m3 threshold for poor ambient air quality and indeed, also lower than 27 µg/m3. As a consequence, measurements of indicate that air quality may be categorized as “good”. This is especially important given that small particulates, smaller than 10 microns, pose the greatest health problems as they can enter deep into the lungs and potentially, into the bloodstream. $PM_{2.5}$ are significantly correlated to negative health outcomes such as decreased lung function, aggravated asthma, increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing, non-fatal heart attacks, irregular heartbeats and premature death in people with heart or lung disease[89].

On the other hand, none measurements of PM_{10} were categorized as “good” air quality. Eight of the locations within the project footprint had PM levels between 40 to 80 µg/m^3, and two slightly above, indicating that the air quality was “moderate” which is consistent with findings of the 2012 baseline assessment. Although the other two measurement are considered “poor” these levels may be attributed to the natural changes in the surrounding environment such as higher wind speeds resulting in greater dispersion of particulate matter such as airborne soil and pollen. However, the levels of PM_{10} in the Matthew’s Ridge community (at the *Shel Nic Nel* Hotel) were at levels which would be considered very poor or hazardous. This is most likely due to the heavy foggy conditions which were prevalent during the sampling periods. In heavy fogs, airflow is restricted and creates circumstances akin to a temperature inversion where particulate matter is suspended in the air. This may have included natural sources coupled with emissions from the generator which was active during the sampling period. The measurements of TSP generally followed the trend observed for PM_{10}.

All gases measured were well within the acceptable levels. However, it should be noted that although the measurements were conducted for 15-minutes for each test, the results were compared to:

- The 10-minute mean for SO_2 and the 1-hour mean for NO_2 from the WHO.
- The 1-hour mean for CO from the Environmental Protection Agency from Victoria, Australia.

There are no major industrial activities in the project locations and most gaseous emissions were related to natural sources such as decomposition and decay of trees and other organic matter and anthropogenic sources of fuel combustion for vehicles, machinery among other mobile sources.

10.2.4 Port Kaituma Air Quality

The 2020 baseline air quality assessment consisted of three sample locations within Port Kaituma. These sites were also selected based on the location of key project components and the proximity of receptors to project components and planned project activities. These sample locations were:

[88] EPA Victoria, 2021. How We Calculate Air Quality Categories.
[89] United States Environmental Protection Agency, 2020. Particulate Matter Pollution

- The Four Miles titled indigenous village. A section of the public road connecting Matthew's Ridge to Port Kaituma passes through this village. As a result, the community is normally exposed dust from traffic related to small scale gold mining and logging activities and transportation of people into and out of Port Kaituma. During the construction phase of the project, GMI's light vehicles and some heavy vehicles frequently passed through the village. During the operational phases of the project, haul trucks will also pass through the village to access the Kaituma Marine Terminal. This sampling location is within the AoI of the project.
- The location of the Kaituma Marine Terminal. There are residents to the left and right of the Marine Terminal. These can be considered as receptors at risk to any potential air quality emissions above baseline levels. This sampling location is within the AoI of the project.
- The *Five Sisters Hotel* in Central Port Kaituma. Settlements in Port Kaituma is some distance away from the Marine Terminal site and is very unlikely to be affected by the Projects operations at the Marine Terminal. This sampling location is not within the AoI of the project but is considered a receptor proximate to key project components.

The sample locations are presented in Figure 10-3 and the results of the air quality assessment are presented in Table 10-4.

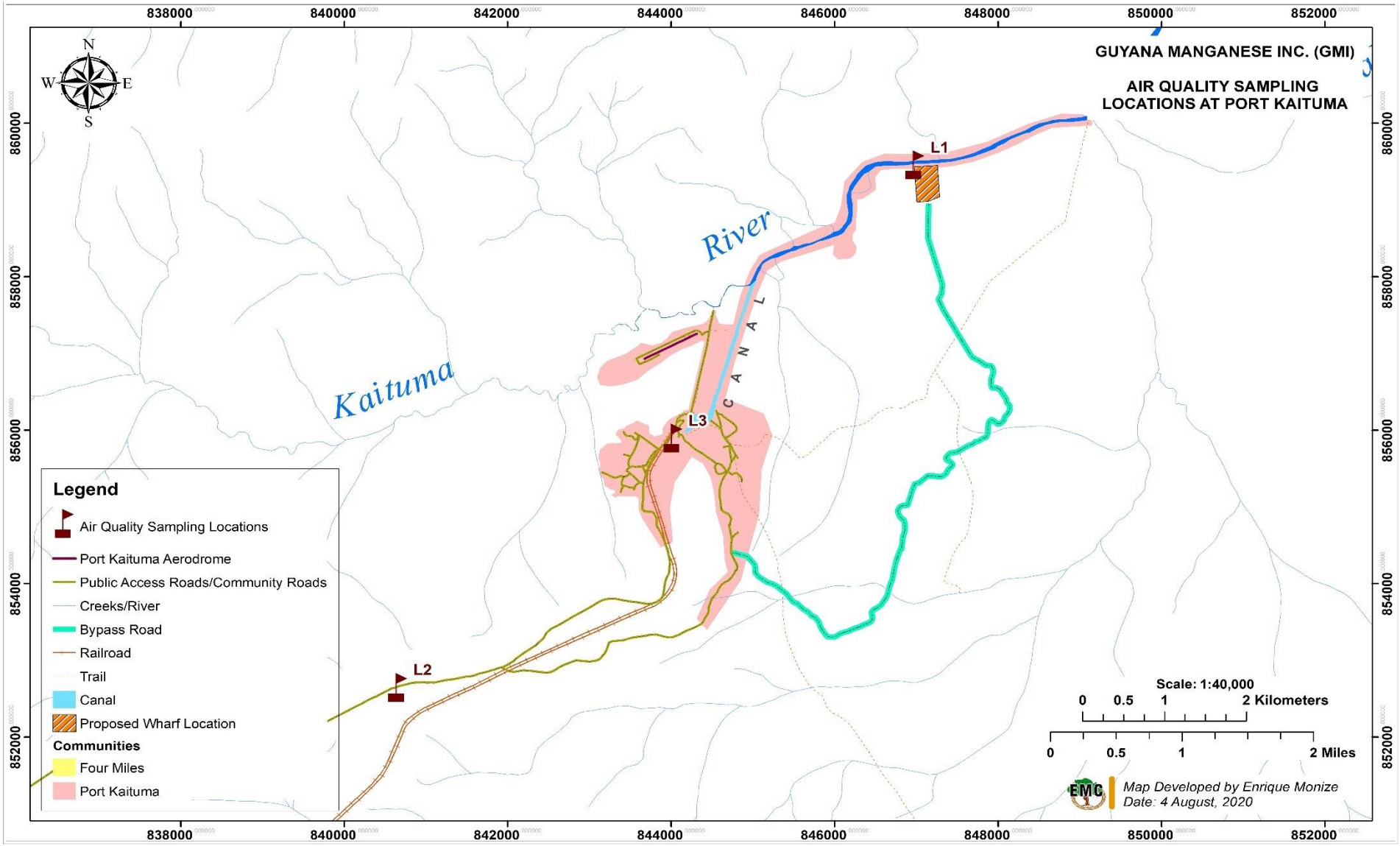


Figure 10-3: Air Quality Sample Locations in Port Kaituma (2020 Baseline Assessment)

Table 10-4: Results of the 2020 Baseline Air Quality Assessment

Locations	Date	Time (hrs)	Particulates 1-hour mean (µg/m³)			Gases: 15-minute mean (mg/m³)				Observations
			$PM_{2.5}$ (62)	PM_{10} (80)	TSP (150)	VOCs	CO (34)	NO_2 (0.2)	SO_2 (0.5)	
Kaituma Marine Terminal	July 14, 2020	14:18	18.9	58.1	59.2	22	0.15	0.081	0	*Weather:* Overcast *Sources:* Boats on the Kaituma Canal
	July 15, 2020	08:40	22.9	88.5	93.6	26.8	0.8	0.040	0	*Weather:* Sunny *Sources:* Boats on the Kaituma Canal
Four Miles Village	July 14, 2020	16:29	19.1	68.0	71.2	15.12	0.5	0.12	0	*Weather:* Intermittent Rain *Sources:* Light Traffic
	July 15, 2020	10:48	29.0	123.8	135.6	12	0.7	0.04	0	*Weather:* Sunny *Sources:* Light Traffic and ATVs
Port Kaituma Community	July 14, 2020	21:30	15.1	95.0	102.0	37.8	0	0.083	0	*Weather:* Sunny *Sources:* Light Traffic and Generators
	July 15, 2020	07:00	5.2	71.7	79.1	31	0	0.083	0	

Based on the Air Quality Index discussed in the previous section, five of the six measurements undertaken for $PM_{2.5}$ indicate that air quality at the Port Kaituma sampling locations was “good”. The measurement for the remaining sampling point is also likely to have been within the “good” categorization but for ATVs traversing on the road during the measurement. Although none of the measurements for PM_{10} would be within the “good” category, one measurement at each of the three sites revealed that air quality was considered “moderate”. The remaining three measurements are expected to have been influenced by other sources in the surrounding environment including natural sources such as wind and anthropogenic sources including traffic on the adjacent road and river networks. TSP measurements followed a similar pattern. However, it should be noted that the levels of all particulates are likely to be greater during the dry season, particularly for the sampling location in the Four Miles village, as recent rainfall may have had a dampening effect on dust which is typically emitted from the laterite roads.

All gases measured were well within the acceptable levels and SO_2 was not detected at any of the sampling locations. This is similar to the measurements at Matthew’s Ridge and is also influenced by the absence of major industrial activities in the project locations. It is expected that most gaseous emissions were related to natural sources such as decomposition and decay of trees and other organic matter and anthropogenic sources of fuel combustion for vehicles, machinery among other mobile sources.

10.3 Impact Assessment – Air Quality

The main potential pollutants from this project are particulate matter and fugitive dust, manganese dust and fumes, sulfur oxides (SO_x), nitrous oxides NO_x), methane (CH_4), carbon oxide and VOCs mainly from the extraction, processing, transportation of ore, and activities requiring fuel combustion. The planned project activities from which these potential emissions may be generated, as well as associated potential impacts and potential receptors are presented in Table 10-5. However, other polluting substances may also be emitted from the project but these are not currently controlled by the WHO. Nevertheless, GMI should conduct a full inventory of all materials and chemicals to be used in their operations to determine whether any emissions from these sources may be considered harmful to human health, in particular for its workers.

Table 10-5: Sources of Air Emissions and Potential Receptors

Potential Emissions	Potential Sources/Activities	Potential Impacts	Potential Receptors
Particulate Matter ($PM_{2.5}$, PM_{10} and TSP)	Stripping, blasting and excavation (Hills 1 to 9)	Visibility, health, vegetation	Workers, residents of Matthew’s Ridge, vegetation
	Dust from the movement of heavy machinery, haul trucks and other project vehicles on internal and public roadways	Visibility, health, vegetation	Workers, road users, residents of communities in Matthew’s Ridge, Eclipse Falls, Four Miles and Port Kaituma, vegetation
	Processing Plant (Crushing and Jigging)	Visibility, health	Workers, residents of Matthew’s Ridge
	Fuel combustion, mainly diesel, from the generators and project vehicles	Visibility, health, vegetation	Workers, of the primary and

Potential Emissions	Potential Sources/Activities	Potential Impacts	Potential Receptors
			secondary AOI, vegetation
	Dust from waste dumps in Matthew's Ridge and ore stockpiles in Matthew's Ridge and Port Kaituma	Visibility, health, vegetation	Workers, residents in the primary AoI
Emissions of Manganese Dust and Fumes	Stripping, blasting and excavation (Hills 1 to 9)	Health	Workers, residents of Matthew's Ridge
	Ore processing (crushing and jigging)	Health	Workers and residents in the vicinity in Matthew's Ridge
	Ore transportation (loading, offloading)	Health	Workers and residents in the vicinity in Matthew's Ridge, Port Kaituma and residents in the secondary and tertiary AoI
CO, VOCs, SO_x, CH_4 and NO_x	Fuel Combustion – power plant, project vehicles and machinery	Health and Vegetation	Workers and residents in the vicinity in Matthew's Ridge and Port Kaituma

10.3.1 Fuel Combustion by the Project

One of the main sources of all types of emissions expected to be generated from planned project activities is the combustion of fuel. As seen in Table 10-6, diesel is the main type of fuel which is planned to be used by the project. The most significant consumer of diesel is the power plant in Matthew's Ridge, with all other sources of emissions being mobile sources associated with project transportation.

Table 10-6: Sources of Fuel Combustion by the Planned Project Activities

Source	Description
Fuel Combustion for Electricity Generation	Matthew's Ridge Power Plant comprises of six 1080-kW generators and is collectively estimated to consume 1,735,000 gallons of diesel per year.
	Two 50-kW generators at the Kaituma Marine Terminal and Log Pond Facility in Port Kaituma are estimated to collectively consume 28,000 gallons of diesel per year.
Fuel Combustion by Mines Machines and Vehicles	Mines machines and vehicles comprise of a combination of the following mines machinery including excavators, 10 trucks, 2 dozers, a grader, a fuel truck and an SUV. These vehicles are estimated collectively consume 301,836 gallons of diesel per year.

Source	Description
Fuel Combustion by Haul Trucks	Thirty haul trucks will transfer ore from Matthew's Ridge to Port Kaituma. Trips will be made twice per day during the dry season and once daily during the wet seasons. These vehicles are estimated to collectively consume 555,660 gallons of diesel per year.
Fuel Combustion by Light Vehicles	The project's light vehicle fleet comprises of 15 SUVs and 14 ATVs which are estimated to collectively consume 3,300 gallons of diesel and 660 gallons of gasoline per year.
Fuel Combustion by Barges	The collective fuel consumption of barges per year is estimated to be 327,823 gallons of diesel.

10.3.2 Potential Impacts from Emissions of Particulate Matter

As is outlined in Table 10-5, particulate matter is expected to be emitted from a several of planned project activities and this could result in a range of potential impacts associated with the project. Firstly, the combustion of diesel by the project is likely to increase the emission of 'diesel particulate matter' which contributes to the production of soot and from which several toxic air pollutants, including benzene and formaldehyde, are expected to be generated. The emission of diesel particulate matter is also associated with several negative health effects including irritation to the eyes, nose, throat and lungs. Exposure to diesel PM is primarily an occupational risk given that workers will spend longer periods in proximity to the sources of diesel combustion. Environmental exposure will be limited given that the power plant is located approximately 300 meters east of the nearest residential receptor and is also downwind of these residences. Moreover, exposure of residents and road users sharing roadways with the project will have limited exposure given that the sources will be mobile in an open-air environment where emissions may easily diffuse. However, the emission of diesel PM can be reduced if cleaner burning fuels are used by the project and engines are fitted with particle trapping filters or scrubbers. As such, potential impacts associated with the emission of diesel PM are **negative, direct, short-term** and **localised** of **negligible significance** but **certain** to occur during the project lifetime. Emissions of diesel PM resulting in adverse health impacts is a **Low Risk** of the project.

Particulate matter is also expected to be generated when vehicles traverse internal and public laterite capped roadways. Dust emissions is an existing concern from vehicles traversing the public road connecting Matthew's Ridge to Port Kaituma during the dry seasons. According to feedback provided by representatives of the Guyana Geology and Mines Commission (GGMC), during the dry seasons, dust emissions from the Matthew's Ridge to Port Kaituma public road result in considerable changes in daily life of the residents of Eclipse Falls who were reported to have to wait until evening and nights, when traffic is lower, to hang out their laundry (EMC Personal Communication 10). According to the Chairperson of the Eclipse Falls Community Development Council, dust covers the roofs of houses and hinders rainwater collection because the dust has to be washed off of the roof surface before rainwater collection can begin. Residents at Eclipse Falls also suggest that dust emissions may lead to illnesses like cold and flu, especially among children (EMC Personal Communication 20). Dust emissions were also reported to cover internal surfaces of homes in Four Miles Village (EMC Personal Communication 19). Ore transportation using haul trucks during the dry to transport ore from Matthew's Ridge to Port Kaituma is expected to significantly contribute to higher levels of dust generated along the roadway. In particular, 30 haul trucks making two return trips per day in addition to interspersed trips using other project vehicles.

Increased emissions of dust generated by project vehicles are anticipated to result in several potential impacts. Existing challenges of managing dust levels from the road during the dry season will be amplified for residents of Eclipse Falls. GMI has made provisions for a watering truck to dampen the road during dry season from the operational site in Matthew's Ridge to the Arakaka/Four Corners Junction, and in Port Kaituma from the toll booth at Four Miles to the Kaituma Marine Terminal. There

are significant logistical challenges of GMI conducting road wetting for roads passing through Eclipse Falls given the distance of the community from the operational bases in Matthew's Ridge and Port Kaituma. These challenges include refueling water trucks and locating an appropriate source of water. However, GMI will construct and maintain at least one speed bump on the road passing through Eclipse Falls to reduce the speed of project and non-project vehicles passing through the community so as to reduce dust levels generated from the road. Drivers of GMI's vehicles will also be required to transit through the community at lower speeds and GMI will also patrol the area liaise with residents to ensure that there is compliance with this policy. Defaulting project drivers will be subject to disciplinary measures.

The dry seasons, in combination with frequent passages by vehicles, may result in rapid drying of the road surface therefore still exposing communities such as Four Miles to dust emissions. Increased dust generated along the Matthew's Ridge to Port Kaituma road is also likely to reduce visibility for all road users, including pedestrians, and contribute to adverse impacts to vegetation. The potential impacts associated with dust emissions are **negative, direct, short-term** and **localised** of **moderate significance** but are **certain** to occur. As such, dust emissions associated with use of the Matthew's Ridge to Port Kaituma public road by project vehicles present **High Risk** to the project.

Finally, particulate matter can be generated from mining operations including stripping topsoil, blasting, open pit mining, ore processing as well as ore handling and transportation. Entrained dust may also be generated from ore stockpiles and waste piles. In general, particulates generated may be relatively inert dusts which have potential to cause inflammatory responses in the lungs. However, manganese dust and fumes may also be released from these sources. As discussed in Chapter 20 – Health, inhalation of manganese dust poses risks of significant adverse health outcomes for people who are occupationally exposed as well as environmentally exposed. Particulate matter may also include trace metals that naturally occur in the soils and surface waters of Matthew's Ridge including iron, lead, zinc and arsenic. These emissions are considered to include particulates of varying sizes ranging from 2.5 to 100 microns which are considered to represent the TSP.

The dispersion of TSP was modelled using SCREEN VIEW, a Gaussian dispersion screening model by the United States Environmental Protection Agency[90]. The model was applied using an TSP emission rate of 0.0000118 grams per second per square meter which is considered to be the typical emissions for activities in an exposed open pit face[91] along with an estimated area of 5,000 square meters. As seen in Figure 10-4, the results of the modelling which suggest that the initial concentration reaches just over 425 µg/m^3 at source and then steeply declines as distance from the source increases. As such, at 500 meters from the source, TSP is anticipated to be just below 100 µg/m^3 and at 1 kilometer from the source approximately <50 µg/m^3 at 1km. It is expected that levels of particulate matter generated during blasting activities may be higher than these TSP predicated by the model. The model considers only a simple flat terrain and presents the worst-case scenario for TSP emissions in all metereological conditions. Ultimately, the concentration and dispersion direction of fugitive dust and suspended particulate matter will be influenced by temperature, wind, precipitation and elevation of the sources and receptors. TSP emissions are typically lower travelling up-slope or down-slope from the source and particulates are likely to settle. In the undulating terrain of Matthew's Ridge, TSP concentration are expected to be significantly lower. As previously noted, wind directions in Matthew's Ridge are east to south east and wind speeds are relatively low. In addition, there are no residential receptors at least 500 meters downwind of any of the operations. As a consequence, environmental exposure to the TSP emissions are expected to be well within the WHO air quality limits for particulate matter exposure. In addition, GMI has put plans in place limit entrained dust generated during the

[90] SCREEN VIEW Screening Air Dispersion Model; Lakes Environmental: Waterloo, Ontario, Canada, 2002.
[91] Chaulya, S.K., 2002. Emission Rate Formulae for Surface Iron Ore Mining Activities.

transport of manganese by truck or barge by covering the ore. In addition, ore stockpiles and waste piles will be wetted to ensure that dust levels remain low.

Potential impacts associated with environmental exposure to high TSP concentrations are expected to be **direct, negative short-term** and **localised** of **moderate significance** and **likely** to occur during the project lifetime. As a result, environmental exposure to particulate matter from project activities, including potential exposure to manganese dust, are **Medium Risks** of the project. However, given the relatively high TSP concentrations at the source, occupation exposure may be high and may occasionally exceed the OSHA permissible limits both for exposure to inert dust as well as exposure to manganese dust. These risks will be greatest for workers in the active mine sites and at the processing plant. All the workers will be equipped with appropriate PPE, including N95 face masks for those exposure to high level of dust. Mine site will also be wetted daily in the dry season. The crushers and the jigging machines are enclosed with steel structures, which will reduce eimissions. The potential health outcomes of occupational exposure to high levels of particulate matter, including exposure airborne manganese, will be **direct, negative short-term** and **localised** of **moderate significance** but **likely** to occur. This results in **Medium Risks** associated with the project activities.

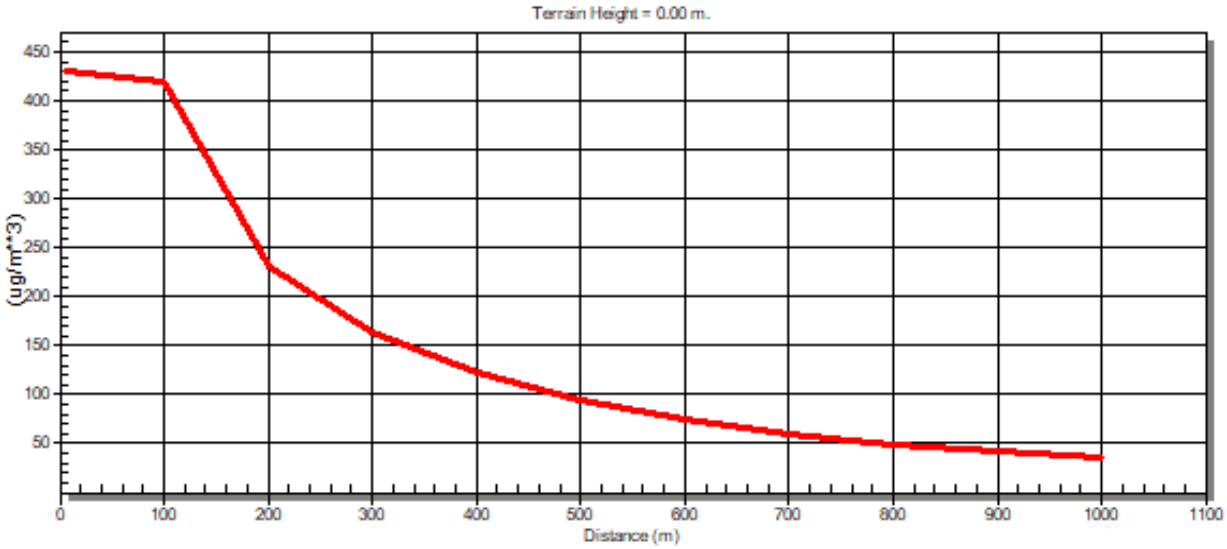


Figure 10-4: Dispersion Model for Total Suspended Particulates (TSP)

10.3.3 Potential Impacts from Emissions of Gases

All gases and particulate matter are expected to be emitted from fuel combustion associated with planned project activities. SCREENVIEW was also used to estimate dispersion rates of NOx, SOx, CO and PM for diesel combustion generators at the Matthew's Ridge Power Plant. Estimations were based on the the USEPA AP-42 emission factors[92] for diesel engines and applied the following assumptions which are typically applied for industrial generators[93]:

- Emissions rates (grams per second per square meter) of 0.088114048 for NOx; 0.005826897 for SOx, 0.018987156 for CO and 0.006253255 for PM_{10}.
- Diesel will be burned in two shift of 10 hours each daily.
- Presence of an emission stack with a height of 10 meters and a diameter of 1.5 meters.

[92] United States Environmental Protection Agency, 2019. Basic Information of Air Emissions Factors and Quantification.
[93] Ground Structures Engineering Consultants. 2018. Draft Environmental and Social Impact Assessment. Marudi Mountain Gold Mine for Romanex Guyana Exploration Limited. Pp 121.

- Stack gas exit velocity of 0.82m/s, and exhaust temperature of 186°C.

The dispersion models are presented in Figure 10-5 to 10-8.

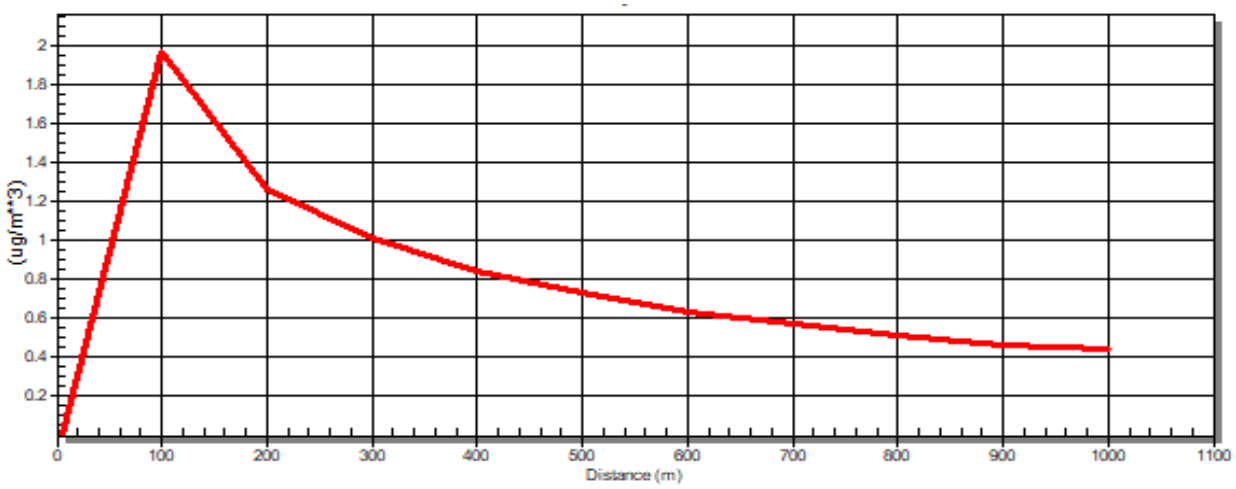


Figure 10-5: Dispersion Model for Nitrous Oxides (NOx) for the Matthew's Ridge Power Plant

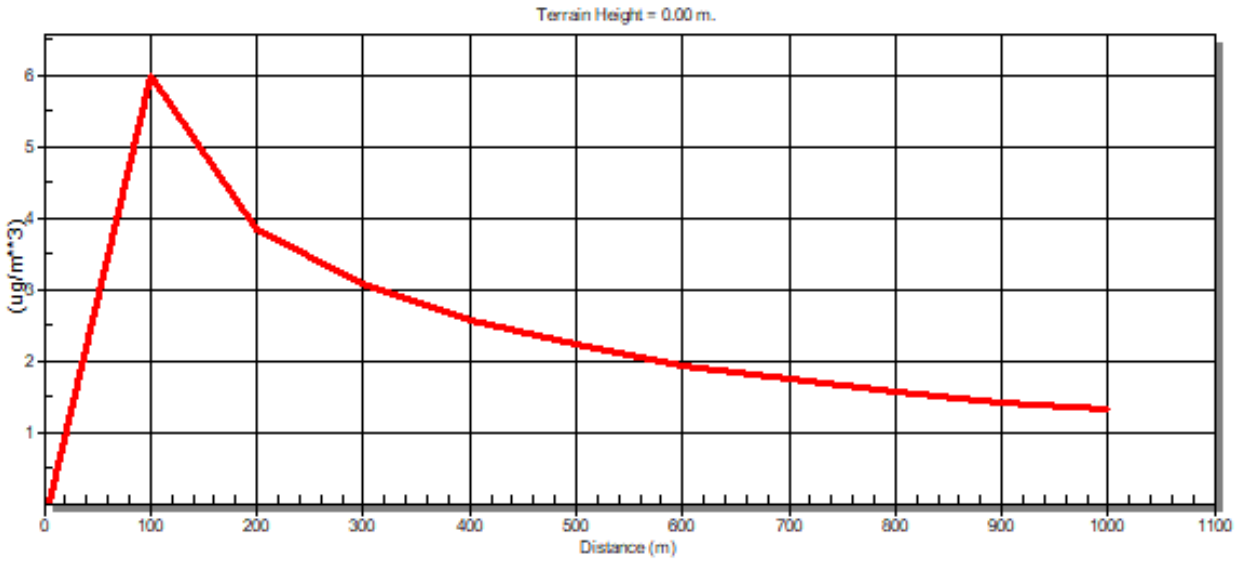


Figure 10-6: Dispersion Model for Carbon Monoxide (CO) for the Matthew's Ridge Power Plant

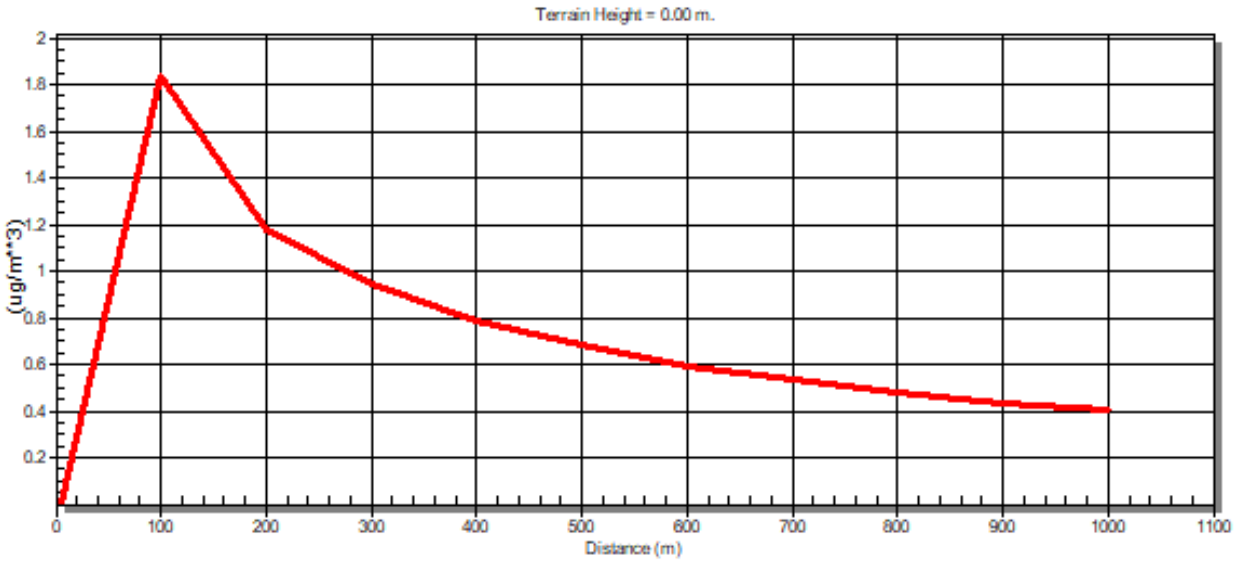


Figure 10-7: Dispersion Model for Sulphur Oxides (SOx) for the Matthew's Ridge Power Plant

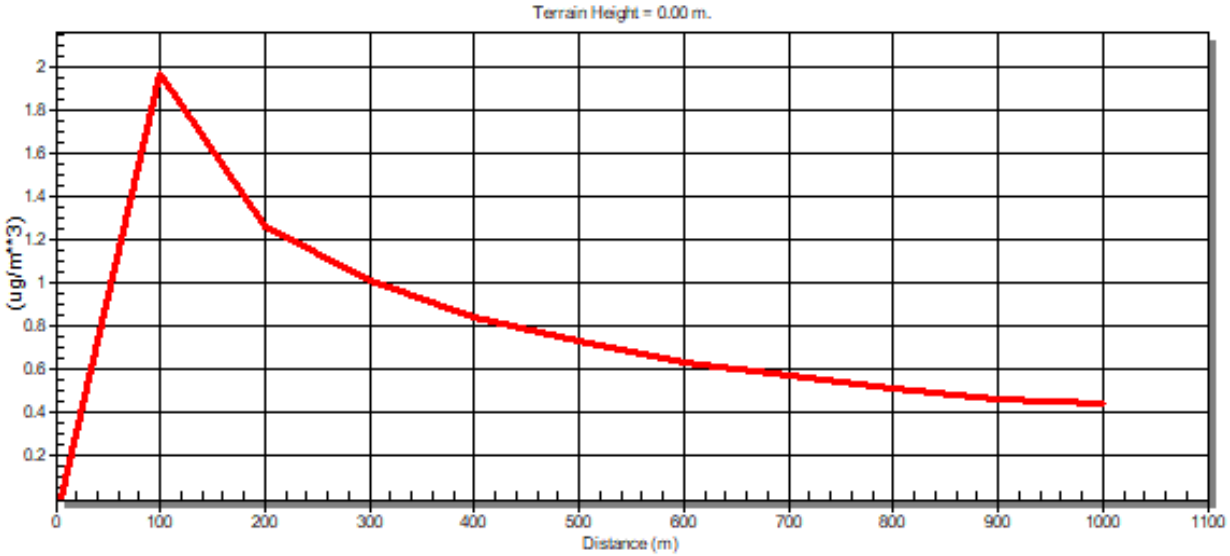


Figure 10-8: Dispersion Model for PM_{10} for the Matthew's Ridge Power Plant

The results of the modelling suggest low concentration levels, with peaks within the first 100 metres from the source then decreasing with distance. These dispersion models were also run under the assumption that the terrain is flat and therefore concentrations of these gases at distances over 100 meters are expected to be lower than estimated by the models. Although the concentrations of VOCs were not modelled, they are expected to behave in a similar manner with peaks within the 100 meters and significantly lower concentrations as emissions disperse with distance. In addition, gaseous emissions from the combustion of fuel will come from non-stationary sources such as heavy vehicles, machinery and barges but the emissions from these will not significantly increase beyond the resulting modelled concentrations. Moreover, these sources are transient and easily dispersed in the open air. Both environmental and occupational exposure to high concentrations of gases from project activities

are expected to be low. As such potential impacts of air pollution from fuel combustion are **negative, direct, short-term** and **localised** of **negligible significance** but **certain** to occur. As such, air pollution from project activities are **Low Risks**.

10.3.4 Potential Impacts of Ozone Formation

Ozone is a secondary pollutant and is formed through a photochemical oxidation process involving nitrogen oxides (NOx) and volatile organic compounds (VOCs) in the presence of sunlight. The high temperatures which are prevalent in Matthew's Ridge can accelerate the formation of ozone. However, high levels of UV radiation also contribute to the destruction of ozone. Mean net radiation in Matthew's Ridge is normally high. Ultimately, a net ozone formation of net ozone destruction will be determined with the quantities of NOx and VOCs which are emitted by project activities. Although natural production NOx and VOCs may be relatively abundant from soils and trees, baseline levels of these pollutants were low. Moreover, as seen in Figure 10-5, the generation and dispersion of NOx from the Matthew's Ridge Power Plant, the largest consumer of fuel in the project, is low and well within the WHO acceptable limits. VOCs generation and dispersion are expected to follow the similar pattern. As such potential impacts of air pollution from fuel combustion are **negative, direct, short-term** and **localised** of **negligible significance** but **unlikely** to occur. As such, air pollution from project activities are **Low Risks**.

10.3.5 Cumulative Impacts

The most significant source of gaseous emissions from the planned project activities will be emitted from the power plant in Matthew's Ridge. In addition to the power generated by GMI, the Guyana Power and Light (GPL) has a power station in Matthew's Ridge which is equipped with a 175kVa generator set. Further, several residences in the Matthew's Ridge community are also equipped with generators. However, as discussed above emissions from the GMI power plant will be low and will disperse rapidly given the prevailing topographical and meteorological conditions of Matthew's Ridge. Similar emissions and dispersion patterns are anticipated for the other generators mentioned above. Moreover, all gaseous emissions from fuel combustion in non-project vehicles are also expected to be transient and quickly dispersed. As such, no cumulative impacts are expected from fuel combustion for project and non-project activities.

As discussed above, during the dry season, 30 haul trucks making two return trips per day in addition to occasional trips using other project vehicles. Each truck making 2 return trips will result in an additional 120 one-way trips per day. This is a significant increase in heavy traffic traversing the Matthew's Ridge to Port Kaituma road. The increase in total road traffic frequently traversing the public road connecting Matthew's Ridge to Port Kaituma is expected to significantly intensify both the existing levels of dust generated when vehicles traverse the road as well as the dust emissions expected to be generated from project vehicles. As previously indicated, GMI has put measures in place to wet certain sections of the road during the dry season, these measures will not cover the public road between the Four Corners Junction and the Toll Booth in Port Kaituma. As such, road users, including users of light vehicles such as ATVs, and the residents of Eclipse Falls are expected to be exposed to significant amounts of dust. This potential impact is expected to be **direct, negative, long-term, cumulative** and **localised** of **moderate significance** and are **certain** to occur. Cumulative emissions of dust from vehicles traversing the Matthew's Ridge to Port Kaituma road are **High Risks** of the project.

10.4 Mitigation and Monitoring Measures – Air Quality

As previously discussed, GMI has already instituted several measures to reduce the potential health risks associated with the project. These measures include:

- Putting measures in place for road wetting in Matthew's Ridge and Port Kaituma by acquiring three water trucks.
- Developing methods to cover manganese ore being transported by haul trucks and barges.
- Wetting of ore stockpiles and spoil piles.
- Enclosing the crushers and jigging machines.
- Suppressing particulates on the conveyor belt by spraying of water.
- Procuring low emission fuels by specification
- Commencing monitoring of $PM_{2.5}$, PM_{10} at Matthew's Ridge.

However, the following mitigation and monitoring measures should also be implemented to minimise dust emissions associated with the project:

- Develop an air quality monitoring programme to determine levels of manganese in the air at high-risk worksites (manganese extraction and processing) and sensitive receptors down-wind of these sites. The air quality monitoring programme should also measure the concentrations of other air pollutants including dust generated along the Matthew's Ridge to Port Kaituma Road in the vicinity of Eclipse Falls. GMI has already commenced the monitoring of $PM_{2.5}$, PM_{10} and noise level at Matthews Ridge.
- Explore options for dust suppression on the Matthew's Ridge to Port Kaituma public roadway.
- Test emissions from the generator house stack annually for NOx and PM to ensure emissions guidelines are met. In addition, specification of fuel is being provided by Sol for each shipment.
- Provide N95 masks for all employees working in areas where risks of exposure from manganese dust are high in particular employees involved in manganese extraction and processing.
- Re-vegetate or cover exposed soils and other erodible materials promptly and as part of mine reclamation.
- Enclose dusty materials storage areas by installing efficient dust suppression methods in these areas.
- Ensure that the loading, transferring, and discharging of materials will take place with a minimum height of fall, and will be shielded against the wind.
- Cover and equip conveyor systems for dusty materials with measures for cleaning return belts.
- Maintain a vegetated buffer zone on the project boundary.
- Establish an automated meteorological station to measure rainfall, temperature (maximum and minimum), humidity, evaporation, wind speed and direction, and hours of sunshine.
- Liaise regularly with nearby receptors to determine if persons are being affected by dust and other emissions.

Table 10-7: Summary of Impacts and Mitigation Measures

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
Air Quality								
Fuel Combustion from Stationary and Mobile Sources	Compliance with Guyana Regulations; IFC and WHO air quality guidelines; Best practices for equipment maintenance	Emissions of diesel PM and pollutant gases (NOx, SOx, CO, VOCs, etc)	Negative, Direct, Short Term, Localised	Negligible	Certain	Low	Adherence to Operational Controls	Monitoring of air quality parameters PMs, including manganese dust, and pollutant gases (NOx, SOx, CO, VOCs, ozone)
Overland Transportation	Compliance with Guyana Regulations; IFC and WHO air quality guidelines; Best practices for equipment maintenance	Emissions to particulate matter as dust generated by project vehicles traversing the laterite roads	Negative, Direct, Short Term, Localised	Moderate	Certain	High	Road wetting in Matthew's Ridge and Port Kaituma	Monitoring of air quality parameters for PMs on project roads including the Matthew's Ridge to Port Kaituma public road
Mining and Processing Ore	Best practices	Environmental exposure to high concentrations of TSP, including manganese dust	Negative, Direct, Short Term, Localised	Moderate	Likely	Medium	Adherence to Operational Controls	Monitoring of air quality parameters PMs including manganese dust
Mining and Processing Ore	Compliance with Legislations and Regulations; Best practices	Occupational exposure to high concentrations	Negative, Direct,	Moderate	Llikely	Medium	Adherence to Operational Controls	Monitoring of air quality parameters PMs

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
		of TSP, including manganese dust	Short Term, Localised				Provision of N95 masks for high-risk staff Dust suppression of ore stockpiles and spoil piles	including manganese dust
Fuel Combustion from Stationary and Mobile Sources	Compliance with Legislation and Regulations	Formation of Ozone	Negative, Direct, Short Term, Localised	Negligible	Unlikely	Low	Adherence to Operational Controls	Monitoring of air quality parameters PMs, including manganese dust, and pollutant gases (NOx, SOx, CO, VOCs, ozone)
Cumulative Impacts								
Overland Transportation	Compliance with Guyana Regulations; IFC and WHO air quality guidelines; Best practices for equipment maintenance	Emissions to particulate matter as dust generated by project and non-project vehicles traversing the laterite roads	Negative, Direct, Long Term, Localised, Cumulative	Moderate	Certain	High	Road wetting in Matthew's Ridge and Port Kaituma	Monitoring of air quality parameters for PMs on project roads including the Matthew's Ridge to Port Kaituma public road Engage with residents of Eclipse Falls

Chapter 11 - Climate and Climate Change

This chapter describes the existing weather and climatic conditions in Guyana with specific focus on the project areas of Matthew's Ridge and Port Kaituma. It assesses potential impacts on climate change due to emissions of greenhouse gases (primarily emissions of carbon dioxide) from planned project activities. This chapter also assesses whether the existing and projected climate-related risks may result in adverse impacts to planned project activities or to the project components which are outlined in Chapter 4.

11.1 Administrative Framework – Climate and Climate Change

Table 10-1 summarises the legislation, policies, strategies, and international treaties related to climate and climate change that are relevant to the planned project activities.

Table 11-1: Legislation, Policies, Strategies and International Treaties

Title	Description	Applicability to the Project
Policies and Strategies		
Green State Development Strategy: Vision 2040 (2019)	Outlines Guyana's 20-year plan for development that follows a green agenda defined by sustainable, low-carbon and resilient development. The GSDS also aligns with the 2030 Sustainable Development Goals (SDGs) outlined by the United Nations.	The GSDS outlines the sustainable management of natural resources as one of the key objectives with policy recommendations for the management of precious metals, minerals and aggregates. Of relevance to the project are recommendations in relation to rehabilitation of mined out areas and to put such sites to productive use as future green economy investments.
Low Carbon Development Strategy (2013)	Outlines Guyana's approach to low-carbon and climate resilient development including but not limited to the use of renewable energy, sustainable forest management, and climate change adaptation.	The LCDS developed a REDD+ mechanism to reduce deforestation and to earn revenue from forest climate services which required prudent management of extractive industry to minimise environmental footprint, in particular forest clearance, and to improve efficiency of operations.
International Treaties and Protocols		
United Nations Framework Convention on Climate Change (1992)	Aims to stabilise greenhouse gas emissions to reduce risks associated with adverse climate change impacts.	Parties to the Convention periodically submit inventories of greenhouse gas emissions and removals as well as information on measures being taken to adapt to climate change impacts. Guyana ratified the Convention in 1994.

Title	Description	Applicability to the Project
Paris Agreement (2015)	Aims to strengthen the global response to climate change by limiting increases to average global temperatures, increasing climate change adaptation and resilience building, and making financing available for low-emissions and climate resilient development.	Parties have taken voluntary contributions on how efforts taken to achieve the goals of the Paris Agreement. Guyana's Nationally Determined Contribution outlines actions to avoid deforestation, including by minimising emissions from the forestry and mining sectors, and to transition to renewable energy for electricity generation.
Montreal Protocol on Substances that Deplete the Ozone Layer (1987 with revisions).	Aims to phase out the use of several groups of halogenated hydrocarbons that may deplete the ozone layer.	A schedule to achieve phasing out of ozone depleting substances by 2030 was developed and is being implemented by the National Ozone Action Unit. Guyana acceded to the Protocol in 1993.
United Nations Convention to Combat Desertification – Land Degradation Target Setting Programme (2015)	Establishes a voluntary target setting programme that allows Parties to establish national targets and associated measures to achieve land degradation neutrality.	Guyana voluntarily undertook the Target Setting Programme in 2016 and established the target of having no net loss for the whole land area of the country and all its land cover classes by 2030 as compared to the 2000-2010 baseline.

11.2 Baseline Conditions – Climate and Climate Change

Guyana is located in the equatorial trough zone and has a wet tropical climate characterized by year-round warm temperatures and abundant precipitation. Guyana's climate, and particularly its precipitation patterns, is influenced primarily by the seasonal migration of the Inter-Tropical Convergence Zone (ITCZ) which is a cloud and rain-bearing belt of rising air where south-easterly and north-easterly trade winds converge. As a result, Guyana's coastal regions experience a bimodal annual cycle of precipitation with distinct wet seasons. The primary wet season commences in mid-April to the end of July and the secondary wet season occurs from mid-November to January. The intervening periods are known as the primary and secondary dry seasons respectively. Rainfall occurs in all seasons but typically more frequently and intensely during the primary and secondary wet seasons. Average annual rainfall ranges between 1,600 to 3,000 millimeters with spatial variability of rainfall across the country.[94]

Air temperatures range between 16°C and 34°C with the lower temperatures being observed in the higher regions of the country. Humidity is high across Guyana and with averages of 80 percent or greater in the coastal regions. Wind speeds in coastal regions average approximately 20 miles per hour and typically decreases in inland areas where lighter winds prevail.

[94] Government of Guyana, 2012. Second National Communication to the United Nations Framework Convention to Climate Change; Page 53

Guyana's climate is also influenced by the El-Niño Southern Oscillation (ENSO). During El Niño episodes, precipitation is lessened and air temperatures are warmer. In 1997 to 1998 and 2015, El Niño episodes have triggered extreme drought events in Guyana. By contrast, La Niña episodes are accompanied by wetter conditions and cooler temperatures and have been linked to flood events in Guyana. ENSO varies on an inter-annual basis in Guyana but its occurrence has been non-linear.[95] Adverse impacts of climate change are already being experienced in Guyana even though Guyana has not been a significant contributor to global climate change. According to a national-level inventory conducted as part of the Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC), Guyana is a net emitter because removals of carbon dioxide from the forests sector significantly exceed greenhouse gas emissions from all sources. In 2004, national level greenhouse gas emissions from all sources totaled 3,300 gigagrams, more than half of which was attributed to the energy sector for electricity generation and transportation. On the other hand, 61,533 gigagrams of carbon dioxide were removed by the forests sector.[96]

11.2.1 Climate Profile of the Project Locations

In order to present specific information regarding the climatic conditions at the project locations, data on monthly rainfall was collected from the Ministry of Agriculture, Hydrometerological Department for Matthew's Ridge and Port Kaituma. This was composited with data collected over the period July 2011 to June 2012 from two meteorological stations which were installed by Reunion Manganese Incorporated (RMI) and logged data on precipitation, air temperatures, evaporation, barometric pressure, humidity, solar radiation and wind speeds. However, there are significant gaps in the datasets that hinder the development of a full climate record for the project areas. For example, there are only 12-year and 5-year complete annual datasets for precipitation for Port Kaituma and Matthew's Ridge respectively. For all other variables, the only time-series available is from July 2011 to June 2012 for Matthew's Ridge.

For the purposes of this EIA, periodicity of the wet and dry seasons was disaggregated to be consistent with the patterns established in Guyana's Second National Communication to the UNFCCC. Accordingly, the primary and secondary wet seasons are May-June-July and November December-January respectively and the primary and secondary dry seasons are August-September-October and February-March-April respectively.

11.2.1.1 Precipitation

Figure 11-1 shows the monthly mean levels of precipitation observed in the 12-year record for Port Kaituma and the 5-year record for Matthew's Ridge. Precipitation throughout the year in both project locations adhered to the bimodal patterns of seasonality with distinct wet and dry seasons. At both project locations, the higher levels of precipitation were observed in the primary and secondary wet seasons as compared to the dry seasons. However, the greatest precipitation occurred in the primary wet season, extending over the period May to July, and highest total monthly rainfall occurred in June at both Matthew's Ridge and Port Kaituma. By contrast, the secondary dry season, occurring from February to April, was the driest period and the lowest level of rainfall occurred during this period at both locations.

Overall, higher levels of precipitation were consistently recorded in Port Kaituma as compared to Matthew's Ridge throughout the year. Based on the data available, total annual rainfall of at least 2,000 millimeters had a 69 percent probability of occurring in Port Kaituma but only a 33 percent probability of occurring in Matthew's Ridge. Moreover, at least 2,000 millimeters of rainfall may be

[95] Government of Guyana, 2012. Second National Communication to the United Nations Framework Convention to Climate Change; Page 177
[96] Government of Guyana, 2012. Second National Communication to the United Nations Framework Convention to Climate Change; Page 87

expected to occur approximately every 1.4 years in Port Kaituma but approximately every 3 years in Matthew's Ridge.

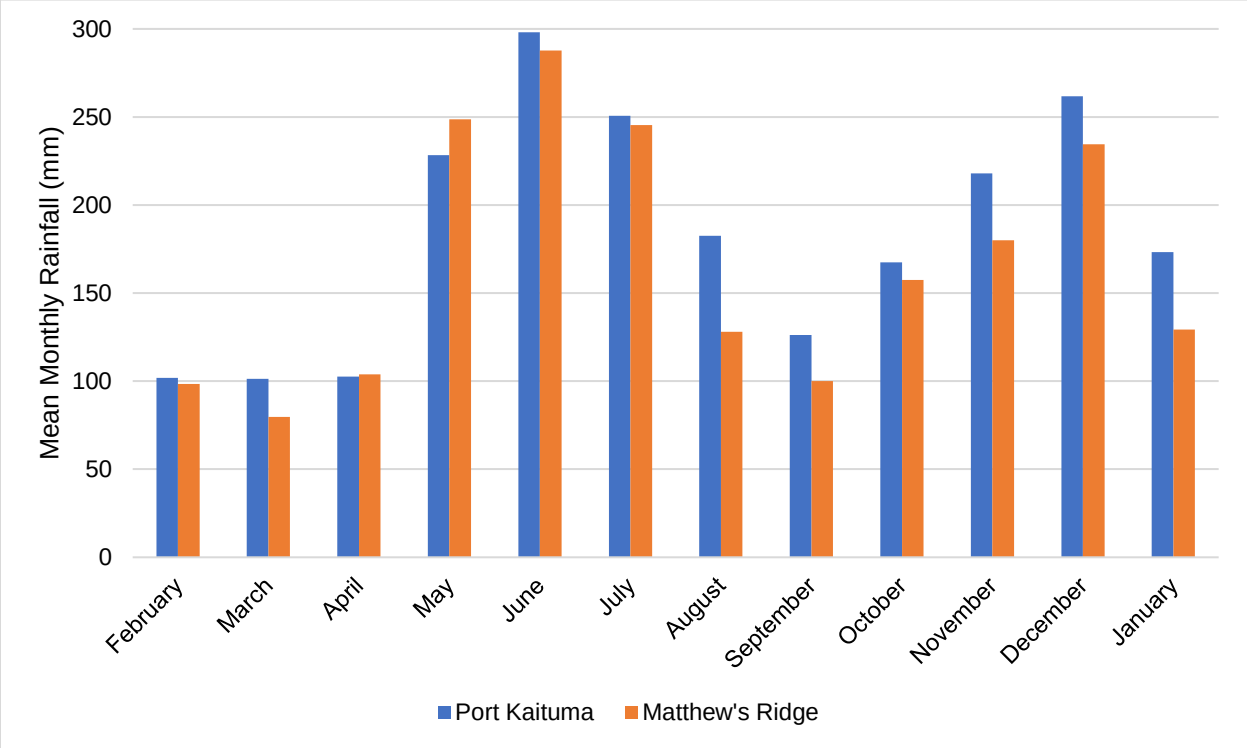


Figure 11-1: Monthly Mean Rainfall at the Project Locations

At both project locations there were strong positive trends for increased quantities of rainfall annually (Figure 11-2). Moreover, trends for monthly maximum rainfall indicate that maximum monthly rainfall increased over time in Port Kaituma but were decreasing over time in Matthew's Ridge (Figure 11-3)[97]. These trends should be considered with caution because of the limited data sets on which they are based. Ideally, robust observations on the direction and strength of any climatic changes should be based on at least 30 years of data. The data gaps and discontinuous records inherent in smaller datasets may either miss flood or drought events or amplify their effects in the observed trends. For example, there were reports of wide-spread droughts in Guyana in 2009 and the lowest level of annual rainfall was recorded in Port Kaituma for that year. Given the small dataset, subsequent records in which rainfall returned to levels typically observed in Port Kaituma are likely to have been amplified therefore contributing to the strong positive trend of increasing annual rainfall over time.

Nonetheless, these trends are consistent changes observed in mean annual precipitation at the national level. According to the Second National Communication to the UNFCCC, since the 1960s observed climate data shows increases in mean annual precipitation with an average rate of increase across Guyana of 4.8 millimeters per month representing an increase of 2.7 percent per decade. This includes consideration of heavy precipitation events in 2005 and 2008. As a consequence, these trends were not considered statistically significant. Moreover, at the national level, there were no statistically significant observations of the occurrence of extreme rainfall events.[98]

[97] Rainfall data for 2012 presented in Figure 1 – 2 and Figure 1 – 3 are composites of data collected over the period July 2011 to June 2012 by RMI's two hydrometeorological stations in Matthew's Ridge.
[98] McSweeney,C; New, M; Lizcano, G, 2010. UNDP Climate Change Country Profiles Guyana. Page 2

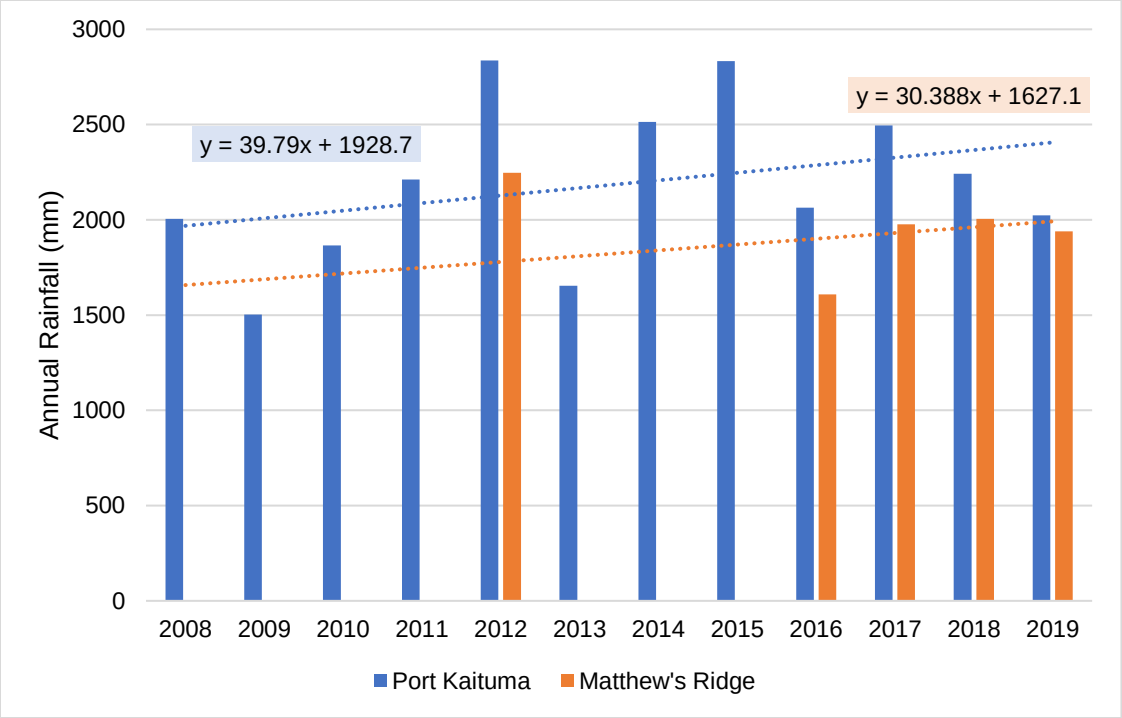


Figure 11-2: Observed Trends in Annual Rainfall at the Project Locations

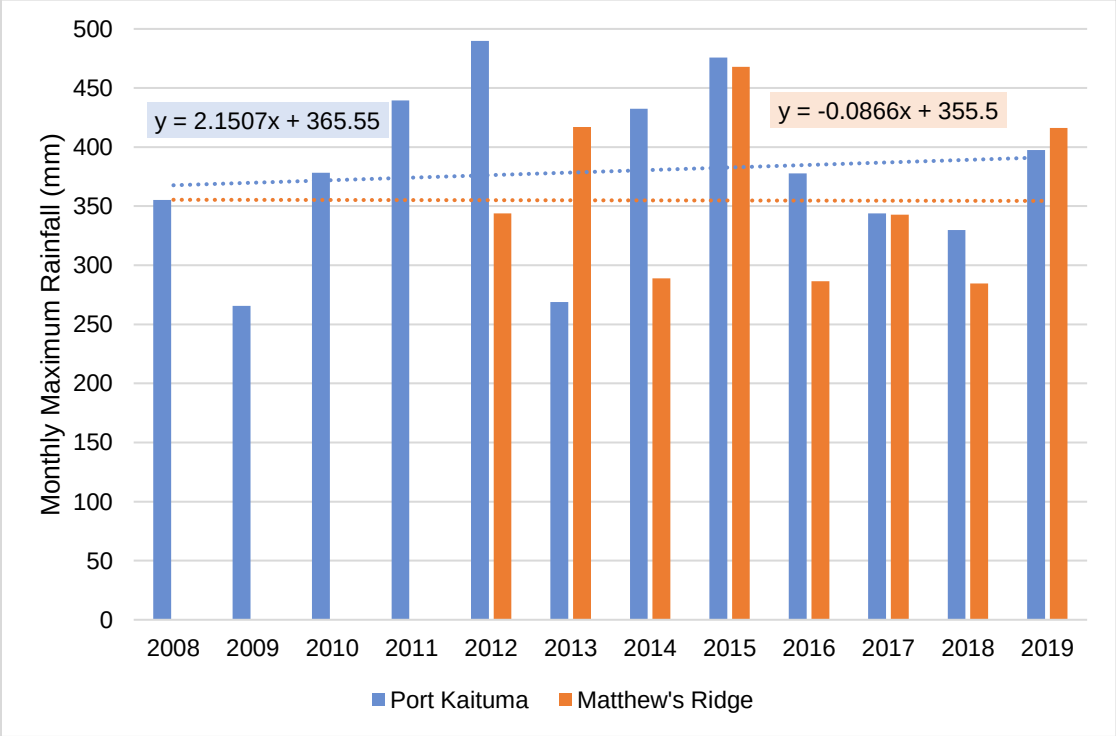
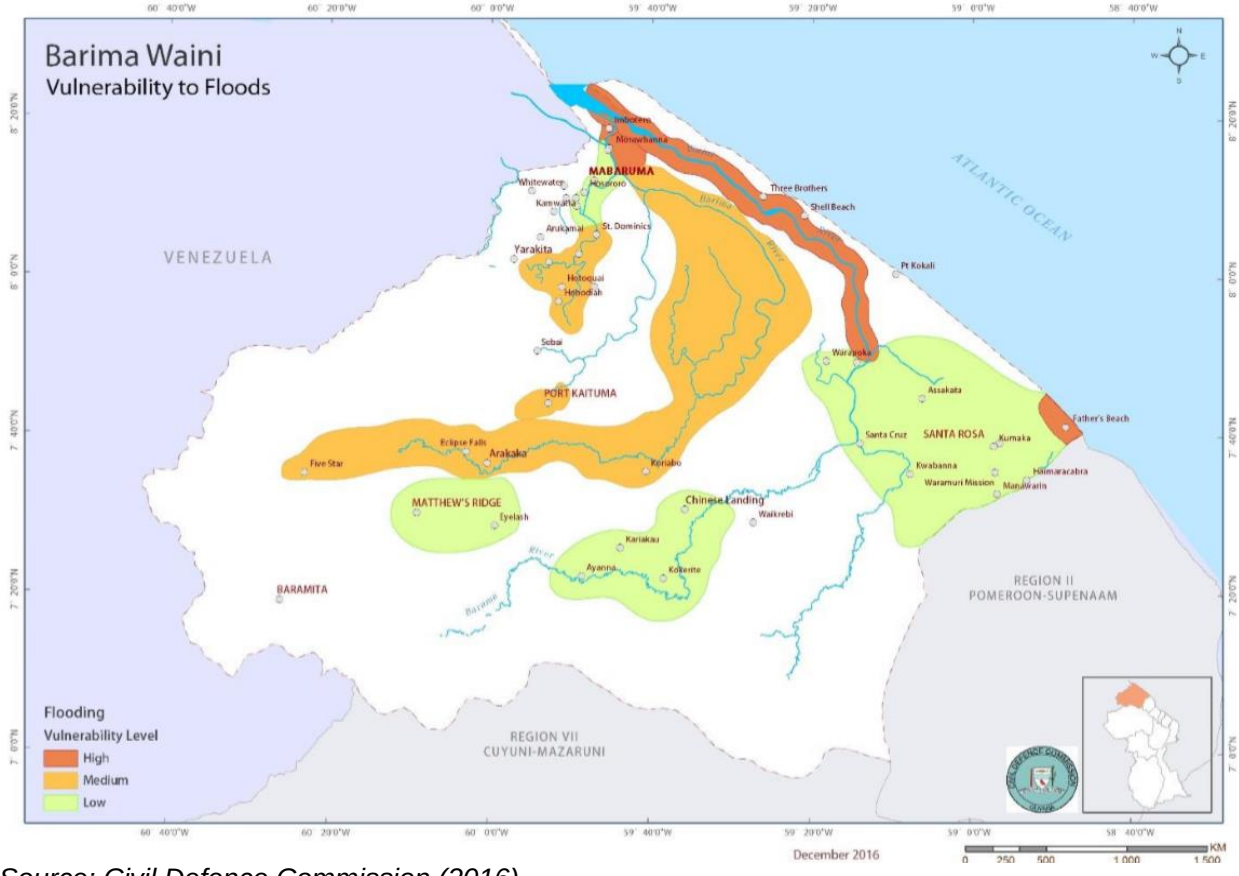


Figure 11-3: Observed Trends in Monthly Maximum Rainfall

Previous Climate-Related Events in the Project Locations

In 2015, several consecutive hours of heavy rainfall resulted in significant flooding in Port Kaituma and several residences along Pump Road in Port Kaituma were flooded. In addition, during periods of heavy rainfall some sections of the Canal Bank are prone to flooding (EMC Personal Communication 17). In addition, Lower Kaituma and St. Anselm, two communities located along the river transport route are also prone to flooding during periods of heavy rainfall (EMC Personal Communication 18).
According to the Hazard and Vulnerability Assessment of Barima – Waini, Region 1[99], prepared by the Civil Defence Commission (2016), there are high levels of localised flooding in the Port Kaituma area. Many of these flooding events are not reported in the national media and are generally viewed as common occurrence at the local level and this contributes to underreporting of flood events. Precipitation based flood events can occur as rapid onset flash floods from short and heavy rainfall events or as slowly developing occurrences during periods of prolonged rainfall. Moreover, occurrences of fluvial flooding were most commonly reported by villages along the banks of the Waini River and to a lesser extent further inland along the banks of the Barima River and the Aruka River. Overall, risks associated with flood hazards were ranked based on a combination of factors including historical and future probability of the hazard occurring; the magnitude of the event and vulnerabilities of communities, properties, businesses and the environment, and preparedness to respond to the hazard. Based on these factors, Port Kaituma was assessed to have a medium risk of flooding while flood risk in Matthew's Ridge was low.



Source: Civil Defence Commission (2016)

Figure 11-4: Flood Vulnerability Map for Region 1

[99] Civil Defence Commission, 2016. Hazard and Vulnerability Assessment of Barima – Waini Administrative Region 1. Pages 17 to 18 and 30 to 33.

By contrast, droughts have occurred historically once every 10 to 12 years while severe drought-like conditions occur on 4 to 5-year cycles and are associated with ENSO events. Drought-like conditions linked to ENSO may have contributed to variable and lower levels of precipitation observed in Port Kaituma in 2009 to 2010 and 2013 and in Matthew's Ridge in 2016. Overall, risks of droughts for Port Kaituma and Matthew's Ridge were not assessed by the Civil Defence Commission's Hazard and Vulnerability Assessment.[100]

Projected Changes in Precipitation

According to the Fifth Assessment Report from the Intergovernmental Panel on Climate Change (IPCC), projected changes in precipitation will vary geographically but increases in average annual precipitation is expected primarily in south-eastern South America while decreases are projected to occur in the northern regions of South America[101].

National-level projections for climate change in Guyana were prepared in 2010 using the outputs from several General Circulation Models (GCMs) following the A2, A1B and B1 scenarios[102]. According to the World Meteorological Organisation (2010), the current levels of greenhouse gas emissions put the world on a trajectory for more than 5°C of warming by end-century. This is most closely aligned with the A2 scenario and as a consequence, the outputs of this scenarios are most relevant to Guyana.

All outputs from these models are changes in the mean relative to a 1960 to 2006 baseline period. The general trend from the three scenarios is that average annual precipitation will decrease but there is no clear direction of the trend as both positive and negative projections of precipitation change are generated when minimum and maximum values are considered. For example, by the 2090s, changes in annual average precipitation are projected to range from an 8 percent increase to a 63 percent decrease for the A2 scenario. By the 2030s and 2060s, the maximum values all show an increasing trend across all scenarios. This direction of change is consistent with observations for both Port Kaituma and Matthew's Ridge. In the A2 scenario, the largest increases are projected to occur in the primary dry season. Table 11-2 shows the maximum values for the 2060s and 2090s for the A2 scenario.[103]

Table 11-2: Maximum Projected Changes in Precipitation under the A2 Scenario

	Projected Maximum Changes by 2030s (mm per month)	Projected Maximum Changes by 2060s (mm per month)
Annual	8	3
May-June-July	6	4
August-September-October	7	3
November-December-January	9	7
February-March-April	18	18

According to the national level projections, the proportion of total precipitation that falls in heavy events does not show a consistent direction of change as both positive and negative projections of change are generated indicating a future that includes risks of both flooding and drought. However, the trend tends toward positive change, particularly in the southern parts of the country. Further, the proportion

[100] Ibid. Pages 27 to 28
[101] Intergovernmental Panel on Climate Change, 2014a. AR5 Climate Change 2014: Impacts, Adaptation and Vulnerability, Chapter 27. Page 1499
[102] In 2000, the IPCC published a Special Report on Emissions Scenarios (SRES) covering a range of the main driving forces of future greenhouse gas emissions such as demographic, technological and economic changes. The A2, A1B and B1 were three of the scenarios developed by the IPCC and which were used to model projected climatic changes in Guyana.
[103] McSweeney,C; New, M; Lizcano, G, 2010. UNDP Climate Change Country Profiles Guyana. Page 3 to 4

of rainfall occurring in heavy events does not show significant consistent change but also tends towards positive changes in the secondary wet and dry seasons particularly in the southern parts of the country.[104]

11.2.1.2 Air Temperatures

Measurements of ambient air temperature in the project locations are only available for Matthew's Ridge over the period July 2011 to June 2012. Mean temperatures ranged from 26.33 to 32.26°C and this is consistent with the range of temperatures observed at the national level. Based on the data available, higher temperatures were observed during the primary and secondary dry seasons while comparatively lower temperatures were observed during the good seasons. In particular, the highest temperatures were observed in April 2012 and September 2011 when monthly temperatures were 43.68°C and 40.89°C respectively. Although data is limited, it is likely that some days and nights in April 2012 and September 2011 were "hot days" and "hot nights"[105] and constituted temperature extremes for this region. By contrast, the lowest temperature was recorded in June 2012 with a temperature of 19.82°C.

Although data is not available for Port Kaituma, it is likely that temperatures will follow similar trends as observed in Matthew's Ridge.

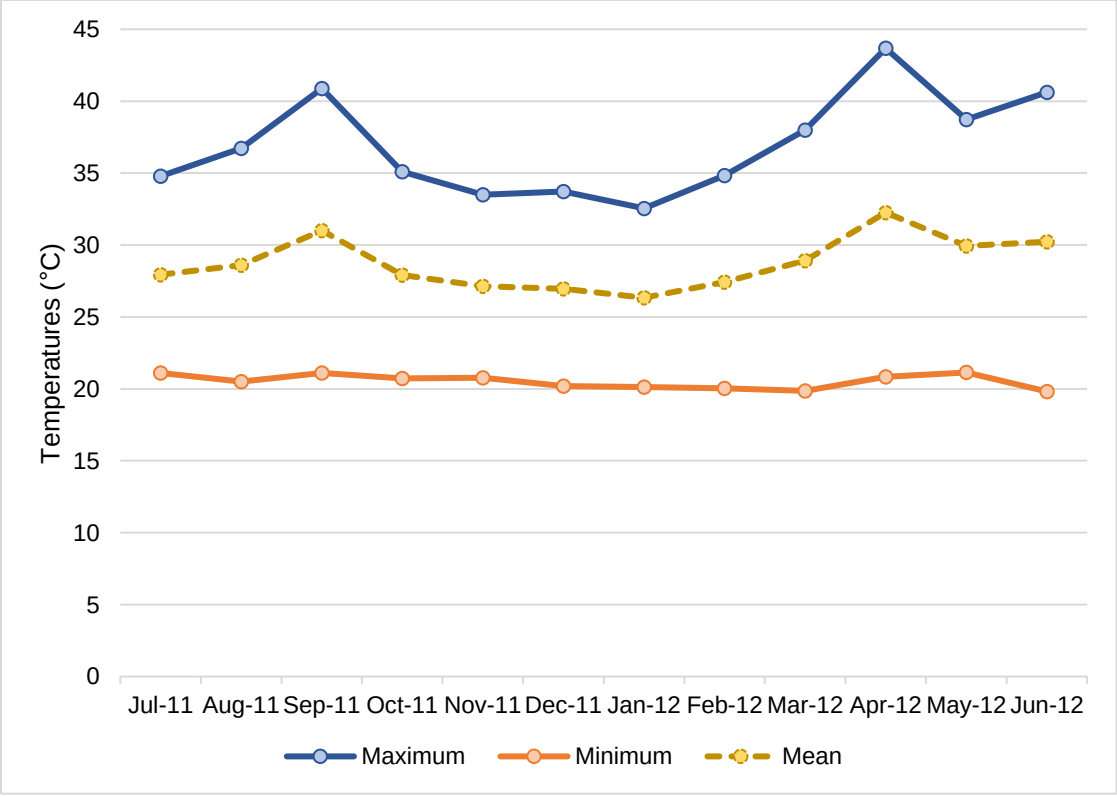


Figure 11-5: Temperatures in Matthew's Ridge for July 2011 to June 2012

Mean annual temperatures in Guyana have increased by 0.3˚C since 1960, an average rate of 0.07˚C per decade. This rate of warming is less rapid than the global average, however it is consistent with

[104] Ibid
[105] A hot day or hot night is defined by the temperature exceeded on 10 percent of days and nights in the current climate of the specific region and season.

projections for equatorial regions. Further, the rate of increase is similar (~0.1˚C per decade) in all seasons, except during the secondary dry season (the February-March-April period), when there is no apparent trend in temperature.

Although the rate of increase in mean temperature is moderate relative to the increase in the global average, the frequency of particularly hot days and nights has shown a significantly increasing trend since 1960 in every season (where data is available). The average number of 'hot' days per year in Guyana has increased by 93 (an additional 25 percent of days) between 1960 and 2003. The rate of increase was seen most strongly in the primary dry season, when the average number of hot summer days has increased by 9 days per month, an additional 30 percent over this period. Further, the average number of 'hot' nights per year increased by 87 (an additional 24 percent of nights) between 1960 and 2003.[106]

Projected Changes in Temperatures

The 2010 projections for Guyana indicate that average annual temperatures will continue to increase relative to the 1961 to 1990 baseline. At the national level, the mean annual temperature is projected to increase by up to 2.0 ˚C by the 2030s, up to 3.3˚C by the 2060s, and up to 5.6˚C by the 2090s.The projected rate of warming is similar in all seasons but highest in the primary dry and wet seasons. Warming is also projected to occur more rapidly in the southern, interior regions of the country than in the northern, coastal regions. Table 11-3 shows the maximum values for the 2030s and 2060s for the A2 scenario.[107]

Table 11-3: Maximum Projected Changes in Temperatures under the A2 Scenario

	Projected Maximum Changes by 2030s (°C)	Projected Maximum Changes by 2060s (°C)
Annual	1.8	3.3
May-June-July	1.8	3.6
August-September-October	1.9	3.5
November-December-January	1.9	3.5
February-March-April	1.8	3.7

According to the IPCC's AR5, warm days and nights will increase as well as increased occurrences of temperature extremes in the South American Region.[108] The 2010 projections follow a consistent trend with substantial increases in the frequency of hot days and nights are observed across all scenarios with the greatest increases occurring during the primary dry season. Consecutively occurring hot days can result in a heat wave. Table 10-4 shows the maximum values for frequency with which hot days are projected to occur by the 2060s and 2090s for the A2 scenario.[109]

[106] McSweeney,C; New, M; Lizcano, G, 2010. UNDP Climate Change Country Profiles Guyana. Page 2 to 4
[107] Ibid
[108] Intergovernmental Panel on Climate Change, 2014a. AR5 Climate Change 2014: Impacts, Adaptation and Vulnerability, Chapter 27. Page 1499
[109] McSweeney,C; New, M; Lizcano, G, 2010. UNDP Climate Change Country Profiles Guyana. Page 2 to 4

Table 11-4: Maximum Values for Frequency of Hot Days by the 2060s for the A2 Scenario

	Projected Maximum Changes by 2060s (%)
Annual	56
May-June-July	63
August-September-October	78
November-December-January	67
February-March-April	69

11.2.1.3 Other Climate-Related Variables

The hydrometeorological stations installed by RMI at Matthew's Ridge also collected one year of data from July 2011 to June 2012 for five other climate variables as seen in Table 11-5. Based on this data:

- Mean net radiation ranged from 149.39 to 216.86 watts/m^2/day in January 2012 and August 2011 respectively. Given Guyana's tropical climate, the mean net radiation at Matthew's Ridge was positive and was consistently higher during the dry seasons as compared to the wet seasons.
- Mean humidity was higher than 75 percent for all months and higher than 85 percent for eight of the 12 months for which data was collected. Greater humidity was recorded in the wet seasons and all months of the wet seasons had humidity of 89 percent or greater.
- Atmospheric pressure was approximately 100 kilopascals throughout the year and this is the level of atmospheric pressure which typically prevails at sea level.
- Evaporation ranged from 40.64 to 115.83 millimeters in November 2011 and August 2011 respectively. As expected, evaporation was highest during the dry seasons with all dry season months recording approximately 94 millimeters of evaporation per month.
- Mean winds speeds peaked in July 2011 with 2.78 meters/second (6.2 miles per hour) which is considerably lower than average wind speeds which are reported to prevail at other locations along Guyana's coast. This may be attributed to Matthew's Ridge relatively inland location. However, maximum wind speeds reached 15.12 meters/second (33.8 miles per hour) in July 2011 and was greater than 13.4 meters/second (30 miles per hour) in September and October 2011. Wind directions are typically east to south-east.

Table 11-5: Data on Other Climate Related Variables at Matthew's Ridge

Month and Year	Mean Net Radiation (watts/m^2/day)	Mean Humidity (percent)	Atmospheric Pressure (kilopascals)	Evaporation (millimeters)	Wind Speeds (meters/second)	
					Maximum	Mean
Jul-11	184.7	89.78	101.57	89.92	15.12	2.78
Aug-11	216.86	83.95	101.56	115.83	13.27	1.59
Sep-11	192.43	84.16	101.53	100.58	14.56	1.64
Oct-11	188.18	89.03	101.33	93.73	14.4	1.27
Nov-11	178.58	90.43	100.75	40.64	13.32	1.24
Dec-11	162	90	100	43.2	11.83	1.28
Jan-12	149.39	91.31	100.01	75.79	10.6	1.26
Feb-12	183.714	83.29	100.01	94.45	12.36	1.53
Mar-12	213.08	76.61	99.78	101.41	12.67	1.61
Apr-12	178.77	84.73	99.88	101.81	10.45	1.21
May-12	152.53	91.17	100.07	85.47	14.1	1.12
Jun-12	177.81	94.42	99.91	80.97	12.97	1.04

11.2.2 Land Uses in the Project Locations

As described in Chapter 19, land uses at both project locations comprise of secondary growth vegetation interspersed with various other land uses. The vegetation cover of the project locations prior to and following the construction phase of the project are further discussed in Chapter 17. The uses of land prior to commencement of the operation are as follows:

- At Matthew's Ridge, active mine sites will be situated at brownfield sites which were previously mined in the 1960s and 1970s. Since mining ceased at Matthew's Ridge, the previously used mining and plant sites were overgrown with secondary vegetation. The site at which the new processing plant is being constructed was not forested and was covered with secondary vegetation. There was no re-vegetation at the tailings pond but several residences were established in proximity to the tailings pond. This tailings pond will be expanded with the construction of a new tailings and water retention dam. The lands within the footprint of the tailings pond is covered primarily by secondary vegetation consisting mainly of shrubs, and a few farmlands. In addition, clearing of secondary vegetation which overgrown the previously used railway line was required to construct the bypass road and to establish the water pumping pipeline connecting the pump house at the Pakera Lake to the new processing plant.

  According to information provided by the GFC, logging commenced by Barama Company Limited (BCL) in state forests near to Matthew's Ridge in 1991. Prior to BCL's operations, loggers were disinterested in harvesting produce from these lands given that the density high-value timber species like greenheart is estimated at 1 tree per 100 hectares and purpleheart at 6 trees per 100 hectares. At present, leases for two forest concessions were provisionally granted by the GFC and final authorization is pending information to be shared by GLSC on agricultural leases and the boundaries of the Matthew's Ridge municipality. GFC will also exclude the area covered by GMI's Mining Lease from the final boundaries of these concessions. As seen in Figure 11-6, the two types of forested vegetation which naturally occurred in Matthew's Ridge were the Mixed Rainforests of the Northwest District and Rainforest and Evergreen Forests on Steep Hills. Moreover, the area covered by GMI's prospecting license is considered as non-productive forests under the Monitoring, Reporting and Verification System (MRVS).

- At Port Kaituma, the proposed location of the Kaituma Marine Terminal comprised of three small, unregulated homesteads whose occupants engaged in small scale agriculture. According to the GFC, the GMI bypass road to the wharf site passes through lands which were heavily degraded due to extensive agricultural activities in the 1960s and 1970s. There are no proximate forest concessions and the nearest forest concession is held by Amazon Caribbean Guyana Limited (AMCAR) for the harvesting of manicole palm. As seen in Figure 11-7, the two types of vegetation located at Port Kaituma are Mixed Rainforests and Coastal Swamp Forests both of which are considered to be non-productive. In addition, the GFC updated its MRVS database using GIS data provided for the Marine Terminal and the bypass road.

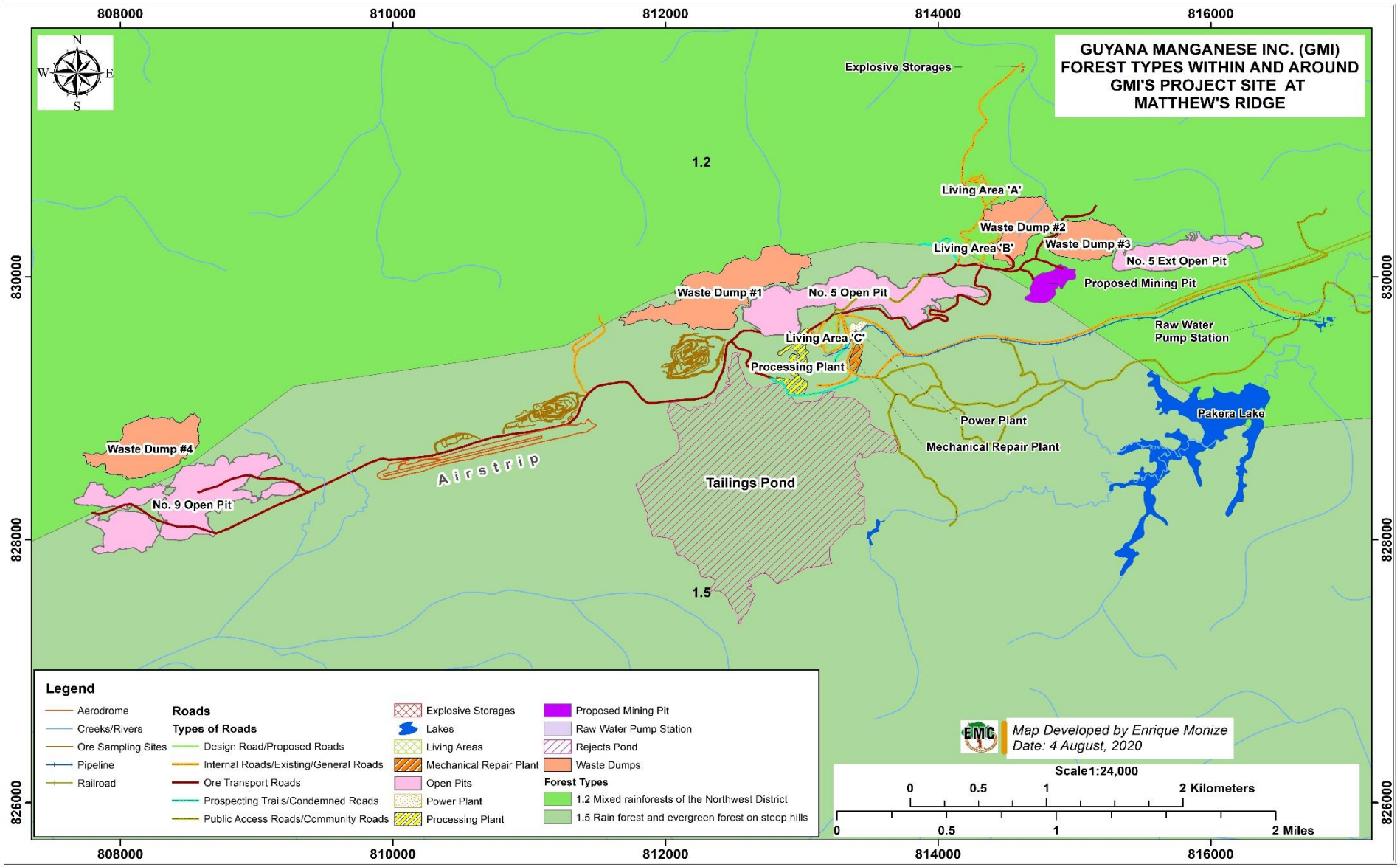


Figure 11-6: Vegetation Types in Matthew's Ridge

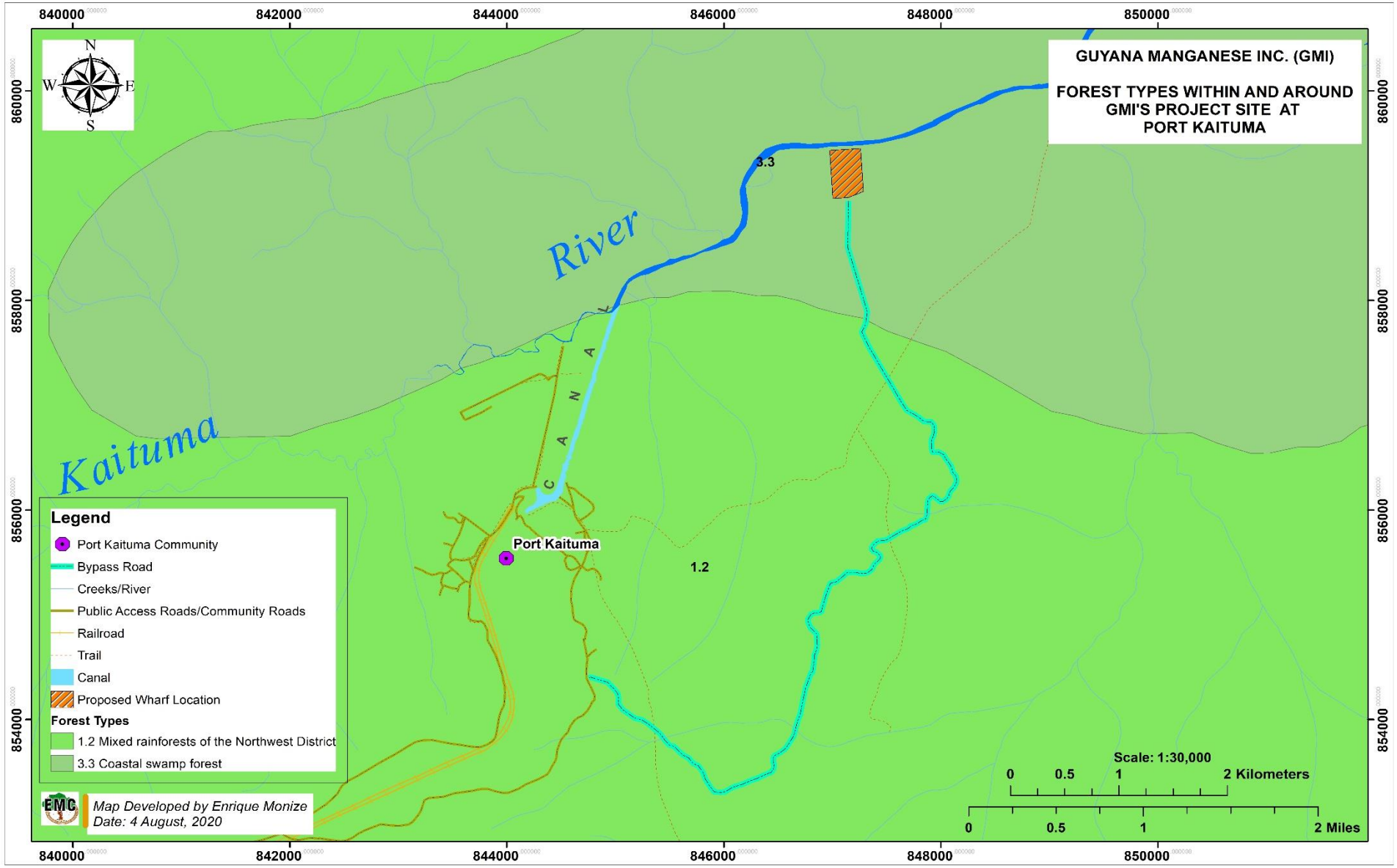


Figure 11-7: Vegetation Types in Port Kaituma

11.3 Impact Assessment – Climate and Climate Change

This section assesses the potential impacts of climate and climate change, and the risks associated with these impacts on planned project activities and project components. It includes an assessment of the key-climate related hazards to which project activities and project components are vulnerable. This section also assesses potential impacts and risks of increased greenhouse gas emissions from the planned project activities.

11.3.1 Vulnerability to Climate Change Impacts

Vulnerability to climate change impacts is defined as the propensity or predisposition to be adversely affected by climate change impacts.[110] The vulnerability of planned project activities and the project components is influenced by the potential climate change impacts and the associated climate-related hazards to which the project is exposed. Table 11-6 presents the potential climatic change and climate-related hazards which are relevant to the project as well as the project components which are considered to be vulnerable to these impacts and hazards. It should be noted that these potential impacts and hazards were identified based on the observed weather patterns in the project location (including observed changes), as well as projected climatic changes discussed in the preceding section. The potential impacts and risks to the project components vulnerable to these hazards are discussed in detail in this section.

Table 11-6: Climate Change Impacts and Climate-Related Hazards Considered in the Assessment

Observed and Projected Climatic Changes	Climate-Related Hazards	Vulnerable Project Components
Increased temperatures and increased frequency with which hot days and hot nights occur.	Heat stresses for project staff	All project components
	Increased emissions of dust from laterite roads	Project roads
	Thermal expansion of joints on project infrastructure	Eclipse Falls Bridge and Kaituma Marine Terminal
Variability of annual average precipitation.	Variable annual rainfall patterns lead to drought and drought-like conditions	Processing plant, project housing and accommodation, and project roads and river transport.
Increased annual average precipitation and increased frequency of rainfall occurring in heavy events.	Flooding	Active mine areas, processing plant, project roads, tailings and water retention dam, pump station and pipeline.

Adverse impacts of climate change, including those identified in Table 10-6, are likely to occur in the project locations even if the project were not implemented. Unlike the other resources considered in this EIA where impact assessment focused on impacts and risks arising from project implementation, this section will assess the impacts and risks which are posed by climate change. For this reason, the methodology outlined in Chapter 3 for impact identification and assessment were adapted for this

[110] Intergovernmental Panel on Climate Change, 2014b. AR5 Annex II Glossary. Page 1775

section. Firstly, the definitions of the types of impacts (Chapter 7) were adapted as presented in Table 11-7. Moreover, the impact significance (Table 11-8) and likelihood (Table 11-9) were adapted so as to be relevant to this chapter. Following this, risk levels were identified using the Risk Assessment Matrix (Chapter 7).

Table 11-7: Definitions of Types of Impacts

Impact Type	Description
Beneficial	An impact that results in a positive effect to the project.
Adverse	An impact that results in a negative effect to the project.

Table 11-8: Impact Significance Level Descriptors

Significance Level of Adverse Climate Change Impacts				
Negligible	**Minor**	**Moderate**	**Major**	**Extreme**
Minimal impact with little or no consequence.	Low impact resulting in no downtime (lost work hours).	Medium impact resulting in minimal project downtime.	High impact resulting in one week of project downtime and requiring investments to address the impacts.	Very high impact resulting in more than one week of downtime and significant investments required to address the impacts.

Table 11-9: Impact Likelihood Levels

Likelihood of Impact Occurring During Project Lifetime				
Rare	**Unlikely**	**Likely**	**Almost Certain**	**Certain**
Highly unlikely to occur but theoretically possible.	May occur within the life of the Project.	Likely to occur more than once during the life of the Project.	Very likely to occur during the life of the Project or activity.	Very likely to occur several times during the project lifetime.

11.3.1.1 Impacts and Risks of Increased Temperatures

As previously discussed, increased average annual temperatures have been observed at the national level and greater increases in temperature are projected to occur within the lifetime of the project. Moreover, based on the 12-month temperature record for Matthew's Ridge, hot days and nights were already being experienced and climate change projections indicate that these events are expected occur with greater frequency. As a consequence, the potential impacts and risks associated with increased temperature are likely to be experienced throughout the lifetime of the project but particularly during the construction and operational phases.

Increased average annual temperatures and more frequent hot days could potentially result in heat stresses including heat strokes, heat exhaustion, heat induced cramps, heat rashes and dehydration being experienced by project staff. Indeed, as previously discussed, mean net radiation is also greatest

during the dry seasons which may create a heat feeling for project staff which exceeds ambient temperature levels. This impact may be amplified for project staff who work around heat generating machinery, who work in enclosed spaces or who spend prolonged periods of strenuous exposed to direct sunlight. Based on the observed and projected temperature trends, potential impacts of heat stress may be worsened during the dry seasons. The potential impacts associated with heat stresses are **adverse,** of **moderate significance** but are **certain to occur** during both the construction and operational phases of this project. As such, heat stresses present a **High Risk** to the project.

Currently, during the dry seasons, significant quantities of dust are produced when vehicles traverse the project roads including the bypass roads in Matthew's Ridge and Port Kaituma as well as the 56-kilometer public roadway connecting Matthew's Ridge to Port Kaituma. According to feedback provided by representatives of the Guyana Geology and Mines Commission (GGMC), during the dry seasons, dust emissions from the Matthew's Ridge to Port Kaituma public road result in considerable changes in daily life of the residents of Eclipse Falls who were reported to having to wait until evening and nights, when traffic is lower, to hang out their laundry (EMC Personal Communication 10). This was supported by feedback from local stakeholders. Dust emissions were reported to cover internal surfaces of homes in Four Miles Village (EMC Personal Communication 19). In Eclipse Falls, dust covers the roofs of houses and hinders rainwater collection because the dust has to be washed off of the roof surface before rainwater collection can begin. Residents at Eclipse Falls also suggest that dust emissions may lead to illnesses like cold and flu, especially among children (EMC Personal Communication 20). Mean net radiation and evaporation are greatest during the dry seasons and this undoubtedly accelerates drying of the roads and the concomitant emissions of dust.

Climatic changes which result in increased temperatures and variable precipitation patterns, and cause drought conditions may further exacerbate dust emissions associated with project vehicles and other road users. Dust emissions may also contribute to negative health outcomes for project staff and proximate communities as the incidence and/or severity non-communicable respiratory diseases such as asthma may increase. Significant quantities of dust emitted as a result of vehicles traversing the road may also reduce visibility thereby create unsafe driving and pedestrian conditions. Given that significant quantities of dust are already generated from vehicles traversing the road, GMI has made provisions for a watering truck to dampen the road during dry season from the operational site in Matthew's Ridge to the Arakaka/Four Corners Junction, and in Port Kaituma from the toll booth to the Kaituma Marine Terminal. There are significant logistical challenges of GMI conducting road wetting for roads passing through Eclipse Falls given the distance of the community from the operational bases in Matthew's Ridge and Port Kaituma. These challenges include refueling water trucks and locating an appropriate source of water. However, GMI will construct and maintain at least one speed bump on the road passing through Eclipse Falls to reduce the speed of project and non-project vehicles passing through the community so as to reduce dust levels generated from the road. Drivers of GMI's vehicles will also be required to transit through the community at lower speeds and GMI will also patrol the area and liaise with residents to ensure that there is compliance with this policy. Defaulting project drivers will be subject to disciplinary measures. The potential impacts associated with dust emissions are **adverse,** of **moderate significance** but are **certain to occur**. As such, dust emissions associated with increased temperatures and variable precipitation present **High Risk** to the project.

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There have been no documented instances of thermal expansion or weakening of the structural integrity of joints in bridges or other infrastructure in Guyana. In general, these impacts are not expected to occur unless temperatures exceed 50°C which is greater than the upper levels of temperatures projected to be reached during the lifetime of the project. Impacts associated thermal expansion of joints are **adverse** and of **moderate significance** but will **occur only rarely**. As a result, **Low Risks** to the project are associated with thermal expansion.

11.3.1.2 Impacts and Risks of Precipitation Variability Resulting in Drought-Like Conditions

In Region 1, droughts typically occur every 10 to 12 years while drier, drought-like conditions associated with ENSO occur every 4 to 5 years. Potential impacts arising from variable precipitation patterns which result in droughts or drought-like conditions are likely to occur in the project locations throughout the lifetime of the project but are likely to most present risks during the operational stages of the project.

Droughts or drought-like conditions could reduce water levels in the Pakera Lake which is the primary source of raw water supply to the processing plant. The Pakera Lake is surface water body supplied by precipitation and runoff. Drier conditions and lower levels of water available for extraction from the Pakera Lake could result in lower volumes of ore being processed, especially during the dry seasons. An estimated 1,258 cubic meters of water is for processing of manganese ore on a daily basis. During the wet seasons, water will be recirculated from the tailings pond. During the dry season, an estimated 34,600 cubic meters of water will be pumped from the Pakera Lake to support processing to compensate for lower water levels in the tailings pond as a result of increased evaporation. Four water tanks will be established around the compound, including in areas near to the powerhouse and mechanical workshops to provide water needed for industrial purposes. This water will be source from both the Pakera Lake and supplemented by rainfall. Based on these conditions, potential impacts of drought and drought-like conditions reducing water availability for processing and industrial purposes are **adverse** and of **extreme significance** and **likely** to occur during the lifetime of the project. Consequently, these climate change impacts which may potentially reduce water available for processing and industrial purposes present **High Risks** to the project.

Similarly, drier conditions associated with variable and reduced precipitation can also potentially reduce water available for domestic uses. Water used for domestic purposes (including bathing, washing) by workers at Matthew's Ridge is pumped from a spring located at the bottom of Hill 5 aback the Guyana House and the GMI Office Buildings. The estimated daily demand of water from the spring are approximately 170 cubic meters during the dry season and 80 cubic meters during the wet season. To a lesser extent, water for domestic uses at Matthew's Ridge will also source 45 cubic meters of water from GWI distribution network for drinking and cooking. It is likely that this spring is also partially supplied by precipitation and that variable or reduced precipitation will reduce the availability of water for domestic purposes. Reduced precipitation can also potentially reduce the water supplied by the GWI as this is also sourced from surface water bodies. Potable water cannot be sourced from the Pakera Lake. At Port Kaituma, potable water for domestic purposes is also supplied by rainwater which is stored in tanks. Drinking water is purchased from a local vendor who pumps water from a well. Potential impacts of droughts and drought-like conditions are **adverse,** of **major significance** and are **likely** to occur during the lifetime of the project. As a result, climate change impacts which may potentially lead to lowered availability of water for domestic purposes present **High Risks** to the project.

In addition, drier conditions may also reduce water available for ancillary processes such as road wetting and firefighting. The company has three water trucks, two based at Matthew's Ridge and one at Port Kaituma, which are used to support both road wetting and firefighting, each of which has the capacity for 20 cubic meters of water. At Matthew's Ridge, water may be sourced from the pump at water pond or any of the four water tanks located around the compound. GMI plans to wet roads from Matthew's Ridge to the Arakaka/Four Corners Junction and in Port Kaituma, from the toll booth to the Kaituma Marine Terminal. For firefighting at Matthew's Ridge, water will be sourced from the spring behind Matthew's Ridge if the two aforementioned sources are insufficient. Drier conditions are likely to reduce the frequency with which road wetting activities are conducted and also reduce water readily available for firefighting. However, it is also recognised that additional firefighting equipment will be in place, including but not limited to fire extinguishers. These impacts are **adverse,** of **moderate**

significance and are **likely** to occur during the lifetime of the project. As a result, climate change impacts which may potentially lead to less frequent road wetting or hinder firefighting efforts present **Medium Risks** to the project.

Further, according to the Hazard and Vulnerability Assessment of Barima – Waini, Region 1 prepared by the Civil Defence Commission (2016), drought conditions are typically linked to reduced surface water flow particularly during the dry seasons including in the Waini River, Aruka River and the Barima River. It follows that extreme drought conditions may also result in lower levels of water in the Kaituma Canal including in the vicinity of the Kaituma Marine Terminal. Drought conditions can potentially reduce water levels at the Marine Terminal and throughout the inland river transportation route thereby reducing the draft required for barge transport. Potential impacts are **adverse,** of **major significance** and may **rarely occur** during the lifetime of the project. As a result, climate change impacts that may potentially reduce water levels in the river transport route present **Medium Risks** to the project.

11.3.1.3 Impacts and Risks of Increased Precipitation and Heavy Rainfall Events

Based on available rainfall records, precipitation showed an increasing trend at both of the project locations and projections of maximum rainfall also follow an increasing trend. Moreover, localised occurrences of flooding are relatively frequent occurrences at Port Kaituma and have been attributed to both short and heavy rainfall events as well as prolonged periods of higher than normal rainfall. Although there is no clear direction of the trend, climate change projections suggest that the proportion of rainfall that falls in heavy events will also increase in the future.

Firstly, increases in annual average precipitation including in particular increases in heavy rainfall events can potentially have several impacts on the road used by the project including the bypass roads in Matthew's Ridge and Port Kaituma as well as the public road connecting Matthew's Ridge to Port Kaituma. Increased precipitation and increased frequency of heavy rainfall can cause slope instability leading to damage of the public road as well as the Matthew's Ridge bypass road. Prior to project construction, there was no established drainage system for the public road connecting Matthew's Ridge and Port Kaituma. However, as part of the design of the planned upgrade for this road, GMI intends to install several drainage features including culverts. In addition, culverts and drainage features were installed along the Port Kaituma wharf access road, particularly where the road is intersected by creeks. The absence of established systems of drainage during wet seasons can contribute to erosion leading to the widespread formation of gullies and ravines along the roadway, surface ponding of water resulting in wash-boarding and weakening of the substructure of the roads, which can also result in sections of the road washing away. Potholes will develop and existing potholes will worsen. Moreover, this produces increased risks of skidding on wet road as friction is lowered and thus reduced safety.

Ultimately, the anticipated consequences of increased and heavy rainfall on the project roads can potentially lead to serious impacts particularly during the wet seasons. These include haul trucks skidding/overturning while descending slopes (on the public road) and laden haul trucks and other project vehicles becoming stuck particularly on the sections of the public road connecting Matthew's Ridge to the Four Corners Junction and on the Port Kaituma access road. Washouts of the road due to heavy precipitation can stall road transport of ore to the Marine Terminal for export and shipment. However, it is recognised that GMI will put measures in place to reduce the likelihood of these impacts occurring. Firstly, a stockpile of ore for shipment will be stored at the Marine Terminal. Secondly, haul trucks will only make one trip per day during the wet seasons as compared to two trips per day during the dry seasons. These potential impacts are **adverse**, of **extreme significance** and are **almost certain** to occur during the lifetime of the project. As a result, increased precipitation and heavy rainfall events presents **Critical Risks** to project roads particularly during the operational stages of the road.

Fluvial flooding on the banks of the Kaituma Canal can potentially result in inundation of the Kaituma Marine Terminal. Typically, water in the Kaituma Canal rises up to 1.5 meters from its low water mark based on tidal influences of the Waini River. Based on hazard assessments conducted by the CDC, fluvial flooding is not known to have previously occurred on the banks of the Kaituma Canal. Moreover, GMI has included several design features for the Marine Terminal to prevent flooding and erosion on the banks. Particularly, side sloped of the basin will be stabilized at an angle of 45 degrees with a revetment constructed of geotextile reinforced gabion-stone baskets. These potential impacts are **adverse**, of **moderate significance** and will **rarely occur.** Fluvial flooding of the Kaituma Canal presents **Low Risks** to the project.

On the other hand, fluvial flooding can also potentially impact project roads which intersect creeks. This is particularly applicable to the Port Kaituma bypass road which intersects several creeks. However, culverts were installed along this road to provide cross drainage. Although the risks of flooding in Matthew's Ridge are considered low by the CDC, increased annual precipitation and heavy precipitation can adversely impact several project components located there. Firstly, heavy rainfall events can potentially cause flooding and erosion of active mine areas. As part of the design of the mine areas, GMI has incorporated several features to reduce the likelihood of mine collapse based on the material type and safety limiting factors. As such, crest elevations will not exceed 84 meters. Benches to be used to access the mining pits will be approximately 30 meters wide and 6 to 12 meters high. In addition, drainage on benches will be assured by catchment berms, drains and culverts to minimise surface water descending into the pit. Pumps in sumps with connecting drains will be placed in pit bottoms to collect and evacuate underground water springs and seepage, and rainfall, as necessary. These potential impacts are **adverse**, of **major significance** but **unlikely to occur**. The impacts associated with erosion and flooding of the active mine areas present **Medium Risks** to the project.

The processing plant was positioned on a hillside so as to benefit from the gravity flow of ore moving through the stages of process. Heavy precipitation can potentially cause erosion of the hillside and damage to the processing plant. As part of the design and construction phase of the project, drainage channels were installed on the eastern and western sides of the processing plant and exposed surfaces were stabilised by concrete. The processing plant and its foundations were constructed of aggregates, steel, cement and the process equipment. These potential impacts are **adverse**, of **moderate significance** and **unlikely to occur**. As such, impact associated with erosion of the processing plant present **Medium Risks** to the project.

In addition, heavy precipitation events can potentially result in overtopping of the tailings and water retention dam. Prolonged bouts of heavy rainfall may also contribute to weakening of the structural integrity of the dam wall. Moreover, the dam was designed with a freeboard to accommodate a 24-hour precipitation maximum of 955 millimeters. The dam design and construction included overflow structures to be incorporated to enable gravity release of water into a spillway. During operational stages, a 24-hour monitoring station will be installed at the dam to monitor piezometric pressures, water levels, signs of displacement and to release water via the spillway as necessary. These potential impacts are **adverse**, of **major significance** and **unlikely** to occur. Impacts of overtopping and failure of the tailings and water retention dam present **Medium Risks** to the project.

Further, increased precipitation and heavy rainfall events can also potentially result in erosion around the pump house and pipeline. Moreover, some sections of the pipeline are located in valleys between the Matthew's Ridge bypass road and the surrounding environment. Heavy rainfall resulting in ponding of water around the foundations of these sections of the pipeline support structure could also accelerate erosion and contribute to instability. However, most sections of the pipeline are situated at or above the level of the Matthew's Ridge bypass road. These potential impacts are **adverse**, of

moderate significance and **likely to occur**. As a result, potential impacts of erosion and flooding around the pump house and connecting pipeline presents **Medium Risks** to the project.

11.3.2 Greenhouse Gas Emissions

The primary direct sources of greenhouse gas emissions from the project include the combustion of fuel for the electricity generation, and for use in machinery and company vehicles. According to data provided by GFC, construction of the Port Kaituma bypass road resulted in deforestation of 15 hectares of forested lands and this would have also resulted in greenhouse gas emissions associated with the project. Emissions associated with lands cover change from secondary vegetation to other land uses were not calculated due to the absence of applicable emissions factors. Instead, the impact of area change is assessed as a function of the extent of the land area which was converted. Moreover, given national controls associated with the importation of ozone depleting substances, significant greenhouse gas emissions are not anticipated from these sources. The primary sources of greenhouse gas emissions estimated as part of this EIA are presented in Table 11-10.

Table 11-10: Direct Sources of Greenhouse Gas Emissions from the Project

Source	Description
Fuel Combustion for Electricity Generation	Matthew's Ridge: Power station comprises of six 1080-kW diesel generators.
	Port Kaituma: The Marine Terminal will be powered by one 50-kW diesel generator.
	Port Kaituma: The Log Pond Facility will be powered by one 50-kW diesel generator.
Fuel Combustion by Mines Machines and Vehicles	Mines machines and vehicles comprise of a combination of the following heavy- and light-vehicles: ▪ Three excavators ▪ Ten trucks ▪ Two dozers ▪ One grader ▪ One fuel truck ▪ One pick-up/SUVs These vehicles are estimated collectively consume 301,836 gallons of diesel per year.
Fuel Combustion by Haul Trucks	Thirty haul trucks will transfer ore from Matthew's Ridge to Port Kaituma. Trips will be made twice per day during the dry season and once daily during the wet seasons. These vehicles are estimated to collectively consume 555,660 gallons of diesel per year.
Fuel Combustion by Light Vehicles	The project's light vehicle fleet comprises: ▪ 15 SUVs ▪ 14 ATVs These vehicles are estimated to collectively consume 3,300 gallons of diesel and 660 gallons of gasoline per year.
Project Support Vehicles	Additional project support vehicles: ▪ 3 water trucks for road wetting. ▪ 1 Fuel trucks. These vehicles are estimated to collectively consume 2,879 gallons of diesel.
Fuel Combustion by Barges	Barges will make seven trips per month to transport 3,000 tonnes ore from Port Kaituma to Trinidad. The collective fuel consumption of these barges per year is estimated to be 327,823 gallons of diesel per year.

Source	Description
Deforestation	15 hectares of forested lands in Port Kaituma

Greenhouse gas emissions from these sources were calculated in two parts:

- Emissions from fuel combustion were calculated using the IPCC Inventory Software which included preloaded default emissions factors per unit of energy consumed for different sources. The software calculated the quantity of emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxides (N_2O). These values were converted to carbon dioxide equivalent (CO_2e) by applying 100-year global warming potentials of 28 for methane and 265 for nitrous oxides.

- Emissions from deforestation associated with project construction were calculated using the emissions factors developed by the GFC for deforestation in areas classified as having "High Potential for Change" for mining infrastructure[111]. Only carbon dioxide emissions were associated with deforestation.

Table 11-11: Annual Greenhouse Gas Emissions from Project Operations

Source	Estimated Annual Emissions (Gigagrams)			
	CO_2	CH_4	N_2O	CO_2e
Electricity generation	19.26	0.00078	0.00016	19.33
Mines Machines and Vehicles	3.28	0.00013	0.00003	3.29
Haul Trucks	5.41	0.00022	0.00004	5.41
Light Vehicles	0.043	0	0	0.043
Barges	3.19	0.00013	0.00003	3.19
Water and Fuel Trucks	0.022	0	0	0.022
Total				**31.29**

Table 11-12: Greenhouse Gas Emissions from Deforestation from Project Construction

Source	Estimated Emissions 2019		
	Hectares	Emissions Factor (Tonnes of CO_2e per hectare)	CO_2e (Gigagrams)
Deforestation	15	1,042	**15.63**

As shown in Table 11-11, estimated annual emissions during the operational phases of the project is approximately 31.29 gigagrams of CO_2e emissions on an annual basis. The majority of the emissions generated by the project originates from the Matthew's Ridge Power Plant which will generate electricity to power all of the project activities at Matthew's Ridge. In total, annual emissions from project implementation is approximately two percent of total national-level greenhouse gas emissions estimated in 2004 as part of Guyana's Second National Communication to the UNFCCC[112]. Over the 13 years of project implementation, total greenhouse gases emissions from project operations is estimated at 406.77 gigagrams and this represents approximately 21 percent of estimated national-level emissions in 2004.

[111] Guyana Forestry Commission, 2014. Forest Carbon Monitoring System: Emissions Factors and their Uncertainties Version 2
[112] Government of Guyana, 2012. Second National Communication to the United Nations Framework Convention to Climate Change; Page 64

In addition, as seen in Table 11-12, deforestation from project construction activities in 2019 accounted for 15.63 gigagrams. Deforestation from project construction was a one-off occurrence and would not be conducted again throughout the lifetime of the project. The extent and emissions association deforestation from project construction was also comparatively insignificant in comparison to national levels. For example, in 2018, the total area deforested was 9,227.1 hectares and emissions from Guyana's forests sector was 11,520 gigagrams[113]. Lands converted from grasslands and secondary vegetation cover to infrastructural or mining lands are principally from lands being used for the mine areas, the processing plant, expansion of the tailings dams, and bypass roads in Matthew's Ridge and Port Kaituma. Reclamation and re-vegetation of mined out lands are expected to occur upon closure and decommissioning of the mining activities and this presents the opportunity for carbon sequestration and reduction of the net emissions associated with the project. However, potential sequestration capacities from reclamation and re-vegetation cannot be estimated at this time.

Climate change is a global issue of significant importance and the Government of Guyana (GoG) has adopted a green agenda to reduce greenhouse gases. This project represents an increase in greenhouse gas emissions but its contribution to national emissions levels will be negligible. Moreover, reclamation and re-vegetation provide the opportunity to reduce the net greenhouse gas emissions associated with the project. Based on these factors, the potential impacts to climate change of the greenhouse gas emissions from this project is **negative**, **direct, short-term** and **localised** in extent. The significance of these impacts is **minor** and their likelihood is **certain**. As a result, greenhouse gas emissions contributing to climate change are considered to present a **Medium Risk** of contributing to increased greenhouse gas emissions at the national level.

Land cover change associated with the project may also have an impact on the LDN initiative being implemented by GLSC. Progress in achieving LDN targets are measured land cover change measured as the conversion from forested lands to shrubs, grasslands or sparsely vegetated areas, and changes in soil organic carbon. Potential impacts on the national LDN initiative are **negative**, **direct, short-term** and **localised**. Given the low levels of deforestation associated with the project, the significance of these impacts is **negligible** but **certain to occur** during the project. As such, the project presents **Low Risk** to the national LDN initiative.

11.3.3 Cumulative Impact Assessment

Fuel combustion within the AoI will be generated from both project and non-project activities. The project activities were discussed above. Non-project activities which require the combustion of fuel include electricity generation by individually owned generators and from stations of the Guyana Power and Light (GPL) as well as fuel required by community or other privately owned vehicles. The emissions from non-project activities were not estimated. Given the volume of traffic which was recorded for 2019 by the toll booth in Port Kaituma (see Chapter 15 – Transportation for details) as well as the relatively small capacities of the generators indicate that greenhouse gas emissions from non-project sources will be similar to emissions generated by the project. The greenhouse gases generated from both project and non-project fuel combustion within the primary and secondary AoI are anticipated to result in potential impacts that are **negative**, **direct, short-term, cumulative** and **localised** of **minor significance** and **certain** to occur. As a result, greenhouse gas emissions from both project and non-project sources present a **Medium Risk** of contributing to increased greenhouse gas emissions at the national level.

[113] Guyana Forestry Commission, 2019. Guyana REDD+ Monitoring, Reporting and Verification System (MRVS) Year 8 Interim Measures Report Version 1

11.4 Mitigation and Monitoring Measures – Climate and Climate Change

This section outlines recommended measures to adapt to and build resilience to the adverse impacts of climate change outlined in Section 11.3 Moreover, measures to mitigation and monitoring the greenhouse gases emissions associated with the project.

11.4.1 Measures to Adapt to Climate Change and Build Resilience

A range of measures are presented in Table 11-13 and recommended to be implemented to address the climate change impacts which were determined to present Critical or High Risks to the project. Only one critical risk was identified and this was associated with the impacts to road transportation of ore during periods of flooding. The risks which were determined to be high were linked to heat stress experienced by workers and reduced water available for domestic purposes.

Table 11-13: Adaptation Measures to Address Critical and High Risks

Climate-Related Hazards and Impacts	Priority Adaptation Measures
Flooding of the project roads resulting in surface ponding of water resulting in wash-boarding that weakens road substructure, increased risk of developing or worsening potholes, and increasing erosion.	Establishing a system for drainage of the roadway including: ▪ Roadside drainage for surface runoff including turnout drains, ditches at frequent intervals, ▪ Installing structures for cross drainage of the road and ensure that these structures are sufficiently elevated. ▪ Monitor road conditions bi-weekly, or more frequently, during the rainy seasons to rapidly identify areas in need of repair and maintenance.
Increased heat stress to project workforce and future users of road and bridge.	▪ Developing an occupational safety and health protocol for the work force to follow during periods of high temperatures including access to emergency health care should a heat stroke occur. ▪ Building awareness of the work force to signs and symptoms of heat stresses and measures to bring relief.
Increased emissions of dust from project vehicles passing through Eclipse Falls.	▪ Instituting dust reduction methods in the absence of road wetting through the village including include reduced speed limits of project vehicles, installation of at least one speed bump and patrolling for compliance..
Droughts and drought-like conditions impacts water available for ore processing	▪ Continuing to explore options for maximizing operational efficiency. Measures being considered include maximising processing during the wet seasons to create an ore stockpile at Matthew's Ridge and maximising overland transport during the dry seasons to stockpile at Port Kaituma.
Droughts and drought-like conditions impacts water available for domestic purposes.	▪ Establishing a system to store a minimum quantity of potable water required for domestic purposes at both Matthew's Ridge and Port Kaituma. ▪ Monitor water levels in the spring from which water is extracted for domestic purposes during dry periods to ensure that sufficient quantities are available for use.

No additional measures are identified to adapt to the climate change impacts and hazards which present medium and low risks to the project as GMI has included several measures in the project design and construction phases. These measures were discussed in Section 11.3.1 and are considered to adequately address impacts and hazards posed by climate change.

However, in order to enhance understanding of the climate profile of the project locations, and to monitor weather changes and extreme meteorological events throughout the lifetime of the project, it is recommended that at least one hydrometeorological station be installed at Matthew's Ridge and Port Kaituma to measure the following weather and climate variables:

- Precipitation
- Temperature
- Radiation
- Humidity
- Atmospheric Pressure
- Wind Speed and Direction

11.4.2 Monitoring of Greenhouse Gas Emissions

Based on the project design, greenhouse gas emissions associated with fuel combustion and land cover change are inevitable elements of the project design. Several energy conservation measures were built into the project design and these include:

- Using high-efficiency heavy digging and transportation machines to achieve high equipment effectiveness.
- Targeting deposits with rich ore quality to enable fast turnarounds and lower energy consumption.
- Taking advantage of the natural landforms when constructing project facilities so as to reasonable shorten transit distances.
- Recirculating water in the processing plant.
- Using energy efficient transformer for the electricity generation plant.
- Using energy efficient equipment and appliances.
- Installation of solar powered lighting fixtures.
- Using solar powered water heaters at camp.
- Using electric tricycles to transfer light-weight items around the compound at Matthew's Ridge.
- Strengthening energy management, including by having relevant workers supervising energy management, keeping records of energy consumption and evaluating potential energy-saving measures to implement continuous monitor energy consumption by the project.

Due to the relatively low quantities of greenhouse gases estimated to be emitted by the project, no mitigation measures are proposed. In addition to the embedded design measures outlined above, GMI should ensure that the monitoring measures outlined below are followed to ensure that all fuel use is done in an efficient manner. The monitoring measures were designed taking into account the IFC Guidelines for Energy Conservation[114]. Moreover, data collected from these monitoring measures may be used to more accurately estimate project emission annually ex-post facto. The monitoring measures which should be implemented are as follows:

- Schedule maintenance of all engines to maximize fuel efficiency periodically.
- Monitor the energy distribution at the Matthew's Ridge facilities in order to reduce losses during energy distribution.

[114] International Finance Corporation, 2007. Environmental, Health and Safety Guidelines. General EHS Guidelines: Environmental

- Develop a staff awareness and education programme on the importance of energy conservation and measures which can be taken to conserve energy.
- Monitor and record, on a continuous basis, the volume of fuel used by all combustion sources.
- Include information on the volumes of fuel used by combustion sources in annual reports submitted to the EPA.

Table 11-14: Summary of Impacts and Mitigation Measures

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management / Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
Climate and Climate Change								
Climate and Climate Change	Best practices for equipment maintenance	Greenhouse gas emissions from fuel combustion and land cover change	Negative Direct, Short Term, Local	Minor	Certain	Medium	Adherence to Maintenance Schedules	▪ Continuous monitoring and record keeping of fuel combustion from all combustion sources. ▪ Monitor the energy distribution to prevent losses. ▪ Staff awareness and education on energy conservation measures.
Climate and Climate Change	Compliance with Guyana's laws and regulations	Land cover change from project construction impacts the Land Degradation Neutrality initiative	Negative Direct, Short Term, Localised	Negligible	Certain	Low	None required	None required
Cumulative Impacts								
Climate and Climate Change	Best practices for equipment maintenance	Greenhouse gas emissions from fuel combustion from project and non-project sources	Negative Direct, Short Term, Local, Cumulative	Minor	Certain	Medium	Adherence to Maintenance Schedules	▪ Continuous monitoring and record keeping of fuel combustion from all combustion sources. ▪ Monitor the energy distribution to prevent losses. ▪ Staff awareness and education on energy conservation measures.

Chapter 12 - Biological and Ecological Resources

This Chapter outlines the baseline biological and ecological resources within the project development areas at Matthew's Ridge and Port Kaituma. The baseline resources assessed include flora, fauna (inclusive of both terrestrial and aquatic fauna), sensitive species, threatened species, endemic species, migratory species and areas of biological interest within the project development areas. It assesses potential impacts of planned project activities on the biological and ecological resources recommend measures to mitigate and monitor these potential impacts.

12.1 Administrative Framework – Biological and Ecological Resources

Table 12-1 summarises the legislation, policies, strategies, and international treaties that are relevant to the planned project activities.

Table 12-1: Legislation, Policies, Strategies and International Treaties

Title	Description	Applicability to the Project
Legislation		
Wildlife Management and Conservation Act (2016)	Provides for the protection, conservation, management, sustainable use, and internal and external trade of Guyana's wildlife.	Creates a mechanism to govern the protection, conservation and management of wildlife. The Act also established the Wildlife Conservation and Management Commission to effectively manage, conserve and sustainably use wildlife.
Environmental Protection Act (1996)	Provides for the management, conservation, protection and improvement of the environment, the prevention and control of pollution, the assessment of the impact of economic development on the environment and the sustainable use of natural resources.	Controls or prevents pollution of the environment (lands, surface water, ground water and marine and coastal areas inter alia) to protect against adverse impacts that may render plant or animal life unfit for use by humans or for its role in the ecosystem.
Forests Act (2009)	Provides for the sustainable management of state forests in Guyana.	Sets out requirements for the removal of produce harvested from state forests.
Policies and Strategies		
Green State Development Strategy: Vision 2040 (2019)	Outlines Guyana's 20-year plan for development that follows a green agenda defined by sustainable, low-carbon and resilient development. The GSDS also aligns with the 2030 Sustainable Development Goals (SDGs) outlined by the United Nations.	The Strategy considers biodiversity as one of Guyana's natural resources which have to be managed sustainably. The GSDS also recommends that approximately two million hectares of land be given protected status as a further measure to protect biodiversity.
National Biodiversity Strategy and Action Plan (2012 to 2020)	Sets out Guyana's national vision and goal for biodiversity. It also, *inter alia*, mainstreams biodiversity conservation into key	The Plan outlines several priority actions including restoration of mined out or degraded areas, promotion of soil health and the

Title	Description	Applicability to the Project
	economic sectors including mining.	expansion of the protected area system.
International Treaties and Protocols		
United Nations Convention on Biological Diversity	Aims to promote conservation and sustainable use of biological resources and the fair and equitable sharing of benefits arising out of the use of genetic resources.	Encourages Parties to attempt to identify activities that may be detrimental to biological diversity and to take steps to reduce any impacts associated with such activities. The Convention promotes rehabilitation of degraded lands and mainstreams biodiversity into key productive sectors. Parties periodically submit reports on national implementation of the Convention. Guyana ratified the Convention in 1994.
The Cartagena Convention for the Protection and Development of the Wider Caribbean Region	Aims to protect and manage the marine environment and coastal areas of the Wider Caribbean Region.	Protects against marine pollution from ships, pollution from dumping, and pollution from land-based sources or activities. Parties to the Convention most also take action to protect habitats of threatened or endangered marine species. Guyana ratified the Convention in 2010.
Convention on International Trade in Engendered Species of Wild Flora and Fauna (CITES)	Aims to ensure that trade of threatened wildlife does not threaten their survival.	Establishes restrictions on collection and trade of endangered species. Guyana acceded in 1977.

12.2 Baseline Conditions – Biological and Ecological Resources

The assessment of baseline conditions aimed to determine whether sensitive species and areas of biological interest within the project development landscape. The mechanism utiliseutilised to conduct this assessment consisted principally of the review of available information on the project AoI[115] at Matthew's Ridge and Port Kaituma during periods corresponding to a single wet season and a single dry season in June-July and October of 2012 respectively. In addition, biodiversity field surveys were also conducted by the EIA team within the project development areas (PDA)[116] in a single dry season in February 2020.

The baseline data compiled considered biodiversity at three levels of scale: global and regional biogeographic provinces; landscapes and ecosystems; and habitats and species. Using the data compiled, an assessment was conducted to determine the presence of threatened species, as defined in the Red List of Threatened Species from the International Union for Conservation of Nature (IUCN),

[115] The AoI is defined as the footprint of the facilities at Matthew's Ridge and Port Kaituma areas of mineral deposits to be targeted and road and river transport corridors to be utilized by GMI. The AoI is fully described in Chapter 2.
[116] The 'project development areas' (PDA) are the combined extent of areas within Matthew's Ridge and Port Kaituma that is directly affected by planned project activities.

endemic or restricted-range species, migratory species, and areas of recognized global, national or local importance to biodiversity within the AoI.

12.2.1 Global and Regional Biogeographic Context

According to the Map of Global Ecological Zones (GEZ) prepared by the Food and Agriculture Organisation (FAO), three global ecological zones exist within Guyana:

- The tropical rainforest zone which occurs extensively within Guyana's central zone;
- The tropical moist deciduous forest located along the country's coast and on the border with Brazil; and
- The tropical montane forest ecological zone centered around the uplands of the Pakaraimas Mountains

The PDA falls within the tropical rainforests ecological zone in Guyana, as depicted in Figure 11-1.

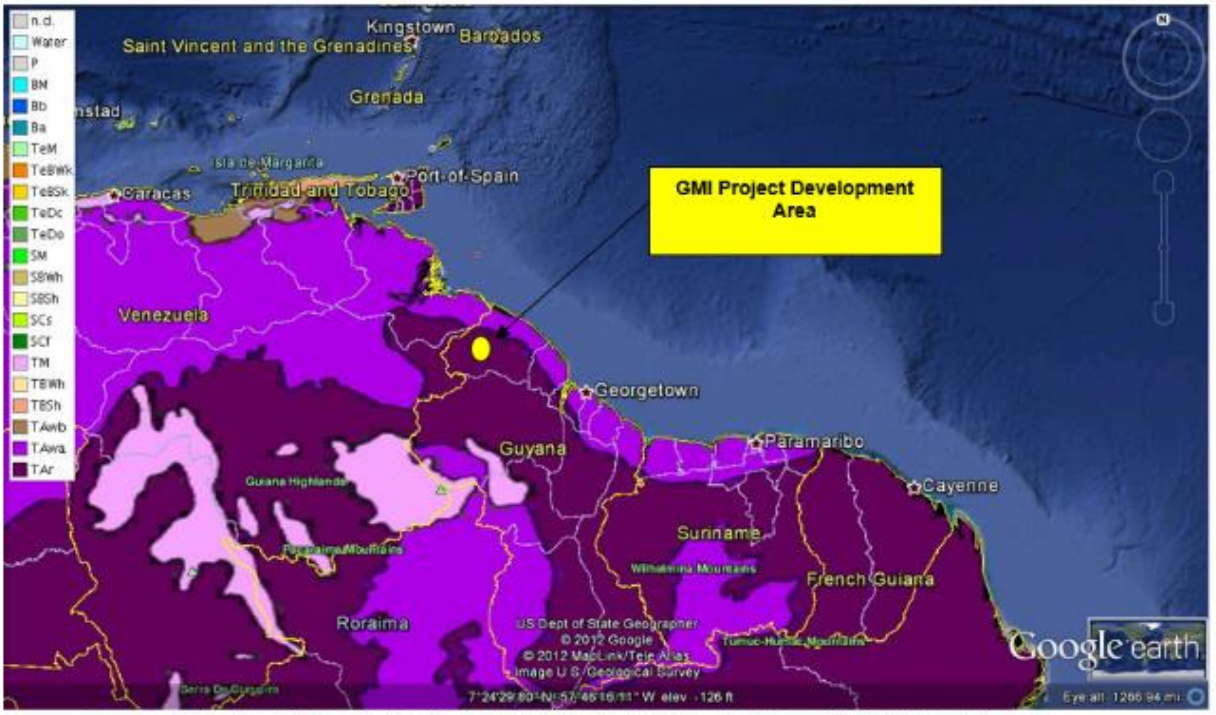


Image taken from Google Earth via FAO Global Ecological Zone (GEZ) Map-Guyana - http://foris.fao.org/static/data/fra2010/ecozones2010.jpg

Key:

- Tropical Rain Forest Ecological Zone
- Tropical Decidious Forest Ecological Zone
- Tropical Montane Forest Ecological Zone

Figure 12-1: Map of FAO Global Ecological Zone Map, Guyana

Four main geographical regions can be distinguished within the GEZ in Guyana[117]. These are:

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

The project development areas fall within the lowland region of undulating forest lands of northwestern Guyana, as described in the second division above. Northwestern Guyana and by extension the entire land mass of Guyana is considered part of the Guiana Shield region as defined by recent regional studies (Huber and Foster, 2003; Hollowell and Reynolds, 2005).

The Guiana Shield is in northeastern South America and includes the large mountain systems that form the watershed between the Amazon and Orinoco Rivers. It covers 2.5 million square kilometers and is bounded roughly by the Amazon River to the south, the Japaura-Caqueta River to the southwest, the Sierra de Chiribiquete to the west, the Orinoco and Guaviare Rivers to the northwest and north and the Atlantic Ocean to the East.

The Guiana Shield accounts for more than 25 percent of tropical forests remaining in the world. Its diverse landscapes have been recognized for their biological endemism, unique ecosystems, pristine forests and cultural diversity. Table 12-2 provides the estimated diversity and endemism of flora and fauna of the Guiana Shield. Figure 12-2 shows the location of Guyana and the project development areas in relation to the Guiana Shield Region.

Table 12-2: Estimated diversity and endemism of the Guiana Shield

Flora/ Fauna	Number of species	Number of endemic species	Percentage of total species that are endemic
Vascular Plants	20,000	7,000	35%
Birds	975	150	15%
Mammals	282	27	10%
Reptiles	280	76	27%
Amphibians	272	127	47%
Freshwater Fish	2,200	700	32%

Source: Conservation Priorities for the Guyana Shield Consensus Report (2002)

[117]. FAO, 2010. Ecological Zones: Guyana.

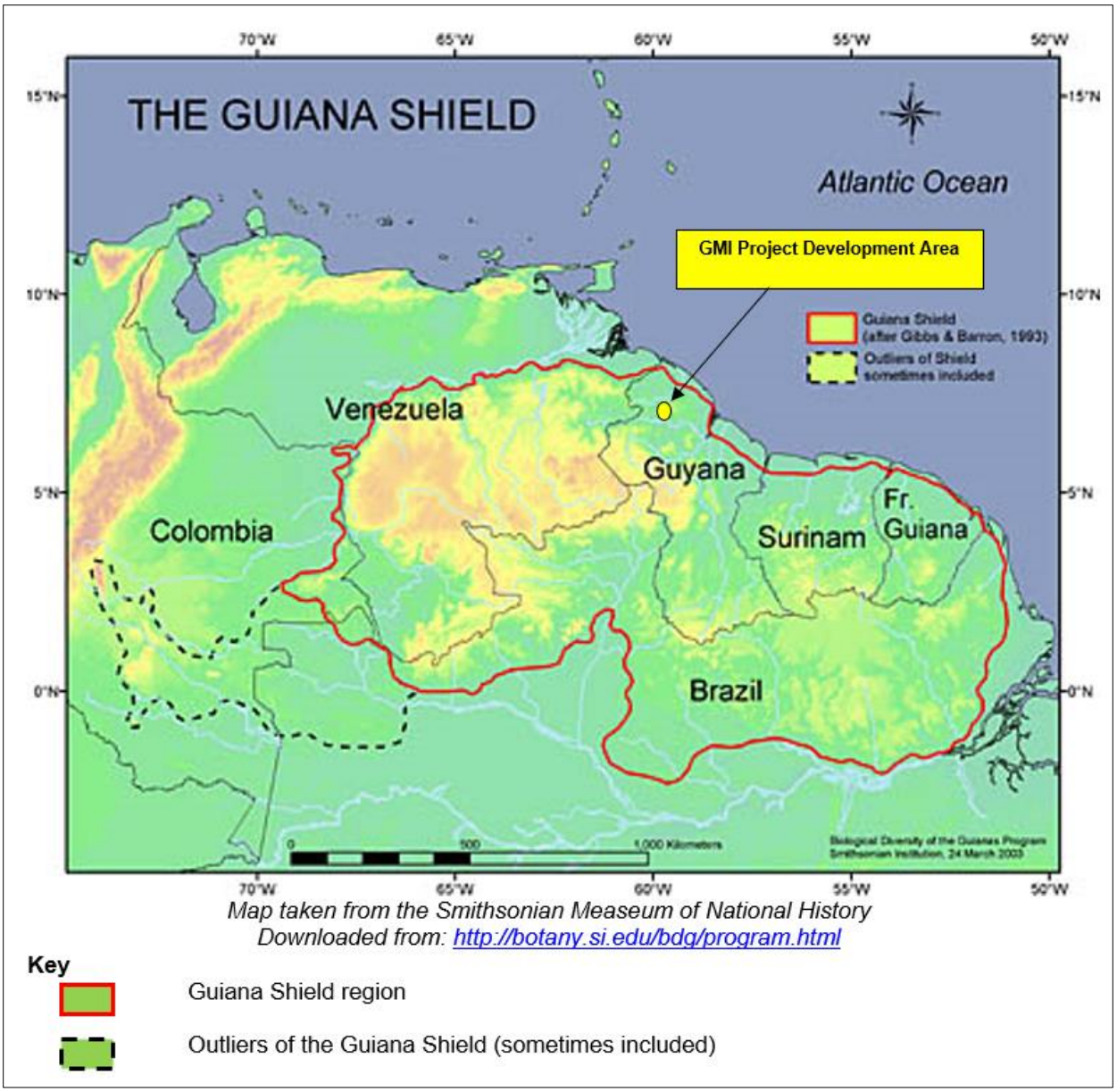


Figure 12-2: Map of the Guiana Shield Region

The lowland rainforests on brown sandy soils, loams, or laterites is the major vegetation type of the Amazon Valley and the Guiana Shield (Steege 2003). These lowland ecoregions are characterized by flat-topped hills, ridges and valleys with an elevation between 50 to 300 m and are biogeographically distinct from the Guiana Shield highlands, which include the tepui formations characterized by relatively high levels of endemisms.

According to a classification of forest of the Guiana Shield region by Steege and Zondervan (2000), there are five divisions of the Guiana forest:

1. Forest of the Coastal Plain (Venezuela-Guyana-Suriname-French Guiana)
2. Forest of the Northwest District of Guyana and Lowland Venezuelan (Venezuela-Guyana)
3. Forest of the White Sands Formation (Guyana-Suriname-French Guiana)

4. Forests of the Pakariama-Central Guiana Upland Region (Guyana-Venezuela-Brazil)
5. Forest of the Southern peneplain (Guyana-Suriname-French Guiana-Brazil)

The project development areas fall within the Guiana forest division broadly described as Forests of the Northwest District of Guyana and Lowland Venezuela. The natural forest composition of the Northwest District is characterized (Steege and Zondervan, 2000) mainly by mixed forest of the Northwest District which includes: mixed forests on clayey soils, mixed forests on lateritic hills, mixed forests on pleistocene brown sands, extensive riverine forest; and open swamps. The description of each forest type is as follows:

- Mixed Forest on Clayey Soils – These dry land forests of the Northwest District of Guyana and eastern Venezuela are characterized by a high abundance of *Eschweilera sagotiana, Alexa imperatricis, Catostemma commune, Licania* spp. and *Protium decandrum*. These species are found abundantly in almost every dry land forest type in this region.

- Mixed Forest on Lateritic Hills – Common trees are *Eschweilera* spp., *Licania* spp., *Swartzia* spp., *Mora gonggrijpii*, *Chlorocardium rodiei*. A local endemic, *Vouacapoua macropetala*, forms extensive stands with *Eschweilera sagotiana, Licania laxiflora, Sterculia rugosa, Poecilanthe hostmanii* and *Pentaclethra macroloba* on lateritic soils in central Guyana. A low shrubby forest is found on the rocky phase of laterite with Myrtaceae (*Eugenia* spp., *Calycolpes, Marlierea*) and Sapotaceae (*Ecclinusa, Manilkara*) being dominant at these locations. Pioneers, such as *Cecropia* spp., *Schefflera morototonii, Jacaranda copaia* and *Pentaclethra macroloba* are also abundantly present on such sites in central Guyana.

- Mixed rainforests on Pleistocene brown sands – These forests on the brown sands of the Berbice formation are almost invariably characterized by species of *Eschweilera* and *Licania* spp. Locally dominant species are *Eschweilera sagotiana, E. decolorans, E. confertiflora, Licania alba, L. majuscula, L. laxiflora, Chlorocardium rodiei, Mora gonggrijpii, Alexa imperatricis, Swartzia schomburgkii, S. leiocalycina, Catostemma commune, Eperua falcata, Pouteria guianensis, P. cladantha, Aspidosperma excelsum* and *Pentaclethra macroloba*. Mono-dominance is common in forests on brown sands in central Guyana and tends to become less in an eastward direction.

- Extensive riverine forest – These are generally found along major rivers, having significant canopy association with species of the Mora forest inclusive of *Eschweilera wachenheimii, E. sagotiana, Clathrotropis brachypetala, C. macrostachya, Eperua falcata, E. rubiginosa, Catostemma* spp*., etc.*

- Open swamps – Herbaceaous and grass swamps in brackish and sweet water with Cyperus, Montrichardia, Commelina, Paspalum and Panicum.

12.2.2 Landscapes and Ecosystems

The Northwest District of Guyana is approximately 8,000 square miles (21,000 square kilometers) and borders Venezuela. The district, known for timber and mineral resources, consists of active mining communities including Port Kaituma, Arakaka, and Matthew's Ridge. The ecosystems of the northwest district are dominated by dense forests which are interlocked among aquatic environments in the form of rivers and creeks, which are seasonally flooded and provide habitats for aquatic biota.

The valleys slopes, hillslopes, and ridgetops support forests that are not seasonally flooded. The forest river ecosystems are integrated through surface and groundwater hydrological processes. The surface waters of the region are generally considered "blackwaters", with low pH, high contents of tannins and organic acids from the breakdown of leaf litter.

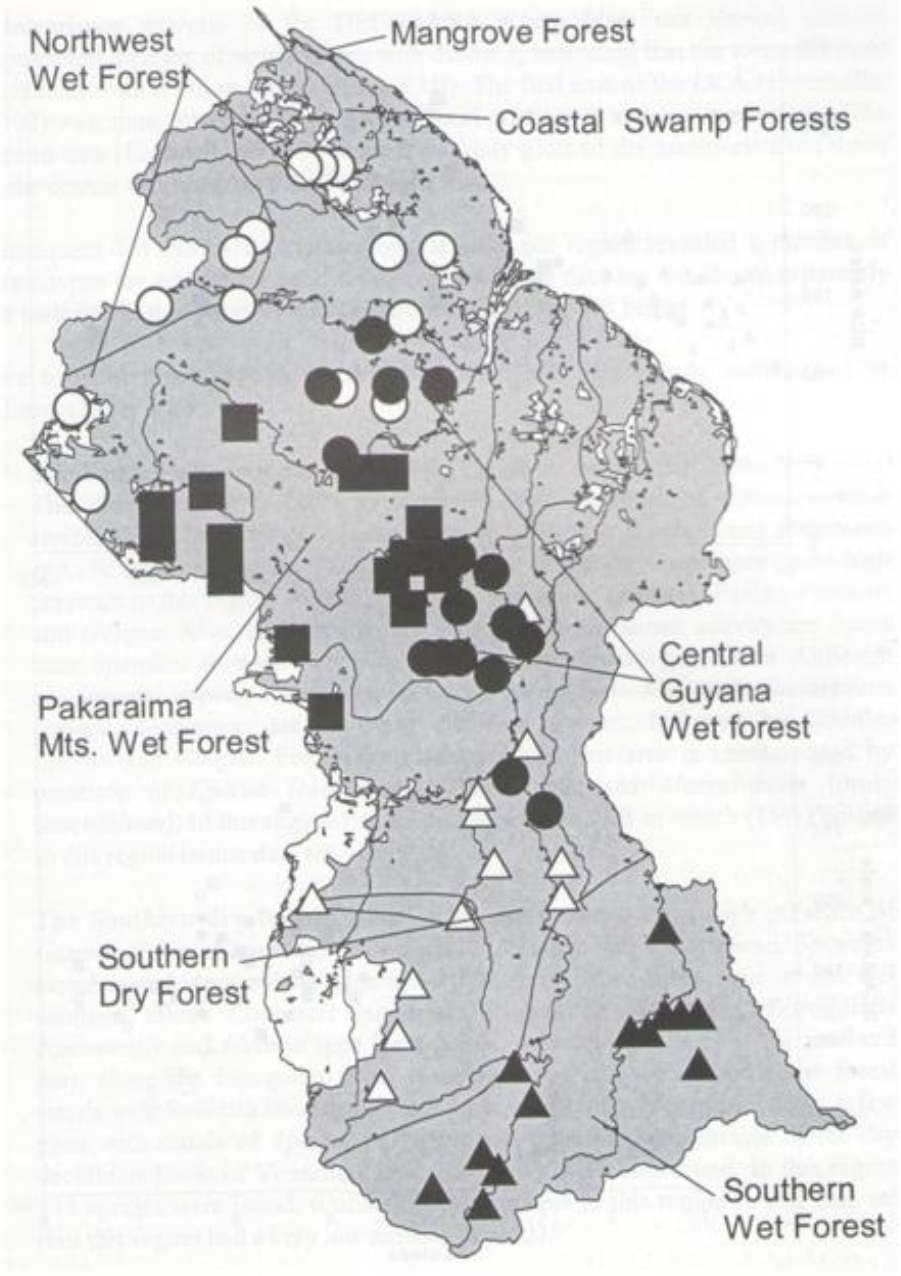
One of the first accounts of the vegetation of northwest Guyana was given by Anderson (1912), who distinguished two major forest categories; forests of the swamp lands and forests on the slightly elevated or hilly lands. Anderson classified forests on slightly elevated or hilly lands as being characterized by Lecythidaceae, Chrysobalanaceae, and *Alexa imperatricis*. More than a decade later, Davis (1929) divided the vegetation of the Northwest District into swamp forests, mora forests and mixed forests.

In 1993, a detailed account of the forest types of the Northwest District was compiled by the Edinburgh Centre for Tropical Forests (ECTF) during the preparation of an Environmental and Social Impact Assessment (ESIA) for Barama Company Limited (BCL). The ESIA study reported that the BCL northwest concession as consisting predominantly of mixed forest types, with intermixed marsh forests of mora and palm. Five species, characteristic of mixed forest in central Guyana, greenheart (*Chlorocardium rodiei*), wallaba (*Eperu falcata* and *E. grandiflora*), morabukea (*Mora gonggrijpii*) and wamara (*Swartzia leiocalycina*), were reported to be virtually absent in the northwest forest studied.

Steege (1998a) conducted a study of the composition and structure of forest regions of Guyana using large scale forest inventory data carried out in Guyana's forest from the 1920's to 1970. The study identified five national forest regions as depicted in Figure 12-3. These regions are as follows:

- The Southern Wet Forests, south of the Cuyuni River to east of the New River,
- The Southern Dry Forests,
- The Pakaraima Mountains Wet Forests,
- The Central Guyana Wet Forests, situated on the sandy Berbice formation and
- The Northwest Guyana Wet Forests.

The project development areas are situated in the northwest Guyana Wet Forest region. According to Steege (2000), the northwest wet forest region is characterized by a high abundance and presence of *Alexa imperatricis*, *Protium decandrum*, *Eschweilera corrugate*, *Pentaclethra macroloba* and *Mora excelsa*.



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

LEGEND

▲*Southern Wet Forest*
○*Northwest Guyana Wet Forests*
●*Central Guyana Wet Forest*
■*Pakaraima mountains Wet Forests*
△*Southern Dry Forest; Light grey areas: area under forest cover*

Figure 12-3: Map of the Five National Forest Regions of Guyana

12.2.3 Habitats and Species

Guyana has a rich diversity of species of flora and fauna. Guyana is home to 429 species of freshwater fish (Funk and Kelloff, 2009). There are 222 species of mammals, 120 species of amphibians and 168 species of reptiles known to occur in Guyana (Hollowell and Reynolds, 2005). Over 850 species of birds are known to exist in Guyana. Guyana has an estimated 5,989 species of flowering plant species, which are found in 1,673 genera and 198 families (Steege, 2000).

As earlier described and depicted in Figure 12-4, the natural landscape of the northwest wet forest region is dominated by lowland mixed forests.The AoI of the project, defined as the footprint of the facilities at Matthew's Ridge and Port Kaituma, areas of mineral deposits to be targeted, and road and river transport corridors to be utiliseutilised by GMI, are made up of degraded forest characterized by secondary growth forest species.

The Matthew's Ridge location consists of a topography of rolling hills with mean elevations 94 m above mean sea level. The habitats of the Matthew's Ridge mining and plant sites are characterized by secondary growth vegetation. Beyond the footprint and buffer of the mine, plant site, building and road areas the secondary vegetation is followed by more mature forest which, show signs of the impact of small-scale timber harvesting, subsistence farming and transient homesteads. Watercourses in the form of small creeks, some of which begin as small springs, representing the headwater rivulets and branches of the Barima River, are frequent and form the sources of water supply for the residents of Matthew's Ridge. The largest body of water within Matthew's Ridge is the Pakera Lake formed by the presence of the old water retention dam on the Pakera Creek installed to provide the water supply source for process water for ore treatment in the plant. The Manikuru and the Fish Creeks, also headwaters of the Barima River, are in the vicinity of the resource development areas within Matthew's Ridge.

The proposed Port Kaituma manganese storage and wharf facility site is characterized by secondary growth on the canal's artificial levee formed originally by the dumping of dredge spoil created during the making of the canal. The result is a dam that is 1.5 meters high and 20 meters wide built on the original peat and mud swamps. Mean site elevation is 13 meters above mean sea level. The canal's water level rises twice daily in response to the tidal influences of the Kaituma River. Tidal variation at site is some 1.5 meters. Small unregulated homesteads, subsistence agriculture, shops and other services are present on both sides of the canal.

Manganese mining and exploration has had a long and tenuous history within the AoI. Manganese occurrences were first identified in Guyana's North West District in 1902, mainly at locations identified as Matthew's Ridge, Arakaka and Pipiani. Beginning in 1954, a Union Carbide subsidiary company, Manganese Mines Management Ltd (MMM) established mining operations by acquiring mining the leases, after geological exploration determined adequate reserves.

MMM dredged the Barima River and Mora Passage; cut the Kaituma Canal and established ship loading, ore concentrate storage, fuel tankage and housing at Port Kaituma. In 1960, the establishment of a thirty (30) mile 3'10" railway with adjacent roadway, a Bailey bridge over the Barima River at Eclipse Falls, the creation of the mine site at Matthew's Ridge with the associated similarly named 'company town', and the establishment of mine buildings and a processing plant followed. A further rail extension was later made to Arakaka. Operations ceased in 1968 due to a fall in the price of manganese presumably due to the development of large, high quality, reserves in Brazil. In March 2011, Canada's Reunion Manganese Inc. (RMI) and Guyana signed mineral agreements allowing for a re-examination of the prospects with the intent of restarting operations. Guyana Manganese Inc. has, since it made the property acquisitions, occupied the site.

Historical and ongoing human activities within the AoI of the project have modified the primary ecological functions of habitats, resulting in habitat loss. Biodiversity resident within the AoI of the project are, therefore, habituated to the constantly changing and human-influenced environments of the AoI.

Biodiversity data compiled for this assessment was evaluated against baseline data compiled for habitats within the lowland mixed forest region that are ecologically similar to the project development areas in Matthew's Ridge and Port Kaituma. As such, biodiversity baseline survey data was considered from the Tassawini gold exploration concession in 2011 and 2007 respectively and a rapid biodiversity assessment conducted in 2011 at the Five Star Mining Area. The Tassawini concession is located at the Chinese Landing within the northwest wet forest region shared with the GMI project landscape. The Five Star mining area is located northeast of Matthew's Ridge, also within the northwest wet forest region shared with the GMI project landscape.

The Tassawini 2007 study compiled data on flora and fauna over a complete yearly seasonal cycle, while the 2011 study compiled data during the short dry season in March of 2011. The Five Star area survey was conducted during the short-wet season in May 2011. The findings of the surveys for each animal taxa except for macro-invertebrates are provided in Table 12-3.

Available data on macro-invertebrates in Guyana is extremely limited. Terrestrial-macro invertebrates recorded in the Tassawini surveys were classified to the family taxa, due to the difficulty of identifying and classifying invertebrates to the species level. The 2007 Tassawini survey recorded 52 families of macro invertebrates from 15 orders, while the 2011 survey recorded 37 families of macro invertebrates from 13 orders.

Table 12-3: Findings of the Tassawini Chinese Landing and Five Star Mining areas biodiversity baseline surveys

Survey Location	Number of Species												IUCN Red List Category
	Mammals		Birds		Fishes		Amphibians		Reptiles		Bats		
	2007	2011	2007	2011	2007	2011	2007	2011	2007	2011	2007	2011	
Five Star Mining Area		12		57		7		3		9			*Panthera onca* - NT
Tassawini Gold Concession	7	19	263	112	69	37	26	26	20	30	4	4	*Panthera onca* (NT)*; Puma concolor* (NT)*; Tapirus terrestris* (V)

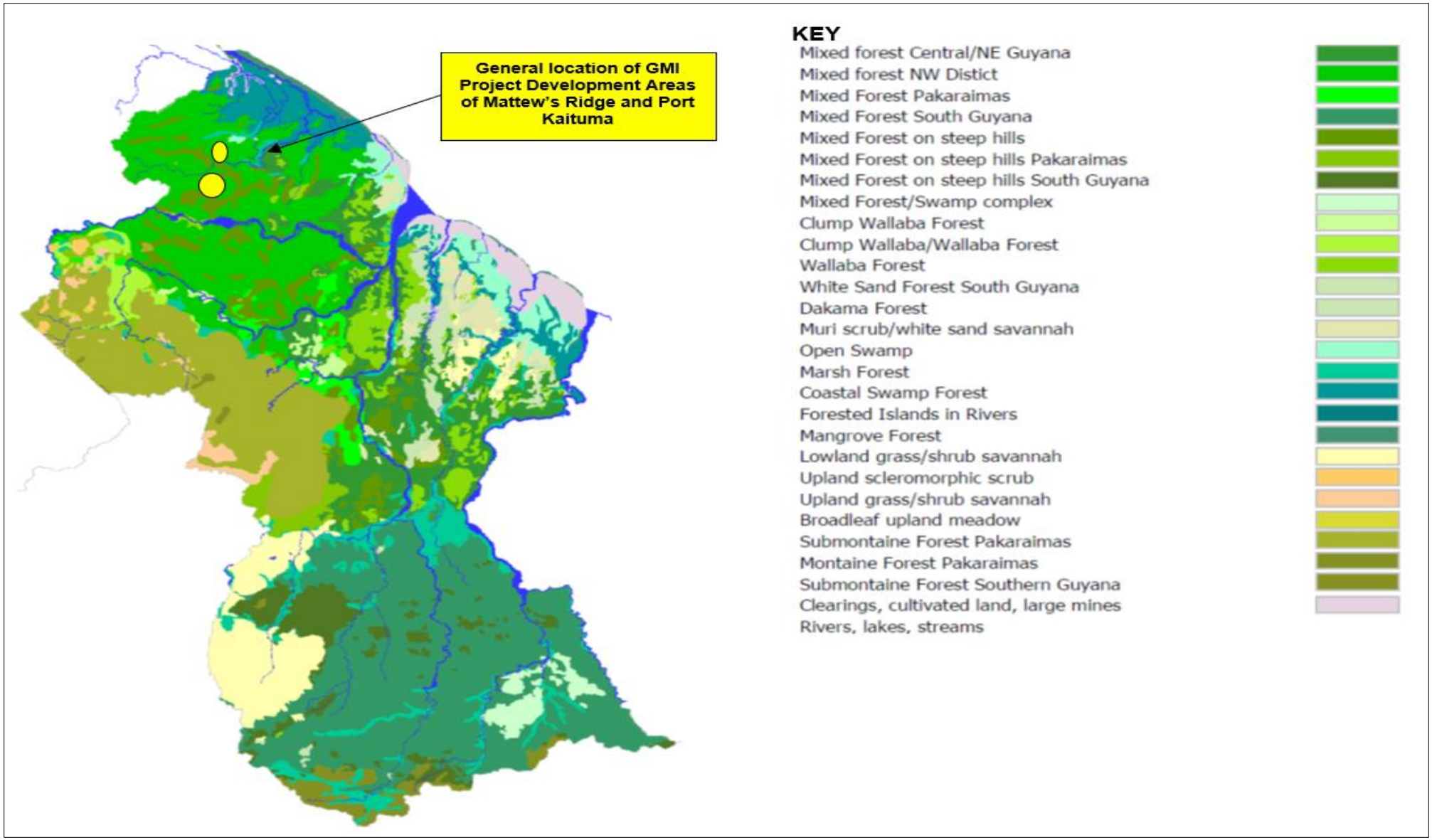


Figure 12-4: National Vegetation Map of Guyana, after Steege (2001)

12.2.3.1 Biodiversity of the Project Development Areas

Baseline field surveys were conducted within the project development areas of Matthew's Ridge and Port Kaituma during periods corresponding to a single wet season and a single dry season in June-July and October 2012, respectively, and a single dry season in February 2020.

The 2012 survey focused on the resource development areas of Hills 1 to 9 within Matthew's Ridge. The 2020 survey expanded on the data compiled in the 2012 survey and was focused on the resource development areas in Matthew's Ridge and the project's community by-pass road and proposed Kaituma Marine Terminal in Port Kaituma. The objective of the biodiversity surveys was to identify and assess whether there are sensitive species, that is, threatened species as defined by the IUCN Red List, endemic or restricted-range species, and migratory species within the project development areas. The biodiversity surveys were conducted using a system of survey transects (sample plots) as depicted in Figures 12-5 to 12-8. Terrestrial survey transects in Matthew's Ridge are labelled T1 to T4, and aquatic survey locations as AQ 3 to AQ 6. The terrestrial and aquatic survey transects within Port Kaituma are labelled T5 and AQ 1 and AQ 2, respectively. Habitat descriptions of the terrestrial and aquatic survey transects are provided in Table 12-4. The baseline survey methodology is provided in Appendix G1.

Table 12-4: Habitat Descriptions of the Terrestrial and Aquatic Survey Transects

Transect ID	GPS Coordinates	Habitat Description
T1 – Matthew's Ridge	60°12'10.728"W 7°29'7.414"N Or 20N8087350828399 UTM	Transect on Hill 9 along primary access road. Primarily mixed forest field on loam land. Includes ravines and hills (side slopes and flat tops). The terrain had an average elevation of 154 meters. Forest canopy height ranged from 15 to 35 meters. The canopy was closed moderately. The canopy had a liana infestation. In these areas, wind breaks created canopy gaps were 51 to 75 precent. Rare hemi-epiphytes. The understory was medium-sparse. Human alterations were evident, including mining exploration drill pads, logging and secondary roads.
T2 – Matthew's Ridge	60°5'52.554"W 7°29'57.988"N Or 20N8203290830029 UTM	Transect located along the old railway line. Forest transect included a small waterfall, with a narrow creek, with depths greater than 4 meters in some places. This transect included extensive secondary vegetation with primary species. Type of soil was loam and gravel. Includes seasonal swamps (inundated area) and slightly elevated hill tops. The terrain was slightly undulating with a 125-meter average elevation. The forest was open with an irregular canopy. Gaps in the canopy were generally 0 to 50 meters. Canopy height ranged from 15 to 35 meters. The understory vegetation ranged from sparse to dense according to disturbance level. Rare epiphytes and hemi-epiphytes. Lianas were prolific in disturbed areas. Human modification included bulldozed trails.
T3 – Matthew's Ridge	60°7'44.274"W 7°30'2.379"N Or 20N8169000830142 UTM	This location was mainly a primary mixed woodland on loam soil with an average 82-meter elevation. Many ravines crisscross the sample area. Sampled areas included ravines and hills (base, slope and hill top). In the canopy, occasional wind breaks (trees fell due to heavy winds) created small gaps (76 to 100 percent). Height

Transect ID	GPS Coordinates	Habitat Description
		ranged from 15 to 35 metres. Human alterations consisted of an active secondary road and farmlands.
T4 – Matthew's Ridge	60°5'11.753"W 7°30'4.117"N Or 20N8215800830226 UTM	A prevalent mixed forest on loam soil with average elevation of 109 meters along the main access road. The forest area's top soils contain substantial clay. The forest had an uneven, sparse canopy. Windfall naturally created canopy gaps. Forest height ranged from 20 to 40 meters with a few emerging species. Lianas were rare, with no canopy infestation. Frequent epiphytes and hemi-epiphytes.
T5 – Port Kaituma	59°50'49.819"W 7°44'23.952"N or 21N1859100856614 UTM	Transect along the community by-pass road to the proposed wharf area. A predominant mixed forest on loam soil. The terrain was mildly undulating with an average 75-meter elevation. The canopy was moderately open and high. Tree heights ranged from 25 to 35 meters. Natural gaps (windbreaks) within the canopy were usually 51 to 75 percent. Rare epiphytes and hemi-epiphytes. Lianas were prevalent. Transect included an ite swamp, and small to medium semi-permanent pools with dead vegetation. Human alterations included logging and farming
AQ1 – Port Kaituma	59°50'47.88"W 7°44'2.471"N or 21N 1859770855943 UTM	Sampling site located along the road by-pass road to area of proposed wharf. The sampled water body was a stream measuring 2 meters at the deepest point and 19 meters width while the length sampled was approximately 50 meters. The bed of the channel was approximately 80 percent woody debris, 5 percent clay, 10 percent sand and 5 percent pebbles, while the bank of the stream was approximately 50 percent shrubs, 10 percent trees and 40 percent grass. Human disturbances included the access road, farmlands, homesteads and logging. The sampling point was sampled for 20 hours.
AQ2 – Port Kaituma	59°51'11.295"W, 7°46'0.486"N Or 21N1852790859576 UTM	The sample location is the area of proposed wharf at the Port Kaituma Canal downstream of Port Kaituma Landing docks. The water body was murky and tidal. The bed of the channel was approximately 20 percent silt, 40 percent clay, 20 percent woody debris and 20 percent leaf litter. The bank of the canal at the area sampled was estimated to be 20 percent grass, 50 percent trees and 30 percent shrubs. Human disturbances included homesteads, farmlands, and moderate levels of boat traffic within the canal. The site was sampled for 8 and a half hours during sunny weather.
AQ3 – Matthew's Ridge	60°7'41.262"W 7°30'2.45"N or 20N8169800830135 UTM	This sampling point is located at the Manikura River along the Matthew's Ridge main access road. The water channel sampled was murky, with 1.5 meters in depth and 5 meters wide, while the length of the stream sampled was approximately 200 meters. The bed of the channel was estimated to be 10 percent silt, 30 percent clay, 30 percent woody debris, 20 percent leaf litter and 10 percent pebbles, while the bank was 60 percent trees, 35 percent shrubs and 5 percent grass. Total sampling time at the survey site was 34 hours. Weather for the duration of this period was sunny.

Transect ID	GPS Coordinates	Habitat Description
AQ4 – Matthew's Ridge	60°7'47.327"W 7°29'47.849"N Or 20N8167960829685 UTM	This site is the flooded areas located at Pakera creek at the old pump house and 'community pool" along the main access road of Matthew's Ridge. Sampling time was 34 hours. The bed of the channel at these locations was estimated to be 35 percent clay, 50 percent woody debris, 10 percent litter and 5 percent pebbles, while the banks were approximately 50 percent grass, 30 percent shrubs and 20 percent trees. The area is frequently used by the community for leisure swimming and subsistence fishing. The channel at the sample location was approximately 7 meters wide and 1.5 meters deep. The water body type was murky at some points and clear at others. The length of channel was sampled was approximately 300 meters. The weather during sampling period was sunny.
AQ5 – Matthew's Ridge	60°6'29.598"W 7°30'8.09"N Or 20N8191770830323 UTM	This sampling point is located at a stream off the the old train line road. Sampling was done for 34 hours during sunny weather. The bed of the channel was estimated to be 10 percent clay, 35 percent silt, 10 percent woody debris, 20 percent leaf litter and 25 percent pebbles, while the bank was 80 percent trees and 20 percent shrubs. There was no evidence of human disturbance. The channel at the area sampled was 3 meters wide, 1.5 meters depth and the length sampled was 150 meters. The stream was fast flowing and clear.
AQ6 – Matthew's Ridge	60°11'9.235"W 7°29'23.536"N Or 20N8106060828897 UTM	This site is the flooded areas/swamps located north of the Matthew's Ridge airstrip. The site is considered as a blackwater pond, 75 meters wide and more than 2 meters in depth. The length sampled was approximately 50 meters. The bed of the channel was estimated to be 20 percent clay, 25 percent silt, 50 percent woody debris and 10 percent leaf litter, while the bank approximately 20 percent trees and 80 percent grass. Canopy cover was estimated to be 10 percent. Total sample time was approximately 34 hours. The weather condition was sunny throughout the sampling period.

(T – Terrrestrial; AQ – Aquatic)

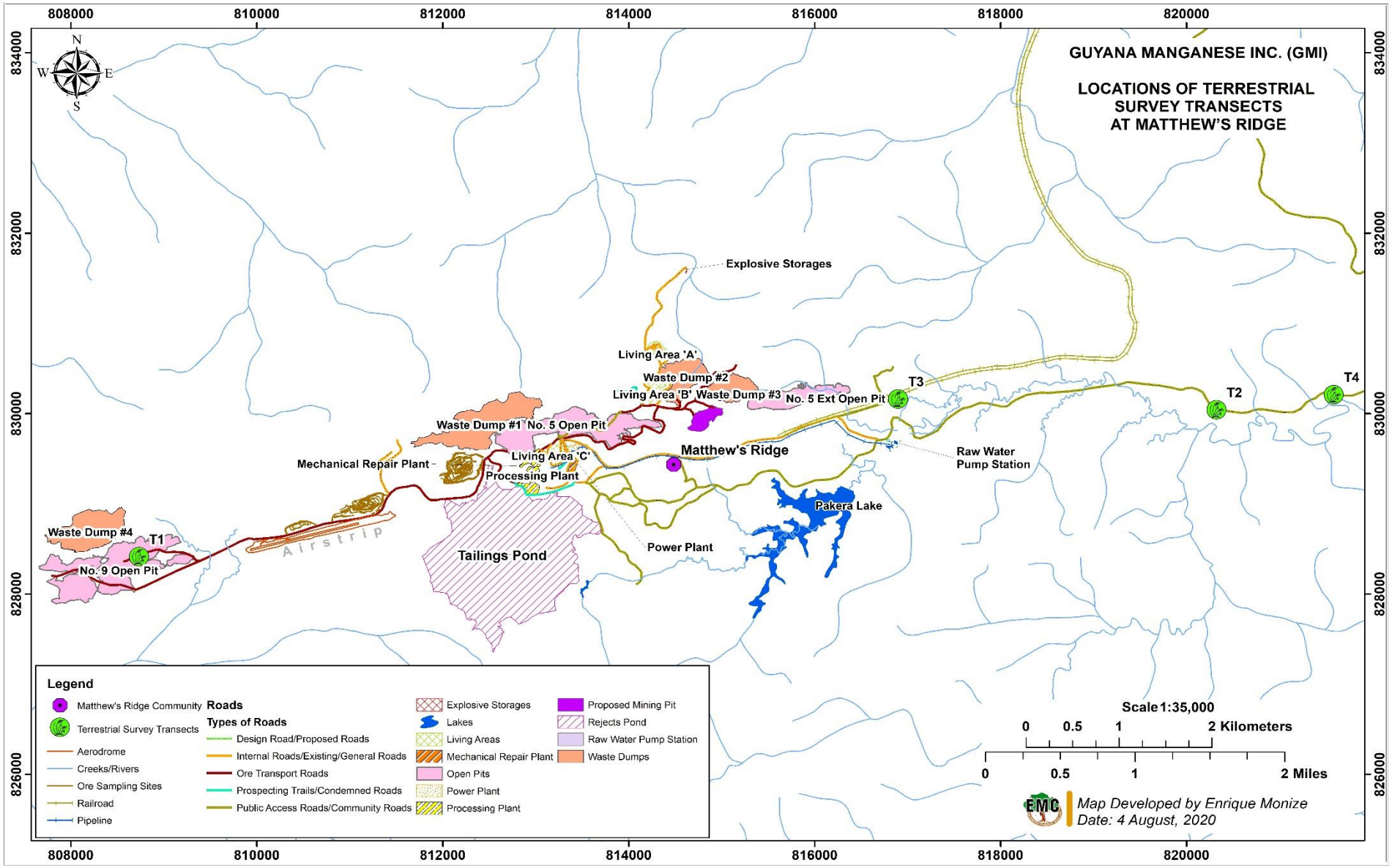


Figure 12-5: Terrestrial Transects at Matthew's Ridge

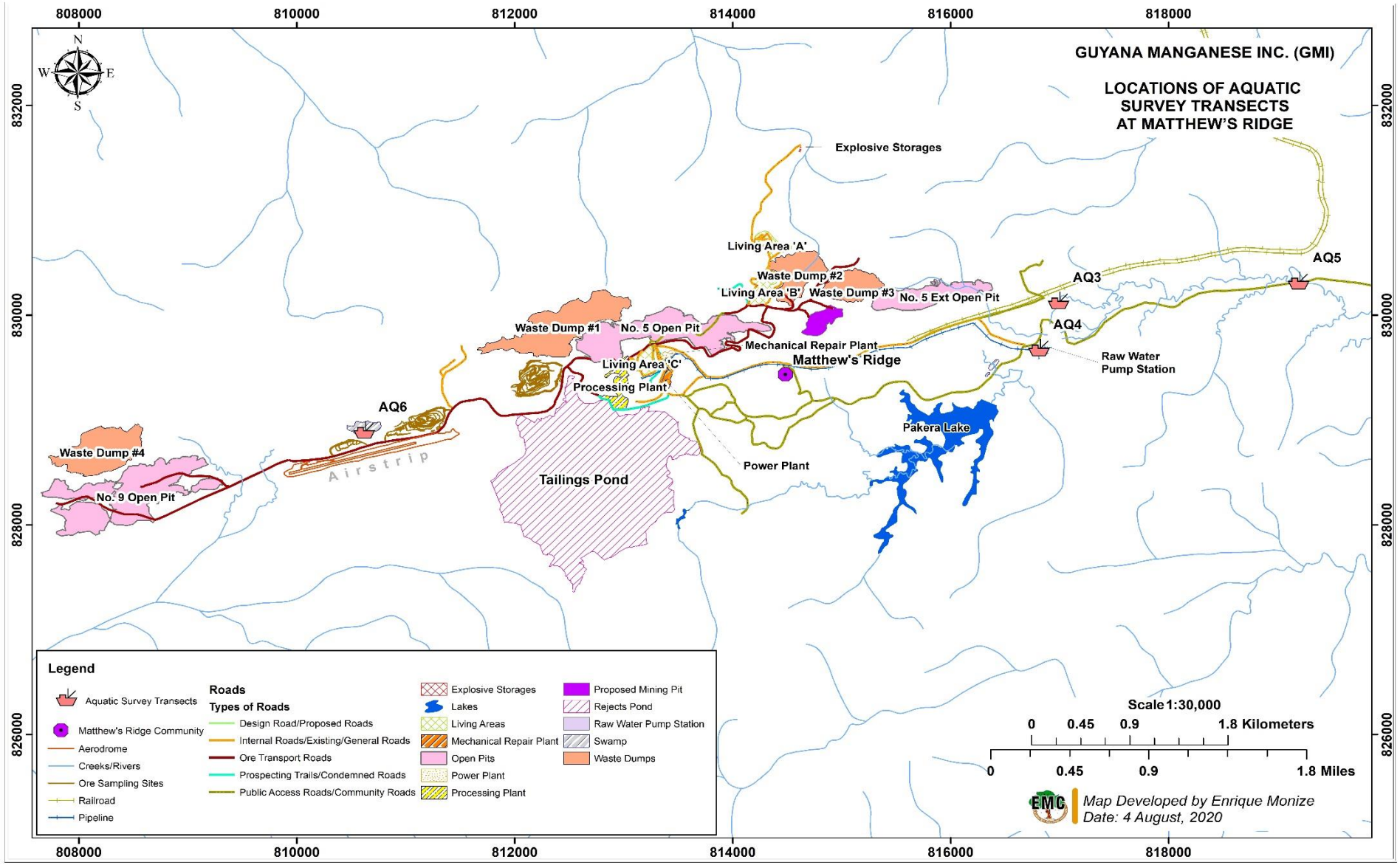


Figure 12-6: Aquatic Survey Locations at Matthew's Ridge

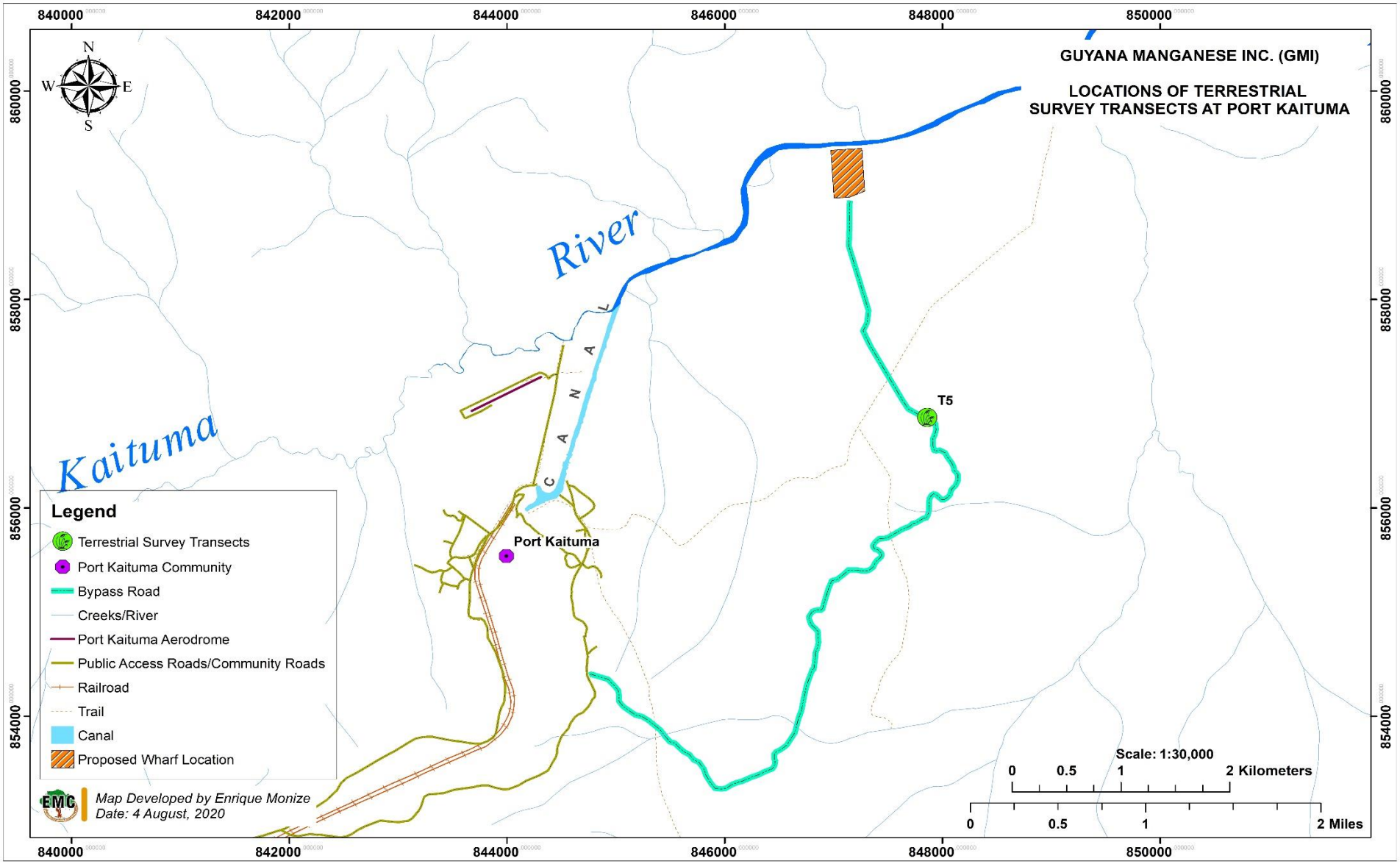


Figure 12-7: Terrestrial Survey Transects at Port Kaituma

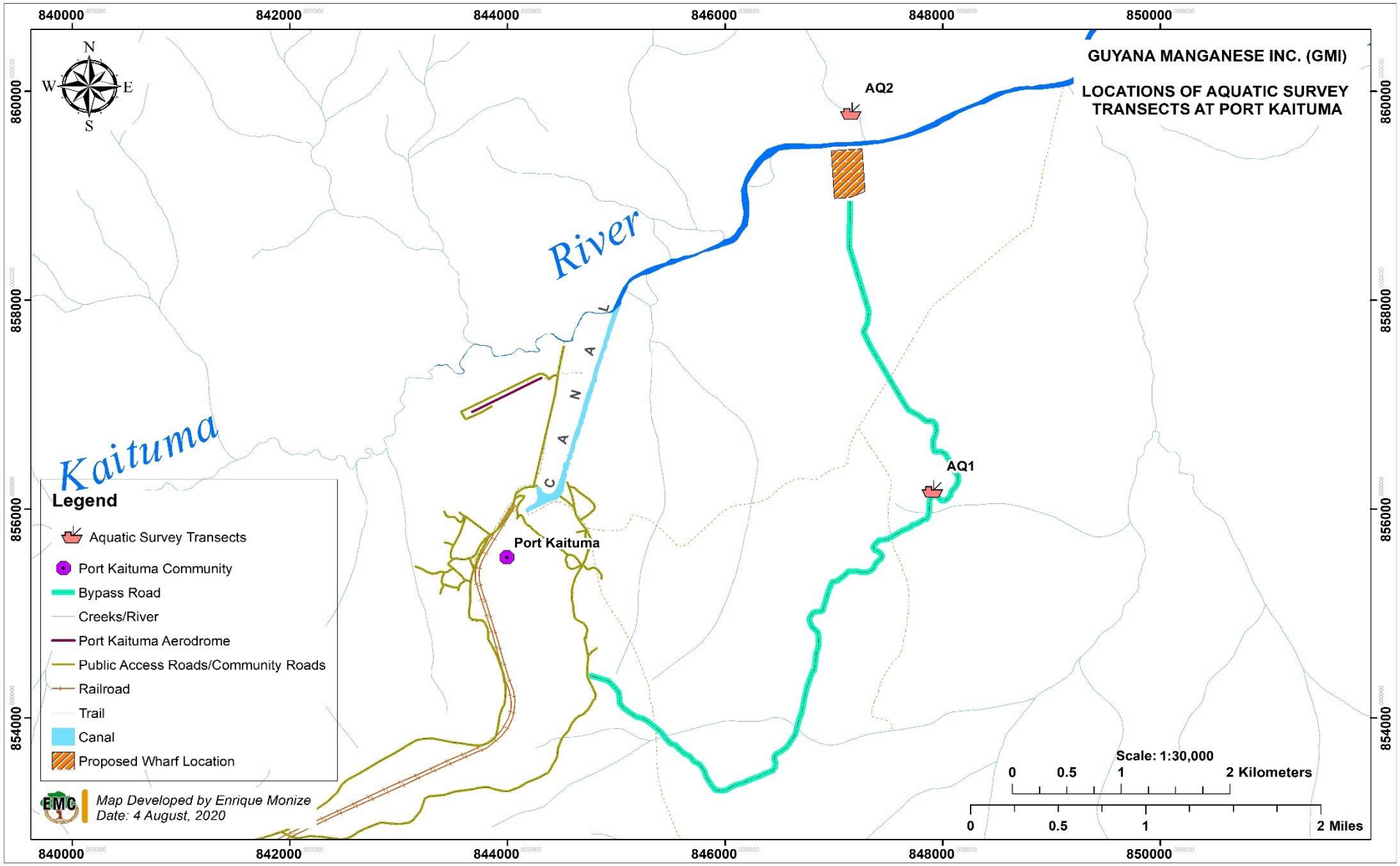


Figure 12-8: Aquatic Survey Locations at Port Kaituma

12.2.3.1.1 Baseline Surveys – 2012

The results of the biodiversity surveys conducted during 2012 within the resource development areas of Matthew's Ridge revealed that the natural landscape is dominated by lowland mixed forests on clayey soils characteristic of the northwest wet forest region. The natural landscape consists of patches of secondary forest and human disturbed habitats in the form of roads, community homesteads, farming, historical and current mining.

All transects surveyed exhibited moderate to high levels human disturbance with low levels of natural disturbances associated with natural tree falls. Other forest ecosystems according to Steege and Zondervan (2000) classification that are characteristic of the northwest wet forest region including mixed forest on lateritic hills, mixed forests on Pleistocene brown sands, extensive riverine forest and open swamps were not encountered within Matthew's Ridge.

Man-made swamps of standing dead and live trees of the species *Pterocarpus officianlis,* and a well-developed razor grass herbaceous stratum were also recorded within the project development areas of Matthew's Ridge. The swamps were observed in association with man-made structures. Examples of the swamp areas observed during the surveys include the area along the railway line/access road in the vicinity of Hill 4, the swamps along the embankment of the old pump station at the Pakera Creek and the swamps along access road in the vicinity of the Matthew's Ridge airstrip. The man-made open swamps areas were interlocked by forested swamps. The forested swamps were dominated by *Euterpe oleraceae*, and *Pentaclethra macroloba* with a well developed herbaceous stratum dominated by *Touroulia guianensis* and *Heliconia spp*.

There are no major rivers within the project development areas of Matthew's Ridge and therefore no extensive riverine forest types were observed. Small extents of riparian mixed forest were observed along the small rivers and streams within the area.

The faunal survey conducted in the wet season (June-July, 2012) recorded a total of 35 species of non-volant mammals from 8 orders and 22 families; 16 species of bats representing 3 families; 164 species of birds from 38 families; 27 species of amphibians from 5 families of the order Anura; 22 species of reptilians representing 3 orders from the class reptilian; 18 orders of terrestrial macro-invertebrate; 10 orders of aquatic macro-invertebrates; and 31 species of fish from 15 families and 6 orders.

The survey conducted in the dry season (October 2012) recorded a total 25 species of non-volant mammals from 7 orders and 17 families; 17 species of bats from 3 families; 119 species of birds from 29 families; 15 species of amphibians from 5 families of the order Anura; 17 species of reptiles from 2 orders; 18 orders of terrestrial macro-invertebrates; 31 species of fish from 15 families and 6 orders; and 9 of the 10 orders of aquatic macro-invertebrates recorded during the wet season survey. Both the wet and dry season surveys documented a total of 146 plant species belonging to 57 families.

The wet and dry season surveys of 2012 did not record Critically Endangered (CE) fauna or flora. Anecdotal evidence gathered through interviews during the surveys indicated the existence of the IUCN Red List Endangered (EN) Giant River Otter (*Pteronura brasiliensis*) within the project development areas of Matthew's Ridge. However, the presence of *P. brasiliensis* was not confirmed during the active surveys. The gymphophalmid lizard, *Echinosaura sulcarostrum,* was recorded at Mathews Ridge in 2012. This lizard is categorised as Endangered (EN) due to its presumed restricted geographical range. Table 12-5 provides the IUCN Red list of threatened species recorded during the 2012 surveys.

Table 12-5: Species from the IUCN Red List Recorded in the 2012 Surveys

SPECIES	COMMON NAMES	IUCN Classification
Mammals		
Pteronura brasiliensis	Giant Otter	Endangered (EN)
Ateles paniscus	Guianan Spider Monkey	Vulnerable (V)
Priodontes maximus	Giant Armadillo	Vulnerable (V)
Tapirus terrestris	Lowland Tapir	Vulnerable (V)
Tayassu pecari	White-lipped Peccary	Vulnerable (VU)
Myrmecophaga tridactyla	Giant Anteater	Vulnerable (V)
Reptiles		
Echinosaura sulcarostrum		Endangered (EN)
Amphibians		
Atelopus spumarius	Pebas Stub-foot toad	Vulnerable (V)

No migratory, endemic and or restricted range species were recorded during the 2012 surveys.

12.2.3.1.2 Baseline Surveys – 2020

The natural landscape of the project development areas of Matthew's Ridge and Port Kaituma share similar habitat characteristics being predominantly of lowland mixed forest vegetation on alluvial soils. Like Matthew's Ridge, the landscape at Port Kaituma consists of patches of secondary forest consistent with human disturbed habitats. As was recorded during the 2012 surveys, all transects surveyed during the 2020 survey exhibited low to moderate levels of human disturbance with low levels of natural disturbances associated with natural tree fall.

A total of 68 species floral species from of 28 families were documented during the 2020 survey within the project development areas of Matthew's Ridge and Port Kaituma. The faunal survey recorded a total of 20 species of non-volant mammals representing 14 (11) families; 14 species of bats from 3 families; 156 species of birds from 36 families; 23 species of amphibians from 5 families; 23 species of reptiles from 9 families; 29 species of fish representing 19 families; 20 orders of terrestrial macro-invertebrates; and 9 orders of benthic macro-invertebrates.

There were no Critically Endangered (CE) or Endangered (EN) floral species recorded during the survey. The Endangered (EN) lizard *Echinosaura sulcarostrum* was recorded at Mathew's Ridge in 2020. A number of species listed as Vulnerable (VU) by the IUCN were recorded in 2020. The Lowland Tapir *Tapirus terrestris* and Giant Armadillo are mammals listed as Vulnerable (VU), while 5 species of birds that were recorded are listed as Vulnerable (VU): the Black curassow (*Crax alector*); Gray tinamou (*Tinamus tao*); Channel-billed toucan (*Ramphastos vitellinus*); Yellow-Ridged Toucan (*Ramphastos culminatus*) and the Red-billed/White-throated toucan (*Ramphastos tucanus*).

12.2.3.1.2.1 Flora

The was a small increase in the floral composition, that is, the number of species and families, recorded within the project development area of Matthew's Ridge during the 2020 survey when compared with the 2012 survey. A total of 563 individuals, representing 68 species from of 28 plant families were documented during the floral survey (Table 12-6). The dominant forest types encountered were lowland mixed forest and (man-made) open swamp on flat or gently rolling terrain on alluvial soils.

The survey transect at Port Kaituma was abundant with the family Lecthidaceae with species *Eschweilera sagotiana, Eschweilera alata, Couratari guianensis* and *Lecythis corrugate*, while the family Annonaceae with species *Duguetia negelecta, Xylopia nitida,* and *Bocageopsis multiflora* was frequent. The families Ebenaceae, Eleocarpaceae, Palmae, Bombacaceae, Euphorbiaceae, Fabaceae, Sapotaceae, Anacardiaceae, Guttiferae, Violaceae, and Lauraceae were less frequent at Port Kaituma.

The most dominant family recorded within the project development area of Matthew's Ridge was Fabaceae with species *Alexa imperatricis, Alexa imperatricis, Inga alba, Pentaclethra macroloba* and *Inga edulis*. The most abundant families at Matthew's Ridge were Chrysobalanaceae with species *Licania canescens, Licania laxiflora and Licania heteromorpha* and Guttiferae with species *Vismia guianensis, Awasokule* and *Symphonia globulifera*. The families Palme, Bombacaceae, Myrtaceae, Lecthidaceae. Celastraceae, Bignoniaceae, Lauraceae, Burseraceae, Euphorbiaceae were frequent. Families such as Dichapetalaceae, Apocynaceae, Boraginaceae, Quiinaceae, Sapotaceae, Moraceae Melastomataceae, Annonaceae, Combretaceae, Sapindaceae and Simaroubaceae were less frequent at Matthew's Ridge.

Table 12-6: Plant Species Recorded in the PDA (Dry Season Survey in February 2020)

Common Name	Species Name	Family
Arara	*Bocageopsis multiflora*	Annonaceae
Abebero	*Paypayrola guianensis*	Violaceae
Aromata	*Clathrotropis brachypetala var.*	Fabaceae
Aruadan	*Sloanea guianensis*	Eleocarpaceae
Asepoko	*Pouteria guianensis*	Sapotaceae
Awasokule	*Tovomita calodictyos Sandw*	Guttiferae
Awati	*Maprounea guianensis Aubl*	Euphorbiaceae
Baba palm	*Socratea exorrhiza*	Palmae
Barabara	*Diospyros guianensis (Aubl.)*	Ebenaceae
Black Kakaralli	*Eschweilera sagotiana*	Lecythidaceae
Broad leaf blood wood	*Vismia macrophylla Kunth*	Guttiferae
Common Baromalli	*Catostemma commune*	Bombacaceae
Congo pump	*Cecropia obtusa*	Moraceae
Duka	*Tapirira guianensis Aubl.*	Anacardiaceae
Duru	*Apeiba petouma Aublet*	Annonaceae
Fine leaf blood wood	*Vismia guianensis (Aubl.)*	Guttiferae
Fukadi	*Terminalia orrugat (J. Gmelin)*	Combretaceae
Futui	*Jacaranda copaia (Aubl.)*	Bignoniaceae
Ginger gale Silverballi	*Aniba cf. guianensis Aubl*	Lauraceae
Guava skin Kakaralli	*Eschweilera alata A.C.Smith*	Lecythidaceae
Haiariballi	*Alexa imperatricis (R.H. Schomb.)*	Fabaceae
Hichu	*Eugenia patrisii*	Myrtaceae
Kabukalli	*Goupia glabra Aubl.*	Celastraceae
Kaditiri	*Sclerolobium guianense Benth.*	Fabaceae
Kairiballi	*Licania heteromorpha var*	Chrysobalanaceae

Common Name	Species Name	Family
Kamakuti	*Bombax falvillorum*	Bombacaceae
Karashiri	*Oxandra asbeckii*	Annonaceae
Kauta	*Licania laxiflora*	Chrysobalanaceae
Kereti silverballi	*Ocotea cf. floribunda*	Lauraceae
Kokoritiablli	*Pouteria reticulata (Engl.)*	Sapotaceae
Kudebushi	*Micropholis venulosa (Mart. & Eichl.)*	Sapotaceae
Kulishiri	*Cupania cf. scrobiculata*	Sapindaceae
Kurokai	*Protium heptaphyllum (Aubl.)*	Burseraceae
Kuyama	*Xylopia nitida (Dunal)*	Annonaceae
Maho	*Sterculia pruriens (Aubl.)*	Sterculiaceae
Manicole palm	*Euterpe oleracea Mart*	Palmae
Maniriballi	*Balizia pedicellaris*	Fabaceae
Manni	*Symphonia globulifera*	Guttiferae
Maporokon	*Inga alba*	Fabaceae
Marishiballi	*Licania cf. canescens*	Chrysobalanaceae
Match wood	*Pourouma guianensis Aubl.*	Moraceae
Okokanchi	*Quiina cf. orruga*	Quiinaceae
Parakusan	*Swartzia jenmanii*	Fabaceae
Ruri	*Chaetocarpus schomburgkianus (Kuntze)*	Euphorbiaceae
Sand Baromalli	*Catostemma fragrans Benth.*	Bombacaceae
Sand mora	*Talisia cf. guianensis*	Sapindaceae
Simarupa	*Simarouba amara Aubl.*	Simaroubaceae
Smooth leaf Kakaralli	*Eschweilera coriacea*	Lecythidaceae
Soft wallaba	*Eperua falcata Aubl.*	Fabaceae
Suradan	*Hyeronima alchorneoides var.*	Euphorbiaceae
Table tree	*Cordia exaltata. Lam.*	Boraginaceae
Tatabu	*Diplotropis purpurea (Rich.)*	Fabaceae
Troolie palm	*Manicaria saccifera Gaertn.*	Palmae
Trysil	*Pentaclethra macroloba*	Fabaceae
Turu Palm	*Jessenia bataua (Mart.) Burret*	Palmae
Ulu	*Trattinickia rhoifolia*	Burseraceae
Wadara	*Couratari guianensis Aubl.*	Lecythidaceae
Waiaballi	*Tapura guianensis Aubl.*	Dichapetalacea
Wakaradan	*Miconia hypoleuca (Benth.)*	Melastomataceae
Waraia	*Miconia punctata*	Melastomataceae
Warakusa	*Inga edulis Mart*	Fabaceae
White Cader	*Tabebuia insignis*	Bignoniaceae
Wina Kakaralli	*Lecythis orrugate Poit.*	Lecythidaceae
Yarri Yarri	*Duguetia negelecta Sandw.*	Annonaceae

Common Name	Species Name	Family
Yarula	*Aspidosperma exselsum Benth.*	Apocynaceae

Table 12-7 shows the floristic composition of the areas surveyed in Matthew's Ridge and Port Kaituma in 2012 and 2020. Photographs taken during the February 2020 field surveys are presented in Appendix G3.

Table 12-7: Floristic Composition of the Areas Surveyed in Matthew's Ridge and Port Kaituma

Floristic Composition	Survey 2012		Survey 2020	
	Average number of plants, plant species, and families			
	Wet Season	Dry Season	Dry Season	
	Matthew's Ridge		Matthew's Ridge	Port Kaituma
Tree layer with Diameter at Breast Height (DBH) greater than 20 centimeters				
Number of individuals in 0.5 ha	92	91	248	52
Number of species in 0.5 ha	27	24	41	12
Number of families in 0.5 ha	17	16	23	10
Mean diameter of trees greater than 20cm DBH	35.4cm	35.5cm	34.5cm	35.2cm
Tree layer with DBH less than 20 centimeters (saplings and seedlings)				
Number of individuals in 0.1 ha	548	511	96	59
Number of species on 0.1 ha	39	38	36	13
Number of families in 0.1 ha	24	24	20	10
Shrub layer with DBH less than 10 centimeters diameter				
Number of individuals in 0.1 ha	47	29	96	32
Number of species in 0.1 ha	5	3	21	8
Number of families in 0.1 ha	5	3	7	3
Herb layer with DBH less than 1.5 centimeters				
Number of individuals in 0.1 ha	70	40	35	19
Number of species in 0.1 ha	4	3	4	3
Number of families in 0.1 ha	4	3	4	3
Palms with DBH less than 20cm				
Number of individuals in 0.1 ha	52	46	19	0
Number of species in 0.1 ha	4	4	2	0
Number of families in 0.1ha	1	1	0	0
Epiphytes, Hemi-epiphytes and Lianas with Diameters greater than 10 cm				
Number of individuals in 0.5ha	54	53	25	14
Number of species in 0.5 ha	9	9	7	6
Number of families in 0.5 ha	7	7	5	5

12.2.3.1.2.2 Terrestrial Fauna

Non-Volant Mammals

Results of the February 2020 Survey

A total of 20 species of non-volant mammals representing 11 families were documented during the survey of the project development areas in Matthew's Ridge and Port Kaituma in 2020. Eleven species from 8 families were recorded at Port Kaituma and a total of 19 species from 13 families were recorded at Matthew's Ridge.

As was documented in the 2012 survey, anecdotal evidence obtained through interviews during the survey reported the presence of the endangered *Pteronura brasiliensis* (Giant River Otter) within the project development area of Matthew's Ridge. However, the presence of the Giant River Otter was not confirmed during the active surveys of 2012 and 2020.

The Water Rat *Nectomys squamipes* recorded at AQ6 (the swamp located north of the Matthew's Ridge Airstrip) and the Little Rufous Mouse Opossum *Marmosa lepida* observed at T5 at Port Kaituma were recorded in the 2020 field exercise but not in the 2012 surveys.

The felines *Panthera onca* (Jaguar), *Leopardus pardalis* (Ocelot) and *Herpailurus yagouaroundi* (Jaguarundi) were documented through anecdotal evidence from interviews of GMI workers and were confirmed by observation of their tracks and in some instances scratch marks during the field survey. The presence of *Puma concolor* (Puma) was confirmed by its tracks.

Several non-volant mammals were recorded as being common in the surveys of 2012 and 2020. These include the Red Brocket Deer *Mazama americana*, Greater Long-nosed Armadillo *Dasypus kappleri,* Red-rumped agouti *Dasyprocta leporina*, Labba *Cuniculus paca* and the Lowland Tapir *Tapiris terrestris*. These species are capable of forage in a variety of habitats and can use a wide range of food resources that are seasonally available. The project development area contains a diversity of habitats and it is clear that the area overall supports a high diversity of game species as observed. Evidence of jaguar *Panthera onca*, puma *Puma concolor* and three other species of felids backs this finding of a 'healthy' abundance of large mammal species despite a long history of people working, living and hunting in the area.

Biodiversity Baseline – Combined Results of the 2012 and 2020 Surveys

Combined with previous surveys in 2012, the 2020 survey brings the total number of species for the project development areas to 44 species of non-volant mammals from 23 families (Table 12 – 8). The Giant Otter, listed as Endangered on the IUCN Red List (Groenendijk *et al*. 2020), is reported as occurring within the project development area. The White-lipped Peccary, listed as Vulnerable on the IUCN Red List, was recorded in 2012 surveys but not in 2020 (Keuroghlian *et al*. 2020). The Giant Armadillo was recorded in 2012 and 2020 and is classified as Vulnerable by IUCN (Anacleto *et al.* 2020). The Giant Anteater and Guiana Spider Monkey, recorded in the project development area in 2012 but not 2020, are both classified by IUCN as Vulnerable (Miranda *et al.* 2020; Mittermeier *et al*. 2020.). Finally, the Lowland Tapir is classified as Vulnerable (Varela *et al*. 2020).

From a review of the checklist of terrestrial vertebrates of the Guiana Shield (Hollowell and Reynolds, 2005), none of the mammalian species recorded in this survey are endemic to Guyana. All mammalian species recorded in this assessment can be classified as wide ranging throughout the project development area. No evidence of Critical [mammal] Habitats was encountered[118].

[118] A critical habitat is a subset of both natural and modified habitat that deserves particular attention. Critical habitats include areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having

Photographic reference of the field surveys conducted during the February 2020 dry season are presented in Appendix G3.2.

special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or which are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic or cultural importance to local communities.

Table 12-8: Non-volant Mammals recorded in the PDA in 2012 and 2020

ORDER	FAMILY	SPECIES	COMMON NAME	SPECIES RECORDED			
				2012 SURVEY – MATTHEW'S RIDGE		2020 SURVEY	
				WET SEASON	DRY SEASON	MATTHEW'S RIDGE	PORT KAITUMA
ARTIODACTYLA	Cervidae	*Mazama americana*	Red Brocket Deer	X	X	X	X
	Cervidae	*Mazama gouazoubira*	Grey Brocket Deer	X	-	X	X
	Tayassuidae	*Pecari tajacu*	Collared Peccary	X	X	-	
	Tayassuidae	*Tayassu pecari*	White-lipped Peccary	X	X	-	
CARNIVORA	Mustelidae	*Eira barbara*	Tayra	X	X	X	
	Mustelidae	*Galictis vittata*	Grison	X	-	-	
	Mustelidae	*Lontra longicaudis*	Neotropical Otter	X	-	-	
	Mustelidae	*Pteronura brasiliensis*	Giant Otter	X	-	-	
	Procyonidae	*Nasua nasua*	Coatimundi	X	X	-	
	Procyonidae	*Potos flavos*	Kinkajou	X	X	-	
	Felidae	*Leopardus pardalis*	Ocelot	X	X	X	
	Felidae	*Panthera onca*	Jaguar	X	-	X	X
	Felidae	*Puma concolor*	Puma	X	-	X	X
	Felidae	*Leopardus wiedii*	Margay	X	-	-	
	Felidae	*Herpailurus yagouaroundi*	Jaguarundi	X	-	X	X
CINGULATA	Dasypodidae	*Dasypus kappleri*	Great Long-nosed Armadillo	X	X	X	
	Dasypodidae	*Dasypus novemcinctus*	Nine-banded Armadillo	X	-	-	
	Chlamyphoridae	*Priodontes maximus*	Giant Armadillo	X	X	X	
DIDELPHIMORPHIA	Didelphidae	*Didelphis marsupialis*	Common Opossum	X	X	X	
	Didelphidae	*Chironectes maximus*	Water Opossum	-	X	-	
	Didelphidae	*Marmosa lepida*	Little Rufous Mouse Opossum	-	-		X
PERISSODACTYLA	Tapiridae	*Tapirus terrestris*	Lowland Tapir	X	X	X	X
PILOSA	Bradypoididae	*Bradypus tridactylus*	Three Toed Sloth	X	-	-	

ORDER	FAMILY	SPECIES	COMMON NAME	SPECIES RECORDED			
				2012 SURVEY – MATTHEW'S RIDGE		2020 SURVEY	
				WET SEASON	DRY SEASON	MATTHEW'S RIDGE	PORT KAITUMA
	Megalonychidae	*Choloepus didactylus*	Two-toed Sloth	**X**	**-**	**-**	
	Cyclopedidae	*Cyclopes didactylus*	Silky Anteater	**X**	**-**	**-**	
	Myrmecophagidae	*Myrmecophaga tridactyla*	Giant Anteater	**X**	**-**	**-**	
	Myrmecophagidae	*Tamandua tetradactyla*	Southern Tamandua	**X**	**-**	**-**	
PRIMATES	Atelidae	*Alouatta macconnelli*	Guianan Howler Monkey	**X**	**X**	**X**	**X**
	Atelidae	*Ateles paniscus*	Guiana Spider Monkey	**X**	**-**	**-**	
	Cebidae	*Cebus olivaceus*	Wedge-capped Capuchin	**X**	**X**	**X**	**X**
	Cebidae	*Pithecia pithecia*	White-faced Saki	**X**	**X**	**-**	
	Cebidae	*Saimiri sciureus*	Squirrel Monkey	**X**	**X**	**X**	
RODENTIA	Erethizontidae	*Coendou prehensilis*	Common Porcupine	**X**	**X**	**-**	
	Echimyidae	*Echymis spp.*	Spiny rat	**-**	**X**	**-**	
	Echimyidae	*Nectomys squamipes*	Water Rat	**-**	**-**	**X**	
	Cricetidae	*Neacomys guianae*	Bristly Mouse	**-**	**X**	**X**	
	Cricetidae	*Oecomys spp. A*	Arboreal rat	**-**	**X**	**-**	
	Cricetidae	*Oecomys spp. B*	Arboreal rat	**-**	**-**	**X**	
	Muridae	*Mus musculus*	House Mouse	**-**	**X**	**-**	
	Scuridae	*Sciurus aestuans*	Guianan Squirrel	**X**	**-**	**-**	
	Scuridae	*Sciurillus pusillus*	Neotropical Pygmy Squirrel	**-**	**X**	**-**	
	Agoutidae	**Cuniculus paca*	Labba	**X**	**X**	**X**	**X**
	Dasyproctidae	*Dasyprocta leporina*	Agouti	**X**	**X**	**X**	**X**
	Hydrochaeridae	*Hydrochoerus hydrochaeris*	Capybara	**X**	**-**	**-**	

(X denotes species presence) **Formerly genus* Agouti

Bats

Results of the February 2020 Survey

A total of 49 individuals representing 14 species from 3 families were recorded during the survey of the project development areas within Matthew's Ridge and Port Kaituma in 2020. Twelve species were from the family Phyllostomidae (sub families: Phyllostominae with 2 species; Lonchophyllina with 1 species; Carollinae with 3 species; and Stenodermatinae with 6 species).

Port Kaituma

At the proposed development area at Port Kaituma (T5), a total of 16 individuals were recorded in 2020 representing 5 species from the family Phyllostomidae (sub families: 1 Phyllostominae; 1 Lonchophyllina; 2 Carollinae and 1 Stenodermatinae). The most abundant species recorded at Port Kaituma was *Carollia brevicauda*, which was represented by approximately 63 percent of total captures (10 individuals), followed by *Artibeus obscurus* and *Micronyteris hirsuta*, each representing 13 percent of total captures with 2 individuals each. *Lionycteris spurelli* and *Rhinophylla pumilio* were each represented by a single capture.

Matthews Ridge

At the proposed development area at Matthew's Ridge 13 species of bats were recorded in 2020. The most abundant species was *Carollia brevicauda*, which was represented by approximately 27 percent of total captures (9 individuals), followed by the *Artibeus lituratus* representing 12 percent of total captures (4 individuals) and then the *Carollia perpsicillata*, *Uroderma bilobatum* and *Vampyrodes caraccioli* representing approximately 9 percent of total captures each with 3 individuals.

Sturnira tildae, *Artibeus obscurus* and *Pteronotus parnellii* recorded 2 captures each, respectively, with each representing 6 percent of total captures at Matthew's Ridge. *Trachops cirrhosis*, *Micronycteris hirsuta*, *Noctilio leporinus*, *Rhinophylla pumilio* and *Sturnira lilium* were represented by a single capture of each species.

Bat species exhibits diverse trophic guilds ranging from species that feed predominantly on fruit, nectar and pollen to arthropods, small vertebrates and vertebrate blood (Patterson, Willig and Stevens 2004). In accordance with Simmons and Voss (1998), bats were assigned to a variety of trophic guilds based on their diets and foraging behaviour: aerial insectivores (all non-Phyllostomidae), frugivores (Carolliinae, Stenodermatinae), gleaning animalivores (all Phyllostominae except *Phyllostomus*), nectarivores (Glossophaginae), omnivores (*Phyllostomus*), sanguinivores (*Desmodus*) and carnivores (*Trachops cirrhosus*). With the exception of sanguinivorous bats, all of these bat guilds were found to be present in the project development area.

Bat species presence can be used as an indicator of the food resources available in the area which reflect the level of anthropogenic disturbance with the project development area. The overwhelming majority of the bats documented in both survey exercises were frugivores. The dominance of *Carollia* spp. and stendodermatine bats within the area which feed predominantly on the fruits of disturbance-associated plant species ('bat-dispersed pioneer plants') indicate a high abundance of pioneer plants belonging to the family Cecropiaceae, Piperaceae, and Solanacea (Patterson, Willig & Stevens 2004). That few captures belonged to the gleaning animalivore guild further in indicates that the forest environment of the project development area shows significant levels of historical disturbance. Whereas frugivorous bats are known to be significantly more abundant in disturbed forest compared to primary forest, gleaning animalivores are rarely captured in disturbed forest (Clarke *et al.* 2005a,b). Aerial insectivorous bats (family: Vespertillionidae) were not recorded as their advanced echolocation and foraging behaviour means that they are rarely trapped in mist nets.

Biodiversity Baseline – Combined Results of the 2012 and 2020 Surveys

Combined with previous surveys in 2012, this brings the total number of bat species recorded for the project development areas to 31 species from four families (Table 12-9). All chiropterans recorded are listed as Least Concern (LC) by the IUCN Red List. However, the Bartica bat (*Glyphonycteris daviesi*) is thought to be rare (Clarke & Racey, 2003). The presence of gleaning animalivorous bats (e.g. Bartica bat) and carnivorous bats (*Trachops*) indicates a 'healthy' fauna of invertebrates' and small vertebrates. There were no records of range-restricted species during the surveys. All bat species recorded during the surveys are widely distributed within the lowland forest habitats of Guyana and by extension the lowland habitats of the Guianan Shield.

Photographic reference of bats from the field surveys conducted during the February 2020 dry season are presented in Appendix G3.3.

Table 12-9: Bat Species recorded within GMI Project Development Areas of Matthew's Ridge and Port Kaituma in 2012 and 2020

COMMON NAMES	FAMILY	SPECIES RECORDED			
		2012 SURVEY – MATTHEW'S RIDGE		2020 WET SEASON SURVEY	
		WET SEASON SURVEY	DRY SEASON SURVEY	MATTHEW'S RIDGE	PORT KAITUMA
Greater Bulldog bat	**Noctilionidae**	*Noctilio leporinus*	-	*Noctilio leporinus*	-
Parnell's Mustached Bat	**Mormoopidae**	*Pteronotus parnellii*	*Pteronotus parnellii*	*Pteronotus parnellii*	-
Long nose bat	**Emballonuridae**	-	*Rhynchonyteris naso*	-	-
White-lined sac wing bat		-	*Saccopteryx bilineata*	-	-
Fruit eating bats	**Phyllostomidae**	-	*Artibeus gnomos*	-	-
Hairy big-eared bat		-	-	*Micronycteris hirsuta*	*Micronycteris hirsuta*
Fringe lipped bat		-	-	*Trachops cirrhosus*	-
Chestnut long-tongued bat		-	-	-	*Lionycteris spurrelli*
Greater fruit eating bat		-	-	*Artibeus lituratus*	-
Tilda's yellow-shouldered bat		-	-	*Sturnira tildae*	-
Common Tent Making Bat		*Uroderma bilobatum*	-	*Uroderma bilobatum*	-
Silver eating fruit bat		*Artibeus (Dermanura) glaucus*	-	-	-
Little white-Shouldered Bat		*Ametrida centurio*	-	-	-
Great striped faced bat		*Vampyrodes caraccioli*	*Vampyrodes caraccioli*	*Vampyrodes caraccioli*	-
Yellow Shouldered Bat		*Sturnira lilium*	*Sturnira lilium*	*Sturnira lilium*	-
Tildaes Bat				*Sturnira tildae*	
Dark fruit eating bat		*Artibeus obscurus*	*Artibeus obscurus*	*Artibeus obscurus*	*Artibeus obscurus*
Silky Short-tailed bat		*Carollia brevicauda*	*Carollia brevicauda*	*Carollia brevicauda*	*Carollia brevicauda*

COMMON NAMES	FAMILY	SPECIES RECORDED			
		2012 SURVEY – MATTHEW'S RIDGE		2020 WET SEASON SURVEY	
		WET SEASON SURVEY	DRY SEASON SURVEY	MATTHEW'S RIDGE	PORT KAITUMA
Seba's short-tailed bat		*Carollia perspicillata*	*Carollia perspicillata*	*Carollia perspicillata*	-
Dwarf Little fruit bat		*Rhinophylla pumilio*	*Rhinophylla pumilio*	*Rhinophylla pumilio*	*Rhinophylla pumilio*
Greater spear-nosed bat		*Phyllostomus hastatus*	*Phyllostomus hastatus*	-	-
Pygmy Round eared bat		*Lophostoma brasiliense*	-	-	-
Schulz' round-eared bat		*Lophostoma schulzi*	-	-	-
Stripe-headed Round-eared bat		*Tonatia saurophila*	-	-	-
Striped hairy nosed bat		-	*Mimon crenulatum*	-	-
Davies big eared Bat		-	*Glyphonycteris daviesi*	-	-
Tiny big eared bat		-	*Micronycteris minuta*	-	-
Pygmy round eared bats		-	*Tonatia brasiliense*	-	-
White-Throated round eared bats		-	*Tonatia silvicola*	-	-
Palla's Long-tongued bat		*Glossophaga soricina*	-	-	-
Lesser-long tailed bat		-	*Choeroniscus minor*	-	-

Birds

Results of the February 2020 Survey

A total of 1,070 individuals representing 156 species of birds from 36 families were recorded at Matthew's Ridge and Port Kaituma in 2020.

Transect T3 recorded the highest number of birds (304) followed by T4 with 241 individuals. The fewest number of birds were recorded at T1 (153).

The highest diversity of bird species was at T3 with 66 species, followed by T2 with 51 species and T5 with 46 species.

Attributing the high species diversity of birds within the project development areas were innumerable microhabitats which included topographic influences such as hilltops and ravines, open and dense forests, seasonally flooded grasslands and shrublands, fruiting and flowering forests, swamps, and other watercourses.

Biodiversity Baseline – Combined Results of the 2012 and 2020 Surveys

The consolidated findings of the 2012 and 2020 surveys revealed a total of 280 species from 46 families (Table 12-10). The most bird diverse families in the project development areas are Antbirds (Thamnophilidae, 32 species), Tyrant Flycatchers (Tyrannidae, 28 species), followed by members of the Thraupidae (18 species), and Parrots (Psittacidae, 19 species).

Avian species encountered during the surveys are common and are widely distributed within the lowland habitats of Guyana and the Guiana Shield. No Critically Endangered (CE), Endangered (EN), endemic or migratory species were recorded during the survey. Five (5) species identified are listed as Vulnerable (VU) by the IUCN Red List: the Black Curassow (*Crax alector*); Gray Tinamou (*Tinamus tao*); Channel-billed Toucan (*Ramphastos vitellinus*); Yellow Ridged Toucan (*Ramphastos culminatus)* and the Red-Billed or White-throated Toucan (*Ramphastos tucanus*).

Although not currently threatened in Guyana, large under-storey birds, such as cracids (Cracidae) and Trumpeters (Psophiidae), are sensitive to major habitat changes. Elsewhere in the Guianas they have been decimated by unrestricted hunting (Ridgley and Agro 1998).

Photographic reference of the field surveys conducted during the February 2020 dry season are presented in Appendix G3.4.

Table 12-10: Birds recorded within the Project Development Areas of Matthew's Ridge and Port Kaituma in 2012 and 2020

COMMON NAME	FAMILY	SPECIES RECORDED			
		2012 SURVEY – MATTHEW'S RIDGE		2020 WET SEASON SURVEY	
		WET SEASON	DRY SEASON	PORT KAITUMA	MATTHEW'S RIDGE
Roadside Hawk	Accipitridae	*Buteo magnirostris*	*Buteo magnirostris*	-	-
Plumbeous Kite	Accipitridae	*Ictinea plumbea*	-	*Ictinea plumbea*	*Ictinea plumbea*
Swallow-tailed Kite	Accipitridae	*Elanoides forticatus*	*Elanoides forticatus*	-	*Elanoides forticatus*
Great Black Hawk	Accipitridae	*Buteogallus urubitinga*	-	-	*Buteogallus urubitinga*
Gray-lined Hawk	Accipitridae	-	-	*Buteo nitidus*	*Buteo nitidus*
Ringed Kingfisher	Alcedinidae	*Ceryle torquata*	*Ceryle torquata*	-	-
Green & Rufous Kingfisher	Alcedinidae	-	*Chloroceryle inda*	-	-
Amazon Kingfisher	Alcedinidae	*Chloroceryle amazon*	-	-	*Chloroceryle amazon*
Muscovy Duck	Anatidae	*Cairina moschata*	-	-	*Cairina moschata*
Horned Screamer	Anhimidae	-	-	-	*Anhima cornuta*
Pygmy Swift	Apodidae	*Micropanyptila furcata*	-	-	-
White-collared Swift	Apodidae	*Streptoprocne zonaris*	*Streptoprocne zonaris*	-	-
Band-rumped Swift	Apodidae	-	-		*Chaetura spinicaudus*
Gray-rumped Swift	Apodidae	-	-	*Chaetura cinereiventris*	-
Striated Heron	Ardeidae	*Butorides striatus*	-	-	-
Great Egret	Ardeidae	-	-	-	*Ardea egretta*
Capped Heron	Ardeidae	-	-	*Pilherodius pileatus*	-
Tricolored Heron	Ardeidae	*Hydranassa tricolor*	-	-	-
Blackish Nightjar	Caprimulgidae	*Caprimulgus nigrescens*	*Caprimulgus nigrescens*	-	-
Band-winged Nightjar	Caprimulgidae	-	-	-	*Caprimulgus longirosris*

COMMON NAME	FAMILY	SPECIES RECORDED			
		2012 SURVEY – MATTHEW'S RIDGE		2020 WET SEASON SURVEY	
		WET SEASON	DRY SEASON	PORT KAITUMA	MATTHEW'S RIDGE
Nacunda Nighthawk	Camprimulgidae	*Podager nacunda*	*Podager nacunda*	-	-
Band-tailed Nighthawk	Camprimulgidae	*Nyctiprogne leucopyga*	*Nyctiprogne leucopyga*	-	-
Lesser Nighthawk	Camprimulgidae	*Chordelies acutipennis*	-	-	-
Least Night Hawk	Camprimulgidae	-	*Chordeiles pusillus*	-	-
Pauraque Nightjar	Camprimulgidae	*Nyctidromus albicollis*	*Nyctidromus albicollis*	-	-
Yellow-Green Grosbeak	Cardinalidae	*Caryothraustes canadensis*	*Caryothraustes canadensis*	-	*Caryothraustes canadensis*
Blue-black Grosbeak	Cardinalidae	*Cyanocompsa cyanoides*	-	-	-
Red-and-Black Grosbeak	Cardinalidae	*Periporphyrus erythromelas*	*Periporphyrus erythromelas*	-	*Periporphyrus erythromelas*
Greater Yellow-Headed Vulture	Cathartidae	*Cathartes melambrotus*	*Cathartes melambrotus*	-	-
Black Vulture	Cathartidae	-	-	-	*Coragyps atratus*
King Vulture	Cathartidae	-	-	-	*Sarcoramphus papa*
Lesser Yellow-headed Vulture	Cathartidae	-	-	-	*Catharthes burrovianus*
Turkey Vulture	Cathartidae	-	-	*Catharthes aura*	*Catharthes aura*
Southern Lapwing	Charadriidae			-	*Vanellus chilensis*
Rudy Quail-Dove	Columbidae	*Geotrygon violacea*	*Geotrygon violacea*	-	-
Pale-vented Pigeon	Columbidae	*Patagioenas cayennensis*	*Patagioenas cayennensis*	*Patagioenas cayennensis*	*Patagioenas cayennensis*
Plumbeous Pigeon	Columbidae	-	-	*Patagioenas plumbea*	-
Blue Ground-Dove	Columbidae	*Claravis pretiosa*	-	-	*Claravis pretiosa*
White-tipped Dove	Columbidae	-	-	-	*Leptotila verreauxi*

COMMON NAME	FAMILY	SPECIES RECORDED			
		2012 SURVEY – MATTHEW'S RIDGE		2020 WET SEASON SURVEY	
		WET SEASON	DRY SEASON	PORT KAITUMA	MATTHEW'S RIDGE
Common Ground-dove	Columbidae	-	-	*Columbina passerina*	-
Scaled Pigeon	Columbidae	*Patagioenas speciosa*	-	-	*Patagioenas speciosa*
Ruddy Pigeon	Columbidae	-	-	-	*Patagioenas subvinacea*
Ruddy Ground-Dove	Columbidae	-	*Columbina talpacoti*	-	*Columbina talpacoti*
Screaming Piha	Cotingidae	*Lipaugus vociferans*	*Lipaugus vociferans*	*Lipaugus vociferans*	-
Purple-throated Fruitcrow	Cotingidae	*Querula purpurata*	*Querula purpurata*	-	*Querula purpurata*
Pampadour Cotinga	Cotingidae	*Xipholena punicea*	-	-	*Xipholena punicea*
Black Curassow	Cracidae	*Crax alector*	*Crax alector*	*Crax alector*	-
Little Chachalaca	Cracidae	*Ortalis motmot*	*Ortalis motmot*	-	*Ortalis motmot*
Marail Guan	Cracidae	-	-	*Penelope marail*	-
Spix Guan	Cracidae	*Penelope jacquacu*	*Penelope jacquacu*	-	*Penelope jacquacu*
Striped Cuckoo	Cuculidae	-	-	-	*Tapera naevia*
Squirrel Cuckoo	Cuculidae	-	-	-	*Piaya cayana*
Great Ani	Cuculidae	-	-	*Crotophaga major*	
Smooth-bill Ani	Cuculidae	*Crotophaga ani*	*Crotophaga ani*	-	*Crotophaga ani*
Rufous-winged Ground Cuckoo	Cuculidae	*Neomorphus rufipennis*	-	-	-
Dark - billed Cuckoo	Cuculidae	*Coccyzus melanogaster*	*Coccyzus melanogaster*	-	-
Slaty-backed Forest Falcon	Falconidae	-	*Micrastur mirandollei*	-	-
Bat Falcon	Falconidae	-	*Falco rufiguris*	-	-
Yellow-headed Caracara	Falconidae	*Milvago chimachima*	-	-	-
Red-throated Caracara	Falconidae	-	-	*Ibycter americanus*	*Ibycter americanus*

COMMON NAME	FAMILY	SPECIES RECORDED			
		2012 SURVEY – MATTHEW'S RIDGE		2020 WET SEASON SURVEY	
		WET SEASON	DRY SEASON	PORT KAITUMA	MATTHEW'S RIDGE
Laughing Falcon	Falconidae	-	-	*Herpetotheres cachinnans*	-
Violaceous Euphonia	Fringillidae	*Euphonia violacea*	*Euphonia violacea*	-	*Euphonia violacea*
White-vented Euphonia	Fringillidae	-	-	-	*Euphonia minuta*
Thick-billed Euphonia	Fringillidae	-	-	-	*Euphonia laniirostris*
Hooded Siskin	Fringillidae	-	-	-	*Spinus magnellanicus*
Short-tailed Antthrush	Formicariidae	*Chamaeza campanisona*	*Chamaeza campanisona*	-	-
Black faced Antthrush	Formicariidae	*Formicarius analis*	*Formicarius analis*	-	-
Rufous-capped Anthrush	Formicariidae	-	*Formicarius colma*	-	-
Olivaceous Woodcreeper	Furnariidae	*Sittasomus griseicapillus*	-	-	-
Wedge-billed Woodcreeper	Furnariidae	*Glyphorhynchus spirurus*	*Glyphorhynchus spirurus*	*Glyphorhynchus spirurus*	*Glyphorhynchus spirurus*
Chesnut-rumped Woodcreeper	Furnariidae	*Xiphorhynchus pardalotus*	-	-	*Xiphorhynchus pardalotus*
Amazonian barred Woodcreeper	Furnariidae	-	-	-	*Dendrocolaptes certhia*
Long-tailed Woodcreeper	Furnariidae	*Deconychura longicauda*	*Deconychura longicauda*	-	-
White-chinned Woodcreeper	Furnariidae	*Dendrocincla merula*	*Dendrocincla merula*	-	-
Buff-throated Woodcreeper	Furnariidae	*Xiphorhynchus guttatus*	*Xiphorhynchus guttatus*	-	-
Curve-billed Scythebill	Furnariidae	*Campylorhamphus procurviodes*	*Campylorhamphus procurviodes*	-	-

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		2012 SURVEY – MATTHEW'S RIDGE		2020 WET SEASON SURVEY	
		WET SEASON	DRY SEASON	PORT KAITUMA	MATTHEW'S RIDGE
Red-billed Scythebill	Furnariidae	*Campylorhamphus trochilirostris*	-	-	-
Buff-throated Foliage-gleaner	Furnariidae	*Automolus ochrolaemus*	*Automolus ochrolaemus*	-	*Automolus ochrolaemus*
Chestnut-crowned Foliage-gleaner	Furnariidae	*Automolus rufipileatus*	-	-	-
Black-tailed Leaftosser	Furnariidae	*Sclerurus caudacutus*	-	-	-
Plain Brown Woodcreeper	Furnariidae	-	*Dendrocincla fuliginosa*	-	-
Spot-Throated Woodcreeper	Furnariidae	-	*Deconyctiura stictoiaema*	-	-
Cinnamon-rumped Foliage-gleaner	Furnariidae		*Philydor pyrrhodes*	-	-
Rufous-tailed Jacamar	Galbulidae	*Galbula ruficauda*	-	-	-
Great Jacamar	Galbulidae	*Jacamerops aurea*	-	-	-
Brown Jacamar	Galbulidae	*Brachygalba lugubris*	-	-	-
Yellow-billed Jacamar	Galbulidae		*Galbula albirostris*	-	-
Green-tailed Jacamar	Galbulidae	-	-		*Galbula galbula*
Paradise Jacamar	Galbulidae	-	-	*Galbula dea*	
Chesnut Crowned Antpitta	Grallariidae	*Grallaria ruficapilla*	-	-	-
Varigated Antpitta	Grallariidae	*Grallaria varia*	-	-	-
Slate-crowned Antpitta	Grallariidae	*Grallaricula nana*	-	-	-
Thrush-like Antpitta	Grallariidae	*Myrmothera campanisona*	-	-	-
Spotted Antpitta	Grallariidae	-	*Hylopezus macularius*	-	-
Scaled Antpitta	Grallariidae	-	*Grallaria guatimalensis*	-	-
White-winged Swallow	Hirundinidae	*Tachycineta albiventer*	-	-	*Tachycineta albiventer*

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		2012 SURVEY – MATTHEW'S RIDGE		2020 WET SEASON SURVEY	
		WET SEASON	DRY SEASON	PORT KAITUMA	MATTHEW'S RIDGE
White-banded Swallow	Hirundinidae	-	-	-	*Atticora fasciata*
Gray-breasted Martin	Hirundinidae	-	-	*Progne chalybea*	*Progne chalybea*
Black-Collared Swallow	Hirundinidae	*Atticora melanoleuca*	-	-	-
Red-rumped Cacique	Icteridae	-	-	-	*Cacicus haemorrhous*
Yellow-billed Cacique	Icteridae	-	-	-	*Amblycercus holosericeus*
Yellow-rumped Cacique	Icteridae	-	-	*Cacicus cela*	*Cacicus cela*
Giant Cowbird	Icteridae	-	-	-	*Molothrus oryzivorus*
Velvet-fronted Grackle	Icteridae	-	-	-	*Lampropsar tanagrinus*
Moriche Oriole	Icteridae	-	-	-	*Icterus c. chrysocephalus*
Olive Oropendola	Icteridae	-	-	*Psarocolius bifasciatus*	*Psarocolius bifasciatus*
Crested Oropendula	Icteridae	-	*Psarocolius decumanus*	-	*Psarocolius decumanus*
Green Oropendola	Icteridae	*Psarocolius viridis*	*Psarocolius viridis*	-	-
Yellow Oriole	Icteridae	*Icterus nigrogularis*	*Icterus nigrogularis*	*Icterus nigrogularis*	-
Carib Grackle	Icteridae	*Quiscalus lugubris*	*Quiscalus lugubris*	-	-
Tropical Mockingbird	Mimidae	-	-	-	*Mimus gilvus*
Olive-backed Tanager	Mitrospingidae	-	-	-	*Mitrospingus oleagineus*
Blue-crowned Motmot	Momotidae	*Momotus momota*	-	-	-
Common Potoo	Nyctibiidae	*Nyctibius griseus*	*Nyctibius griseus*	-	-

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		2012 SURVEY – MATTHEW'S RIDGE		2020 WET SEASON SURVEY	
		WET SEASON	DRY SEASON	PORT KAITUMA	MATTHEW'S RIDGE
Rufous Potoo	Nyctibiidae	*Nyctibius bracteatus*	*Nyctibius bracteatus*	-	-
Marbled Wood-Quail	Odontophoridae	*Odontophorus gujanensis*	*Odontophorus gujanensis*	-	-
Riverbank Warbler	Parulidae	-	-	-	*Myiothlypis rivularis*
Red-necked Woodpecker	Picidae	*Campephilus rubicollis*	*Campephilus rubicollis*	-	*Campephilus rubicollis*
Crimson-crested Woodpecker	Picidae	*Campephilus melanoleucos*	-	*Campephilus melanoleucos*	*Campephilus melanoleucos*
Yellow-tufted Woodpecker	Picidae	*Melanerpes cruentatus*	*Melanerpes cruentatus*	-	*Melanerpes cruentatus*
Waved Woodpecker	Picidae		*Celeus undatus*	-	-
Red-crowned Woodpecker	Picidae		*Melanerpes rubricapillus*	-	-
Chesnut Woodpecker	Picidae		*Celeus elegans*	-	-
Lineated Woodpecker	Picidae	-	-	*Dryocopus lineatus*	-
Little Woodpecker	Picidae	-	-	-	*Veniliornis passerinus*
Powerful Woodpecker	Picidae	*Campephilus pollens*	*Campephilus pollens*	-	*Campephilus pollens*
Black nunbird	Picidae	-	-	*Monasa atra*	-
Smoky -brown Woodpecker	Picidae	*Veniliornis fumigates*	-	-	-
White-bearded Manakin	Pipridae	*Manacus manacus*	-	-	*Manacus manacus*
White-crowned Manakin	Pipridae	*Psuedopipra pipra*	*Psuedopipra pipra*	*Psuedopipra pipra*	*Psuedopipra pipra*
White-fronted Manakin	Pipridae	*Pipra serena*	*Pipra serena*	-	-
Tiny Tyrant Manakin	Pipridae	*Tyranneutes virescens*	-	-	-
Golden-headed Manakin	Pipridae	*Pipra erythrocephala*	*Pipra erythrocephala*	*Pipra erythrocephala*	*Pipra erythrocephala*

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		WET SEASON	DRY SEASON	PORT KAITUMA	MATTHEW'S RIDGE
Blue-backed Manakin	Pipridae	*Chiroxiphia pareola*	-	-	-
White-Throated Manakin	Pipridae	*Corapigo gutturalis*	*Corapigo gutturalis*	-	*Corapigo gutturalis*
Olive Manakin	Pipridae	*Chloropipo uniformis*	*Chloropipo uniformis*	-	-
Least Grebe	Podicipedidae	*Tachybaptus dominicus*	-	-	-
Long-billed Gnatwren	Polioptilidae	*Ramphocaenus melanurans*	*Ramphocaenus melanurans*	-	-
Tropical Gnatcatcher	Polioptilidae	*Polioptila plumbea*		-	-
Blue and Yellow Macaw	Psittacidae	*Ara ararauna*	*Ara ararauna*	-	*Ara ararauna*
Red-bellied Macaw	Psittacidae	*Orthopsittaca manilata*	-	-	-
Red and Green Macaw	Psittacidae	*Ara chloropterus*	*Ara chloropterus*	*Ara chloropterus*	-
Yellow-headed Parrot	Psittacidae	*Amazona ochrocephala*	*Amazona ochrocephala*	-	-
Blue-headed Parrot	Psittacidae	*Pionus menstruus*	-	-	*Pionus menstruus*
Saffron-headed Parrot	Psittacidae	-	-	-	*Pyrilia pyrilia*
Scarlet macaw	Psittacidae	*Ara macao*	*Ara macao*	-	*Ara macao*
Black-headed Parrot	Psittacidae	*Pionites melanocephala*	-	-	*Pionites melanocephala*
White eyed Parakeet	Psittacidae	*Psittacara (Aratinga) leucophthalmus*	-	-	-
Painted Parakeet	Psittacidae	-	-	-	*Pyrrhura picta*
Lilac-tailed Parrotlet	Psittacidae		*Touit batavicus*	-	*Touit batavicus*
Festive Parrot	Psittacidae	*Amazona festiva*	-	-	-
Orange-winged Parrot	Psittacidae	-	-	*Amazona amazonica*	*Amazona amazonica*
Dusky Parrot	Psittacidae	*Pionus fuscus*	*Pionus fuscus*	*Pionus fuscus*	-
Caica Parrot	Psittacidae	*Pyrilia caica*	*Pyrilia caica*	-	*Pyrilia caica*
Mealy Parrot	Psittacidae	*Amazona farinosa*	*Amazona farinosa*	*Amazona farinosa*	*Amazona farinosa*

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		WET SEASON	DRY SEASON	PORT KAITUMA	MATTHEW'S RIDGE
Blue Cheeked Parrot	Psittacidae		*Amazona dufresniana*	-	-
Red-fan Parrot	Psittacidae	-	-	-	*Deroptyus accipitrinus*
Golden-winged Parakeet	Psittacidae	-	-	-	*Brotogeris chrysoptera*
Gray-winged Trumpeter	Psophiidae	-	-	-	*Psophia crepitans*
Rufous-necked Wood rail	Rallidae	-	-	*Aramides axillaris*	-
Channel-billed Toucan	Ramphastidae	*Ramphastos vitellinus*	*Ramphastos vitellinus*	-	*Ramphastos vitellinus*
Black-necked Aracari	Ramphastidae	*Pteroglossus aracari*	*Pteroglossus aracari*	-	*Pteroglossus aracari*
Green Aracari	Ramphastidae	-	-	-	*Pteroglossus viridis*
Red-billed Toucan	Ramphastidae	*Ramphastos tucanus*	*Ramphastos tucanus*	*Ramphastos tucanus*	
Cuvier's Toucan	Ramphastidae	*Ramphastos cuvieri*	*Ramphastos cuvieri*	-	-
Yellow Ridged Toucan	Ramphastidae		*Ramphastos culminatus*	-	-
Tropical Screech-Owl	Strigidae	*Otus choliba*	*Otus choliba*	-	-
Ferruginous Pygmy Owl	Strigidae	*Glaucidium brasilianum*	*Glaucidium brasilianum*	-	-
Mottled Owl	Strigidae	*Ciccaba virgata*	*Ciccaba virgata*	-	-
Crested Owl	Strigidae	*Lophostrix cristata*		-	-
Rufous-throated Antbird	Thamnophilidae	*Gymnopithys rufigula*	*Gymnopithys rufigula*	-	-
Scale-backed Antbird	Thamnophilidae	*Hylophylax poecilonota*	*Hylophylax poecilonota*	-	-
White bellied Antbird	Thamnophilidae	*Myrmeciza longipes*	-	-	-

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		WET SEASON	DRY SEASON	PORT KAITUMA	MATTHEW'S RIDGE
Rufous-winged Antwren	Thamnophilidae	*Herpsilochmus rufomarginatus*	-	-	-
White-flanked Antwren	Thamnophilidae	*Myrmotherula axillaris*	*Myrmotherula axillaris*	-	-
Plain-winged Antwren	Thamnophilidae	*Myrmotherula behni*	-	-	-
Brown-bellied Antwren	Thamnophilidae	*Myrmotherula guttata*	-	-	-
Black - Chined Antbird	Thamnophilidae	*Hypocnemoides melanopogon*	*Hypocnemoides melanopogon*	-	-
White-plumed Antbird	Thamnophilidae	*Pithys albifrons*	*Pithys albifrons*	*Pithys albifrons*	-
Common scale-backed Antbird	Thamnophilidae	-	-	-	*Willisornis poecilinotus*
Dusky Antbird	Thamnophilidae	*Cercomacra tyrannina*	-	*Cercomacra tyrannina*	*Cercomacra tyrannina*
Cinereous Antshrike	Thamnophilidae	*Thamnomanes caesius*	*Thamnomanes caesius*	*Thamnomanes caesius*	-
Mouse-colored Antshrike	Thamnophilidae	*Thamnophilus murius*	*Thamnophilus murius*	-	*Thamnophilus murius*
Dusky - Throated Antshrike	Thamnophilidae	*Thamnomanes ardesiacus*	-	-	-
Great Antshrike	Thamnophilidae	-	-	-	*Taraba major*
Ferruginous-backed Antbird	Thamnophilidae	*Myrmeciza ferruginea*	*Myrmeciza ferruginea*	-	*Myrmeciza ferruginea*
Silvered Antbird	Thamnophilidae	*Sclateria naevia*	*Sclateria naevia*	-	-
Spotted winged Antshrike	Thamnophilidae	*Pygiptila stellaris*	*Pygiptila stellaris*	-	-
Wing-banded Antbird	Thamnophilidae	*Myrmornis torquata*	*Myrmornis torquata*	-	-
Faciated Antshrike	Thamnophilidae	*Cymbilaimus lineatus*	-	-	-
Barred Antshrike	Thamnophilidae	*Thamnophilus doliatus*	-	-	*Thamnophilus doliatus*
Spot- winged Antbird	Thamnophilidae	*Schistocichla rufifrons*	*Schistocichla rufifrons*	-	-

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		WET SEASON	DRY SEASON	PORT KAITUMA	MATTHEW'S RIDGE
Warbling Antbird	Thamnophilidae	*Hypocnemis cantator*	*Hypocnemis cantator*	-	-
White-browed Antbird	Thamnophilidae	*Myrmoborus leucophrys*	*Myrmoborus leucophrys*	-	-
Gray Antbird	Thamnophilidae	*Cercomacra cinerascens*	*Cercomacra cinerascens*	-	-
Spot -tailed Antwren	Thamnophilidae	*Herpsilochmus sticturus*	-	-	-
Black Throated Antshrike	Thamnophilidae	*Frederickena viridis*	-	-	-
Black throated Antbird	Thamnophilidae		*Myrmeciza atrothorax*	-	-
Slaty Antwren	Thamnophilidae		*Myrmotherula schisticolor*	-	-
Rufous-bellied Antwren	Thamnophilidae		*Isleria (Myrmotherula) guttata*	-	-
Immaculate Antbird	Thamnophilidae		*Hafferia (Myrmeciza) immaculata*	-	-
Fulvous Shrike-Tanager	Thamnophilidae	*Lanio fulvus*	*Lanio fulvus*	-	-
Red-Legged Tinamou	Tinamidae	*Crypturellus erythropus*		-	
Variegated Tinamou	Tinamidae	*Crypturellus variegatus*	*Crypturellus variegatus*	-	-
Brown Tinamou	Tinamidae	*Crypturellus obsoletus*	*Crypturellus obsoletus*	-	-
Gray tinamou	Tinamidae	-	-	*Tinamus tao*	*Tinamus tao*
Little Tinamou	Tinamidae	-	-	*Crypturellus soui*	*Crypturellus soui*
Black-tailed Tityra	Tityridae	-	-	-	*Titrya cayana*
Black-crowned Tityra	Tityridae	-	-	-	*Titrya inquisitor*
Whiskered Flycatcher	Tityridae	*Myiobius barbatus*	-	*Myiobius barbatus*	

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		WET SEASON	DRY SEASON	PORT KAITUMA	MATTHEW'S RIDGE
Fork-tailed Woodnymph	Trochilidae	*Thalurania furcata*	*Thalurania furcata*	*Thalurania furcata*	*Thalurania furcata*
White-chinned Sapphire	Trochilidae	*Hylocharis cyanus*	-	-	-
Blue-chinned Sapphire	Trochilidae	-	-	-	*Chlorostilbon (Chlorestes) notata*
White-tailed Sabrewing	Trochilidae	-	-	*Campylopterus ensipennis*	*Campylopterus ensipennis*
White-vented Plumeleteer	Trochilidae	-	-	-	*Chalybura buffonii*
Red-billed Emerald	Trochilidae	-	-	-	*Chlorostilbon gibsoni*
Glittering-throated Emerald	Trochilidae	-	-	-	*Amazilia fimbriata*
Blue-tailed Emerald	Trochilidae	-	-	-	*Chlorostilbon mellisugus*
Sooty-capped Hermit	Trochilidae	*Phaethornis augusti*	-	*Phaethornis augusti*	*Phaethornis augusti*
Long -tailed Hermit	Trochilidae	*Phaethornis superciliosus*	*Phaethornis superciliosus*	-	*Phaethornis superciliosus*
Pale-bellied Hermit	Trochilidae	*Phaethornis anthophilus*		-	*Phaethornis anthophilus*
Gray-Chinned Hermit	Trochilidae	*Phaethornis griseogularis*	*Phaethornis griseogularis*	*Phaethornis griseogularis*	*Phaethornis griseogularis*
Rufous-breasted Hermit	Trochilidae	-	-	-	*Glaucis hirsutus*
Gray-breasted Sabrewing	Trochilidae	*Campylopterus largipennis*	*Campylopterus largipennis*	*Campylopterus largipennis*	*Campylopterus largipennis*
Reddish hermit	Trochilidae	-	-	*Phaethornis ruber*	*Phaethornis ruber*
Pale-tailed Barbthroat	Trochilidae	*Threnetes leucurus*	-	-	-
Crimson Topaz	Trochilidae	*Topaza pella*	-	-	-

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		WET SEASON	DRY SEASON	PORT KAITUMA	MATTHEW'S RIDGE
Slate-colored Grosbeak	Thraupidae	*Saltator grossus*	-	-	*Saltator grossus*
Bananaquit	Thraupidae	*Coereba flaveola*	-	-	*Coereba flaveola*
Black-faced Grassquit	Thraupidae	*Tiaris bicolor*	-	-	-
Blue dacnis	Thraupidae	-	-	-	*Dacnis cayana*
Chestnut-bellied Seedeater	Thraupidae	*Sporophila castaneiventris*	-	-	*Sporophila castaneiventris*
Blue-black Grassquit	Thraupidae	-	-	-	*Volatinia jacarina*
Fulvous-crested Tanager	Thraupidae	-	-	*Tachyphonus surinamus*	*Tachyphonus surinamus*
Bay-headed tanager	Thraupidae	-	-	-	*Tangara gyrola*
Yellow-backed Tanager	Thraupidae	-	-	-	*Hemithraupis flavicollis*
Yellow-bellied Seedeater	Thraupidae	-	-	-	*Sporophila nigricollis*
White Lined Tanager	Thraupidae		*Tachyphonous rufus*	-	-
Palm Tanager	Thraupidae	-	-		*Thraupis palmarum*
Silver-beaked Tanager	Thraupidae	*Ramphocelus carbo*	*Ramphocelus carbo*	*Ramphocelus carbo*	*Ramphocelus carbo*
White-shouldered Tanager	Thraupidae	-	-	-	*Tachyphonus luctuosus*
Purple Honeycreeper	Thraupidae	-	-	*Cyanerpes caeruleus*	*Cyanerpes caeruleus*
Olivaceous Flatbill	Thraupidae	*Rhynchocyclus olivaceus*	-	-	-
Blue-gray Tanager	Thraupidae	*Thraupis episcopus*	*Thraupis episcopus*	*Thraupis episcopus*	-
Amazonian white-tailed Trogon	Trogonidae	-	-	-	*Trogon viridis*
White-breasted Wood-Wren	Troglodytidae	*Henicorhina leucosticta*	-	-	-

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		WET SEASON	DRY SEASON	PORT KAITUMA	MATTHEW'S RIDGE
Muscian Wren	Troglodytidae	*Cyphorhinus arada*	*Cyphorhinus arada*	-	-
Coraya Wren	Troglodytidae	-	-	*Pheugopedius coraya*	-
Swainson's Thrush	Turdidae	-	-	*Catharus ustulatus*	-
Black-billed Thrush	Turdidae	*Turdus ignobilis*	-	-	-
Bare-eyed Robin	Turdidae	*Turdus nudigenis*	-	-	-
Cocoa Thrush	Turdidae		*Turdus fumigatus*	-	-
Dusky-capped Flycather	Tyrannidae	*Myiarchus tuberculifer*		-	-
Helmeted pygmy – Tyrant	Tyrannidae		*Lophotriccus galeatus*	-	-
Yellow Tyrannulet	Tyrannidae		*Capsiempis flaveola*	-	-
Slate-headed Tody-Flycatcher	Tyrannidae		*Poecilotriccus sylvia*	-	-
Streat-throated Bush-Tyrants	Tyrannidae		*Myiotheretes striaticollis*	-	-
Greater Kiskadee	Tyrannidae	*Pitangus sulphuratus*	*Pitangus sulphuratus*	-	*Pitangus sulphuratus*
Lesser Kiskadee	Tyrannidae	*Philohydor lector*	-	-	*Philohydor lector*
Rusty-margined Flycatcher	Tyrannidae	-	-	-	*Myiozetetes cayanensis*
McConnell's Flycatcher	Tyrannidae	-	-	-	*Mionectes macconnelli*
Fork-tailed Flycatcher	Tyrannidae	-	-	*Tyrannus savana*	-
Ochre-lored Flycatcher	Tyrannidae	-	-	-	*Tolmomyias flaviventris*
Streaked flycatcher	Tyrannidae	-	-	-	*Myiodynastes maculatus*
Short-crested Flycatcher	Tyrannidae	-	-	-	*Myiarchus ferox*

COMMON NAME	FAMILY	SPECIES RECORDED			
		2012 SURVEY – MATTHEW'S RIDGE		2020 WET SEASON SURVEY	
		WET SEASON	DRY SEASON	PORT KAITUMA	MATTHEW'S RIDGE
Tropical Kingbird	Tyrannidae	-	-	-	*Tyrannus melancholicus*
Yellow-throated Flycatcher	Tyrannidae	-	-	-	*Conopias parvus*
Ochre-bellied Flycatcher	Tyrannidae	-	-	*Mioectes oleagineus*	-
Yellow-crowned Tyrannulet	Tyrannidae	-	-	*Tyrannulus elatus*	-
Pale-bellied Mourner	Tyrannidae	-	-	-	*Rhytipterna immunda*
Bright-rumped Attila	Tyrannidae	*Attila spadiceus*	-	-	*Attila spadiceus*
Forest Elaenia	Tyrannidae	*Myiopagis gaimardii*	*Myiopagis gaimardii*	-	-
Yellow-bellied Elaenia	Tyrannidae	*Elaenia flavogaster*	-	-	-
Greenish Elaenia	Tyrannidae	*Myiopagis viridicata*	-	-	-
Spotted Tody-Flycatcher	Tyrannidae	*Todirostrum maculatum*	-	-	-
Common Tody-Flycatcher	Tyrannidae	*Todirostrum cinereum*	*Todirostrum cinereum*	-	-
Pale-tipped Tyrannulet	Tyrannidae	*Inezia subflava*	-	-	-
Bran-coloured Flycatcher	Tyrannidae	*Myiophobus fasciatus*	-	-	-
Ringed Antpipit	Tyrannidae	*Corythopis torquata*	-	-	-
White - throated Spadebill	Tyrannidae	*Platyrinchus coronatus*	*Platyrinchus coronatus*	-	-

Amphibians

Results of the February 2020 Survey

In total, more than 390 individuals of amphibians representing 23 species from 5 families were recorded during the survey of the project development areas at Matthew's Ridge and Port Kaituma in 2020. All amphibians recorded were anurans (frogs).

Matthew's Ridge

There were more than 269 individuals of amphibians representing nineteen (19) species from four (4) families recorded from the five survey locations at Matthew's Ridge. The most abundant species recorded at Matthew's Ridge were *Rhinella marina* (52 individuals)*, Leptodactylus mystaceus* (42 individuals)*, Boana (Hypsiboas) cinerascens* (21 individuals) and *Scinax boesemani* (19 individuals). The most species diverse and greatest abundance amphibian locations were AQ 6 (the swamp located north of the the Matthew's Ridge Airstrip) with 84 individuals and 10 species and T4 Road with 46 individuals and 9 species. AQ6 was found to have a high diversity and abundance as a direct consequence of the varying types of microhabitats found there (overhanging vegetation over the waterbody, open pond, marsh vegetation, leaf litter), while the relatively high abundance at T4 was due to the high number of *Leptodactylus mystaceous* encountered. *Leptodactylus mystaceous* is a leaf-litter species typically found in the forest. Most of the individuals encountered were found at the forest edge.

The site with the least abundance and diversity was T1 with 7 individuals and 3 species. T1 is situated on Hill 9 and was extremely dry without any pools of water that could be used by amphibians for breeding, hence the limited observations.

Fifteen individuals of *Leptodactylus knudseni* were observed on the forest floor at transect at T4 Forest. This forested transect had relatively uniform leaf litter, and most of the individuals observed were seen at the entrance of holes in the forest floor. *Ameerega trivittata* was observed at T3 and T2 only. Each observation made was of single frogs sitting in relatively open-spaces along the transects.

Port Kaituma

At Port Kaituma (T5), more than 120 amphibians were detected representing 14 species from 4 families. All species recorded were anurans. The most abundant species recorded were *Rhinella marina* (>30 individuals), *Scinax boesemani* (25 individuals), and *Leptodactylus mystaceus* (19) individuals. Both *Rhinella marina* and *Scinax boesemani* were recorded at a creek that was dissected by the access road to the GMI proposed wharf, which has resulted in pooling, and the subsequent flooding of the nearby forest edge. Most *Leptodacylus mystaceus* recorded were observed at the edge of the forest. Two Taylor's Glass Frogs *Hyalinobatrichum taylori* were recorded at T5. Both were observed sitting in small pools of water, vocalizing, which is indicative of breeding behavior.

Biodiversity Baseline – Combined Results of the 2012 and 2020 Surveys

Combined with previous surveys in 2012, the findings of the 2020 survey bring the total number of species for the project development areas to 31 species of frogs from six (6) famiies (Table 12-11). *Atelopus spumarius* is categorised as Vulnerable on the IUCN Red List (Azevedo-Ramos *et al*. 2010). No other threatened, endemic or migratory amphibian species were recorded from the project developmental areas. Biogeographically, all amphibian species documented in the survey are widespread and abundant within Guyana and the wider Amazonian region. They can be found in tropical moist forest and other biogeographic provinces throughout the Guianas (Kok and

Kalamandeen, 2008; Starace, 1998; Lescure and Marty, 2000; Smithsonian Institute, 2000; Donnelly *et al*., 1998; Senaris *et al.*, 2005).

Photographic reference of the field surveys conducted during the February 2020 dry season are presented in Appendix G3.5.

Table 12-11: Amphibian Species recorded within the Project Development Areas

FAMILY	SPECIES RECORDED				COMMON NAME
	2012 SURVEY – MATTHEW'S RIDGE		2020 SURVEY		
	WET SEASON	DRY SEASON	MATTHEW'S RIDGE	PORT KAITUMA	
Aromobatidae	*Allobates femoralis*	*Allobates femoralis*	-	-	Brilliant-Thighed Poison-Arrow Frog
Bufonidae	*Atelopus spumarius*	-	-	-	Pebas Stud-Toed Toad
Bufonidae	*Rhaebo guttatus*	*Rhaebo guttatus*	*Rhaebo guttatus*		Spotted Toad
Bufonidae	*Rhaebo nasicus*	*Rhaebo nasicus*		*Rhaebo nasicus*	Werner's Toad
Bufonidae	*Rhinella marina*	*Rhinella marina*	*Rhinella marina*	*Rhinella marina*	Neotropical Giant Toad
Centrolenidae	-	-	-	*Hyalinobatrachium taylori*	Taylor's Glass Frog
Dendrobatidae	*Ameerega trivittata*	*Ameerega trivittata*	*Ameerega trivittata*		Three-Striped Poison Arrow Frog
Hylidae	*Dendropsophus minutus*	-			Lesser Treefrog
Hylidae	**Boana boans*	*Boana boans*	*Boana boans*	*Boana boans*	Giant Gladiator Treefrog
Hylidae	**Boana calcaratus*	*Boana calcaratus*	*Boana calcaratus*	*Boana calcaratus*	Troschel's Treefrog
Hylidae	**Boana cinerascens*	*Boana cinerascens*	*Boana cinerascens*	*Boana cinerascens*	Demerara Falls Treefrog
Hylidae	**Boana geographicus*	-	*Boana geographicus*	-	Map Treefrog
Hylidae	**Boana multifasciatus*	-	*Boana multifasciatus*	-	Many-Banded Treefrog
Hylidae	**Boana punctatus*	*Boana punctatus*	*Boana punctatus*	-	Polka-Dot Treefrog
Hylidae	*Osteocephalus buckleyi*	-	-	-	Buckley's Slender-Legged Treefrog
Hylidae	*Osteocephalus taurinus*	-	*Osteocephalus taurinus*	*Osteocephalus taurinus*	Manaus Slender-Legged Treefrog
Hylidae	*Phyllomedusa vaillanti*	-	-	-	White-lined Leaf Frog
Hylidae	-	-	*Phyllomedusa bicolor*	-	Giant Monkey Frog
Hylidae	*Physalaemus cuvieri*	-	-	-	Cuvier's Dwarf Frog
Hylidae	*Pseudis paradoxa*	*Pseudis*	*Pseudis paradoxa*	-	Paradoxical Frog

FAMILY	SPECIES RECORDED				COMMON NAME
	2012 SURVEY – MATTHEW'S RIDGE		2020 SURVEY		
	WET SEASON	DRY SEASON	MATTHEW'S RIDGE	PORT KAITUMA	
		paradoxa			
Hylidae	*Scinax boesemani*	-	*Scinax boesemani*	*Scinax boesemani*	Boeseman's Snouted Treefrog
Hylidae	*Scinax ruber*	*Scinax ruber*	*Scinax ruber*	*Scinax ruber*	Red Snouted Treefrog
Leptodactylidae	*Leptodactylus spp.1*	-	-	-	Thin-Toed Frog
Leptodactylidae	***Ademenora hylaedactyla*	***Ademenora hylaedactylus*	***Ademenora hylaedactylus*	***Ademenora hylaedactylus*	Forest Chirping Frog
Leptodactylidae	*Leptodactylus knudseni*	-	*Leptodactylus knudseni*	-	Knudsen's Thin-Toed Frog
Leptodactylidae	*Leptodactylus longirostris*	-	*Leptodactylus longirostris*	*Leptodactylus longirostris*	Long Snouted Thin-Toed Frog
Leptodactylidae	*Leptodactylus validus*	-	-	*Leptodactylus validus*	Garman's Thin-Toed Frog
Leptodactylidae	*Leptodactylus mystaceus*	-	*Leptodactylus mystaceus*	*Leptodactylus mystaceus*	Amazonian White-Lipped Frog
Leptodactylidae	*Leptodactylus pentadactylus*	-	*Leptodactylus pentadactylus*	-	Smokey Jungle Frog
Leptodactylidae	-	****Lithodytes lineatus*	-	-	Gold-Striped Frog
Leptodactylidae	-	-	-	*Leptodactyuys* spp. 2	Thin-Toed Frog

*Formerly classified as genus *Hypsiboas* according to taxonomic review.
** Now *Ademenora hylaedactyla* according to taxonomic review.
*** Now classified as *Lithodytes lineatus.*

Reptiles

Results of the February 2020 Survey

One hundred and eight (108) individuals representing 23 species of reptiles from 9 families were recorded in 2020 within the project development areas at Matthew's Ridge and Port Kaituma. All reptiles recorded were from the orders of Sauria (lizards), Serpentes (snakes) and Crocodylia (caiman). No Testudinae (turtles and tortoises) were recorded in 2020.

Matthew's Ridge

Eighty-nine (89) individuals representing 18 species of reptiles from 9 families were recorded from the 4 survey locations (T1 to T4) at Matthew's Ridge. The sample areas with the greatest species diversity was the forest transect at T3 with 7 species. This transect followed an old access trail with pioneer plant species filling in the forest gaps that provided spaces for hiding and for basking by reptiles. There were also small semi-permanent pools along the transect with tadpoles and aquatic insects that are prey for reptiles.

The greatest abundance of reptiles was at T2 Road (20 individuals, 4 species), followed by T4 Road (15 individuals, 4 species). These sites were road transects which allowed for more sun basking opportunities for reptiles, hence the increased rates of observation as compared to the transects under forest cover.

The site with the lowest species diversity and abundance was the forest transect located at T1. This area is on the incline of Hill 9 with very sparse trees and leaf litter. The area was relatively dry and offered no spaces from species to shelter and prevented basking due to the openness of the area.

The Teid lizards were the most abundant reptiles at the transects in the Matthew's Ridge area with 21 individuals of *Ameiva ameiva* and 31 individuals of *Kentropyx calcarata*. *Oxyrohopus melanogenys, Helicops angulata Tupinambis teguixin, Plica plica* and *Gonotodes annularis* were each represented by a single individual recorded.

Port Kaituma

There were 19 reptiles representing 12 species from seven 7 families recorded at the Port Kaituma (T5) in 2020. At Port Katiuma, the species with the greatest abundance were *Kentropyx calcarata* (5 individuals) and *Ameiva ameiva* (2 individuals). One caiman (*Paleosuchus palpebrosus*) was observed in a small creek located along the forest edge of the study site. Other species represented in the Port Kaituma study area by a single individual included the lizards *Iphisa elegans* and *Anolis chrysolepis,* and the snakes *Erythrolamprus mimus* and *Chironius scurrulus*. Two *Micrurus lemniscatus* were recorded from Port Kaituma transects.

Biodiversity Baseline – Combined Results of the 2012 and 2020 Surveys

Combined with previous surveys in 2012, the 2020 survey fundings bring the total number of species for the project development areas to 32 species of reptiles from 12 families. *Echinosaura sulcarostrum* is categorised as Endangered on the IUCN Red List (Ouboter & Hoogmoed, 2017). The yellow-footed tortoise *Chelonoidis denticulata* recorded in 2012 but not 2020 is listed as Vulnerable by the IUCN (Tortoise & Freshwater Turtle Specialist Group. 1996). No endemic or migratory reptilian species were recorded from the project developmental areas. The reptile fauna is typical of lowland rain forest in Guyana. Biogeographically, with the exception of *Echinosaura sulcarostrum*, all reptile species recorded within the project development areas are widespread throughout Guyana and the wider Amazonian region. They can be found in tropical moist forest and other biogeographic provinces

throughout the Guianas (Chippaux, 1986; Avila Pires, 1995; Starace, 1998; Smithsonian Institute, 2000; Donnelly *et al*., 1998; Senaris *et al.*, 2005; Pires, 1995).

Photographic reference of the field surveys conducted during the February 2020 dry season are presented in Appendix G3.5.

Table 12-12: Reptile Species recorded within the Project Development Areas

FAMILY	SPECIES RECORDED				COMMON NAME
	2012 SURVEY – MATTHEW'S RIDGE		2020 SURVEY		
	WET SEASON	DRY SEASON	MATTHEW'S RIDGE	PORT KAITUMA	
Gymnophthalmidae	*Echinosaura sulcarostrum*	-	*Echinosaura sulcarostrum*	-	-
	Iphisa elegans	-	-	*Iphisa elegans*	Glossy Shade Lizard
	***Loxopholis percarinatum*	-	***Loxopholis percarinatum*	***Loxopholis percarinatum*	Muller's Tegu
	-	*Neusticurus bicarinatus*	*Neusticurus bicarinatus*	-	Two-faced Neusticurus
	-	*Echinosaura* spp.	-	-	-
Polychrotidae	*Anolis chrysolepis*	*Anolis chrysolepis*	-	*Anolis chrysolepis*	Yellow-Tongued Anole
	Anolis fuscoauratus	*Anolis fuscoauratus*	*Anolis fuscoauratus*	*Anolis fuscoauratus*	Slender Anole
*Sphaerodactylidae	*Gonatodes annularis*	*Gonatodes annularis*	*Gonatodes annularis*	-	Annulated Gecko
	Gonatodes humeralis	*Gonatodes humeralis*	*Gonatodes humeralis*	-	Bridled Forest Gecko
	Lepidoblepharis heyerorum	*Lepidoblepharis heyerorum*	-	-	Amazon Dwarf Gecko
Teiidae	*Ameiva ameiva*	*Ameiva ameiva*	*Ameiva ameiva*	*Ameiva ameiva*	Amazon Race Runner
	Kentropyx calcarata	*Kentropyx calcarata*	*Kentropyx calcarata*	*Kentropyx calcarata*	Striped Forest Whiptail
	-	-	*Tupinambis teguixin*	-	Golden Tegu/Salipenter
		Kentropyx spp.			
			Kentropyx striata		Forest Lizard
Tropiduridae	*Uranoscodon superciliosus*	*Uranoscodon superciliosus*			Diving Lizard
			Plica plica		Harlequin Racerunner
Boidae	*Corallus hortulanus*				Amazon Tree Boa
Colubridae	*Chironius fuscus*	*Chironius fuscus*	*Chironius fuscus*		Brown Sipo

FAMILY	SPECIES RECORDED				COMMON NAME
	2012 SURVEY – MATTHEW'S RIDGE		2020 SURVEY		
	WET SEASON	DRY SEASON	MATTHEW'S RIDGE	PORT KAITUMA	
	Leptophis ahaetulla				Black-Skinned Parrot Snake
				Chironius scurrulus	Wagler's Sipo
			Siphlophis compressus		Tropical Flat Snake
			Pseudoboa coronata	*Pseudoboa coronata*	Crowned False Boa
			Helicops angulata		Brown Banded Water Snake
Dipsadidae	*Oxyrhopus melanogenys*		*Oxyrhopus melanogenys*		Tschudi's False Coral Snake
	Erythrolamprus mimus			*Erythrolamprus mimus*	False Coral Snake
	Oxyrhopus petolarius		*Oxyrhopus petolarius*	*Oxyrhopus petolarius*	Forest Flame Snake
Elapidae	*Micrurus lemniscatus*	*Micrurus lemniscatus*	*Micrurus lemniscatus*	*Micrurus lemniscatus*	South American Coral Snake
Viperidae	*Bothrops atrox*				South American Lancehead
Testudinidae	*Chelonoidis denticulata*				Yellow-footed tortoise
Alligatoridae	*Paleosuchus palpebrosus*			*Paleosuchus palpebrosus*	Cuvier's Dwarf Caiman
	Caiman crocodilus				Spectacled Caiman

*Formerly family Gekkonidae before taxonomic revision.
** Formerly genus *Leposoma.*

Terrestrial Macro-Invertebrates

In general, invertebrates play vital roles in ecological systems since they are an essential component of most food webs, they both consume and are consumed by plants and other animals, they recycle organic matter thereby putting it back into circulation for use by other parts of the ecosystem, they cross pollinate flowers, they assist in the transmission of disease and they are instrumental in controlling the number of other species. Despite challenges with tropical forest invertebrate taxonomy, the survey team endeavoured to compile a list of the various taxa encountered in 2020. Sampling invertebrates presents several technical challenges (including the lack of available entomologists and user-friendly guides for several major invertebrate groups, the high sampling effort required for aquatic and terrestrial ecosystems, and time available for identification because many species require microscopic identification). Terrestrial-macro invertebrates recorded during the surveys were therefore classified to order due to the difficulty of identifying and classifying invertebrates to the species level.

Results of the February 2020 Survey

Macro-invertebrates exist in large colonies/groups so counting individuals is often difficult and sometimes impossible. Macro-invertebrate orders encountered were, therefore, simply categorized as Uncommon, Fairly Common, Common, and Abundant (see Table 12-13).

The 2020 dry season survey of Matthew's Ridge and Port Kaituma recorded a total of 20 orders. The orders Acari, Araneae, Blattidea, Hymenoptera, Isoptera and Lepidoptera were the most abundant macro-invertebrates detected at all survey transects sampled, followed by the orders Isoptera, Odonata and Coleoptera. The least abundant order was the Mantodea, which was recorded at T2, followed by the order Amblypygi, which was recoded at T2 and T3. The survey transects at T2 and T3 contain meandering creeks of rocks, which serve as suitable habitats for the order Amblypygi.

The survey transect T2 recorded the greatest richness of macro-invertebrate orders with 19 orders, followed by transects T4 with 18 orders, T3 with 17 orders, T5 with 16 orders and T1 with 14 orders. The order Odonata was abundant at survey transects with water bodies as they require an aquatic habitat to complete their lifecycle.

Biodiversity Baseline – Combined Results of the 2012 and 2020 Surveys

Twenty Orders of terrestrial macro-invertebrates have been recorded from the project development areas in total – 2012 and 2020 survey results combined. Tailess whip scorpions and isopods were recorded in 2020 but not in 2012. It should be noted that no endemic species of invertebrates were recorded. The endemic invertebrate species of Guyana[119] include: a grasshopper *Acantheremustenuis*[120], a katydid *Cnemidophyllumgranti*[121], an ant *Rogeriatsumani*[122], and a leafhopper *Tomopennistumidus*[123]. Other endemic invertebrates include a jumping spider *Scopociracarinata*[124], a huntsman spider *Sparianthina rufescens*[125], a goblin spider *Scaphiellakartabo*[126], and a freshwater crab *Microthelphusameansi*[127].IUCN recorded two endemic

[119] Living National Treasures, unknown. Guyana.
[120] Orthoptera Species File Online, unknown. Taxa Hierarchy. Species *Acantheremus tenuis*
[121] *Orthoptera Species File Online, unknown. Taxa Hierarchy. Species* Cnemidophyllum (Peucestophyllum) granti
[122]Lapolla, J. & J. Sosa-Calvo, 2006. Review of the ant genus Rogeria (Hymenoptera: Formicidae) in Guyana.Zootaxa1330: 59–68.
[123]J. Maldonado Capriles, 1984. Studies of Idiocerinae Leafhoppers, Xvi: Tomopennis, A New Genus from Guyana and a key to the Neotropical Genera of the Subfamily Carib. J. Sci. 20(3-4). 1984
[124]http://salticidae.org/salticid/diagnost/scopocir/carinata.htm
[125]Jäger, P., P. C. Anne Rheims, and F. Martín Labarque, 2009. On the huntsman spider genera Sparianthina and Anaptomecus Simon, 1903 from South and Central America (Araneae, Sparassidae). ZooKeys 16:115-147
[126]Platnicka, N and N. Dupérréb. 2010. The Goblin Spider Genus Scaphiella (Araneae, Oonopidae). Bulletin of the American Museum of Natural History Number 332 :1-156.
[127]Cumberlidge, N. 2007. A new species of freshwater crab of the genus Microthelphusa (Brachyura: Pseudothelphusidae) from western Guyana, South America. Zootaxa 1447: 57–62

species of freshwater crabs from Guyana[128] and one threatened species[129] (grouped as 'Other Invertebrate'). None of Guyana's butterfly species are listed in the IUCN Red List of Threatened Species as endangered, rare or threatened[130].

Table 12-13: Terrestrial Macro-invertebrates Orders and Abundance Recorded

Vernacular Name	Orders	2012 Survey	2020 Survey				
		Concession	Matthew's Ridge				Port Kaituma
			T1	T2	T3	T4	T5
Mites and Ticks	Acari	X	A	A	A	A	A
Segmented Worms	Annelida	X	-	U	U	U	F
Spiders	Araneae	X	A	A	A	A	A
Cockroaches	Blattidea	X	A	A	A	A	A
Centipedes	Lithobiomorpha	X	-	U	U	U	U
Beetles	Coleoptera	X	A	A	A	A	C
Millipedes	Callipodida	X	U	-	-	U	F
True Flies	Diptera	X	A	A	A	A	A
True Bugs	Hemiptera	X	U	U	U	F	C
Bees, Wasp and Ants	Hymenoptera	X	A	A	A	A	A
Termites	Isoptera	X	A	A	A	A	A
Butterflies, moths and skippers	Lepidoptera	X	A	A	A	A	A
Praying Mantis	Mantodea	X	-	U	-	-	-
Dragon and Damselflies	Odonata	X	U	A	A	A	U
Grasshoppers, locusts, crickets	Orthoptera	X	A	A	C	A	C
Stick Insects	Phasmidae	X	-	F	-	U	-
Scorpions	Scorpiones	X	-	U	U	F	U
Aqua worms, earth worms	Haplotaxida	X	U	F	U	F	F
Tailless whip scorpion	Amblypygi	-	-	U	U	-	-
Isopods	Isopoda	-	F	F	A	F	

Key:
U (Uncommon) – Small numbers recorded, within proximity to transect
F (Fairly common) – Observer between two to four individuals daily
C (Common) – Observed between five to ten individuals daily
A (Abundant) – Observed more than ten individuals daily
X – Present (Adundance not estimated)

[128]http://www.iucnredlist.org/documents/summarystatistics/2011_2_RL_Stats_Table6a.pdf
[129]http://www.iucnredlist.org/documents/summarystatistics/2011_2_RL_Stats_Table5.pdf
[130] The IUCN Red List of Threatened Species (https://www.iucnredlist.org/)

12.2.3.1.2.3 Aquatic Fauna

Fish

Fish are key components of the Amazonian rain forest ecosystems (Lowe-McConnell 1995; Lundberg 2001; Watkins *et al.* 2004). They are linked to forests by migrations of fish through inundated forest ecosystems and through nutrient flows into wetlands. Furthermore, fish are of immense value to humans and are often critical traditional food sources that define human-forest relationships (Robinson and Redford, 1991) Fish are also the subject of international agreements and can be used as general indicators of pollution (Nelson, 1994). Because fish play a very important role in forested Amazonian ecosystems, their importance to the survival of local people, and their use as indicators of pollution, it is important to understand patterns of fish diversity in Guyana's rivers and wetlands, especially in areas that are to be exploited.

Results of the February 2020 Survey

The 2020 fish survey of the project development areas within Matthew's Ridge and Port Kaituma recorded a total of 456 fish from 36 species belonging to 19 families. From the 2020 surveys, AQ1 recorded a sampling population of 7 individuals representing 4 species. AQ2 recorded a total of 29 individuals representing 7 species while at AQ3 recorded a total of 76 individuals representing 15 species. AQ4 recorded a total of 213 individuals representing 10 species, while AQ5 recorded 101 individuals representing 12 species and AQ6 with 30 individuals representing 6 species. AQ4 was the most species-rich survey transect followed by AQ5.

The most dominant species recorded was *Hemigrammus* spp. (Characidae) with a total of 80 individuals – found only at AQ1 - followed by *Astyanax bimaculatum* (Characidae*)* with a total of 76 individuals. Except for AQ1, *Astyanax bimaculatum* was found at all of the survey transects.

The species *Gephyrocharax cf. valencia* collected at AQ 3 and AQ5 was not known to occur in Guyana prior to the survey. This survey record represents the first known record of *G. valencia* in Guyana. The genus *Gephyrocharax* is known to be widely distributed throughout Panama and other South America countries leading more towards Mexico, Venezuela and most recently, Trinidad and Tobago for the Caribbean countries (Donald Taphorn, 2020-Personal Communication).

Biodiversity Baseline – Combined Results of the 2012 and 2020 Surveys

Combined with previous surveys in 2012, the 2020 survey findings bring the total number of fish species recorded from the project development areas to 62 species from 25 families. The most abundant family of fish recorded in 2012 and 2020 surveys were the characidae. A notable capture is *Anablepsoides* (*Rivulus) waimacui)* which is an endemic species. No threatened or migratory fish species were recorded from the project developmental areas.

Photographic reference of the field surveys conducted during the February 2020 dry season are presented in Appendix G3.6.

Table 12-14: Fish Species recorded within the Project Development Areas

COMMON NAME	ORDER	FAMILY	SPECIES RECORDED			
			2012 SURVEY – MATTHEW'S RIDGE		2020 WET SEASON SURVEY	
			WET SEASON	DRY SEASON	MATTHEW'S RIDGE	PORT KAITUMA
Dag fish	Characiformes	Acestrorhynchidae	*Acestrorhynchus falcatus*	*Acestrorhynchus falcatus*	-	-
Daray	Characiformes	Anostomidae	*Leporinus friderici*	*Leporinus friderici*	-	*Leporinus friderici*
Painta	Characiformes	Anostomidae	*Leporinus melanostictus*	*Leporinus melanostictus*	-	-
Celebe	Characiformes	Characidae	*Astyanax fasciatus*	*Astyanax fasciatus*	-	-
Celebe	Characiformes	Characidae	-	-	*Astyanax bimaculatus*	*Astyanax bimaculatus*
Glass headstander	Characiformes	Characidae	*Charax gibbosus*	*Charax gibbosus*	-	-
Gold tail	Characiformes	Characidae	*Moenkhausia oligolepis*	*Moenkhausia oligolepis*	*Moenkhausia oligolepis*	-
Discus tetra	Characiformes	Characidae	*Poptella orbicularis*	-	-	--
Silver belly	Characiformes	Characidae	-	-	-	*Poptella* spp.
X-ray tetra	Characiformes	Characidae	*Pristella maxillaris*	-	-	-
Piranna	Characiformes	Characidae	*Serrasalmus eigenmanni*	*Serrasalmus eigenmanni*	-	-
Silver belly	Characiformes	Characidae	-	-	*Hyphessobrycon* spp.	-
Silver belly	Characiformes	Characidae	-	-	*Hemigrammus sp 1.*	-
Silver belly	Characiformes	Characidae	-	-	*Hemigrammus sp 2.*	-
New fish	Characiformes	Characidae	-	-	*Gephyrocharax cf. valencia*	-
Silver belly	Characiformes	Characidae	-	-	*Hyphessobrycon unilineatus*	-

COMMON NAME	ORDER	FAMILY	SPECIES RECORDED			
			2012 SURVEY – MATTHEW'S RIDGE		2020 WET SEASON SURVEY	
			WET SEASON	DRY SEASON	MATTHEW'S RIDGE	PORT KAITUMA
Daray	Characiformes	Curimatidae	-	-	*Cyphocharax spilurus*	-
Daray	Characiformes	Curimatidae	-	-	*Steindachnerina* spp.	-
Yarrow	Characiformes	Erythrinidae	*Hoplerythrinus unitaeniatus*	*Hoplerythrinus unitaeniatus*	*Hoplerythrinus unitaeniatus*	-
Huri	Characiformes	Erythrinidae	*Hoplias malabaricus*	*Hoplias malabaricus*	*Hoplias malabaricus*	*Hoplias malabaricus*
Himara	Characiformes	Erythrinidae	*Hoplias aimara*	*Hoplias aimara*	-	-
Huri	Characiformes	Erythrinidae	*Hoplias macrophthalmus*	*Hoplias macrophthalmus*	-	-
Pencil fish	Characiformes	Lebiasinidae	*Pyrrhulina eleanorae*	*Pyrrhulina eleanorae*	-	-
Pencil fish	Characiformes	Lebiasinidae	-	-	*Pyrrhulina filamentosa*	-
Silva	Characiformes	Gastreropelecidae	-	*Gasteropelecus sternicla*	*Gasteropelecus sternicla*	-
Prianna	Characiformes	Serrasalmidae	-	-	-	*Pristobrycon calmoni*
Prianna	Characiformes	Serrasalmidae	-	-	*Serrasalmus hollandi*	*Serrasalmus hollandi*
	Characiformes	Prochilodontidae	-	-	*Prochilodus* spp.	
Patwa	Cichilformes	Cichlidae	*Cichlasoma bimaculatum*	*Cichlasoma bimaculatum*	*Cichlasoma bimaculatum*	*Cichlasoma bimaculatum*
Patwa	Cichilformes	Cichlidae	*Aequidens tetramerus*	-	-	--
Patwa	Cichilformes	Cichlidae	-	-	*Aequidens potaroensis*	-
Sun fish	Cichilformes	Cichlidae	*Crenicichla alta*	*Crenicichla alta*	*Crenicichla alta*	-
Patwa	Cichilformes	Cichlidae	-	-	*Apistogramma* spp.	-
Herring	Clupeiformes	Engraulidae	-	*Lycengraulis batesii*	-	-

COMMON NAME	ORDER	FAMILY	SPECIES RECORDED			
			2012 SURVEY – MATTHEW'S RIDGE		2020 WET SEASON SURVEY	
			WET SEASON	DRY SEASON	MATTHEW'S RIDGE	PORT KAITUMA
Guppy	Cyprinodontiformes	Poeciliidae	*Poecilia reticulata*	*Poecilia reticulata*	*Poecilia reticulata*	-
Guppy	Cyprinodontiformes	Rivulidae	-	-	*Anablepsoides (Rivulus) waimacui*	-
Ghost knife fish	Gymnotiformes	Apteronotidae	*Apteronotus albifrons*	*Apteronotus albifrons*	-	-
Knife fish	Gymnotiformes	Apteronotidae	-	-	*Sternarchorhynchus freemani*	-
Tiger knife fish	Gymnotiformes	Gymnotidae	*Gymnotus anguillaris*	*Gymnotus anguillaris*	-	-
Glass knife fish	Gymnotiformes	Sternopygidae	*Eigenmannia limbata*	*Eigenmannia limbata*	-	-
Knife fish	Gymnotiformes	Sternopygidae	-	-	*Eigenmannia virescens*	-
Knife fish	Gymnotiformes	Sternopygidae	*Sternopygus macrurus*	*Sternopygus macrurus*	*Sternopygus macrurus*	-
River sting ray	Myliobatiformes	Potamotrygonidae	*Potamotrygon brachyura*	-	-	-
Dawaloo	Siluriformes	Auchenipteridae	*Ageneiosus inermis*	*Ageneiosus inermis*	-	-
Imerhri	Siluriformes	Auchenipteridae	*Trachycorystes galeatus*	*Trachycorystes galeatus*	*Trachelyopterus galeatus*	-
Hassar	Siluriformes	Callichthyidae	*Callichthys callichthys*	*Callichthys callichthys*	*Callichthys callichthys*	*Callichthys callichthys*
Blackstripe cory	Siluriformes	Callichthyidae	-	*Corydoras bondi*	-	-
Sand hassar	Siluriformes	Callichthyidae	*Hoplosternum littorale*	-	-	-
Kassie	Siluriformes	Heptapteridae	*Rhamdia quelen*	*Rhamdia quelen*	*Rhamdia quelen*	-
Kassie	Siluriformes	Heptapteridae	*Rhamdia argentina*	*Rhamdia argentina*	-	-
Kassie	Siluriformes	Heptapteridae	*Rhamdia foina*	*Rhamdia foina*	-	-

COMMON NAME	ORDER	FAMILY	SPECIES RECORDED			
			2012 SURVEY – MATTHEW'S RIDGE		2020 WET SEASON SURVEY	
			WET SEASON	DRY SEASON	MATTHEW'S RIDGE	PORT KAITUMA
Kassie	Siluriformes	Heptapteridae	-	-	*Pimelodella cristata*	-
	Siluriformes	Heptapteridae	-	-	*Imparfinis* spp.	-
	Siluriformes	Loricariidae	*Ancistrus* spp.	*Ancistrus* spp.	-	-
Smoke hassar	Siluriformes	Loricariidae	-	*Hypostomus plecostomus*	-	-
Armoured catfish	Siluriformes	Loricariidae	-	*Planiloricaria cryptodon*	-	-
Smoke Hassar	Siluriformes	Loricariidae	-	-	-	*Hypostomus* spp.
Hassar	Silurifomes	Loricariidae	-	-	*Lasiancistrus schomburgkii*	
Larima	Siluriformes	Pimelodidae	-	*Pimelodus blochii*	-	-
Dwarf marbled catfish	Siluriformes	Pseudopimelodidae	-	*Microglanis poecilus*	-	-
Catfish	Siluriformes	Trichomycteridae	-	-	*Ochmacanthus flabelliferus*	-
Conga eel	Synbranchiformes	Synbranchidae	-	-	-	*Synbrachus marmaratus*

Benthic Macro-Invertebrates

Nine (9) orders of benthic macro-invertebrates were recorded in 2020 (Table 12-15). These Orders were also recorded in the 2012 surveys along with the Amphipoda and Adelphia bringing the total to 11 Orders. The most abundant macro-invertebrates encountered belonged to the orders Decapoda (crabs, shrimps), Nepomorpha (stick insects) and diptera (mosquito, sandflies).

Table 12-15: Benthic Macro-invertebrates recorded within the Project Development Areas

COMMON NAME	ORDER RECORDED	
	2012 SURVEY – MATTHEW'S RIDGE	2020 SURVEY – MATTHEW'S RIDGE /PORT KAITUMA
Diving water beetle	Adephaga	Adephage
Semi aquatic spider	Araneae	Araneae
Scud	Amphipoda	-
Shrimp	Decapoda	Decapoda
Crab	Decapoda	Decapoda
Sand flies	Diptera	Diptera
Mosquito	Diptera	Diptera
Snail	Gastropoda	Gastropoda
Water strider	Hemiptera	Gerromopha
Aquatic woodlouse	Isopoda	Isopoda
Water boatman	Nepomorpha	-
Water stick	Nepomorpha	Nepomorpha
Dragonfly	Odonata	Odonata
Water beetle	Adelphia	-

12.2.3.1.2.4 Summary of Fauna Baseline Results

Based on the 2012 and 2020 biodiversity field surveys, the combined fauna baseline results is as follows:

- Terrestrial macro-invertebrates 20 orders
- Benthic macro-invertebrates 11 orders
- Fish 62 species
- Amphibians 31 species
- Reptiles 32 species
- Birds 280 species
- Non-volant Mammals 44 species
- Bats 31 species

12.2.3.2 Areas of Biological Interest

Areas of recognized global, national or local importance to biodiversity within Guyana were considered in this assessment to determine whether the project development areas are identified as a priority area for conservation interest. This includes consideration of legally protected areas, World Heritage Sites, Ramsar Sites, Important Bird Areas, Key Biodiversity Areas, Community reserves, and natural reserves, as well as ecoregional planning areas within Guyana.

The project development areas of Matthew's Ridge and Port Kaituma has not been identified by the Government of Guyana (GOG) 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.

The conservation priority sites identified by the GOG include the legally protected areas of the Kanuku Mountains, the Shell Beach Protected Area, the Kaieteur National Park, the Iwokrama Rainforest Reserve, and the Community Owned Conservation Area at Konashen, and other areas of biological interest not legally protected including GFC Moraballi and Mabura Reserves, the Orinduik Falls and Roraima Mountains. None of the legally protected areas and other areas of biological interest are located near the GMI project development landscape within Matthew's Ridge and Port Kaituma (Figure 12-9).

Recently, the BMP, depicted in Figure 12-10, has been proposed for special protected area (SPA) status under the Guyana Mangrove Restoration Project. The proposed BMP-SPA is situated in the northern part of Region One near the Venezuelan border, north of the town of Mabaruma and adjacent to the Morawanha settlement at the intersection of the mouth of the Barima and Aruka Rivers. The sections of the Barima and Kaituma Rivers within the BMP includes part of the proposed GMI shipping route from Port Kaituma to the Atlantic Ocean. A section of the BMP at the mouth of the Waini River borders the Shell Beach Protected Area. The BMP is a major trans-shipment route for goods and services between northwestern Guyana and the capital city of Georgetown, and also to neighbouring Venezuela.

In addition, eco-regional planning was done at the level of the Guiana Shield Region in April 2002 through the "Guyana Shield Conservation Priority-setting Workshop" co-sponsored by Conservation International (CI), the Guiana Shield Initiative of the Netherlands Committee for the IUCN, the Caribbean Sub-regional resource Facility of the United Nations Development Programme (UNDP), UNDP Suriname, and UNDP Guyana. The workshop identified a series of priority areas for biodiversity and conservation within the Guyana Shield Region. The workshop identified the Cuyuni Basin and the Waini-Shell Beach areas in the North-West District as "biological and conservation priority" areas, with the areas being included because of their importance for floristics, plant ecology, amphibians and reptiles. The workshop also established that plant ecology priority areas are relatively well distributed throughout the Guiana Shield region and because plant ecology areas are quite large, they need not be protected in their entirety to preserve and sustain the region's biodiversity (Steege 2003).

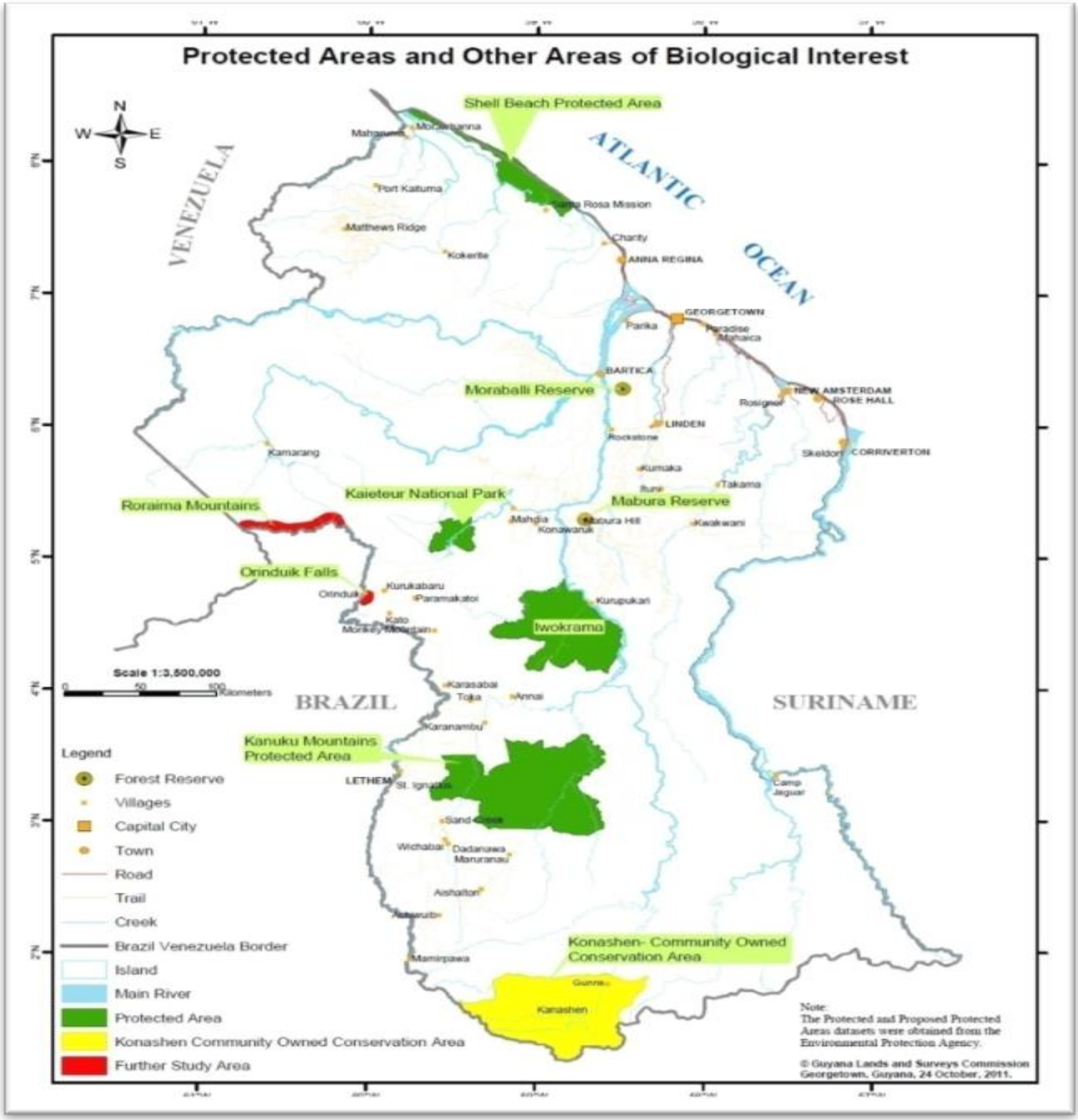
The biodiversity and conservation priority areas were not bio-geographically defined by the workshop. The workshop, however, developed a schematic map which identified Guyana Shield Conservation Priority Areas in Guyana. That map, depicted as Figure 12-11, indicates that the areas of Matthew's Ridge and Port Kaituma fall within the Cuyuni Basin Conservation Priority Area and the project's shipping route within the Waini-Shell Beach area. Other priority areas in Guyana include the White Sand Belt, the Eastern Upland and Tepui area and the Rupununi Wetlands. None of these areas fall within the project development areas.

Historical and ongoing human activities within the project development landscape, including the proposed shipping route of the project within the BMP have modified the primary ecological functions and species composition of habitats, resulting in habitat loss and species displacement. Biodiversity resident within the project landscape are, therefore, habituated to the constantly changing and human-influenced environments. Consequently, project development activities are not expected to significantly transform existing habitats and or affect the long-term survivability of species habituated to human activities within the project landscape.

Figure 12-12 identifies the Zero Extinction Sites in northern South America, including Guyana. There are no Zero Extinction Sites in Guyana. The Reserva Forestal Imataca site in Venezuela along the

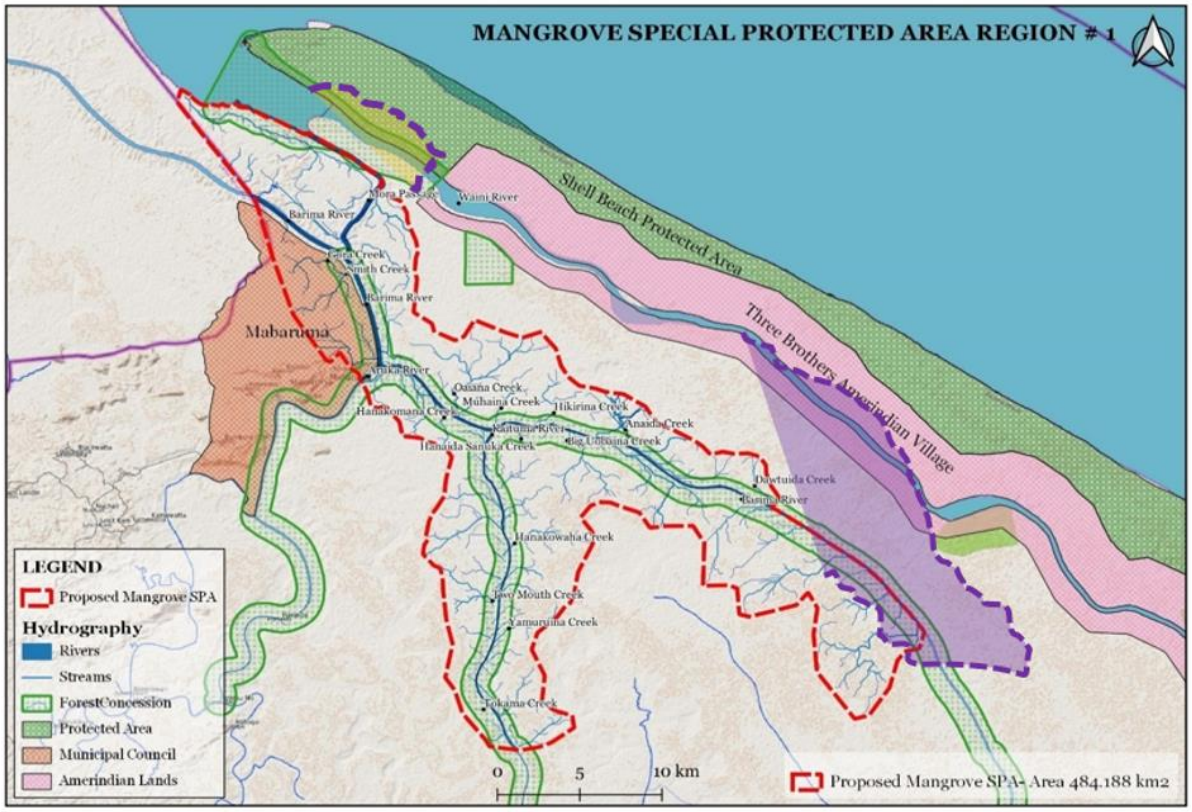
northwestern Guyana border is an important bird area (IBA) triggered by the Endangered (EN) Thripophaga amacurensis (Delta Amacuro Softtail).

Guyana is not a signatory of the Ramsar Convention and has no proposed or listed Ramsar wetland sites. There are no designated areas in Guyana identified as Important Bird Areas (IBAs). However, Birdlife International has identified two Endemic Bird Areas (EBAs) within Guyana, depicted in Figure 12-13: the Rio Branco Gallery Forest of Brazil and Guyana; and the tepuis (or table-mountains) scattered throughout Bolívar and Amazonas states of southern Venezuela (south of the Orinoco river), penetrating as far as west-central Guyana and northern Brazil. None of the two EBAs identified in Guyana are located within the project development areas.



Map Source: Guyana Lands and Surveys Commission, 2013

Figure 12-9: Protected Areas and Other Areas of Biological Interest within Guyana with respect to the GMI Project Development Areas within Matthew's Ridge and Port Kaituma



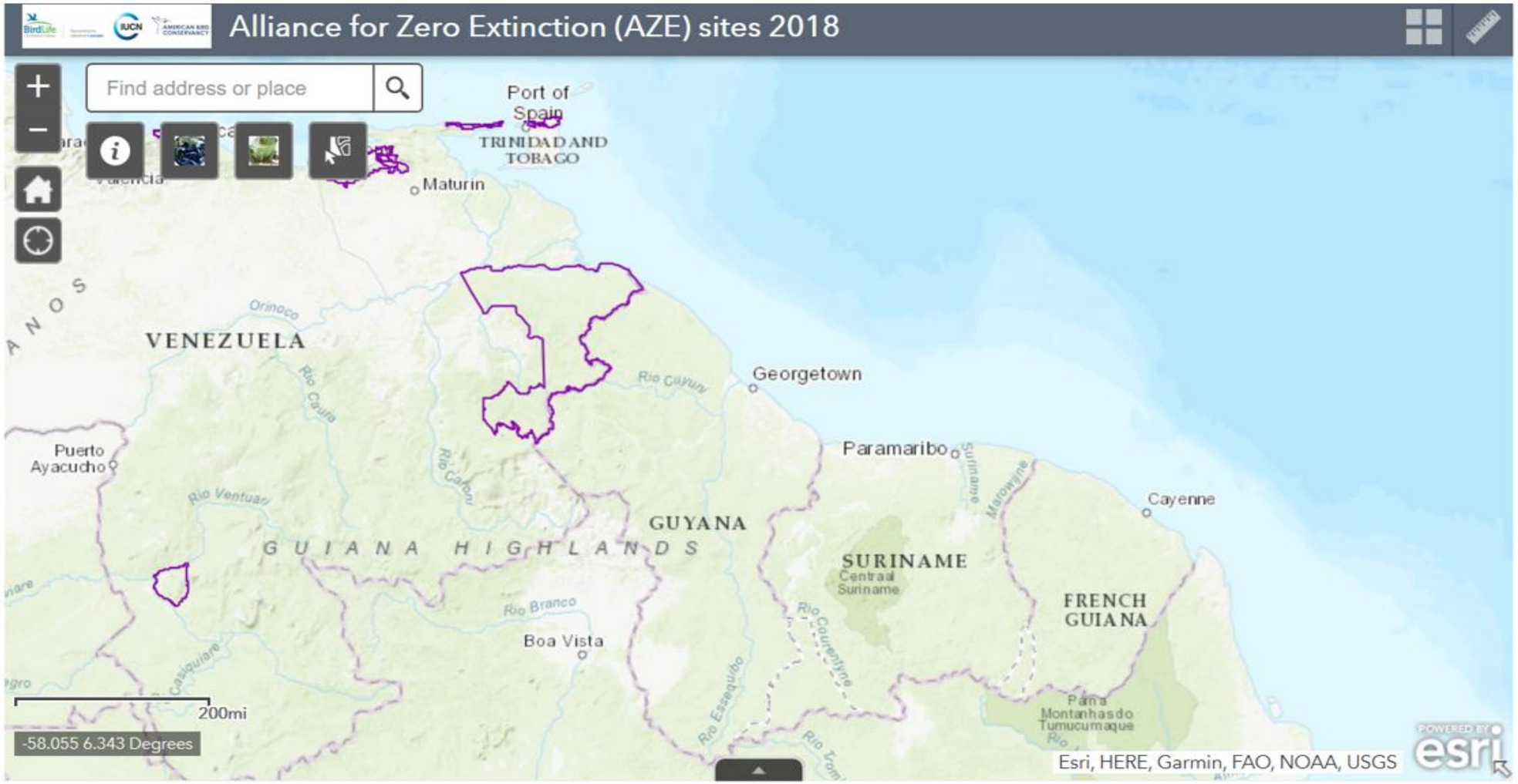
Note: orange dashed line is an extension of the original boundaries around the Waini peninsula; Purple dashed line is boundary of extended East Barima River.

Map produced by Landell Mills, 2020 and sourced from the Mangrove Forests Reserve - Barima-Mora Passage Biodiversity & Ecosystem Services Assessment (Draft report), 2020; European Union Funded Project in Collaboration with Guyana Mangrove Restoration Project

Figure 12-10: Proposed Barima-Mora Passage Special Protected Area

Source: The Guiana Shield Conservation Priority Setting Workshop Report, 2003

Figure 12-11: The Cuyuni Basin and the Waini Shell Beach Conservation Priority Areas in Northwest District of Guyana

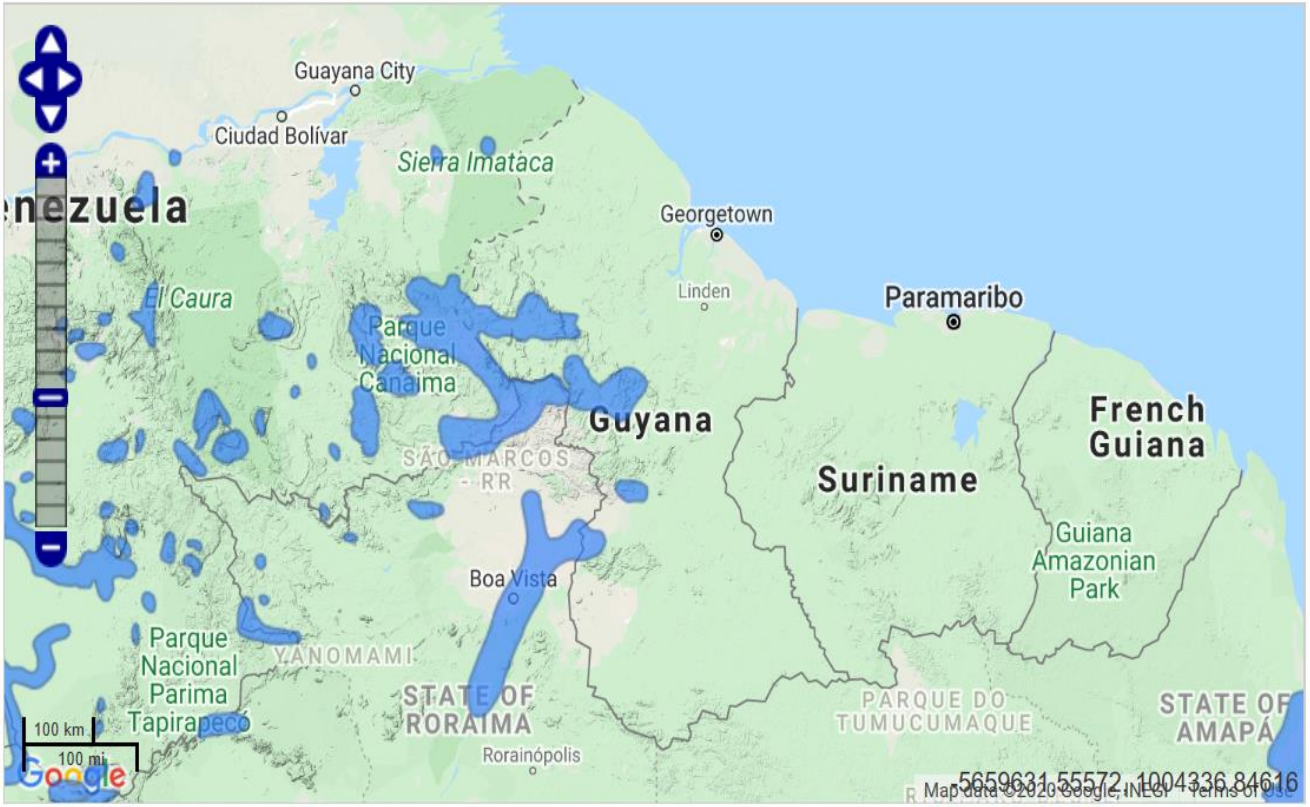


Note: The Reserva Forestal Imataca site in Venezuela along the northwestern Guyana border is an important bird area (IBA) triggered by the Endangered (EN) Thripophaga amacurensis (Delta Amacuro Softtail); also see there are no sites in the Amazonian and Guianas regions.
Source: Downloaded from Alliance for Zero Extinction Map; 2018 Global AZE Map

Figure 12-12: Alliance for Zero Extinction Sites in northern South America
Source: BirdLife International, 2020. Country profile: Guyana.

Guyana

Species | IBAs | EBAs | Marine | Policy | Resources



Guyana at a glance

Capital
Georgetown

Area
214,969 km^2

BirdLife Partner
None

Species

Total number of birds	796
Globally threatened birds	16
Country endemics	0

Important Bird & Biodiversity Areas

Number of IBAs	0
Total IBA area	0 ha

Endemic Bird Areas

Number of EBAs	2

Figure 12-13: EBAs within Guyana

12.2.3.3 Sensitive Species

The biodiversity baseline data compiled was examined to assess whether there are sensitive species, that is, threatened species as defined by the IUCN Red List (Critically Endangered, Endangered, and Vulnerable), endemic or restricted range species, and migratory species within the project development landscape.

12.2.3.3.1 Threatened Species

The IUCN Red List of Threatened Species[131] was used to conduct this assessment. The criteria used for the classification of the IUCN Red List of threatened species are provided in Table 12-16. The globally threatened categories are species listed as Vulnerable (VU), Endangered (EN) or Critically Endangered (CE).

Table 12-16: Classification Criteria of the IUCN Red List of Threatened Species

IUCN Threat Category	Classification
Extinct (E)	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), and throughout its historic range have failed to record an individual.
Extinct in the Wild (EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual.
Critically Endangered (CR)	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see 2001 IUCN Redlist Categories and Criteria Version 3.1), and it is therefore considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see 2001 IUCN Redlist Categories and Criteria Version 3.1), and it is therefore considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see 2001 IUCN Redlist Categories and Criteria Version 3.1), and it is therefore considered to be facing a high risk of extinction in the wild.
Near Threatened (NT)	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

[131] Version 2020-1 of the Red List was utilised

IUCN Threat Category	Classification
Least Concern (LC)	A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
Data Deficient (DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat.
Not Evaluated (NE)	A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

Note: Shaded rows depict the globally threatened categories

The following assesses whether the project development landscape contains habitats that are critical for the survivability of threatened species as defined by the IUCN Red List. Table 12-17 provides the IUCN Red List of threatened species recorded during the surveys of the project development landscape.

Table 12-17: IUCN Red List of Threatened Species Recorded in the PDA

SPECIES	COMMON NAMES	IUCN Classification
Mammals		
Pteronura brasiliensis	Giant Otter	Endangered (EN)
Priodontes maximus	Giant Armadillo	Vulnerable (VU)
Tapirus terrestris	Brazilian Tapir	Vulnerable (VU)
Myrmecophaga tridactyla	Giant Anteater	Vulnerable (VU)
Ateles paniscus	Guiana Spider Monkey	Vulnerable (VU)
Tayassu pecari	White-lipped Peccary	Vulnerable (VU)
Birds		
Crax alector	Black curassow	Vulnerable (VU)
Tinamus tao	Gray tinamou	Vulnerable (VU)
Ramphastos vitellinus	Channel-billed toucan	Vulnerable (VU)
Ramphastos tucanus	Red-Billed or White-throated toucan	Vulnerable (VU)
Ramphastos culminatus	Yellow Ridged toucan	Vulnerable (VU)
Reptiles		
Chelonoidis denticulata	Yellow-footed Tortoise	Vulnerable (VU)
Echinosaura sulcarostrum		Endangered (EN)
Amphibians		
Atelopus spumarius	Pebas Stubfoot Toad	Vulnerable (VU)

Plants

Review of the IUCN Red List revealed no threatened plant species recorded in the project development areas. The only EN or CE plant species listed by the IUCN Red List that occurs in Guyana are: *Trichilia surumuensis* (EN), *Aniba rosiodora* (EN), *Virola surinamensis* (EN), and *Vouacapoua americana* (CR). These species are widespread within their ranges in forest lands of Guyana and are not known to occur within the project development landscape. *Trichilia surumuensis* is an understorey species restricted to the Roraima highlands of Brazil and Guyana; the *Aniba rosiodora* is native to

northern South America and the genus *Aniba* occurs widely in Wallaba forest and in mixed forest on white and brown sand in Guyana; *Virola surinamensis* is widely distributed and are abundant to frequent in marsh forest, Mora forest and swamp forest in Guyana; the genus *Vouacapoua* is locally common in mixed forest in the near interior growing in reefs on rocky hills or sandy clay, and in swamp forests on alluvial flats in southeastern Guyana. *Vouacapoua Americana*, *Aniba rosiodora*, and *Virola surinamensis* are timber species that are not commercially targeted in Guyana.

Mammals

No CE mammals are known to occur in Guyana. The only EN mammal listed by the IUCN for Guyana is the Giant River Otter (*Pteronura brasiliensis*). Anecdotal information obtained during the surveys indicate the possible existence of *Pteronura brasiliensis* within project development area of Matthew's Ridge. However, the presence of *P. brasiliensis* was not confirmed during active surveys. *P. brasiliensis* is classified as EN due to inferred future population decline because of habitat loss and exploitation. The giant otter is a highly social mammal and are seen in groups ranging in size from two to extended family groups of 5 to 8 individuals. Solitary animals called 'transients', usually sub-adults, will pass through an area in search of mates or a steady group, but seldom remain for long (Duplaix, 1980).

Like many carnivores, giant otters select habitat according to prey abundance/availability/vulnerability which may fluctuate seasonally. According to Duplaix (1980), the giant otter prefers slow flowing clear black water creeks and rivers, particularly during the dry season, and rivers with low levels of human activity. Low sloping banks with good forest cover and close access to prime fishing areas are preferred by otters. Most of these conditions are not met within the project development areas of Matthew's Ridge. The rivers and creeks within the Matthew's Ridge appear to have historically been subjected to degradation from historic and current mining activities. Additionally, the landscape of Matthew's Ridge contains relatively high levels human activity, resulting in the reduction of habitats suitable habitats that may support the giant otter. Matthew's Ridge is also not known to be critical for the support of regionally and or globally important concentrations of the giant otter.

P. brasiliensis is endemic to the rainforests and wetlands of South America. The northern extent of its range occurs near, but does not include, the Caribbean Sea, and the southern extent of its range reaches Argentina. The majority of the animals are found in the Brazilian Amazon and the regions immediately bordering this area. In Guyana, there are a number of known localities with stable giant otter populations in the Rupununi Region such as the Bat Creek, Lower Rewa River, Upper Rewa River, Karanambo, Upper Rupununi River (Duplaix, 2002).

Priodontes maximus (Giant Armadillo), the largest of all armadillo species, ranges from northern Venezuela (east of the Andes) and the Guianas (French Guiana, Guyana, and Suriname), south to Paraguay, and northern Argentina. Although widespread, *Priodontes maximus* is listed as Vulnerable since it is rare over its entire range. Population decline of *Priodontes maximus* is based on habitat loss and hunting.

Myrmecophaga tridactyla (Giant Anteater) is listed as Vulnerable. The species is widespread geographically, but there have been many records of population extirpation, especially in Central America (where it is considered the most threatened mammal) and the southern parts of its range. The dietary specificity, low reproductive rates, large body size, along with threats to habitat degradation in many parts of its range, have proved to be significant factors in its decline. The Giant Anteater is native to the following countries: Argentina; Brazil; Colombia; Ecuador; French Guiana; Guyana; Honduras; Nicaragua; Panama; Paraguay; Peru and Suriname.

Tapirus terrestris (Lowland Tapir) is found in lowland regions of northern and central South America, from Argentina, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Paraguay, Peru,

Suriname, and Venezuela. This species is considered Vulnerable due to an ongoing population reduction as a result of habitat loss, illegal hunting and competition with livestock. The Lowland Tapir populations seem unlikely to persist anywhere humans occur at densities any greater than 1/km^2. Even where habitat remains, populations are reduced and dispersed because of hunting. This is greatly amplified around increasing human populations and settlements within its habitat range.

Ateles pansicus (Guiana Spider Monkey) occurs in primary high forest, and seldom found in edge or degraded forest. In Guyana, it is known from the far south and from the east of the Essequibo River. *Ateles paniscus* is Vulnerable due to habitat loss caused by expanding agriculture, ranching, mining, hydroelectric and associated road construction, which contributes to heavy hunting pressure.

Tayassu pecari (White-lipped Peccary) is classified as Vulnerable on the IUCN Red List. This species is found in lowland forest from southeastern Mexico in the north, through Central America and northern and central South America, as far south as Entre Rios in northern Argentina and Rio Grande do Sul in southern Brazil. Widespread and continued deforestation and intense hunting pressure are the main causes for the decline and extinction of many White-lipped Peccary populations throughout its vast biogeographical range. White-lipped Peccaries form large herds and consequently require extensive and contiguous areas of habitat to obtain sufficient resources throughout the year.

Birds

According to BirdLife International (2020), there are 16 threatened bird species that are known to occur in Guyana. Of these, 3 species are listed as Endangered (EN): Sun Parakeet (*Aratinga solstitialis* - is restricted to dry, semi-deciduous forests on the slopes of north and north-eastern Roraima); the Great-billed Seed-finch (*Sporophila maximiliani* - occurs in riparian thickets, freshwater marshes/wetlands, second-growth scrub and shrubland/grassland savanna habitats) and the Red Siskin (*Spinus cucullatus* – is known to occur in southwestern Guyana between 100-1,500m moving semi-nomadically and altitudinally (seasonally and daily) between moist evergreen forest, dry deciduous woodland and associated edge habitats, shrubby grassland and pastures).

Two species are listed as Critically Endangered (CE): the Hoary-throated spinetail (*Synallaxis kollari* – is known to occur in the upper Rio Branco in north Roraima of Brazil and adjacent Guyana in seasonally flooded riverine forest with an understorey of dense thickets and vines - suitable habitat is restricted to within 0.5 km^2 of the rivers), and the Rio Branco Antbird (*Cercomacra carbonaria* - is limited to middle sections of the Rio Branco and some of its tributaries in Roraima, extreme north Brazil, and adjacent Guyana. It ranges from Caracarai in the south, along the Rio Branco and Rio Takutu to the Ireng River in Guyana, less than 2 km from its confluence with the Rio Takutu). None of the EN or CR birds that are known to occur in Guyana were recorded or are known to occur within the project development areas.

Five bird species recorded during the surveys are listed as Vulnerable (VU). These species are the Black curassow (*Crax alector*), Gray tinamou (*Tinamus tao*), Channel-billed toucan (*Ramphastos vitellinus*), Yellow Ridged Toucan (*Ramphastos culminatus*) and the Red-Billed/White-throated toucan (*Ramphastos tucanus*).

The Black Curassow (*Crax alector*) is extant in Brazil, Colombia, French Guiana, Guyana, Suriname and Venezuela. *Crax alector* is described as ‘fairly common’ and inhabits humid "terra firme" (without flooding) and gallery forest, often being seen in open habitats such as old plantations, but preferring thickets along rivers or forest borders. *Crax alector* is listed VU based on a model of future deforestation in the Amazon basin, and its susceptibility to hunting and trapping. Large under-story birds, such as the Black Curassow and other cracids (Cracidae) and Trumpeters (Psophiidae), are sensitive to major habitat changes which will arise when mining commences. Elsewhere in the Guianas they have been decimated by unrestricted hunting (Ridgley and Agro 1998).

The Gray tinamou (*Tinamus tao*) is extant in Bolivia, Plurinational States of Brazil, Colombia, Ecuador, Guyana, Peru and Venezuela. *Tinamus tao* is described as 'uncommon' and is found in a range of forest types, including rainforest in the Andes, dense secondary forest throughout in Brazil and cloud forest in Venezuela. *Tinamus tao* is listed as Vulnerable based on a model of future deforestation in the Amazon basin, the species' sensitivity to habitat fragmentation and disturbance and its vulnerability to hunting.

The Channel-billed toucan (*Ramphastos vitellinus*) is extant in Brazil, Colombia, French Guiana, Guyana, Suriname, Trinidad and Tobago and Venezuela. It is 'fairly common' within its range and inhabits forested lowlands, most often near water, forest edge, swamp forest, clearings, riverine forest, patches in savannas and much less common in secondary and selectively cut forest. The primary threat to this species is accelerating deforestation in the Amazon basin and hunting pressure.

The Red-billed/White-throated Toucan (*Ramphastos tucanus*) is extant in Brazil, French Guiana, Guyana, Suriname and Venezuela. It is 'common' within its range and inhabits lowland tropical forest, especially old riverbeds, late stage successional forest, and mature forest near water. Also forages in secondary forest, edges, clearings, forest patches, pasture trees, plantations, gardens, mangroves in Guyana. The *Ramphastos tucanus* is listed Vulnerable based on a model of deforestation in the Amazon basin, and the species' susceptibility to hunting.

The Yellow-ridged Toucan (*Ramphastos culminatus*) has an extensive range across much of Amazonia. The primary threat to this species is accelerating deforestation in the Amazon basin as land is cleared for cattle ranching and soy production, facilitated by expansion of the road network, and as a result of hunting pressure.

Reptiles

Echinosaura sulcarostrum is listed by IUCN as Endangered. *Echinosaura sulcarostrum* was recorded during the surveys of the project development areas. This semi-aquatic/riparian Gymnopyhalmid lizard species was first described by Donelly *et al.* (2006) in 1992 at Baramita, Northwest District, at elevation 100 m. According to Donelly *et al.,* (2006), the *E. sulcarostrum* species is known to occur on the Atlantic versant of the Guiana Shield.

E. sulcarostrum species is also known from Mount Wokomung, Guyana (Cole *et al*. 2013). According to Ouboter & Hoogmoed (2017) this species likely occurs between the Baramita and Mount Wokomung localities, and probably more widely as this recently-described species is very poorly known. The extent of occurrence based on known records is estimated to be approximately 1,250 km^2, based on the sites being 250 km apart and a polygon width of 5 km, however the distribution of this species is almost certainly incompletely known and an accurate estimate of extent of occurrence cannot more accurately be derived from only two localities.

There is no information on the population status of *E. sulcarostrum*. It is a small species that occurs in a very poorly-surveyed area of Guyana; while it was described in 1992, it was only recorded from the second locality - Mt. Wokomung in 2004, where it was represented by a single specimen. Specimens collected in Baramita and during the survey at Matthew's Ridge were in leaf litter under high canopy evergreen lowland forest on wet clayey soil near slow flowing black water creeks. The Baramita locality where the species was first recorded is near the village, with both agricultural and mining activities, although there was plenty of relatively undisturbed habitat when this locality was surveyed in 1992.

The southern (Mount Wokomung) locality is more remote with little human impact at this locality in 2004 and favourable habitat was abundant. Figure 11-14 depicts the known geographical range of the *E. sulcarostrum* within Guyana.

E. sulcarostrum is listed as EN because the extent of occurrence is approximately 1,250 square kilometers, the species is (previously) known from two locations, and the habitat at one location is subject to ongoing decline in quantity and quality as a result of gold mining activities. The Matthew's Ridge record represents a third known locality. Manganese mining and exploration activities have been in existance since the early 1970s. Historical and ongoing human activities within Matthew's Ridge, have modified the primary ecological functions and species composition of habitats. Biodiversity resident within the project landscape are, therefore, habituated to the constantly changing and human-influenced environments. Ongoing project development activities are not expected to significantly transform exisitng habitats and or affect the longterm survivability of *E. sulcarostrum.*

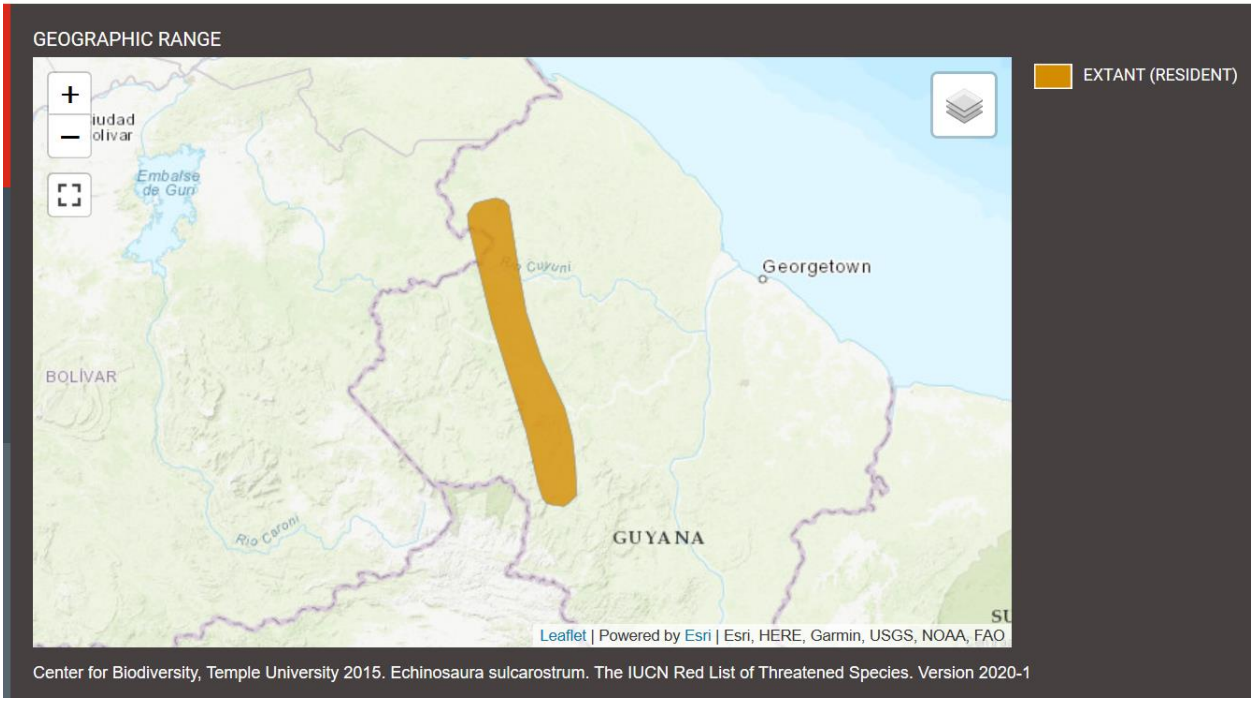


Figure 12-14: The Geographical Range of the *E. sulcarostrum* in Guyana

The Yellow-footed Tortoise (*Chelonoidis denticulata*) is listed as Vulnerable. It occurs in Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, Trinidad & Tobago, Venezuela, and Bolivia. This tortoise is still commonly encountered in Guyana (see Kok and Kalamandeen, 2008; Smithsonian Institute, 2000; Donnelly *et al*., 1998; Senaris *et al*. 2008); whereas elsewhere in the region they have been unsustainably harvested for their meat and are less frequently encountered.The yellow-footed tortoise is a food source for the local people and indigenous communities in the region.

Amphibians

There are no CR or EN amphibians known to occur in Guyana. *Atelopus spumarius* (Pebas Stubfoot Toad) recorded during the 2012 survey within Matthew's Ridge is a locally abundant amphibian species and is known to occur in the Amazonian lowlands of Colombia, Ecuador and eastern Peru, to Amazonas, Pará, Amapá (Brazil), and the Guianas. It ranges from sea level to 600 m above sea level. This species is listed as Vulnerable, Population Trend - Stable in the IUCN Redlist (Azevedo-Ramos *et al*. 2010). *Atelopus spumarius* is listed as Vulnerable because of a projected population decline, estimated to be more than 30% over the next ten years, inferred from declines in other Atelopus species in the same region. Threats to *Atelopus spumarius* include forest loss due to agriculture, and logging and clear cutting, especially in eastern Amazônia. It occurs below the altitude at which chytridiomycosis is normally a problem, but declines have nevertheless taken place elsewhere.

Fish

Guyana has no listed CR or EN terrestrial or freshwater vertebrates. The only fish and non-avian vertebrates listed as CR or EN for Guyana are marine species that are not known to occur within the project development landscape.

Summary

Despite their listing on the IUCN Red List, evidence supported by several surveys suggests that the threatened species recorded within project development landscape are found widespread in healthy populations throughout their ranges in Guyana. In 2009, the Zoological Society of London conducted a biodiversity assessment of the Head of the Rewa River in southern Guyana. Their survey documented a high density of the threatened faunal species recorded within the project development landscape within the Rewa area. Similarly, in 1998, studies conducted within the Iwokrama Forest of central Guyana indicate that the Iwokrama forest supports healthy populations of the threatened faunal species.

Additionally, historical and ongoing human activities within the project development landscape, including the proposed shipping route of the project within the BMP have modified the primary ecological functions and species composition of habitats, resulting in habitat loss and species displacement. Biodiversity resident within the project landscape are, therefore, habituated to the constantly changing and human-influenced environments of the landscape. Consequently, ongoing project development activities are not expected to significantly transform existing habitats and or affect the long-term survivability of threatened species of the project landscape.

12.2.3.3.2 Endemic/ Restricted Range Species

There is no clear picture of endemism in Guyana. Guyana is no phytogeographic entity in itself but is part of the Guiana Shield region. Local plant endemism is often associated with such habitats as white sands, serpentine rock, swamps, igapo, verzea, rock outcrops and cloud forest (Gentry, 1992). As such, concentrations of endemics in Guyana can be expected in the white sands area and the Pakarima Highlands (Steege, 2000).

The Guiana Shield has a variety of landscapes scattered throughout the region and includes sandstone tepuis, granite inselbergs, white sands, seasonally flooded tropical savannas, lowlands with numerous rivers, isolated mountain ranges, and coastal swamps, each supporting a characteristic vegetation (Huber et al., 1995, Huber, 1995b). The highlands of the Shield have flora and fauna with numerous endemic species. Some tepui endemic species occur at elevations as low as 300 m, with increasing numbers at elevation of 1500 m to 1800 m, and fully developed communities occurring above elevation 2000 m (Funk and Berry, in press). While there are a number of terrestrial vertebrate species that are broadly endemic to the Guiana Shield region, none of the Guiana Shield endemics or the Guyana lowland endemics that are known to occur within the project development landscape have ranges that can be considered restricted.

The project development landscape is located in the tropical lowland moist forest of north western Guyana with elevations ranging between 10 m – 250 m. According to Steege (2003), the lowland rain forest on brown sandy soils, loams, or laterites is the major vegetation type of the Amazon Valley and the Guiana Shield. This lowland eco-region is biogeographically distinct from the Guiana Shield Highland centers of endemism. The Guiana Shield Lowland forest fauna is shared with other lowland eco-regions of the Amazonia Basin.

Plants

Catostemma commune (Baromalli) is the only (Guiana Shield) endemic species recorded within the in the project development areas of Matthew's Ridge and Port Kaituma. According to Huber (1995), the dry land forest of the Northwest District of Guyana and eastern Venezuela are characterized by a high abundance of *Catostemma commune* and other species such as *Eschweilera sagotiana, Alexa imperatrics, Protium decandrum*, and Licania spp. *Catostemma commune* species is found abundantly in almost every dry land forest type in the Northwest District region of Guyana (Huber, 1995). *C. commune* is frequent to abundant in mixed forest and mora forest and occurs principally in the Essequibo and Cuyuni River Basins (Steyermark, 1987). Catostemma commune is listed as Least Concern (LC) by the IUCN Red List.

Non-volant mammals

According to Lim *et al*. (2005), there are fifteen mammalian lowland endemic species of the Guiana Shield Region, five of which have restricted distribution occurring in areas outside of Guyana. The others are found throughout the Guiana Shield and include: *Didelphis imperfect, Monodelphis brevicaudata, Lophostoma schulzi, Neacamys guianae, Lasiurus atratus, Neacamys paracou, Oecomys auyantepui, Ateles paniscus, Oecomys rex, Oecomys rutitus, Sphiggurus melanura, Proechimys hoplomyoides, Isothrix sinnanmariensis, Pithecia pithecia.*

Two of the species recorded during the 2012 surveys, *Pithecia pithecia* (White-faced Saki Monkey) and *Ateles paniscus* (Guiana Spider Monkey) are lowland Guiana Shield endemics with widespread distributions. *Pithecia pithecia* (White-faced Saki) is listed as LC while the *Ateles paniscus* is VU.
The *Ateles pansicus* (Black Spider Monkey) occurs in primary high forest, and seldom found in edge or degraded forest. In Guyana, it is known from the far south and from the east of the Essequibo River (Sussmann and Phillips-Conroy 1995). *Ateles paniscus* is threatened due to habitat loss caused by expanding agriculture, ranching, mining, hydroelectric and associated road construction, which contributes to heavy hunting pressure. *Pithecia pithecia* is herbivorous and insectivorous and has been reported to thrive well in degraded forests. The habitat range of these species extend beyond the project development areas and by extension the northwest wet forest region.

Bats

The Checklist of the Terrestrial vertebrates of the Guiana Shield identified 3 bat species that are specifically endemic to Guyana. These are *Eptesicus andinus* from the family Vespertilionidae, *Eumops bonariensis* and *Molossus*, both from the family Molossidae (Hollowell and Reynolds, 2005). None of these bats were recorded within the project development areas during the surveys. The bat *Lophostoma schulzi* was recorded during the surveys is geographically restricted to the Guiana Shield. This species is known from the Guianas and northern Brazil (Sampaio *et al.,* 2008) and is native in Brazil, Guyana, French Guiana and Suriname. *Lophostoma schulzi* is listed as LC.

Birds

Based on Braun's (2000) endemism classification system, the Rufous-throated Antbird (*Gymnopithys rufigula*), Brown-bellied Antwren (*Myrmotherula guttata*), White-fronted manakin (*Pipra serena*), Tiny-Tyrant Manakin (*Tyranneutes virescens*), Black-throated Antshrike (*Frederickena viridis*), Caica Parrot (*Gypopsitta caica*) and White-Throated Manakin (*Corapigo gutturalis*) recorded during the surveys are restricted to the Guianas and adjacent Venezuela and Brazil. Four species recorded during the surveys are restricted to the Amazonian (and Guianan) lowlands north of the Amazon. These are the Black-headed parrot (*Pionites melanocephala*), Black Curassaw (*Crax alector*), Spot-tailed Antwren (*Herpsilochmus sticturus*) and Silvered-beak tanager (*Ramphocelus carbo*).

Amphibians

Most of the Guiana's endemic amphibians are largely restricted to the Guyana Shield Highlands, generally strongly associated with the Tepui formations (Senaris and Mac Culloch, 2005). Some amphibian endemics occur at relatively low elevations, and these tend to have wider distributions than do highland endemics. Amphibian species endemic to the Guyana Lowlands are; *Stefania evansi*, endemic to Guyana at 20 to 890 meter elevations; and *Anomaloglossus kaiei*, endemic to Guyana at 150 to 900 meter elevation. None of these species were recorded during the surveys of the project development areas.

Reptiles

As is the case with other vertebrate fauna, most of the endemic reptiles are restricted to highland areas (Senaris and Mac Culloch, 2005). None of the reptilian species recorded during the surveys are known to be endemic or range restricted within the project development areas.

Fish

According to an updated list of freshwater fish species endemic to Guyana by Vari *et al*., (2009), a total of eighty-four (84) freshwater fish species are endemic to Guyana. The majority of the listed species are found in the highlands of the Guyana Shield, especially in the Potaro River basin, or in the Rupununi Savannas Region. Review of this list against the fish species recorded during the surveys of the project development areas revealed one fish species endemic to Guyana: *Anablepsoides* (*Rivulus) waimacui.*

Macro-invertebrates

The biodiversity of the invertebrate communities of the Guiana Shield region is extremely poorly known (Lavelle, 2003). The invertebrate Orders Hymenoptera (Family-Formicidae, ants); Lepidoptera (butterflies); and Opisthopora (earthworms) are estimated to have high endemism within the Guiana Shield Region (Lavelle, 2003). Earthworms were estimated to exhibit a very high degree of endemism as depicted in Table 12-18. According to Lavelle (2003), many species of the invertebrate groups exhibiting extremely high rates of endemism are likely to disappear from areas as deforestation progresses and endemic species are largely eliminated.

Table 12-18: Estimated Species Richness in Eight Groups of Invertebrates in the Guiana Shield Region

Taxa	World	Guiana Shield (Expected)	Endemic (Estimated)	Endangered
Order Lepidoptera: Family Sphingidae (hawkmoths)		95	16	No Data
Family Apidae: Genus Meliponinae (Stingless bees)	500	90	10	No Data
Oder Hymenoptera: Family Vespidae (Social Wasps)	1000	200	12	No Data
Order Isoptera (Termites)	400	225	10	No Data
Order Hymenopers: Family Formicidae (ants)	7000	1500	300	No Data
Order Lepidoptera (Butterflies)	15000	1500	150	20
Order Odonata (Dragon Flies)	5600	240	No Data	No Data
Order Opisthopora (Earthworms)	7000?	2000	1900	Many

Source: Adapted from Lavelle, 2003.

Summary

The project development landscape forms part of the lowland forest ecosystems typical of the lowland forest habitats of the national forest regions and is part of the lowland forests of the Guyana Shield Region and the Amazon Basin. Even though these lowland forested areas may have heterogeneity in the nature of soils, they are present across the lowland forests of the national forest regions and therefore do not have significant transitional habitats that may have potential importance for key evolutionary processes such as speciation. Moreover, while there are a number of terrestrial vertebrate species that are broadly endemic to the Guiana Shield region, none of the Guiana Shield endemics or the Guyana lowland endemics that are known to occur within the project development landscape have ranges that can be considered restricted.

Unlike the Guiana Shield Highlands centres of endemism occurring at elevations of 1500 meters or more, the lowland forest habitats of the project development landscape are characterized by biota that is widespread throughout the Guiana Shield and Amazonia lowlands. As a result, there are no ecological features/functions or ecosystem services characteristic of the project development landscape that are not replicated across the Guianas and Amazonia lowlands.

12.2.3.3.3 Migratory Species

The Barima and Kaituma Rivers serve as the major rivers draining the project development landscape. These rivers form part of the river system that drains the Northwest District of Guyana. Unlike the Essequibo River drainage basin, the river system of the Northwest District is not known to serve as a major biological corridor for aquatic species. The Essequibo drainage basin is seasonally linked to the Amazon drainage when the flooded savannas of the Rupununi form a continuous expanse of water between the tributaries of the Rio Branco and the Rupununi River (Watkins *et al*., 2004). The Cuyuni, Mazaruni, Potaro, and Siparuni River Basins connect the Amazonia aquatic systems via the Essequibo River, thereby serving as biological corridors linking to the Amazon Basin. Unlike the river basins which connect to the Essequibo drainage, the Barima and Kaituma Rivers are not connected to the Amazonia aquatic ecosystems and does not form part of any known migratory pathway for fish species and aquatic biota.

The interior lowlands of Guyana are not known to be critical habitats for migratory species. Unlike the Atlantic Coastline of the Northwest District of Guyana (Shell Beach Protect Area), which supports the nesting and foraging grounds of migratory sea turtles and birds such as the Scarlet Ibis (*Eudocimus ruber*), the project development landscape does not include any significant habitat areas known to assemble migratory terrestrial species.

12.3 Impact Assessment – Biological and Ecological Resources

Manganese mining and exploration has had a long history within the AoI. Manganese occurrences were first identified in Guyana's North West District in 1902, mainly at locations identified at Matthew's Ridge, Arakaka and Pipiani. As a consequence of the historical and ongoing human activities within the AoI, the primary ecological functions of the habitats within the project landscape have been modified, resulting in habitat loss and species displacement. Biodiversity resident within the AoI of the project are, therefore, habituated to the constantly changing and human-influenced environments.

The AoI comprises degraded forest characterized by secondary growth forest. The habitats of the Matthew's Ridge mining and plant sites are considered 'brownfield sites' and are characterized by secondary growth vegetation. Beyond the footprint and buffer of the mine, plant site, building and road areas the secondary vegetation is followed by more mature forest which, shows signs of the impact of small-scale timber harvesting, subsistence farming and transient homesteads. The site of the proposed Port Kaituma manganese storage and wharf facility is characterized by secondary growth

vegetation on the Kaituma canal's artificial levee formed originally by the dumping of dredge spoil created during the making of the canal. Small unregulated homesteads of varying design and quality are present on both sides of the canal to the Port Kaituma landing.

12.3.1 Potential Impacts during the Construction Phase

Project construction activities will entail the re-establishment of disused and degraded mine infrastructure including mine roads, pit benches, stockpile areas for ore and concentrate, mine administration and facility buildings; water retention sites and dam structures; the building of a completely new processing plant; the construction of an upgraded road profile to move processed concentrates from the Matthews's Ridge process plant to a new storage and wharf facility on the Kaituma Canal; and the dredging on the Kaituma Canal for wharf construction. The impacts on the biodiversity component of the AoI from project construction activities are assessed below.

12.3.1.1 Vegetation

Land clearing activities during project construction will result in the loss of habitat and vegetation cover. Land clearing of predominantly secondary growth vegetation will be undertaken primarily for the creation of the new storage and wharf facility on the Kaituma Canal, and the footprint area of the mine.

Land clearing in areas identified for upgrade works such as the existing mine roads, overburden storage, the mine tailings and waste rock disposal areas will be confined to the existing footprint of these areas, which does not include the current extent of mature forest of the AoI. Land clearing of mature forest will be limited to the new 9.7 kilometers roadway of a maximum width of 8 metres from Port Kaituma to the new storage and wharf facility on the right bank of the Kaituma Canal.

The loss of predominantly secondary growth vegetation from land clearing activities pose **negative, direct, long-term and localised** of **minor significance** but are **certain** to occur. These impacts present a **Medium Risk**. Though land clearing will entail the loss of some secondary growth vegetation within the project construction footprint, these plants are prevalent and widespread in the immediate surrounding landscape of the impacted areas of the project. Plant species that will be impacted by land clearing are predominantly remnant vegetation and are not species of special conservation interest.

Vegetation clearing in mature forests areas, though limited to the footprint of the new access road from Port Kaituma to the new storage and wharf facility will create new forest edge. The creation of new forest edge may increase the vulnerability of in-tack mature forest to edge effects. Though the formation of the edge effect will be beneficial to some species such as forest edge specialists and early successional species, these conditions can reduce the floristic structure and composition in the affected areas of mature forest. This impact is anticipated to pose **negative, direct, long-term and localised** of **moderate significance** but are **certain** to occur. These impacts present a **High Risk**.

Vegetation clearing even in areas with predominantly secondary growth vegetation will result in the loss of natural habitat and the intensification of habitat fragmentation. Habitat fragmentation may potentially result in the creation of weaker ecological sub-units and may make the ecosystem of the impacted area as a whole, more vulnerable to invasion and degradation. This impact is **negative, direct, long-term and localised** of **minor significance** but are **certain** to occur. These impacts present a **Medium Risk**.

Additionally, most animal species follow established patterns in their daily and seasonal movements. The areas through which animals travel on their way to and from feeding, breeding and birthing grounds, and between their seasonal ranges, are known as corridors. The riparian vegetation along the rivers and streams within the project impacted areas and the AoI is considered an important wildlife

corridor that provides a stabilizing shelter for semi-aquatic fauna particularly small birds and mammals, and serves as a nutrient-rich food source for their prey. Consequently, the preservation of vegetation will be necessitated in areas not earmarked for project development, particularly in riparian areas along streams and rivers, including the aquatic habitats sheltered by riparian vegetation. The loss of vegetation cover along the riparian habitats is expected to be **negative, direct, long-term and localised impacts** of **moderate significance** but are **certain** to occur. These impacts present a **High Risk**.

Small amounts of clearing of secondary growth vegetation will be undertaken within the area of the tailings pond as part of the rehabilitation of the facility. The tailings area will be scraped of topsoil material, grasses and trees as part of the preparation process for the facility to receive tailings, mainly as a measure to mitigate changes in the water (nutrient) quality of the tailings pond during operation that could lead to the formation of a lentic environment. If left in place, dead and decaying vegetation and organic material within the tailings pond can be a source of nutrients, and the excessive proliferation of methane, resulting in water quality impacts and the formation of a lentic environment within the facility. This impact is anticipated to pose **negative, direct, short-term and localised impacts** of **moderate significance** but are **unlikely** to occur. These impacts present a **Medium Risk**.

The loss of cover vegetation may also result in the depletion of soil nutrients from enhanced leaching, occasioned by clearing, and the washing away by surface runoff during rains. This may cause plant regeneration to be affected in the impacted area if not effectively managed. The absence of nutrients may result in the proliferation of aggressive successional vegetation consisting mainly of grass species. The proliferation of aggressive grass species can effectively prevent seed-bearing plants from finding satisfactory living conditions. These grasses can, however, serve as a significant food source for habituated fauna. The potential depletion of soil nutrients from enhanced leaching, occasioned by clearing impact is anticipated to present **negative, direct, long-term and localised impacts** of **moderate significance** which are **likely** to occur. These impacts present a **Medium Risk**.

The removal of vegetation cover and excavation activities may result in the increase of sediment loads to receiving water bodies from eroded soil run-off during rain events resulting in the changes in water quality and increase turbidity. Changes in the water quality may result in temporarily reduce habitat quality for aquatic organisms, in turn resulting in the changes in the aquatic ecology and floristic composition of the receiver. Turbidity increases could impede light penetration of receivers, resulting in the exacerbated growth retardation and or the die off of aquatic vegetation, particularly within receivers presently affected by high turbidity levels from ongoing human activities within the AoI.

Similarly, the loss of vegetation cover may also result in increases of nutrient loads in receiver water bodies from surface run. Increases in nutrient loads could promote the proliferation of primary producers and lead to eutrophication and algal blooms. Algal blooms can disrupt normal ecosystem functioning of the receiver and cause problems such as oxygen depletion and the blocking of sunlight for submerged plants. This will eventually lead to the death of aquatic organisms including vegetation. The potential increase of sediment and nutrient loads in receiver water bodies from the loss of vegetation cover is expected to pose **negative, direct, long-term and localised impacts** of **moderate significance** which are **likely** to occur. These impacts present a **Medium Risk**.

12.3.1.2 Terrestrial and Aquatic Fauna

Historic and current human activities within the AoI of the project have altered the primary ecological functions of the area, which has resulted in the fragmentation and loss of natural habitats. Biodiversity of the project AoI are, therefore, habituated to the constantly changing and human-influenced environments of the project landscape. As a consequence, ongoing project development activities are not expected to significantly transform existing habitats and or affect the long-term survivability of species within the project landscape.

Vegetation clearing in mature forests areas, though limited to the footprint of the new access road from Port Kaituma to the new storage and wharf facility, may result in a barrier to the dispersal and movement of some animals. The barrier effect may be further intensified if road construction and expansion clearing create a berm or barrier of a mix of vegetation waste and surplus soil parallel to cleared area. The intensification of the barrier effect will add additional stress and restrictions on the movement of less mobile species. The Guianan spider monkey (*Ateles paniscus*) is very much a canopy species, rarely venturing to the understory or ground. As such, movements of local social groups may be constrained by logging road construction and their territories fragmented if the canopy cover above the road is removed since individuals will not be able to move easily between forests fragments. Barriers to animal dispersal may also have localised consequences on the processes of pollination, seed dispersal and herbivory, resulting in changes in the structure, and floristic and faunal diversity in areas near to the cleared band. This impact is anticipated to be **negative, direct, long-term and localised impacts** of **moderate significance** and **likely** to occur thereby posing **Medium Risks**.

Ongoing project development activities, vegetation clearing and habitat loss will result in some mortality of terrestrial vertebrate species, particularly species with reduced movement capabilities such as herpeto-faunal species and invertebrates. Only temporary and/or localised displacement of birds and small mammals and aquatic fauna is, however, expected due to their high mobility and the availability of alternative areas of similar suitable habitat types adjacent to the project AoI.

Resident fauna, particularly small and medium sized mammals will move to adjacent habitat areas to avoid construction impacts, while species habituated to existing conditions such as resident birds and aquatic fauna and their predators may easily adapt to and thrive successfully during project construction owing to their ability to adapt well to human altered environments.

Habitat loss and displacement impacts will extend to benthic fauna in areas where river dredging is anticipated. Impacts to benthic fauna will similarly be limited to the relatively small riverbed areas of the Kaituma Canal as compared to the vast areas of available riverbed habitat that will be left untouched by dredging activities during construction. Riverbed areas affected by dredging are expected to recover and normalize within the short term. The impacts of nabitat loss and displacement impacts on terrestrial and aquatic fauna are **negative, direct, short-term** and **localised** of **negligible significance** and **likely** to occur. This impact is expected to be **Low Risk**.

The areas through which animals travel on their way to and from feeding, breeding and birthing grounds, and between their seasonal ranges, are known as corridors. If the new project infrastructure, such as the new road from Port Kaituma to the Kaituma Marine Terminal, newly laid culverts and or bridges, intersect or block wildlife corridors, animals may cease use of corridors.

Construction of surface water flows at culverts and other road crossings may potentially create currents too fast for some fish species to survive, and if blocked fish will no longer be able to undertake longitudinal access to first order streams, resulting in the reduction of access to suitable spawning habitat, reduced spawning success and the modification of migration patterns. The riparian vegetation along the creeks and river crossings at the intersections of road infrastructure are important wildlife corridors for the animal species particularly for small mammals, aquatic and semi-aquatic vertebrates. Impacts resulting from the potential blocking of wildlife corridors are anticipated **negative, direct, long-term** and **localised** of **moderate significance** and **likely** to occur thereby posing **Medium Risks**.

The removal of vegetation cover may result in the increase of sediments being transported to receiving water bodies from eroded soil run-off during rain events resulting in the changes in water quality and increase turbidity. Changes in the water quality may result in temporarily reduced habitat quality for aquatic organisms, in turn resulting in temporary changes in the aquatic ecology. There may also be

increases in the nutrient load from the deposition of eroded materials into receiving water bodies. Increases in nutrient loads could promote the proliferation of primary producers and lead to eutrophication and algal blooms. Algal blooms can disrupt normal ecosystem functioning of the river and cause many problems such as oxygen depletion and the blocking of sunlight for submerged plants. This will eventually lead to the death of aquatic fauna. It is expected that most aquatic fauna will be able to avoid these impacts by moving to areas with better conditions. These impacts are expected to be **negative, direct, long-term** and **localised impacts** of **moderate significance** and **likely** to occur thereby posing **Medium Risks**.

The physical disturbance and noise produced by equipment may impose additional stresses upon wildlife and may lead to increased migration away from impacted areas. While disturbances may be stressful for some wildlife, other species may easily adapt to and thrive successfully in the area owing to the phenomenon of habituation. These impacts are **negative, direct, long-term** and **localised impacts** of **negligible significance** and **likely** to occur. This impact is expected to be **Low Risk**.

During construction there could be the possibility of hydrocarbon contamination of the aquatic systems from accidental spills of lubricants and fuel and other contaminants. Hydrocarbons introduced into aquatic environments may change aquatic plant and animal growth, mortality and communities. Contaminants entering the aquatic systems could be ingested by aquatic organisms causing reproductive impairment, stunted growth, and other physiological effects. Also, as contaminants naturally break down, they use dissolved oxygen, sometimes significantly reducing the dissolved oxygen content of the water, which could reduce the overall habitat suitability for many aquatic organisms. These impacts are expected to be **negative, direct, short-term** and **localised impacts** of **major significance** and **likely** to occur thereby posing **High Risks**.

The presence of workers and work camps during construction may promulgate the presence of domestic and synanthropic species during construction. An increase in these species may affect native species by acting as predators, competitors and disease vectors. Synanthropic species such as mice and rats tend to increase due to the availability of food from worker camps. Predator and scavenger species may also be attracted to the site for fleeing or dead animals. These impacts are **negative, direct, short-term** and **localised impacts** of **negligible significance** and **likely** to occur. This impact is expected to be **Low Risk**.

Traffic along roads can affect wildlife directly, by collision, or indirectly, by disturbance. Jaguars, peccaries and tapir actively use small roads and are known to have been killed in Guyana though collision with vehicles. Animal species not adapted for rapid movement on the ground across open spaces are particularly vulnerable e.g. sloths. Human-wildlife conflicts often increase during road construction and operation. Roadkill of wildlife may be prevalent if drivers and vehicle users are not educated on cautionary driving to prevent road accidents with wildlife. Hunting and gathering of wildlife by workers may occur if not strictly managed. These impacts are expected to be **negative, direct, short-term** and **localised** of **moderate significance** and **likely** to occur thereby posing **Medium Risks**.

12.3.2 Potential Impacts during the Operational Phase

Project operation will entail the activities related to mining and processing of manganese ore, including, overburden removal and the retrieval of ore, the extraction of water from the Pakera Lake for processing, crushing and washing of ore, tailings deposition to the tailings pond, the storage and trucking of manganese ore concentrate to the Kaituma Marine Terminal and the marine transport of manganese ore concentrate by barge from Port Kaituma to Trinidad via barges and tug boats. The impacts on the biodiversity components of the AoI from project operation activities are assessed in the sections below.

12.3.2.1 Vegetation

The deposition of tailings to the tailings pond during mine operations will likely cause a rise in the ground water level/table in surrounding areas, which may lead to the creation of a swamp/wetland habitat with ensuing changes to the micro-climate of the pond edges. The creation of a new wetlands maybe positive in terms of enhancing overall biodiversity. However, the environmental change if it occurs will be long term and may have a direct impact on the vegetative structure of the affected area in that it may facilitate the proliferation of vegetation more adapted to abiotic conditions. This impact is, however, expect to be medium risk and will be confined to the areas of the pond edges. The magnitude or size of the created wetland will be a function of the surface topography in and outside of the tailings pond boundary and the permeability of soils immediately outside of the pond. These potential impacts are expected to be **negative, direct, long-term** and **localised** of **moderate significance** and **likely** to occur thereby posing **Medium Risks**.

Processing water for ore processing and power plant engine cooling will be extracted from the Pakera Lake via the dam intake structures. The withdrawal of water from the Pakera Lake may become a concern if the rate of withdrawal exceeds the rate of natural replenishment, especially during the dry seasons. Intensive extraction of water from the pond may induce water stress in the ecosystems of the pond and the adjoining Pakera Creek beyond their natural variability when ecosystem needs are not met. Water stress induced changes may include changes in quantity (over-exploitation and altered flow regimes) and quality (excess nutrient, pollution and less biodiversity). These changes could lead to significant increases in algal biomass and metabolism, reduced invertebrate richness, abundance and density, and organic matter decomposition with ensuing changes in the vegetative structure and habitats of the pond and creek. The magnitude of significant effects will be dependent on the rainfall regime, period of the year, the size of the pond and the rate of natural replenishment of the Pakera Creek. GMI intends to reduce, or even cease production activities during the dry season to maintain the equipment and focus on the transportation of ore from Matthew's Ridge to Port Kaituma. Potential impacts from the intensive extraction of water from the Pakera Lake are expected to be **egative, direct, long-term** and l**ocalised impacts** of **major significance** and **unlikely** to occur thereby posing **Medium Risks**.

Traffic on the access road during the operation phase would impact the early succession/edge and secondary forest habitats located along this road by increasing dust, which will settle on vegetation. Dust accumulation on plants has been found to impair biological functions including metabolism and photosynthesis, stunt growth, make them more susceptible to disease, and even cause mortality. Given the limited geographic scope of this impact, the potential impacts of dust accumulation on plants are expected to be **negative, direct, long-term** and **localised impacts** of **negligible significance** and **certain** to occur. This impact is expected to be **Low Risk**.

12.3.2.2 Terrestial and Aquatic Fauna

The rehabilitation and creation of the tailings' impoundment dams will encompass several streams containing fishes. The footprint of the mine pits is also highly likely to encompass several streams. Fish likely to be trapped within the tailings impoundment is expected to remain in the pond. Process discharge to the tailings pond is unlikely to meet surface water quality standards. Fishes trapped within the impoundment created for the tailings' pond will be impacted by the impaired water quality.

The impaired water quality in the pond will result in a direct, permanent loss of aquatic habitat within these pond and loss of aquatic fauna and degradation of aquatic habitats and water quality. Process discharge to the pond will contain sediments which will result in decreased transparency and a reduction of light available to aquatic plants, a primary food source for aquatic organisms. Further, the suspended sediment will ultimately settle onto instream habitat features (e.g., downed wood, gravel, etc.) or the bottom substrate causing embeddedness, which will decrease the value of instream habitat

for macroinvertebrates and fish. These impacts are expected to be **negative, direct, short-term** and **localised** of **minor significance** but **certain** to occur. These impacts pose a **Medium Risk**.

River transport activities of the project will involve the operation of three barges and tugboats to transport manganese concentrates from the Kaituma Marine Terminal to international markets via the Kaituma River, and Mora Passage. The Kaituma River and Waini Mora Passage is a major trans-shipment route for goods and services between northwestern Guyana and the capital city of Georgetown, including neighbouring Venezuela.

The project's marine activities will result in a minor increase in the existing marine vessel traffic within the Kaituma River and Waini Mora Passage shipping route. The small increase in marine traffic that will occur as a result of the Project may result in a slight incremental increase in temporary avoidance behavior and displacement of aquatic fauna within the trans-shipment route, which itself represents a small portion of the vast riverine habitat of the Kaituma River and Waini Mora Passage available to aquatic fauna. It is expected that resident aquatic fauna of the transport route will move away (or have already moved away based on the pre-existing history of marine vessel activity) to areas of lower vessel traffic. These impacts are expected to be **negative, direct, short-term** and **localised** of **negligible significance** but **certain** to occur. These impacts pose a **Low Risk**.

As is the case during construction, the potential exists for hydrocarbon contamination of the aquatic systems from accidental spills of lubricants and fuel during project operation activities. Hydrocarbons spillage into aquatic environments may change aquatic plant and animal growth, mortality and communities. These impacts are expected to be high risk. Similarly, the potential risk of environmental contamination that may affect biodiversity of the AoI from eroded soil run-off during rain events resulting in the changes in water quality and increases in turbidity and the nutrient load from the deposition of eroded materials to the river will ensue during the operation phase. These impacts are expected to be **negative, direct, short-term** and **localised impacts** of **major significance** and **likely** to occur thereby posing **High Risks**.

The occupation of work camps and accommodation by workers may promulgate the presence of synanthropic species. The potential impacts of synanthropic species are **negative, direct, short-term** and **localised impacts** of **negligible significance** and **likely** to occur. This impact is expected to be **Low Risk**.

Hunting and gathering of wildlife by workers may increase if not strictly managed. Roadkill of wildlife may also be prevalent if drivers and vehicle road users are not educated on cautionary driving to prevent road accidents with wildlife. These potential impacts are **negative, direct, short-term** and **localised impacts** of **moderate significance** and **likely** to occur. This impact is expected to be **Medium Risk**.

The physical disturbance and noise produced from operation activities will impose additional stresses on wildlife, which may lead to some species displacement to the vast available adjacent habitat areas that are less impacted by operation activities. While disturbances may be stressful for some wildlife, other species may easily adapt to and thrive successfully. These potential impacts are **negative, direct, short-term** and **localised impacts** of **negligible significance** and **likely** to occur. This impact is expected to be **Low Risk**.

12.3.3 Potential Impacts of Project Closure

During regeneration the area may encounter encroachment by particularly aggressive and unwanted plant species (pests). These pests may result in the loss of some vegetation species. These pest species may have effects on native ecosystems by changing fire regimes, changing soil nutrient regimes, increasing soil erosion, eliminating or altering the natural vegetative strata, and displace or

outcompete other species. Regrowth in the area after closure may consequently alter the diverse nature of the trees present in the area. This impact is expected to pose potential impacts that are **negative, direct, short-term** and **localised** of **negligible significance** and **likely** to occur thereby posing **Low Risk.**

A weed management program should be implemented to control the spread of pest species, which would result in residual impacts of low risk.

12.3.4 Cumulative Impact Assessment

The potential impacts of planned project activities, including ancillary project activities, are discussed above. Currently, there are no existing or planned project activities within or proximate to the AoI which are expected to create situations similar to the project activities which are anticipated to result in potential impacts to biological and ecosystem resources. As a consequence, no cumulative impacts to these resources are anticipated.

12.4 Mitigation and Monitoring Measures – Biological and Ecological Resources

This section outlines the recommended mitigation and monitoring measures relating to the impacts requiring mitigation, and or monitoring, as is indicated in Section 12.3.

12.4.1 Mitigation and Monitoring during the Construction Phase

12.4.1.1 Vegetation

Impacts resulting from the loss of vegetation should be mitigated by the following measures:

- Establish and implement of a vegetation monitoring plan for GMI Mining License area.
- Develop vegetation clearing procedures to ensure that vegetation removal is staged to minimise soil erosion and unwanted loss of vegetation cover, and that remnant vegetation is preserved, particularly the riprian gallery forest habitats of the project site.
- Maintain riparian cover vegetation to the extent practical as vegetative exclusive zones to protect the forest and aquatic habitats, which are important biodiversity corridors.
- Conduct any vegetation clearing in a manner to maintain the aesthetics of the natural landscape and should be limited only to areas required for construction.
- Re-vegetate the area using native vegetation where practical, particularly in areas susceptible to erosion.
- Limit vegetation clearing for road expansion works to the area designated within the existing easement of roads.
- Maintain, to the extent it is practical, the riparian forest along the road and creek intersections for wildlife corridors. Consideration should be given to the establish vegetation cover for animal passage particularly at stream crossings, and wildlife underpass crossings at bridges and culverts for species with reduced movement capabilities.
- Use vegetation waste and surplus soils from land clearing as land spread to conform to the natural topography of the surrounding area to minimize water accumulation, provide general stability and to maintain relative ease of movement for wildlife.
- Avoid clearing and creation of new areas for source materials for construction activities such as quarries and maximize the use of existing quarries and borrow pits, where practical.
- Utilise overburden and cleared vegetation in the restoration activities to foster native plant regeneration, where practical.
- Monitoring continuously the water quality of receiving water bodies within project impacted areas to ensure ecologically acceptable turbidity, nutrient and sediment levels are maintained during construction.

- Retain topsoil with native seeds where available and used to regenerate areas cleared of vegetation.

12.4.1.2 Terrestrial and Aquatic Fauna

Impacts on terrestrial and aquatic fauna during construction should be mitigated by the following measures:

- Maintain vegetated corridors and timed construction activities to enable wildlife present in the area to relocate to adjacent areas.
- Allow animals with reduced movement capabilities to escape if encountered by construction workers.
- Bridge areas of standing water via culverts and or bridges. Bridge spans for new bridges should be wide enough to provide under passage for animals during the wet and dry seasons.
- Design culverts to enable the passage of migratory aquatic species by incorporating baffles to slow the flow enough to allow fish and others to swim against the current, and by setting culvert bottoms below the level of the stream bed. Consideration should be given in the design of culverts to include eco-passage sizing, substrate placement, natural lighting and water level requirements for fishes, small mammals and herpetofauna.
- Maintain native vegetation in areas not earmarked for land development, particularly in areas along the riparian forest habitats of the streams at the intersection of road infrastructure.
- Sanitize worker dwellings and camp food ration and waste storage and disposal should be undertaken according to best practices.
- Develop and implement an Erosion and Sediment Control Plan and spill clean-up plan outlined in the Emergency Response Plan to mitigate potential erosion, sediment and hydro-carbon contamination impacts respectively.
- Monitor receiver water quality continuously during construction to ensure ecologically acceptable turbidity, nutrient and sediment levels.
- Prohibit hunting, fishing, trapping, harming and gathering of wildlife in the project area by construction employees. The workforce should be educated about the consequences of hunting.
- Report any occurrences of wildlife hunting, trapping and trading to the EPA and Wildlife Management Authority;
- Educate and increase the awareness of drivers on avoiding road kills of wildlife and reporting incidents of accidents with wildlife.
- Limit the width of roads to 8m or less and, if possible, retain canopy cover across roads to benefit arboreal animals especially spider monkey (Ateles paniscus); Study species migration routes to establish migration patterns (e.g. Ateles paniscus) and install animal crossing signage, and other forms of animal crossing awareness signalization at established crossing paths.

12.4.2 Mitigation and Monitoring During the Operation Phase

12.4.2.1 Vegetation

Potential impacts on flora during the operation phase should be mitigated by the following measures:

- Road wetting, where practical, during the dry seasons to reduce dust draft and settlement on vegetation.
- Undertake hydrological studies of the Pakera Creek to determine seasonal environmental flows and replenishment regimes; industrial and processing water needs and appropriate water withdrawal rates from the pond.
- Establish a vegetation monitoring plan for its Mining Permit area.

12.4.2.2 Terrestrial and Aquatic Fauna

Impacts on the terrestrial and aquatic fauna of the AoI during project operation should be mitigated and managed by the following measures:

- Allow animals with reduced movement capabilities to escape if encountered.
- Maintain vegetation in place, to the extent practical, within project impacted areas, for example, the riparian gallery vegetation along the riverbanks and along the intersection of road infrastructure and river/creeks crossings.
- Sanitize workers dwellings routinely and camp food ration and waste storage and disposal should be in accordance with best practices.
- Prohibit hunting, fishing, trapping, harming and gathering of wildlife in the project area by employees and visitors.
- Report any observed occurrences of wildlife hunting, trapping and trading to the EPA and Wildlife Management Authority;
- Educate the workforce on the consequences of hunting. Educate drivers on avoiding road kills of wildlife and reporting incidents of accidents with wildlife.
- Develop and implement an Erosion and Sediment Control Plan, and implement spill clean-up measures outlined in the Emergency Response Plan to mitigate potential erosion, sediment and hydro-carbon contamination impacts.
- Monitor discharges and receiver water quality to ensure ecologically acceptable turbidity, nutrient and sediment levels.
- Implement a vegetation monitoring plan.
- Construct tailings impoundment at a rate slow enough to allow aquatic organisms to relocate outside of the footprint of the pond.

12.4.3 Mitigation and Monitoring During Closure

GMI should implemented the following measures to ensure the impacts to biodiversity during the closure phase are prevent or minimised, as well as to enhance the biodiversity of the project areas:

- A weed management program should be implemented to control the spread of pest species.

- As far as is practical only native species should be utiliseutilised for re-vegetation purposes.

- GMI should prepare a detail Closure Plan prior to closure for approval by the EPA. A conceptual Closure Plan is included in Section 22.6.5 outlining areas to be addressed.

Table 12-19: Summary of Impacts and Mitigation Measures

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likeliho od			
Ecological Resources								
Construction Phase – Vegetation								
Land clearing in areas identified for upgrade works	Compliance with Guyana Regulations. Best practices for equipment maintenance	Loss of habitat and vegetation cover of predominantly secondary growth forest	Negative Direct, Long Term, Localised	Minor	Certain	Medium	▪ Vegetation clearing procedures will be developed to ensure that vegetation removal is staged to minimise soil erosion, unwanted loss of vegetation cover and that remnant vegetation is preserved, particularly the riprian gallery forest habitats of the project site. ▪ Riparian cover vegetation will be maintained in place to the extent practical as vegetative exclusive zones to protect the forest	▪ Establishment and implementation of a vegetation monitoring plan, which will include, inter alia, the monitoring of changes in the vegetation structure of the habitats along the boundary of the tailings impoundment dams where ground water levels may rise. ▪ Water quality of receiving water bodies within project impacted areas will be continuously monitored to ensure ecologically
Land Clearing for the new access road from Port Kaituma to the storage and wharf facility	Compliance with Guyana Regulations. Best practices for equipment maintenance	Loss of habitat and vegetation cover of predominantly mature forest	Negative, Direct, Long Term, Localised	Moderate	Certain	High		
Land clearing in areas identified for upgrade works	Compliance with Guyana Regulations. Best practices for equipment maintenance	Loss of natural habitat and the intensification of habitat fragmentation	Negative, Direct, Long Term, Localised	Minor	Certain	Medium		

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likeliho od			
Land clearing in areas identified for upgrade works	Compliance with Guyana Regulations. Best practices for equipment maintenance	Loss of vegetation cover along the riparian habitats	Negative, Direct, Long Term, Localised	Moderate	Certain	High	and aquatic habitats, which are important biodiversity corridors. ▪ Clearing will be conducted to maintain the aesthetics of the natural landscape and will be limited only to areas required for construction. ▪ Re-vegetation utilising native vegetation will be applied where practical, particularly in areas susceptible to erosion. ▪ Vegetation clearing for the road expansion works will be limited to the area designated within the existing	acceptable turbidity, nutrient and sediment levels are maintained during construction.
Land clearing in areas identified for upgrade works	Compliance with Guyana Regulations. Best practices for equipment maintenance	Changes in the water (nutrient) quality of the tailings pond	Negative, Direct, Short-Term, Localised	Moderate	Unlikely	Medium		
Land clearing in areas identified for upgrade works	Compliance with Guyana Regulations. Best practices for equipment maintenance	Loss of cover vegetation and the depletion of soil nutrients from enhanced leaching	Negative, Direct, Long-Term, Localised	Moderate	Likely	Medium		
Land clearing in areas identified for upgrade works	Compliance with Guyana Regulations. Best practices for equipment maintenance	Loss of vegetation cover and increases of nutrient loads in receiver water bodies	Negative, Direct, Long-Term, Localised	Moderate	Likely	Medium		

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likeliho od			
							easement of roads. ▪ Maintaining to the extent practical the riparian forest along the road and creek intersections for wildlife corridors. Consideration will be given to the establishment of vegetation cover for animal passage particularly at stream crossings, and wildlife underpass crossings at bridges and culverts for species with reduced movement capabilities, and the maintenance of canopy cover across roads to benefit movement of *Ateles paniscus*.	

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likeliho od			
							▪ Vegetation waste and surplus soils from land clearing will be land spread to conform to the natural topography of the surrounding area to minimise water accumulation, provide general stability and to maintain relative ease of movement for wildlife. ▪ The clearing and creation of new areas for source materials for construction activities such as quarries should be avoided and maximize the use of existing quarries and borrow pits, where practical. ▪ Overburden and cleared vegetation	

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likeliho od			
							may be utiliseutilised in the restoration activities to foster native plant regeneration, where practical. ▪ The Project will establish a vegetation monitoring plan, which will delineate the vegetative exclusive zones, and clearing zones, and establish a monitoring regime to ensure vegetative zones are not inadvertently encroached or destroyed. ▪ The tailings pond will be scraped of topsoil material, grasses and trees as part of the preparation	

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likeliho od			
							process for the facility to receive tailings.	
Construction Phase – Terrestrial and Aquatic Fauna								
Land clearing in mature forests areas - the new access road from Port Kaituma to the new storage and wharf facility	Compliance with Guyana Regulations. Best practices for equipment maintenance	Loss of vegetation and intensification of the barrier effect	Negative, Direct, Long-Term, Localised	Moderate	Likely	Medium	▪ Vegetated corridors will be maintained, and construction activities timed to enable wildlife present in the area to relocate to adjacent areas. ▪ Animals with reduced movement capabilities will be allowed to escape if encountered by construction workers. ▪ Areas of standing water will be bridged via culverts and or bridges. Bridge spans for new bridges will be wide enough to provide under passage for	▪ Receiver water quality will be continuously monitored during construction to ensure ecologically acceptable turbidity, nutrient and sediment levels
River dredging of Kaituma canal and the Waini Mora Passage	Compliance with Guyana Regulations. Best practices for equipment maintenance	Habitat loss and displacement of benthic fauna	Negative, Direct, Short-Term, Localised	Negligible	Likely	Low		
Construction and rehabilitation of project infrastructure - newly laid culverts and or bridges	Compliance with Guyana Regulations. Best practices for equipment maintenance	Blocking of wildlife corridors	Negative, Direct, Long-Term, Localised	Moderate	Likely	Medium		
Land clearing in areas identified for	Compliance with Guyana Regulations.	Loss of vegetation cover and increase of sediments	Negative, Direct, Long-Term,	Moderate	Likely	Medium		

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likeliho od			
upgrade works	Best practices for equipment maintenance	transported to receiving water bodies from eroded soil	Localised				animals during the wet and dry seasons. ▪ Culverts will be designed to enable the passage of migratory aquatic species by incorporating baffles to slow the flow enough to allow fish and others to swim against the current, and by setting culvert bottoms below the level of the stream bed. Consideration will be given in the design of culverts to include eco-passage sizing, substrate placement, natural lighting and water level requirements for fishes, small mammals and herpetofauna.	
Construction activities and physical disturbances	Compliance with Guyana Regulations. Best practices for equipment maintenance	Noise produced by equipment, imposing additional stresses upon wildlife, leading to increased displacement	Negative, Direct, Long-Term, Localised	Negligible	Likely	Low		
Construction activities	Compliance with Guyana Regulations. Best practices for equipment maintenance	Hydrocarbon contamination of the aquatic systems	Negative, Direct, Short-Term, Localised	Major	Likely	High		
Construction activities - presence of workers and work camps	Compliance with Guyana Regulations. Best practices for equipment maintenance	Increase in domestic and synanthropic species	Negative, Direct, Short-Term, Localised	Negligible	Likely	Low		
Construction activities - presence of workers and work camps	Compliance with Guyana Regulations. Best practices for equipment maintenance	Increase in hunting and roadkill of wildlife	Negative, Direct, Short-Term, Localised	Moderate	Likely	Medium		

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likeliho od			
							▪ The maintenance of native vegetation not earmarked for land development, particularly in areas along the riparian forest habitats of the streams at the intersection of road infrastructure. ▪ Worker camps and dwellings will be routinely sanitized and camp food ration and waste storage and disposal will be according to best practices. ▪ Develop and implement an Erosion and Sediment Control Plan, and implement spill clean-up measures outlined	

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likeliho od			
							in the Emergency Response Plan to mitigate potential erosion, sediment and hydro-carbon contamination impacts. ▪ Hunting, fishing and gathering of wildlife in the Project area by construction employees will be strictly prohibited. The workforce will be educated about the consequences of hunting. ▪ Drivers will be educated on avoiding road kills of wildlife and reporting incidents of accidents with wildlife. ▪ Species migration routes will be studied to establish migration	

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likeliho od			
							patterns and animal crossing signage, and other forms of animal crossing awareness signalization installed at established crossing paths.	
Operation Phase - Vegetation								
Operation of the tailings facility	Compliance with Guyana Regulations. Best practices for equipment maintenance	Rise in the level of the ground water level/table in surrounding areas of the tailings impoundment, resulting in the proliferation of vegetation more adapted to abiotic conditions	Negative, Direct, Long-Term, Localised	Moderate	Likely	Medium	▪ Wetting roads where practical during the dry seasons to reduce dust draft and settlement on vegetation. ▪ Hydrological studies of the Pakera Creek will be undertaken to determine seasonal environmental flows and replenishment regimes, industrial and processing water needs and the appropriate water withdrawal	
Abstraction of water from Pakera for industrial processing	Compliance with Guyana Regulations. Best practices for equipment maintenance	Intensive extraction of water from the pond, inducing water stress in the ecosystems of the pond and the adjoining Pakera creek	Negative, Direct, Short-Term, Localised	Major	Unlikely	High		

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likeliho od			
Traffic on access roads	Compliance with Guyana Regulations. Best practices for equipment maintenance	Dust impacts on early succession/edg e and secondary forest habitats	Negative, Direct, Short-Term, Localised	Negligible	Certain	Low	rates from the pond. ▪ The Project will establish a vegetation monitoring plan, which will include inter alia, the monitoring of changes in vegetation in areas along the margin of the tailings pond where the ground water levels may rise.	
Operation Phase – Terrestrial and Aquatic Fauna								
Process discharge to the tailings pond		Impaired water quality in the pond, resulting in a direct, permanent loss of aquatic habitat within the pond	Negative, Direct, Short-Term, Localised	Minor	Certain	Medium	▪ Animals with reduced movement capabilities will be allowed to escape if encountered. ▪ Vegetation will be maintained in place to the extent practical within	▪ Monitoring of receiver water quality to ensure ecologically acceptable turbidity, nutrient and sediment levels
Increase in marine traffic		Incremental increase in temporary	Negative, Direct,	Negligible	Certain	Low		

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likeliho od			
		avoidance behavior and displacement of aquatic fauna within the trans-shipment route	Short-Term, Localised				Project impacted areas, for example, the riparian gallery vegetation along the riverbanks and along the intersection of road infrastructure and river/creeks crossings. ▪ Worker camps and dwellings will be routinely sanitized and camp food ration and waste storage and disposal will be according to best practices. ▪ Hunting and gathering of wildlife in the Project area by employees and visitors will be prohibited. ▪ The workforce will be educated about the consequences	
Operation activities	Compliance with Guyana Regulations. Best practices for equipment maintenance	Hydrocarbon contamination of the aquatic systems	Negative, Direct, Short-Term, Localised	Major	Likely	High		
Operation activities - presence of workers and work camps	Compliance with Guyana Regulations. Best practices for equipment maintenance	Increase in domestic and synanthropic species	Negative, Direct, Short-Term, Localised	Negligible	Likely	Low		
Operation - presence of workers and work camps	Compliance with Guyana Regulations. Best practices for equipment maintenance	Increase in hunting and roadkill of wildlife	Negative, Direct, Short-Term, Localised	Moderate	Likely	Medium		
Operation activities and physical disturbances	Compliance with Guyana Regulations. Best practices for	Noise produced by equipment, imposing additional stresses upon wildlife, leading	Negative, Direct, Short - Term, Localised	Negligible	Likely	Low		

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likeliho od			
	equipment maintenance	to increased displacement					of hunting. Drivers will be educated on avoiding road kills of wildlife and reporting incidents of accidents with wildlife. ▪ Develop and implement an Erosion and Sediment Control Plan, and implement spill clean-up measures outlined in the Emergency Response Plan to mitigate potential erosion, sediment and hydro-carbon contamination impacts. ▪ Implementation of a vegetation monitoring plan, which will include, inter alia, the monitoring of changes in the vegetation structure of the	

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likeliho od			
							habitats along the boundary of the tailings impoundment dams where ground water levels may rise. ▪ Construction of the tailings impoundment at a rate slow enough to allow aquatic organisms to relocate outside of the footprint of the pond.	
Closure Phase								
Regeneration of the project areas	Compliance with Guyana Regulations. Best practices for equipment maintenance	Encroachment by particularly aggressive and unwanted plant species (pests)	Negative, Direct, Short - Term, Localised	Negligible	Likely	Low	▪ A weed management program will be implemented to control the spread of pest species. ▪ As far as is practical only native species will be utiliseutilised for re-vegetation purposes.	

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likeliho od			
							▪ GMI will prepare a detail Closure Plan prior to closure.	

Chapter 13 - Ecosystem Services

This section describes the ecosystem services from which communities located within the area of influence of the project benefit. It provides a brief description of each community including the extant use of available natural resources and ecosystem. Finally, it evaluates the services which ecosystems currently provide to the local populations.

13.1 Administrative Framework – Ecosystem Services

Table 13 -1 summarises the legislation, policies, strategies, and international treaties related to ecosystem services provided in the project areas that are relevant to the planned project activities.

Table 13-1: Legislation, Policies, Strategies and International Treaties

Title	Description	Applicability to the Project
Legislation		
Environmental Protection Agency (1996)	Provides for the management, conservation, protection and improvement of the environment, the prevention or control of pollution, the assessment of the impact of economic development on the environment and the sustainable use of natural resources.	The Act controls or prevents pollution of the environment (lands, surface water, ground water and marine and coastal areas inter alia) and protect against adverse impacts to ecosystems and natural resources.
Forests Act (2009)	Consolidates and amends forest legislation. The Act also provides for the sustainable management of forest resources, including mangrove forests.	Mangrove forests are located along the Mora Passage, an important section of the river transport route. This section of the river transport route is also being considered for as a potential protected area. The Act also regulated harvesting of timber in other project locations.
Policies and Strategies		
Green State Development Strategy: Vision 2040 (2019)	Outlines Guyana's 20-year plan for development that follows a green agenda defined by sustainable, low-carbon and resilient development and aligns with the 2030 Sustainable Development Goals (SDGs) outlined by the United Nations.	The GSDS outlines the sustainable management of natural resources as one of the key objectives with policy recommendations for the sustainable management of natural resources so as to limit potential impacts to ecosystems.
Low Carbon Development Strategy (2013)	Outlines Guyana's approach to low-carbon and climate resilient development including but not limited to the use of renewable energy, sustainable forest management, and climate change adaptation.	The LCDS developed a REDD+ mechanism to reduce deforestation and to earn revenue from forest climate services.

Title	Description	Applicability to the Project
International Treaties and Protocols		
United Nations Convention on Biological Diversity	Aims to promote conservation and sustainable use of biological resources and the fair and equitable sharing of benefits arising out of the use of genetic resources.	Encourages Parties to attempt to identify activities that may be detrimental to biological diversity and to take steps to reduce any impacts associated with such activities. This includes potential impacts to ecosystems and natural resources.

13.2 Baseline Conditions – Ecosystem Services

Ecosystem services are defined as the benefits people obtain from ecosystems[132]. There are four types of ecosystem services[133]:

- Provisioning Services: The products obtained from ecosystems, including, for example food, freshwater and timber among others.
- Cultural Services: The nonmaterial benefits people obtain from ecosystems including, for example, for spiritual enrichment, recreation, reflection and aesthetic values among others.
- Supporting Services: The ecosystem services that support the production of other ecosystem services such as provision of habitats, soil formation and nutrient cycling among others.
- Regulating Services: The benefits obtained from the regulation of ecosystem processes including climate regulation and prevention of erosion among others.

13.2.1 Community Resource Use

There are nine communities within the wider project area, including settlements in proximity to the operational areas of the project as well as those along road and river ore transport routes. Matthew's Ridge and Port Kaituma is where the project activities will occur. Four Miles and Eclipse Falls are located along the access road from Port Kaituma to Matthew's, where the haul trucks will pass through. St Anselm, Lower Kaituma, Aruka Mouth, Smith's Creek and Morawhanna are located along the shipping route. These communities were assessed as part of the ecosystem services assessment conducted for this EIA. The communities located along the road and river transport routes are shown in Figure 13-1. Residents in these communities depend on the natural environment to support their lives and livelihoods.

[132] Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well Being: Synthesis. Page V
[133] The definitions for the types of ecosystem services are based on definitions and examples provided in: (i) Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well Being: Synthesis. Page V, and (ii) Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well Being: Policy Responses Glossary. Pages 600 and 603 to 604.

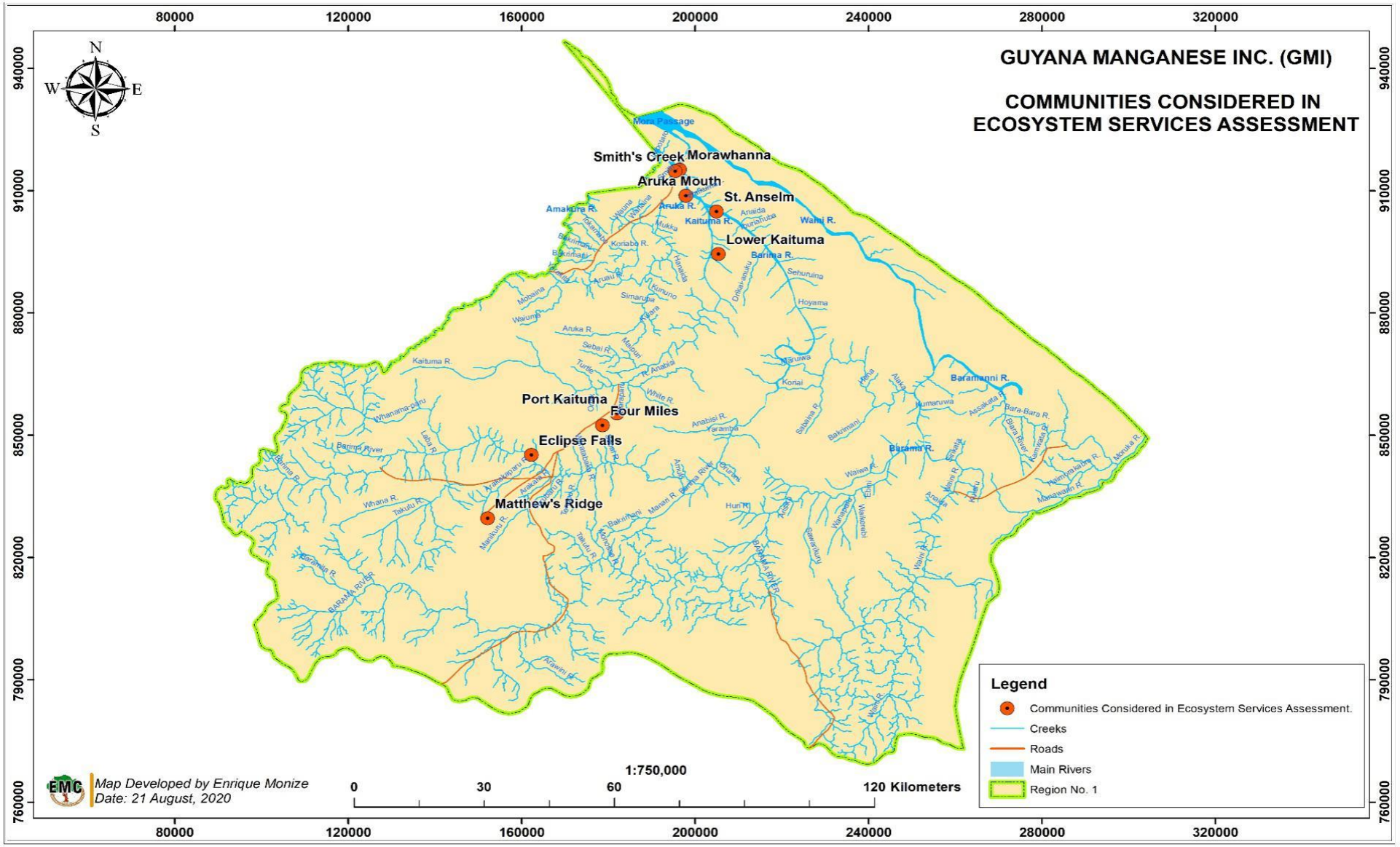


Figure 13-1: Communities Considered as part of Ecosystem Services Assessment

The sections below provide brief community profiles and discuss how natural resources are used by local populations.

Port Kaituma[134]

Port Kaituma was established to facilitate the export of manganese mined in Matthew's Ridge during the 1960s. As a result, the Kaituma Canal was created by cutting a route to allow shipping vessels to travel from Port Kaituma to the Kaituma River. The dredge spoils from the creation of the Canal were placed along both sides of the banks of the Canal creating a community called Canal Bank. Based on national population and census,[135] Port Kaituma had a population of 1,152 people in 2012. In addition, according to Chairman of the NDC, in 2020, there were more than 300 households along Canal Bank (EMC Personal Communication 17). The head office for the NDC for the Matarkai sub-district is based in Port Kaituma and administers Port Kaituma, Matthew's Ridge, Arakaka and the households located along the road network between these communities. There are several villages within Port Kaituma including Fitzburg, Citrus Grove and Oronoque among others. There is also a titled Amerindian village within the boundaries of the Matarkai sub-district. Overall, the following additional community administration structures also support administration of settlements in the Matarkai sub-district:

- CDC for Canal Bank.
- CDC for Eclipse Falls.
- CDC for Arakaka.
- NDC Office in Matthew's Ridge headed by the Vice-Chair of the NDC.
- Village Council for the Four Miles indigenous village.

There are several other social and economic structures based in Port Kaituma. These include a hospital, police station as well as local offices for GFC and Maritime Administration. Key privately run services are also available in the Port Kaituma including banking services, cell phone and internet data service towers, and satellite television. In addition, there are also nursery, primary and secondary schools in Port Kaituma. Students from villages across the Matarkai sub-district travel to Port Kaituma to attend secondary school.

Port Kaituma is one of the principal entry points to the most active mining areas in Region 1. As such, the main livelihood activities include employment of periods in the small and medium-scale mining industry. Many persons are also involved in crop cultivation for sustenance and commercial purposes. In particular, almost all households along Canal Bank practice subsistence farming while a few engage in small-scale crop cultivation. Produce is transported via the Kaituma Canal to market in Port Kaituma for sale. Farming is increasing as a livelihood activity in Port Kaituma as crop cultivation has commenced along the new GMI bypass road leading to the Kaituma Marine Terminal. Livestock farming is limited in Port Kaituma and most meat is imported from Georgetown. In addition, small-scale timber harvesting is occurring on the lands adjacent to GMI's bypass road. Residences as well as agricultural lands were displaced and resettled as a result of the GMI's activities to construct the Kaituma Marine Terminal on the Canal Bank. Other livelihood activities in Port Kaituma include small to medium scale service providers in shops, bars, accommodation, restaurants/food stands, spare parts and boat operators.

Residents from the Canal Bank and Port Kaituma frequently fish in the Kaituma Canal for sustenance. In addition, operators of the fuel boats also catch fish in the Kaituma Canal. Residents have noted that fish caught sometimes smell and taste of diesel and believe this may be due to fishing by fuel boat operators. Many persons engage in wild meat hunting in particular labba, deer and wild hogs. Although the NDC has established an official dumpsite for Port Kaituma, located within the Four Miles village,

[134] Community Profile based on field observations by the EIA team and interviews with the NDC for which notes are available in EMC Personal Communication 17.
[135] Guyana Bureau of Statistics, 2012. National Population and Housing Census, 2012 Population by Village.

disposal of garbage in Port Kaituma is done in a haphazard manner in several areas around the commercial areas of the community.

Canal Bank residents use the water from the Kaituma Canal for domestic purposes. In addition, GWI also sources surface water from a creek that is located along the Kaituma Canal to supply to approximately 700 to 800 persons in Port Kaituma. GWI previously had to suspend supplying residents with water from this creek due to contamination from gold mining activities (EMC Personal Communication 07). Moreover, the Chairman of the NDC expressed concerns of water quality of the Canal Bank in the vicinity of the GMI Kaituma Marine Terminal on account of activities to dredge the new turning basin.

River transportation is key to Port Kaituma. It is estimated that all of the households along Canal Bank own small boats or canoes which are required for travel from their homes. Passenger boats (speedboats) travel into Port Kaituma from Charity, Mabaruma and Moruca on a daily basis. However, entry of these vessels into Port Kaituma was temporarily suspended as part of measures to prevent the spread of COVID-19. The ferry operated by the Government's Transport and Harbours Department transports passengers to and from Georgetown every two weeks. Due to the COVID-19 pandemic, only half of the total passenger capacity of the ferry was filled. Similarly, cargo vessels, carrying food items and vehicles among other cargo, arrive in Port Kaituma (Figure 13–2). Approximately seven cargo vessels frequently travel to Port Kaituma. There are also approximately 12 small fuel boats which frequently bring fuel imported from Venezuela to Port Kaituma. In some instances, these fuel boats travel from Morahwanna, where imported fuel is first offloaded.

Figure 13-2: Cargo Vessel Offloading Food Items at Port Kaituma

Port Kaituma is an area of international renown as the location of the 'Jonestown' agricultural commune and mass suicide. There is a sports facility on Canal Bank which is run and maintained by the Canal Bank CDC. There are approximately six churches along Canal Bank and several churches in Port Kaituma. Many people visit Canal Bank for swimming. On weekends, residents from communities in Port Kaituma such as Fitzburg and Oronoque among others also visit the Canal Bank for recreational purposes. In particular, there is a small resort called Dawn's Resort (Figure 13-3) which is frequented by the locals. In addition, there is a well-known spot of white sand beach along the Kaituma Canal which is also used for recreational purposes by persons from Port Kaituma and Canal Bank. Some persons also excavate sand from this beach for sale to private companies. There is limited natural erosion along the Canal Bank but intentional removal of sand contributes to erosion. Some

sections of Canal Bank are prone to flooding during the rainy season. However, flooding is rare in Port Kaituma.

Figure 13-3: Dawn's Resort on Canal Bank

Matthew's Ridge[136]

The Matthew's Ridge community developed as a direct result of manganese mining operations which started in the community in the 1960s. According to national population and housing census[137], in 2012, the community had a population of 1,433 persons and 339 households. The community has eight residential areas and covers an area of 700 hectares. The community has a hospital, police station, a nursery school, a primary school and a secondary school department.

The local economy in Matthew's Ridge has historically depended on the extractives sectors of mining and forestry. Currently, the active mine sites and tailings facility of the 1960s are brownfield sites having never been rehabilitated following the cessation of mining in 1968. Moreover, large-scale logging activities commenced by Barama Company Limited (BCL) in lands adjacent to Matthew's Ridge. BCL's activities resulted in the construction of a main road connecting Matthew's Ridge and Port Kaituma, located west of both the public road and railway line, as well as several secondary logging roads. These roads significantly increased access to areas for small scale mining and logging.

At present, the main economic activity in the community is small- and medium-scale mining, including pork-knocking. Approximately 42 percent of the population work in the mining sector although most of the mining occurs outside the boundaries of the Matthew's Ridge community. Further, approximately 16 percent of the population is engaged in agriculture and forestry related industries. According to information provided by GFC, GLSC issued 79 agricultural leases in Matthew's Ridge as of 2019. The GL&SC also had plans to issue an addition 41 agricultural leases. Moreover, the GFC has provisionally issued leases for small logging concessions within five kilometers of Matthew's Ridge and will finalise the boundaries of these concessions based on the agricultural leases issued by the GL&SC as well as the boundaries of GMI's mining lease. Approximately 10 percent of residents are small business owners of shops that sell groceries, household items and provide entertainment and eight percent are transportation providers. Approximately 21 percent of the population are involved in other livelihood activities in Matthew's Ridge including employment including public servants and construction workers

[136] Community Profile based on field observations by the EIA team and information collected remotely from the NDC Office in Matthew's Ridge.
[137] Guyana Bureau of Statistics, 2012. National Population and Housing Census, 2012 Population by Village.

among others. Residents as well as agricultural lands were displaced and resettled as a result of the GMI's activities in the area.

GWI provides freshwater to most residents in Matthew's Ridge which are sourced from springs and stored at two locations before being distributed to the community. GMI also sources water for domestic purposes from a spring located in the area behind the Guyana House. Water supply is supplemented by rainfall for both residents and GMI. The Pakera Lake (Figure 13-4) was one of the main recreational areas for residents in Matthew's Ridge and people visited frequently, particularly during the dry seasons, to swim, picnic and fish. In a few instances, the Pakera Lakel was also used for domestic purposes such as washing clothes. GMI will be pumping water from the Pakera Lake to supply the processing plant during the dry season and has agreed with the NDC that community access to the Pakera Lake will be restricted, due to safety concerns.

Figure 13-4: Section of the Pakera Lake during the Dry Season (January 2020)

Other recreational areas in the community include places of worship, a sports field and a community centre. A Digicel cell and data tower is also in installed in the village. Finally, there are several remnants of the manganese processing plant from the 1960s in the area. There is a dumpsite in the community which appears to have been recently commissioned. Finally, approximately 15 percent of residents utilise firewood for cooking while 54 percent use gas and 31 percent use kerosene.

Four Miles[138]

Four Miles is a titled indigenous village located in proximity to Port Kaituma. A section of the public road which connects Matthew's Ridge to Port Kaituma passes through the village. The village has a population of approximately 1,200 people. There is a nursery school in the village. Students travel to Port Kaituma for primary and secondary school. There is a Health Outpost where a Medex is stationed. There is also a Village Office and a Multi-Purpose Building. Residents access services from the Guyana Police Force from the Port Kaituma Police Station.

The main economic livelihoods are from mining/pork-knocking and farming. Irrigation for crops is reported to be a challenge because the main source of freshwater is from rainfall. The Wallabacka Creek runs through the village and was previously used by some residents to supplement freshwater needs for domestic purposes and agriculture. However, residents do not use water from this creek

[138] Community Profile based on field observations by the EIA team and a telephone interview with the Toshao for which notes are available in EMC Personal Communication 19.

anymore because is contaminated by discharges from gold mining as well as some runoff from small cattle pastures. Freshwater for domestic use and irrigation is a major challenge for the community. The village is not prone to flooding during the rainy seasons but heavy rainfall events have been linked to crop damage, in particular to 'cassava rot'. Most of the meat and other food items are imported from Georgetown via boat cargo into Port Kaituma and thereafter by road to the village. Approximately 50 percent of the residents use gas for cooking and the other 50 percent depend on firewood.

The dumpsite run by the NDC is located in the village in close proximity to houses. Garbage in the dumpsite is burned but oftentimes garbage is not completely burned. This was reported to attract flies and other pests. Many residents believe this to be a source of illness in the community.

There are five churches in the village for different denominations of Christians. There is also a burial ground in the village. The monument erected in memory of the mass murder-suicide in 'Jonestown' in 1978 is also located in the Four Miles village. There is a playground, including a pavilion, where sports like cricket, football and volleyball are played.

Eclipse Falls[139]

Eclipse Falls is located along the public road which connects Matthew's Ridge to Port Kaituma where the road crosses the Barima River. The Eclipse Falls Bridge, which includes remnants of the old railway line, serves as the bridge across the River. The community has approximately 120 residents and approximately 40 households with more men than women (70 percent and 30 percent respectively). The population has been steadily declining as people have been migrating to Matthew's Ridge, Port Kaituma and Arakaka in search of employment. A divisional office of the Guyana Geology and Mines Commission (GGMC) is located within the village. Eclipse Falls is not a titled indigenous village but is in the process of applying for a title. It is likely that the Eclipse Falls may become a titled village within the 13-year project lifetime.

The main economic livelihood for residents is the gold mining sector. Approximately 50 percent of residents are employed with gold miners and approximately 25 percent are engaged in pork-knocking or prospecting. The latter activity is reported to occur both within and outside of the Eclipse Falls community. The remaining 25 percent of residents are engaged in crop cultivation of plantains, bananas and cassava. Livestock farming is not common in the village. Most of the meat and other food items are imported from Georgetown via boat cargo into Port Kaituma and thereafter by the public road from Port Kaituma to Eclipse Falls. In addition, there are a few small businesses including a cookshop and a grocery shop in the village. The majority of residents depend on firewood for cooking even though they also use either gas or kerosene.

The primary source of freshwater for domestic use is from rainfall. The collection of rainwater for domestic purposes is hindered by dust which accumulates on the rooftops of houses as a result of vehicles traversing the public road. Residents must wait for the dust to wash off of the roof before rainwater collection can begin. Residents also collect water from the Barima River for domestic purposes including bathing and washing. Previous contamination of the Barima River from gold mining activities had temporarily stopped use of this water for domestic purposes. However, the causes of this contamination have been addressed. In addition, GWI has a solar pump in village which supplies water to Government buildings. During the interview with the Chairman of the Community Development Council (CDC), concerns were raised about potential contamination of the Arakaparu Creek, the head of which is in Matthew's Ridge and ultimately connects to the Barima River which supplies freshwater to Eclipse Falls and Arakaka.

[139] Community Profile based on field observations by the EIA team and a telephone interview with the CDC Chairman for which notes are available in EMC Personal Communication 20.

There is a church and burial ground in the village. Approximately 30 percent of the residents attend church regularly. A community-owned tourist resort and guesthouse is being developed in the village. Many locals visit this resort to play games, go camping and to fish for recreation in the Barima River. There is a primary school in the village which is attended by 50 students. In addition, about four students attend school in Port Kaituma. There is also a Health Outpost in the village. Residents access services from the Guyana Police Force from the Port Kaituma Police Station.

Lower Kaituma[140]

The community of Lower Kaituma is located along the Kaituma River. The main economic livelihood is the harvesting of manicole palms (heart of palm) for the AMCAR. In addition, most villagers fish in the Kaituma River and Barima River for sustenance purposes. However, a few villagers were also reported to be engaged in artisanal fishing for commercial purposes. Fishes caught are transported, using small privately owned vessels, to the Kumaka Wharf in Mabaruma for sale at markets on Tuesdays and Saturdays.

Most villagers were also reported to practice crop cultivation for sustenance purposes. In addition, a few villagers also engaged in small-scale crop cultivation for commercial purposes and produce is also transported to the Kumaka Wharf for sale on market days. Crop cultivation for commercial purposes is challenging because of water availability and access for irrigation. In addition, the village is prone to flooding during the rainy seasons and this can also cause crop damage.

The main source of freshwater for the village is from rainfall. During prolonged dry seasons, or during periods of drought, the villagers travel using canoes to nearby villages (mainly to Hosororo) to collect freshwater for cooking and drinking. Some villagers use water from the Kaituma River for other domestic purposes such as bathing and washing. There is at least one church in Lower Kaituma. However, there is no sports facility in the community.

St. Anselm[141]

The community of St. Anselm is located at the confluence of the Kaituma River and the Barima River. The community has approximately 400 residents and 100 households. At present, the CDC is not functional because of administrative issues which followed the most recent community election. There are more men than women in the community. There is a primary school in the village but students travel daily to Mabaruma or Hosororo to attend secondary school. Each household owns a small vessel most of which are canoes. However, a few vessels are fitted with small outboard engines.

The main economic activity is harvesting of manicole palm (heart of palm) for sale to AMCAR company. On a daily basis, boats filled with harvested manicole leave the village for transportation to the AMCAR facility at Drum Hill. All households are engaged in fishing for sustenance purposes. However, a few persons are also engaged in artisanal fishing. A few villagers were also reported to be engaged in fishing for commercial purposes. Fishes caught are transported, using small privately owned vessels, to the Kumaka Wharf in Mabaruma for sale at markets on Tuesdays and Saturdays.

Most villagers were also reported practice crop cultivation for sustenance purposes. In addition, a few villagers also engaged in small-scale crop cultivation for commercial purposes and produce is also transported to the Kumaka Wharf for sale on market days. Crop cultivation for commercial purposes is challenging because of water availability and access for irrigation. In addition, the village is prone to

[140] Community Profile based on field observations by the EIA team and a telephone interview with the RDC Chairman for which notes are available in EMC Personal Communication 18.
[141] Community Profile based on field observations by the EIA team and a telephone interview with a resident for which notes are available in EMC Personal Communication 21.

flooding during the rainy seasons and this can also cause crop damage. Most villagers harvest firewood to use for cooking.

The main source of freshwater for the village is from rainfall. During prolonged dry seasons, or during periods of drought, the villagers travel using canoes to nearby indigenous villages (mainly to Hosororo) to collect freshwater for cooking and drinking. Some villagers use water from the Kaituma River for other domestic purposes such as bathing and washing.

Villagers, particularly children, swim in the Barima and Kaituma Rivers for recreational purposes. There are churches in the village and a recreational ground for sports. There is a Health Outpost in the community but currently, no medical personnel are based at the Outpost. As a result, residents travel to Mabaruma to access health care services. Similarly, residents access services provided by the Guyana Police Force from the Mabaruma Divisional Office.

Aruka Mouth[142]

The community of Aurka Mouth is located on the confluence of the Aruka and Barima Rivers and has a population of approximately 300 people, with an approximately equal male/female ratio. The primary economic activity is commerce, with many persons trading in fuel, household items, fresh/salted fish, and crabs. The community is considered a part of the Mabaruma Town Council. There is one primary school that housed 48 students in 2018 and higher grades attend school at Mabaruma or Hosororo.

Many people have shops and trade in fuel, but 80 percent of the population is focused on fishing and manicole palm harvesting. Fishing is done both in the ocean and rivers in vicinity of the community. Many men work on fishing vessels, catching fish for the weekly markets at Kumaka and also catching crabs. Shrimp is caught during certain periods. Crabs are prevalent during the crab season when all households contribute to crabbing, while five households specifically supply the twice-a-week market at Kumaka. Some households have farms and use the lands to cultivate crops (when there is no flooding) for subsistence and sale at the local market.

Community members claim that most of the aquatic mammals have moved away due to increased fuel in the water. A few households are involved in the harvesting of manicole palms. There are no cultural sites and traditional religious practices have reportedly ceased. Some medicinal plants are collected from within the community. Mangroves are utiliseutilised by persons living in swampy areas as posts for construction and for building foundations and firewood. Some people utilise the Kissing Rocks and Shell Beach for recreational purposes.

The community does not have a health facility and residents must go to the Mabaruma Regional Hospital.

Morahwanna[143]

The community has 85 people from 17 households, mainly of mixed ethnicity. The primary economic activity is fishing by two large boats and about a dozen small boats. There is one primary school shared with Smith's Creek that has 88 children. Students attend secondary school in Mabaruma. The area has a major wharf, Guyana Revenue Authority outstation, Coast Guard base, police outstation, and a teachers' accommodation.

Fishing is the major economic activity in the village. Large boats (similar to trawlers) from Venezuela visits the port to purchase fresh fish. There are two fishing boats from the community which typically have two to three fishing trips per month. For prolonged fishing trips, fishermen establish camps on

[142] ERM, EMC, GSEC (2019). EEPGL Environmental Impact Assessment Payara Development Project. Pages 8-214 to 8-216.
[143] ERM, EMC, GSEC (2019). EEPGL Environmental Impact Assessment Payara Development Project. Pages 8-218 to 8-219.

the beaches close to the Waini Mouth. Some villagers also work on fishing boats from other villages. Approximately 15 people continuously conduct crabbing for sale at the Kumaka market and to hucksters on the ferry to Georgetown. Commercial activities are important for livelihoods with food purchased from Mabaruma or at the many local shops.

There are no household farms in the area, as flooding is common. Flooding occurs during the dry season due to high tides and lack of mangroves and dams and is exacerbated during the rainy seasons. Some persons use traditional plants (noni and fergosa) for medicinal purposes. The area has many species of fish and birds that roost nearby in a few locations. Dolphins were reportedly sighted in the past but have not been seen recently.

There are no cultural or heritage sites in the community. Traditional religious practices have reportedly ceased. Mangroves are utiliseutilised by people for construction and for building foundation and for firewood. Barks are also harvested for use in tanning. Persons from the community travel to the beach at Waini Point for recreational purposes, especially at Easter.

There is a health center but it is not operational. All health matters are referred to Mabaruma Regional Hospital and Hosororo.

Smith's Creek[144]

The community has 208 people, mainly of Warrau descent, with more females than males (60 percent and 40 percent, respectively). The primary economic activity is sale of fish followed by manicole palm harvesting and farming. The community is considered part of the Mabaruma Town Council. There is no primary school in the village and children attend primary school in Morawhanna. Students attend secondary school at Mabaruma and Hosororo.

Fishing is important to the community for livelihoods, with three large boats and 15 small boats fishing on an average of two times per month. Large boat trips are up to 10 days while smaller boats are 2 to 3 days. Fresh fish is sold at Kumaka market and to Venezuelan Trawlers. Freshwater fishing is also conducted in the rivers. Fish camps by small boats are sometimes set up at the Waini Mouth. Three households have farms and use the lands to cultivate crops where the land is high enough to not flood. The village is easily flooded and thus farmers are discouraged from farming. All community members conduct crabbing during the crab seasons, as well as the harvesting of manicole. A family or crew can harvest 2,500 sticks of manicole palms per trip, making one trip per month.

The area has many species of birds; curry curry (scarlet ibis) and gaulins (cattle egrets) roost nearby in a few locations. There are also ducks at the creek head and there is limited trapping in the outlying areas. There are no cultural heritage sites in the area and traditional religious practices have reportedly ceased. Medicinal plants including noni and mangroves are collected from the beach. Mangroves are utiliseutilised by persons for construction and for building foundations, firewood, fishing poles, and medicinal uses.

There is no health facility and all health matters are referred to Mabaruma Regional Hospital, although the residents would more easily access the health clinic in Morawhanna Village if it was operational.

13.2.2 Summary of Ecosystem Services

Based on the use of resources in the communities within the wider project area, the ecosystem services on which residents rely are discussed below.

[144] ERM, EMC, GSEC (2019). EEPGL Environmental Impact Assessment Payara Development Project. Pages 8-220 to 8-221.

Provisioning Services

The following provisioning services are provided by ecosystem to local populations:

- Aquatic Transportation is crucial for all communities. There are established ports in Morahwanna, Mabaruma and Port Kaituma for the transportation of fuel and cargo into the Region as a whole. Transportation using small vessels, such as canoes or boats fitted with small outboard engines, are the sole mode of transportation available to the residents of Canal Bank, Lower Kaituma, St. Anselm, Smith's Creek and Morahwanna to travel from their homes and communities.

- Freshwater for domestic use is important to all communities. Residents of the Canal Bank depend on the Kaituma Canal for water for domestic purposes including drinking. Residents of other communities along the river transport route also depend on the rivers for water for domestic purposes such as washing and cleaning. In addition, GWI sources water from surface water bodies connect to the river transport route to supply some of the residents of Port Kaituma. GWI also sources water from surface springs to supply the residents of Matthew's Ridge. Residents of Eclipse Falls depend on the Barima River for freshwater. All communities depend on rainfall to supplement their water supply. However, Four Miles village, and to a lesser extent Eclipse Falls, Lower Kaituma and St. Anselm, depend solely on rainfall for water for domestic purposes.

- Freshwater for irrigation is a challenge for all communities and most depend on rainfall for crop irrigation.

- Fishing for subsistence or commercial sale for residents in Port Kaituma, Lower Kaituma, St. Anselm, Smith's Creek and Morahwanna.

- Crop cultivation for subsistence is practiced by residents of all communities except Morahwanna. In particular, commercial crop cultivation is important for residents of Matthew's Ridge and Port Kaituma.

- Housing and commercial activities are important for all communities. In particular, there are well established marketplaces and market days in Mabaruma and Port Kaituma. In addition, shops are located within the project area of influence in Matthew's Ridge and Eclipse Falls.

- People in most communities depend on firewood for cooking.

- Hunting for wild meat is practiced by residents of Port Kaituma and other communities.

Cultural Services

The following cultural services are provided by the ecosystems to local populations:

- Cultural value assigned to places of worship, such as churches, are important to all communities.

- The use of the natural environment and resources for local tourism and local recreation. Notable examples include the resorts located in Canal Bank and Eclipse Falls, beach along Canal Bank, swimming, recreational fishing and residents from Aruka Mouth, Smith's Creek and Morahwanna travelling to coastal beaches for recreation and use of the Pakera Lake at Matthew's Ridge.

- The cultural value of remnants of the industrial history of the Matarkai sub-district including elements of the railway line at the Eclipse Falls Bridge and the former processing plant at Matthew's Ridge.

- The cultural and historical value of Port Kaituma as the site of the "Jonestown" and the "Jonestown" monument erected in Four Miles village.

Supporting Services

The following supporting services are provided by ecosystems:

- Habitats are provided for fishes which are caught by local populations for subsistence and for sale.

- Habitats for other types of biodiversity are provided along the road and river transport routes.

Regulating Services

The following regulating services were provided by ecosystems:

- Shoreline protection and mangroves in Smith's Creek and Morahwanna and along the Mora Passage.

- Climate regulation provided by forest and mangrove ecosystems adjacent to the road and river transport routes.

13.3 Impact Assessment – Ecosystem Services

The potential impacts to the natural resources, including potential cumulative impacts, which can in turn affect ecosystems services are discussed in the substantive chapters of this EIA report. Specifically:

- Potential impacts to water quality and water availability are discussed in Chapter 8.

- Potential impacts are a result of displacement and resettlement are discussed in Chapter 21.

- Potential impacts arising from changes to recreational areas due to project operations are discussed Chapter 21.

- Potential impacts to river traffic and traditional transportation uses of the river transport route are discussed in Chapter 15.

- Potential impacts of dust emissions from road traffic are discussed in Chapter 10 and 11.

- Potential impacts to habitats and biological resources are discussed in Chapter 12.

13.4 Mitigation and Monitoring Measures – Ecosystem Services

Potential impacts to ecosystem services should be mitigated and monitored by fully implementing the recommended measures for the relevant environmental components outlined in the Environmental and Social Management Plan (ESMP) presented in Chapter 22.

Chapter 14 - Noise and Vibrations

This chapter outlines the baseline sound pressure levels existing at the locations of the key project components as well as receptors within or proximate to the project's AoI. The baseline levels include recordings of primary data collected by the EIA team. It also assesses potential impacts of noise emissions from planned project activities to proximate receptors. Finally, it proposes a suite of mitigation and monitoring measures which should be followed to manage risks associated with noise pollution.

14.1 Administrative Framework – Noise and Vibrations

Table 14-1 summarizes the legislation, policies, strategies, and international treaties that are relevant to the planned project activities.

Table 14-1: Legislation, Policies, Strategies, and International Treaties

Title	Description	Applicability to the Project
Legislation		
The Environmental Protection Act (1996)	Provides for the management, conservation, protection and improvement of the environment and has provisions for the prevention or control of pollution including noise pollution. The Act also established the Environmental Protection Agency.	Sets out requirements for consideration of noise emissions as well as offences for noise pollution that results in adverse effects.
The Environmental Protection (Noise Management) Regulations (2000)	Establishes general provisions for noise avoidance and restrictions from industry, transport and construction among other activities. The Regulations also authorize the EPA to set specific permissible noise levels.	Requires submission of an application for noise generating activities. The Regulations also include stipulations for compliance including requirements for monitoring noise levels, maintaining records and submitting reports to the EPA.
Guidelines and Standards		
GNBS Guidelines for Noise Emission into the Environment (2010)	Established standards to be used for measuring and monitoring of noise emission into the environment. The Standard also established permissible noise levels for various types of activities.	Sets out the permissible noise levels for residential, commercial, industrial, construction and transportation receptors (day and night) with which the project must comply.
Guidelines for Noise and Vibration from Blasting (2020)	Established standards to be used to regulate, among other things, airblast overpressure and peak particle velocity (PPV) for surface mining operations. Established by the Queensland Government in Australia.	Sets out threshold limits which may be followed to manage noise and vibrations from blasting activities. Compliance with these guidelines will be voluntary.

14.2 Baseline Conditions – Noise and Vibrations

In order to generate baseline datasets, the EIA team conducted measurements of SPLs at the project locations in Matthew's Ridge and Port Kaituma as well as for nearby receptors. The sampling locations were selected based on two principal criteria namely, the location of key project components from which noise may be generated and at locations where receptors were proximate to planned project activities. At the dates of the assessment, construction of the new project facilities at Matthew's Ridge were approximately 80 percent completed. Minimum and maximum SPLs were measured at each identified sampling point for a period of approximately one hour during both morning and afternoon hours. At each sampling point, the sound level meter was placed about 1.5 meters (5 feet) from ground level to simulate the average height of the human ear. It should be noted longer measurement periods (up to 24-hours for some locations) were initially included in sampling plan. However, the duration of the field exercise to collect baseline data was curtailed because of national and other safety restrictions for the COVID-19 pandemic. In turn, this restricted the duration for which SPL measurements could have been taken at each identified sampling point. The number and location of the sampling points were not influenced by the COVID-19 restrictions.[145] In addition, SPLs were measured in 2012 as part of an environmental baseline study commissioned by Reunion Manganese Incorporated (RMI) and these results are also presented. However, for this survey SPLs were only measured for project areas at Matthew's Ridge project and proximate receptors in the Matthew's Ridge community.

14.2.1 Permissible Noise Levels

The permissible noise levels from the *Guidelines for Noise Emission into the Environment*[146] applicable to this project are outlined in Table 14-2 below. Blast vibration standards or permissible limits are not included in the national guidelines for noise emissions. As a result, the guidelines for noise and vibration from mine blasting for surface mining from the Queensland Government, Australia[147] were adopted for comparison with predicted blast vibration levels. These permissible levels are also presented in Table 14-2 below.

Table 14-2: Decibel Limits for Various Activities

Type of Activity	Day Time Limit (dB)	Night Time Limit (dB)
Guidelines for Noise Emissions into the Environment (Guyana Bureau of Standards, 2010)		
Residential, Institutional, Educational	75	60
Industrial, Transportation	100	80
Commercial	80	65
Construction	90	75
Guidelines for Noise and Vibration from Blasting (Queensland Government, 2020)		
Air blast overpressure	115 dB (linear) peak for nine out of ten consecutive blasts and not greater than 120 dB (linear) peak at any time.	No blasting or more stringent limits which have been justified by the project proponent.
Ground vibration peak particle velocity (PPV)	Five millimetres per second PPV for nine out of ten consecutive blasts and not greater than ten millimetres per second PPV at any time.	No blasting or more stringent limits which have been justified by the project proponent.

[145] The Standard Operating Procedure which guided baseline data collection and a description of the equipment used are presented in Appendix H.
[146] Guyana Bureau of Standards, 2010. Guidelines for Noise Emission into the Environment
[147] Queensland Government, 2020. Guideline: Noise. Noise and Vibration from Blasting

14.2.2 Ambient Noise Levels Matthews Ridge

Baseline noise levels were measured for 13 sampling points in Matthew's Ridge and the surrounding environment in 2012. During this assessment, SPLs were recorded every other month for an average of two hours at different times of the day and night at each of the sampling points. As seen in Table 14-3, the average SPLs of all recordings were well below the day-time permissible limits for all categories set by GNBS and the EPA. This is expected as minimum and maximum values would have averaged out and that the SPLs would have been representative of community activities at that time.

Table 14-3: Matthews Ridge Sampling Locations and SPLs (2012)

Location	Sound Pressure Level (dB)
Hill 1	40
Hill 2	40
Hill 3	40
Hill 4	40
Hill 5 Centre Extension	40
Hill 6	40
Hill 7	40
Hill 8	40
Hill 9 Centre	40
Office Quarters	52.57
Living Quarters #A	45.43
Living Quarters #B	51.14
Compound Workshop Area	61.43
Village (Market)	58.67

The 2020 baseline assessment comprised of six sample points within Matthews Ridge representing key components of the planned project footprint and in the Matthew's Ridge community as follows:

- Hills 5 and 9. These two sampling locations are within the footprint of the active mine area and are within the project AoI. These deposits will be mined within the first seven years of the project;
- GMI's power plant and workshop, located approximately 1 km meters from the centre of the Matthew's Ridge community. The closest residents are situated approximately 300 meters to the east and 150 meters to the south. This sampling location is also within the project AoI.
- GMI's pump station which is located approximately 1 km from the centre of Matthew's Ridge community. The closest residents are located approximately 400 meters away. This sampling location is also within the project AoI.
- GMI's new processing plant which is located approximately 1.5 km meters away from the centre of the Matthew's Ridge community. The closest residents are situated approximately 600 meters east. This sampling location is also within the project AoI.
- The *Shel Nic Nel* Hotel which is located in the central Matthew's Ridge community. This is the only sampling point in Matthew's Ridge which is not located directly within the project AoI but proximate to the project areas.

It should be noted that both the school compound and the Matthew's Ridge Hospital are located approximately 600 meters south-east of the power plant, processing plant and Hill 5. The six sampling points are presented in Figure 14-1.

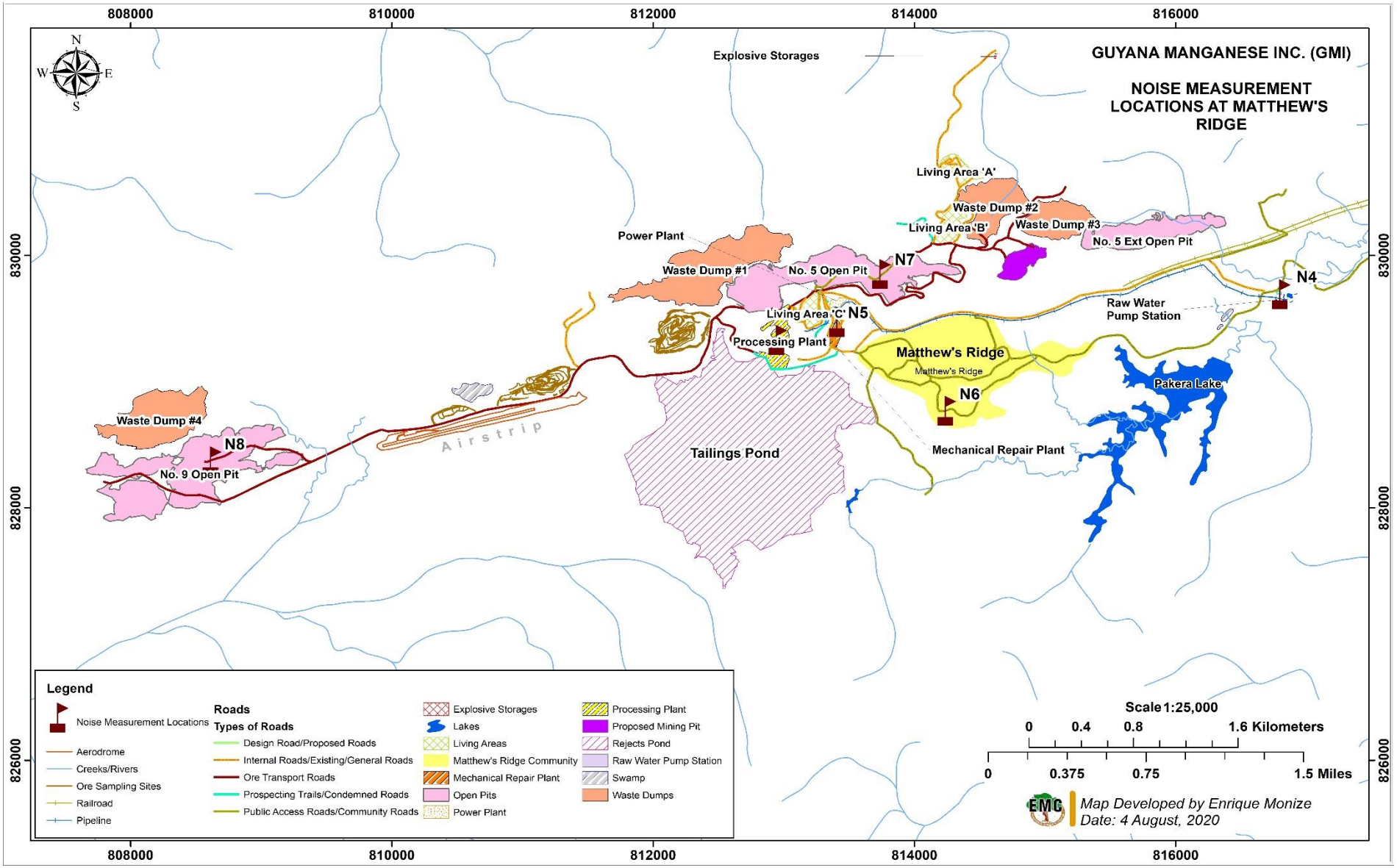


Figure 14-1: SPL Sample Locations in Matthews Ridge

The results of the SPLs recorded for the six sample points are presented in Table 14-4. Construction activities coupled with other background noises during sampling provided a SPL scenario which may typically occur during the operational phase of the project. For example, the highest maximum SPL was 88.6 dBA and recorded at the sampling point at the power plant/workshop. These maximum baseline values, whilst higher than values recorded in 2012, shows similarity with regards to the higher SPL generated at the workshop area. This is expected as the area can be categorized as a commercial area in Matthews Ridge, comprising a base for activities related to vehicle washing, shops, and the main camp for a local mining company. The construction activities undertaken by GMI has therefore resulted in the increased SPLs. Given that construction activities were also ongoing at the sampling point located at the site of the new processing plant and therefore, the SPLs were also representative of onsite noise emissions during project construction.

By contrast, the lowest maximum SPL was 46.1dBA which was recorded at Hill 5. This may be considered as the baseline level of noise in the absence of industrial and construction activities. All maximum SPLs were well within the EPA/GNBS permissible limits for both construction and industrial sites. The highest and lowest minimum SPL were 49.5 and 34 dBA respectively. The maximum and minimum SPL for the community (residential) were 64.5 dBA and 47.4 dBA respectively. These were also within EPA/GNBS permissible limits. It must be noted that as typical with remote mining areas where shops and bars typically play music on loud speakers and there is regular traffic related to pickups and ATVs frequently traversing the main thoroughfare of the community.

Table 14-4: Sample Sites and SPL Results at Matthew's Ridge

Locations	Time (hrs)	Date	Maximum SPL (dBA)	Minimum SPL (dBA)	Observations
Pump Station	14:55	Jul 15, 2020	66.4	49.5	*Weather:* Overcast. *Sources:* Intermittent thunder and light traffic on the adjacent public road.
	14:13	Jul 16, 2020	61.1	35.6	
Power Plant/ Workshop	16:55	Jul 15, 2020	84.7	49.5	*Weather:* Overcast *Sources:* Light traffic, birds, machinery
	15:30	Jul 16, 2020	88.6	49.2	*Weather:* Overcast and raining *Sources:* Heavy machinery including front end loaders, trucks, ATVs and other construction equipment
Hill 5	08:08	Jul 16, 2020	46.1	41.6	*Weather:* Overcast *Sources:* Light traffic, vehicle horns, birds, machinery
	11:29	Jul 17, 2020	65.8	36.3	*Weather:* Sunny *Sources:* Music from residents, light traffic, vehicle horns, workshop machinery, birds
Hill 9	10:03	Jul 16, 2020	54.1	36.2	*Weather:* Overcast with light intermittent rain *Sources:* Light traffic in the distance, insects, birds, rain drizzles
	08:40	Jul 17, 2020	55.4	34	*Weather:* Overcast *Sources:* Insects, birds, wind and rustling trees

Locations	Time (hrs)	Date	Maximum SPL (dBA)	Minimum SPL (dBA)	Observations
Processing Plant	12:41	Jul 16, 2020	54.6	41.2	*Weather:* Sunny *Sources:* Light traffic, birds
	10:08	Jul 17, 2020	77.2	50.3	*Weather:* Sunny *Sources:* Light traffic, construction machinery, conversations, air traffic
Matthew' Ridge Community (Shel Nic Nel Hotel)	20:32	Jul 15, 2020	64.5	47.4	*Weather:* Foggy *Sources:* Generators and intermittent traffic
	05:55	Jul 17, 2020	63.2	46.9	*Weather:* Heavy fog *Sources:* Generators, ATVs, birds

14.2.3 Vibrations at Matthew's Ridge

Natural sources of ground vibration are usually related to volcanic occurrences and seismic activities caused by movements along the edges of the plates that make up the Earth's crust. No records of seismic or volcanic activity have been found for the project area. During the construction phase, the main anthropogenic sources of background vibration at the project site were attributed to the movement of heavy trucks and earth moving equipment. Heavy trucks will also be used during the operational phase of the project. In addition, mine blasting will occur during the operational phase of the project but is expected to be intermittent and of short duration. No blasting is scheduled to occur during night time hours.

14.2.4 Ambient Noise Levels Port Kaituma

The 2020 baseline noise assessment consisted of three sample locations within Port Kaituma. These sites were also selected based on the location of key project components and the proximity of receptors to project components and planned project activities. These sample locations were:

- The Four Miles titled indigenous village. A section of the public road connecting Matthew's Ridge to Port Kaituma passes through this village. As a result, the community is normally exposed to routine traffic related to small scale gold mining and logging activities and transportation of people into and out of Port Kaituma. During the construction phase of the project, GMI's light vehicles and some heavy vehicles frequently passed through the village. During the operational phases of the project, haul trucks will also pass through the village to access the Kaituma Marine Terminal. This sampling location is within the AoI of the project.
- The location of the Kaituma Marine Terminal. There are residents to the left and right of the Marine Terminal. These can be considered as receptors at risk to any potential SPL above baseline levels. This sampling location is within the AoI of the project.
- The *Five Sisters Hotel* in Central Port Kaituma. Settlements in Port Kaituma is some distance away from the Marine Terminal site and is very unlikely to be affected by the Projects operations at the Marine Terminal. This sampling location is not within the AoI of the project but is considered proximate to key project components.

The sample locations are presented in Figure 14-2 below.

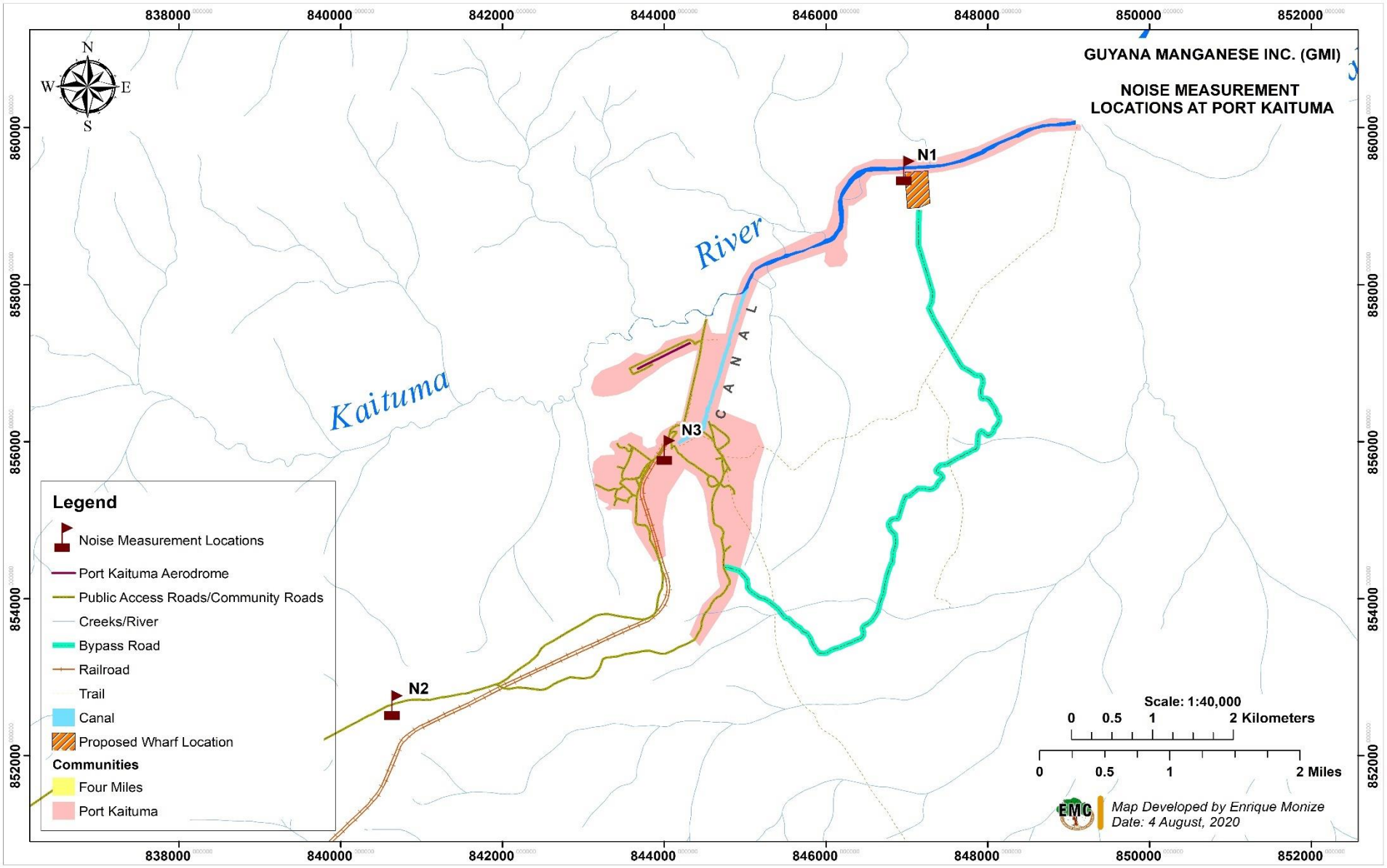


Figure 14-2: SPL Sample Locations in Port Kaituma

The results of the SPL recordings for the three sample points in Port Kaituma are shown in Table 14-5 below. The maximum and minimum recorded SPL at the proposed marine terminal site was recorded as 71.7 dBA and 44.6 dBA respectively. These SPLs were influenced by boats traversing the Kaituma River and resulting wave action on riverbanks. There were no project related activities at the location of the Kaituma Marine Terminal during the measurement exercise and this may be considered as a representative baseline noise level to which residents of the Canal Bank are routinely exposed principally from the small vessels which frequently traverse the Kaituma Canal. These levels were within the permissible limits for residential areas. Nonetheless, it should also be noted that these SPLs may be temporarily amplified when larger vessels, such as cargo boats, fuel boats and the ferry, traverse the Kaituma Canal.

The highest maximum SPL of 77.9 dBA was recorded at the sampling point in the Four Miles village. This was influenced by a combination of background noise emanating from ATVs and other vehicles traversing the location, dogs barking, and conversations among villagers. No noise sources at this location were associated with project activities. It should be noted that the maximum SPL recorded slightly exceeded the permissible limits for noise in residential areas. At Port Kaituma the maximum SPL recorded was 69 dBA with generators, ATV traffic, birds and conversations and was within the noise levels for residential areas.

Table 14-5: Sample Locations and resulting SPLs

Locations	Time (hrs)	Date	Maximum SPL (dBA)	Minimum SPL (dBA)	Observations
Kaituma Marine Terminal	14:18	July 14, 2020	71.7	44.6	*Weather:* Overcast *Sources:* Vessels traversing the Canal, birds, waves hitting riverbanks
	08:40	July 15, 2020	60.8	44.2	
Four Miles	16:29	July 14, 2020	77.9	40.5	*Weather:* Overcast with intermittent drizzles *Sources:* ATVs, rain drizzles, dogs barking, conversations
	10:48	July 15, 2020	65.6	39	*Weather:* Overcast *Sources:* Light traffic
Port Kaituma Community	21:30	July 14, 2020	53.4	48.1	*Weather:* Overcast *Sources:* Light traffic
	07:00	July 15, 2020	69	45.6	*Weather:* Overcast *Sources:* ATVs, Generators, birds, conversations

14.2.5 Vibrations at Port Kaituma

Similar to Matthew's Ridge, no records of seismic or volcanic activity have been found for the project areas in Port Kaituma. During the construction phase of the Port Kaituma access road, the main anthropogenic sources of background vibration at the project site were attributed to the movement of heavy trucks and earth moving equipment. Potential sources of vibration during the construction of the wharf at the Kaituma Marine Terminal include the use of heave machinery and earth moving equipment as well as pile driving and installation of sheeting revetments.

14.3 Impact Assessment – Noise and Vibrations

The main project components are situated within the previous and existing mine footprint in Matthew's Ridge and new ancillary Kaituma Marine Terminal at Port Kaituma. The sources of noise and vibration impacts that are anticipated from mining-related activities are typical for large, modern, open-pit mining operations located in hilly terrain. The nature and quantity of such sources will vary with different project phases. Noise sources during the operational phase of the project at Matthew's Ridge include but are not limited to:

- Operation of motorised vehicles for transportation of personnel, materials, and equipment to, from, and within the project site.
- Drilling and blasting operations in the construction phase and excavation of ore from the pits during mine operation.
- Operation of mobile and stationary motorised equipment, which will typically include haul trucks, excavators, bulldozers, loaders, drill rigs, crushers, conveyor systems, excavators, graders and generators.
- Operation of major items of ore beneficiation equipment (e.g., gyratory crushers, grinding mills, separators, conveyors) in the mill or processing plant.
- Mine construction activities including site preparation, earthworks construction, pit pre-stripping blasting, airstrip grading and maintenance, construction and maintenance of internal mine roads, and other minor activities from time to time.
- Periodic operation of various auditory safety signals, alarms, or sirens (e.g., vehicle backup alarms, blast warning and all-clear sirens).

Some construction, such as additional mine pit development, will occur intermittently over the life of the project at Matthew's Ridge. During operations at Port Kaituma, noise will be generated by heavy vehicles and equipment associated principally with ore movement and transport. At both project locations, non-project noise emissions associated with aircraft, road and river traffic will continue.

The closure phase of the Project is dominated by reclamation activities, and therefore noise will primarily be associated with vehicles and activities associated with the decommissioning of the mine site, such as dismantling infrastructure, land restoration, re-vegetation, access and haul road decommissioning and ongoing monitoring**.** Noise is not expected to be a concern for the post-closure phase, as only occasional, minor noise will occur due to some activities associated with ongoing monitoring and inspection programs involving small vehicles.

The potential effects of the project on the acoustic environment are assessed by predicting noise and vibration levels in the study areas. Expected source noise and vibration levels for the suite of activities and equipment and machinery to be utilised at Matthew's Ridge and Port Kaituma were examined and sound power level determined from manufacturers' specifications and from the literature for similar activities, equipment and machinery[148]. These are provided in Table 14-6.

[148] Trinity Consultants Pty Ltd T/A ASK Consulting Engineers. 2019. Gemini Project. Noise Impact Assessment. Report 197401.0181.R01V04. Pp 17-19 *and* GSEC. 2018. Draft Environmental and Social Impact Assessment. Marudi Mountain Gold Mine for Romanex Guyana Exploration Limited. Pp 208.

Table 14-6: Sources, Locations and Estimated Maximum SPLs

Activities	List of Equipment and Machinery	Locations of Use	SPL (dBA)	Combined SPL (dBA)[149]
Drilling and Blasting	Explosives	Hills 1 to 9 (Year 4 onwards)	137	TBD
Excavation, loading, offloading ore	6 bull dozers 8 excavators 2x55 tonnes Crane 9 Loaders 3 Graders	Hills 1 to 9	114 104 TBD 113 111	111
Haulage	30 Trucks	Hills 1 to 9 and Internal Roads between Pits and Plant	116 to 118	111
Processing	Crushers, Conveyors, Bins, Scrubber, Pumps; Screening Plant, Jigging Plant; and Process Control Station	Processing Plant	≤ 111	≤ 111
Power Generation	6x4.5 KvA 60 hz generators	Power Plant	≤ 111	≤ 111
Transportation of Concentrate	Haul trucks	Matthew's Ridge to Port Kaituma Public Road (sections passing through	116-118	111
Marine Terminal Operation	Loaders, Crane	Canal Bank, Port Kaituma	113	111
Barging	3-3000 tonne (86.8 x 18 x 3.6m) Self-Propelled Barges	Kaituma Canal, Kaituma River, Barima River and the Mora Passage	45 to 50	50

14.3.1 Receptors

Noise is generally defined as loud, unpleasant, unexpected, or undesired sound that is typically associated with human activity and that interferes with or disrupts normal activities. Human environments are characterized by a generally consistent noise level although these levels vary by location and this is referred to as ambient noise. Although exposure to high noise levels has been demonstrated to cause hearing loss, the principal human response to environmental noise is annoyance. The response of individuals to similar noise events is diverse and influenced by the type of noise, perceived importance of the noise and its appropriateness in the setting, time of day and type of activity during which the noise occurs, sensitivity of the individual, and change from ambient conditions. These factors determine sensitivity to noise stimuli.

The receptors which may be potentially impacted by planned project activities consist of workers located within a range 15 to 500 meters from the noise source; and residents, schools, medical institutions all of which are located at distances greater than 500 meters from the sources. Noise from the project activities were considered to include steady, continuous noise and there would be

[149] The Combined SPL refers to estimate SPLs from multiple sources operating at same time with baseline ambient noise levels being measured at a distance of 15 meters from each source.

associated primarily with the processing plant, the power plant and the Pakera Lake pump station during dry seasons. The other is short-term, intermittent noise, typically associated with the effects of vehicles hauling ore and waste rock, drilling, blasting in the open pit mine, airstrip operation and the access road traffic. Predominant occupational, community, and ecological receptors have been identified for the purpose of this assessment and the potential receptors for mining-related noise and vibration in Matthew's Ridge, and Port Kaituma include the mining workforce, the human population within and adjacent to the AoI are presented to Table 14-7.

Table 14-7: Project Components, and Sensitive Receptors

Locations	Stimuli	Potential Sources	Sensitive Receptors
Matthew's Ridge	Noise and Vibration	Extraction: Drilling, blasting, hydraulic hammering, and excavation	Workers, Matthew's Ridge, community (Hill 5), School, Hospital, Biodiversity
	Noise and Vibration	Haulage/Transportation: Loading, heavy duty trucks moving between mine site to processing plant	Workers, Matthew's Ridge community
	Noise	Processing: crushers, jigs and wash plant,	Workers, nearby residents
	Noise	Power generation: Generator sets	Workers
Matthew's Ridge to Port Kaituma Public Road	Noise and Vibration	Haulage/Transportation: Heavy duty transport trucks	Workers, Eclipse Falls, Four Miles and Farmsteads
Port Kaituma	Noise and Vibration	Loading and movement of heavy-duty vehicles, Power generation	Workers, residents neighbouring marine terminal
Kaituma River/Barima River	Noise	Barge movements up and down rivers	Residents along the river transport route

Project activities and resulting noise levels will vary continuously for the duration of the project. For this reason, a conservative, worst-case scenario has been analysed, defined as the highest potential number of equipment units in operation at one time, operating 100 percent of the time (24-hours), and receptors are 50 to 3000 metres linear distance from sources. The impact assessment has been carried out assuming a typical operation (including any construction activities) scenario where common equipment types are used. SPLs were estimated for the type of sources or activity, vehicle and equipment based on their specifications and information from existing literature. The SPL propagation with varying distance from source to receptors were estimated using a publicly available SPL propagation tool[150]. The prediction of sound pressure levels at different distances from the sources/activities' location where most of the equipment would be located (reasonable worst-case scenario) is shown in Table 14-8.

[150] Mas Environmental, 2006. Multiple Noise Sources Calculator – Point Source Model

Table 14-8: Predicted SPL across various distances from source

Sources	Loudest Activity or Equipment	Combined SPL (dBA)	dBA from Noise Source (meters)						
			50	100	500	1000	1500	2500	3000
Blasting	Explosive Blasts	137	127	121	107	101	97	93	91
Hills 1-9 Excavation, Loading and Offloading Ore	Excavator/ Bulldozer/Grader	111	75 to 101	69 to 95	55 to 81	49 to 75	45 to 71	41 to 67	39 to 65
Pakera Lake Pump Station	Pump engine	45-50	35 to 40	29 to 34	15 to 20	9 to 14	N/A	N/A	N/A
Haulage	Truck	111	78	72	58	52	48	44	42
Processing	Crusher/ Jigger	≤ 111	101	95	81	75	71	67	65
Power Generation	6 Generators	≤ 111	101	95	81	75	71	67	65
Airstrip (Take-off and Landing)	Fixed-wing Cessna Caravan	111	75	69	55	49	45	41	39
Transportation of Concentrate	Trucks	111	78	72	58	52	48	44	42
Marine Terminal Operation	Front-end Loader/Trucks	111	78	72	58	52	48	44	42
Barging	Barge engine	45 to 50	35 to 40	29 to 34	15 to 20	9 to 14	N/A	N/A	N/A

14.3.2 Potential Impacts of Noise Nuisance

According to the literature blast noise is predominantly low frequency sound, with most of the audible sound energy below 50 hertz, low attenuation in air and omnidirectional[151]. The magnitude and propagation of the airblast, measured in dBA, is influenced by factors such as the explosive type, loading densities, weight, the spacing of blasting holes, the detonator delays, including ambient atmospheric conditions.[152] If the noise is above peak linear values of around 115 to 120 dBA, in accordance with the *Guidelines for Noise and Vibrations* prepared by the Queensland Government, it can impact receptors within a few hundred metres of the blast. However, with distance its impact diminishes. Some atmospheric conditions, such as low cloud cover, cause the sound waves to propagate over a greater distance, resulting in a more noticeable "bang," referred to as an "air blast." Although not impossible, it is unusual for blasting to result in air waves that will cause damage to buildings, and if it should occur it will present itself in form of shattered window glass. It is possible for blast noise to reach 20 to 20,000 hertz where it may cause alarm to residents, especially if they are not aware[153]. However, GMI's blasting design will incorporate procedures to reduce noise and airblast including millisecond delays and decking.

[151] International Association for Measurement and Evaluation of Communication, 2015. Environmental Impact Assessment. Blackwater Gold Project. Pp5.2.2-18
[152] Ibid, pp 5.2.2-18
[153] Nicholson, R. 2005. Determination of Blast Vibration using Peak Particle Velocity at Bengal Quarry in St. Ann, Jamaica. Msc. Thesis. Lulea University of Technology. Pp. 25

Based on the estimation of blasting noise propagation, noise levels are expected to be below the Queensland Government's 115 to 120 dBA limit for airblast overpressure with distance of community receptors located within 500 meters of the site. Although the frequency of blasting will be developed by GMI in a Blasting Plan, each blasting event will be of short duration. In general, GGMC recommends maintaining a minimum safe blast radius of 500 to 600 meters. However, the Blasting Plan to be developed by GMI should include safe blast radii for blasting in various areas earmarked for mining. As such, the potential impacts of noise nuisance from blasting to community residents are expected to be **negative**, **direct**, **short-term**, and **localised**. The impacts are anticipated to be of **minor significance** and are **certain** to occur during the lifetime of the project. This results in **Medium Risks** from planned project activities.

Project staff, in particular mine workers, are also considered receptors to noise from mine blasting activities. Although the minimum safe blast radius outlined by GGMC should be maintained, GMI should outline further measures in the Blast Plan to ensure that occupational safety and health of workers of maintained. Additional measures to protect workers' health and safety, such as ear protection and emergency response measures, should also be outlined in the Blast Plan. As such, impacts associated with noise exposure to workers from blasting are **negative**, **direct**, **short-term**, and **localised.** The impacts are anticipated to be of **minor significance** and are **likely** to occur during the lifetime of the project. This results in **Medium Risks** from planned project activities.

Based on the estimation of both continuous and short-term operational noise from the other planned project activities, SPLs are not estimated exceed the permissible levels for industrial operations at distances of 50 meters from the source of the noise. Given the community receptors at Matthew's Ridge are located at distances that exceed 1,000 meters of the project activities, no significant impacts of noise nuisance are anticipated. However, receptors on to the east, west and south of the Kaituma Marine Terminal on Canal Bank, Port Kaituma will be, in some cases, within 100 meters of the noise sources. However, these levels are estimated to be within the permissible levels for industrial operations and consistent with the maximum SPLs recorded for Canal Bank during the 2020 baseline assessment. Nonetheless, based on the SPLs recorded in Matthew's Ridge during construction activities, noise levels may be amplified during the construction of the Kaituma Marine Terminal beyond maximum SPLs recorded for Canal Bank in the baseline assessment. Finally, estimated noise emissions from haul trucks are well within the permissible limits for transportation and are also consistent with maximum SPLs recorded in the Four Miles village. Although noise from haul trucks may exceed minimum noise levels in some communities, the source is mobile and moves relatively rapidly from the vicinity of any receptor. Impacts of noise nuisance to community receptors are **negative**, **direct**, **short-term**, and **localised** of **minor significance** and **certain** to occur. These are associated with **Medium Risks** from planned project activities.

However, project workers will frequently be within 15 meters of various noise sources for continuous time periods depending on their respective job. According to the standard from the US Department of Labour, Occupational Safety and Health Administration, workers are at risk of adverse effects of noise exposure, including hearing loss, when noise exposure is at or above 85 decibels averaged over 8 working hours, or an 8-hour time-weighted average[154]. Most of the combined SPLs for noise sources, presented in Table 14-6, exceed this limit for safe occupational exposure to noise. However, GMI will provide ear protection to workers who will be exposed to significant levels of occupational noise. The potential impacts of exposure to dangerous levels of occupational noise are **negative, direct**, **short-term** and **localised** of **major significance** but are **unlikely** to occur. As such, exposure to occupation noise are associated with **Medium Risks**.

Noise sources during the closure phase will be similar to the construction related impacts. However, noise effects will be lower because high-level noise sources such as drills, and blasting will be absent.

[154] US Department of Labour, Occupational Safety and Health Department, undated. Occupational Noise Exposure.

Therefore, the construction associated noise levels can be used as a conservative assessment of noise during the closure phase. No post-closure impacts are anticipated, since no noise-generating activities or equipment will be present once the Project is decommissioned. These impacts will be **negative**, **direct**, **short-term** and **localised** of **minor significance** and **certain** to occur. As such, noise emissions during closure and decommissioning present **Medium Risks.**

14.3.3 Potential Impacts of Vibrations

The environmental impacts of blasting include ground vibration, defined as the speed of excitation of particles within the ground resulting from vibratory motion. The intensity of ground vibrations is known as units of peak particle velocity (PPV). Under typical conditions, blasting vibration intensity diminishes with distance at a rate of about one third of its previous value each time the distance from the vibration source is doubled. Blasting will occur during the operational phase of the project to open mine pits. Blasting design comprises a non-electric initiation system, millisecond delays and decking to reduce vibrations. In order minimise the ore losses and dilution, single-row or multi-row millisecond blasting will be selected flexibly according to the rock occurrence condition. All emulsions will be waterproof. It is expected that blasting will commence in the third year of operations onwards to open mining pits at Hills 5, 7 and 9, and from the seventh operations year onwards for Hills 1, 3 and 8. Worst case vibration PPV was estimated using a publicly available sinusoidal vibration calculator[155]. In a scenario where, frequency ranged from 5 to 15 Hz and displacement ranged from 500 to 1000 metres, PPV was estimated to range from a minimum of 8 millimeters per sector to a maximum of 47 millimeters per second. Based on this worst-case scenario PPV may exceed the stringent Queensland Government standard of millimeters per second. It should be noted that according to Australian Standard AS2187.2 and experience from Trinity/ASK Consultants,[156] PPV is not realistically expected exceed 6 millimeters per second for blasting activities of this nature.

Adverse impacts associated with vibration PPV is typically associated with structural damage to buildings within the blast radius. This includes buildings and facilities constructed for the project as well as any residential dwellings or other social infrastructure withing the blast radius. Most houses are believed to withstand ground vibrations of approximately 137 to 508 millimetres per second before resulting in damage but is largely dependent on the construction material and integrity of the structure[157]. Structural damage may also occur at significantly lower levels of about 50 millimetres per second. However, given that the PPV strength diminishes with distance, structural damage is not expected for any of the dwellings in Matthew's Ridge. As a result, structural damage associated with blast vibrations have impacts which are **negative**, **direct**, **short-term** and **localised** of **minor significance** but **certain to occur**. These impacts result in **Medium Risks** of project activities.

Vibration caused by travel of haul trucks and heavy machinery will be short-lived. Trucks are supported on flexible suspension systems and pneumatic tires and are therefore not an efficient source of ground vibration. Any vibration caused by a truck hitting a pothole or other obstruction will be localised, diminishing rapidly with distance. Project roads will be maintained on a regular basis to assure the smooth travelling of vehicles, including trucks. These impacts are expected during both the construction and operational phases of the project. Vibration impacts associated with heavy vehicles (haul trucks) and machinery are **negative**, **direct**, **short-term**, and **localised.** The impact significance is expected to be **negligible** and **unlikely** to occur, resulting in a **Low Risk**.

Finally, there may be vibration associated with pile and sheet driving at Port Kaituma as part of the construction of the Kaituma Marine Terminal. Vibration is generated from the pile driver to the pile. As

[155] Compliance Engineering, 2020. Vibration Calculator: Sinusodial Vibration Equations
[156] Trinity Consultants Pty Ltd T/A ASK Consulting Engineers. 2019. Gemini Project. Noise Impact Assessment. Report 197401.0181.R01V04. Pp 24-25.
[157] Nicholson, R. 2005. Determination of Blast Vibration using Peak Particle Velocity at Bengal Quarry in St. Ann, Jamaica. Msc. Thesis. Lulea University of Technology. Pp. 29

the pile is driven into the surrounding soil, vibrations are transferred and propagated through the ground where it interacts with structures. The vibration may also disturb occupants of the any impacted structures. There are residential structures to the east, west and south of the proposed location of the Manganese Marine Terminal. However, there are small creeks between the Terminal location and the houses east and west of the facility. The Kaituma Canal is a buffer between houses to the south of the Terminal. As a consequence, the land distance and the water bodies separating the Terminal from the residences will both serve to dampen the vibrations associated with pile driving. As a result, structural damage associated with vibrations from pile driving have impacts which are **negative**, **direct**, **short-term** and **localised** of **minor significance** and **unlikely to occur**. These impacts result in **Low Risks** of project activities.

14.3.4 Cumulative Impacts

Potential impacts of noise of vibrations from the project and its ancillary activities are discussed above. Although heavy vehicles which are currently used by non-project activities may contribute to noise and vibrations, these are also transient. As such, even under circumstances of project and non-project heavy vehicles traversing road ways at the same time potential noise and vibrations generated will also be transient. Currently, there are no existing or planned project activities within or proximate to the AoI which are expected to generate significant levels of noise and vibrations. Potential impacts of noise and vibrations from project and non-project heavy vehicles traversing the roadway are **direct, negative, short-term, cumulative** and **localised** of **negligible significant** but are **almost certain** to occur thereby resulting in **Low Risks**.

14.4 Mitigation and Monitoring Measures – Noise and Vibrations

Based on the project design and equipment procured for the implementation of planned project activities, the following noise reduction measures will be in place:

- Constructing an enclosure of the generator at Port Kaituma and power plant at Matthew's Ridge where six generators will be operational.
- Procuring of generators that are sound attenuated.
- Procuring of haul trucks with built-in noise dampening technologies such as silencers on exhaust systems.
- Issuing relevant PPE for each protection to minimise exposure to occupational noise.
- Putting measures in place to provide the residents of Matthew's Ridge with a schedule of blasting activities.
- Putting measures in place to provide notice to the Matthew's Ridge community in advance of each blasting activity.
- Conducting training and refreshing training sessions on Blasting Safety Practices.
- Closing of roads within at least 500 meters of blasting locations when blasting is occurring.
- Siting of offices and workers living areas away from noise sources.

In addition, GMI should also implement additional mitigation and monitoring measures to manage risks of noise levels generated by the planned project activities. These measures were also informed by the guidelines for noise management included in the Environmental, Health and Safety Guidelines (General and Mining) issued by the International Finance Corporation (IFC). The mitigation and monitoring measures which should be implemented are:

- Develop and implement of a Blast Management Plan that will examine or model various scenarios for blast design taking account of best management practices and operational controls to prevent harmful impacts to various receptors. Ultimately, the blast design selected should aim to limit airblast overpressure to lower than 120 dBA and that PPV to lower than 10 millimeters per second. The Blast Management Plan should also include:

  - Baseline ground vibration assessments prior to the commencement of blasting.
  - Establishment of a blast exclusion and safety zone so as to create a safe blast. The Plan should evaluate whether the minimum safe blast radius of 500 to 600 meters established by the GGMC is appropriate for this site.
  - Clearly outline procedures for engaging the residents of Matthew's Ridge to provide adequate notice prior to blasting exercises and to receive feedback from community members on any adverse impacts they experienced as a result of blasting activities.
  - Occupational health and safety measures that should be followed by workers during blasting activities.
- Install sound suppression devices (such as mufflers) on earthmoving equipment and other heavy equipment and machinery, if possible, if these technologies are not built in to the equipment.
- Insulate employees' living and dining areas from noise.
- Develop a training module on noise nuisance, the importance of wearing appropriate PPEs for ear protection as well as occupational health and safety measures to be followed during blasting activities.
- Enforce workers use of PPEs for ear protection.
- Install signage to remind workers of the proper use of PPEs.
- Conduct annual hearing tests and maintaining records for workers at risk of occupational noise exposure.
- Develop a noise monitoring programme under which ambient noise levels including occupational noise at measure at least monthly so as to ensure compliance with the permissible limits and recommended threshold levels.

Table 14-9: Summary of Impacts and Mitigation Measures

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
Noise including Noise from Blasting Activities	Compliance with Environmental Protection (Noise) Regulations 2000 and noise limits set for both industrial and residential. Best practices for equipment maintenance	Noise Nuisance to Sensitive Receptors	Negative Direct, Short Term, Localised	Minor	Certain	Medium	Adherence to Operational Controls Informing communities in advance activities with significant potential for noise generation	Monitor daily during blasting for first few weeks of operations and intermittent monitoring as necessary thereafter.
Noise	Compliance with Environmental Protection (Noise) Regulations 2000 and noise limits set for both industrial and residential. Best practices for equipment maintenance	Hearing impact to workers	Negative Direct, Short Term, Localised	Major	Unlikely	Medium	Blast management Plan and adherence to Operational Controls Noise insulation of workers living and dining areas	Company should conduct regular (weekly/monthly) on spot SPL checks as part of their HSE programme. It is recommended that a detailed bi-annual assessment of SPLs be conducted by independent assessor. Frequent training sessions on OSH practices for noise management

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
								Frequent refresher trainings on the Blast Management Plan
Vibrations from project activities	International Best Practice	Potential damage to buildings, Nuisance to Sensitive Receptors	Negative Direct, Short Term, Localised	Minor	Unlikely	Low	Blast Management Plan and adherence to Operational Controls	Monitor daily during blasting for first few weeks of operations and intermittent monitoring as necessary thereafter.
Cumulative Impacts								
Noise and Vibrations from Movement of Heavy Vehicles	Best practices for equipment maintenance	Noise and vibrations due to project and non-project heavy vehicles traversing the roads	Negative Direct, Short Term, Localised, Cumulative	Negligible	Almost Certain	Low	N/A	/A

Chapter 15 – Transportation

The operations of GMI will be dependent on the safe and efficient transportation of workers, supplies and the mined and processed manganese ore. This chapter presents the existing transportation infrastructure and traffic in the primary, secondary and tertiary AoI. It also assesses potential impacts of planned project activities. Finally, it proposes a suite of mitigation and monitoring measures which should be followed to manage risks associated with project transportation.

15.1 Administrative Framework – Transportation

Table 15-1 summarises the legislation, policies, strategies, and international treaties that are relevant to the planned project activities.

Table 15-1: Legislation, Policies, Strategies and International Treaties

Title	Description	Applicability to the Project
Legislation		
Explosives Act (1973)	Regulates the importation, storage, carriage and sale of gunpowder and other explosive substances. This Act also regulates the construction of the magazine for the storage of the explosives at the mine site.	GMI will be required to import, transport and store explosives for blasting purposes in its operations.
Roads Act (1909)	Provides for the construction and maintenance of public roads in Guyana under the supervision of the Ministry of Public Works.	GMI will rehabilitate and maintain the public roads connecting Matthew's Ridge to Port Kaituma. The company has also constructed bypass roads in Matthew's Ridge and Port Kaituma which will be shared use.
Maritime Zones Act (2010)	Regulates internal waters, sea, territorial sea, contiguous zone, the continental shelf and the exclusive economic zone, and the regulation of the activities in those areas. It also provides that the internal waters comprise the areas of the sea that are on the landward side of the baselines which form the inner limits of the territorial sea as well as all rivers, bays, historic bays, ports, harbours and waters lying landward of the baselines.	The project will need to take cognizance of river transportation and dredging activities and impacts on rivers, riverbeds and navigability. In addition, dredging and disposal of dredged materials will require approval under this Act. Further, there are specific security requirements for ports that will serve as international ports.
Sea and River Defence Act (1933 with amendments)	Authorizes the Sea Defence Board to take any action to secure the maintenance of sea, rivers, and outer dams of properties that are on or are near the river or sea shore.	The construction of the wharf facility at Port Kaituma will require the approval of the Board. The reserve area of the compound will need to be maintained by GMI to ensure access is available to the Board for inspections, maintenance and repairs to the river defence.
International Treaties and Protocols		
United Nations Convention on the Law of the Sea	Outlines rights and obligations of Parties when using the mouths of rivers, the sea, the exclusive economic zone and the high seas.	The project will require the use of the mouth of the Waini River and the sea for transportation of ore to La Brea, Trinidad.

15.2 Baseline Conditions – Transportation

Transportation infrastructure in the Matarkai sub-district was largely developed as a result of the manganese mining operations of the 1960s. In order to facilitate the export of manganese ore, Manganese Mines Management Limited, constructed a 48-kilometer (30-mile) railway as well as an adjacent roadway connecting Matthew's Ridge to Port Kaituma. The company also constructed a Bailey bridge over the Barima River at Eclipse Falls, cut the Kaituma Canal; established a turning basin in the Kaituma Canal, built infrastructure for ship loading, ore concentrate storage, fuel tankage and housing at Port Kaituma; and dredged the Barima River and Mora Passage. Airstrips were also constructed at Matthew's Ridge and Port Kaituma to support these operations. After mining operations ceased in 1968, there was major degradation of the transportation infrastructure and significant sections of the railway were disbanded.

Infrastructural development in the sub-district was relatively stagnant until 1991, when Barama Company Limited (BCL) was granted a large-scale forestry concession by the Government of Guyana. BCL established its main operational base at Port Kaituma. However, as its operations progressed southwards, its primary haul road was established well west of the Matthew's Ridge to Port Kaituma Railway and Matthew's Ridge to Port Kaituma Road respectively. BCL's logging road crossed the Barima River above Eclipse Fall, thence to a point near the mouth of Arunamai River, left bank Barama River. Several secondary roads were however constructed within areas south of Matthews Ridge, with one such road extending to a point on Barama River near Kariako Amerindian Village. BCL closed operations in the areas north of Barama River around 2006 leaving a vast network of roads which facilitated extensive itinerant gold mining operations in and around Matthew's Ridge and the wider area. By the end of 2002, BCL would have constructed in excess of 1,500 kilometers of main and secondary access roads within the area so as to access areas that were previously inaccessible. However, most of these secondary roads were not maintained after BCL's operations in the area concluded. The Government has been maintaining some of the roads leading to the main mining areas. The road network in the Region can be observed in Figure 15-1.

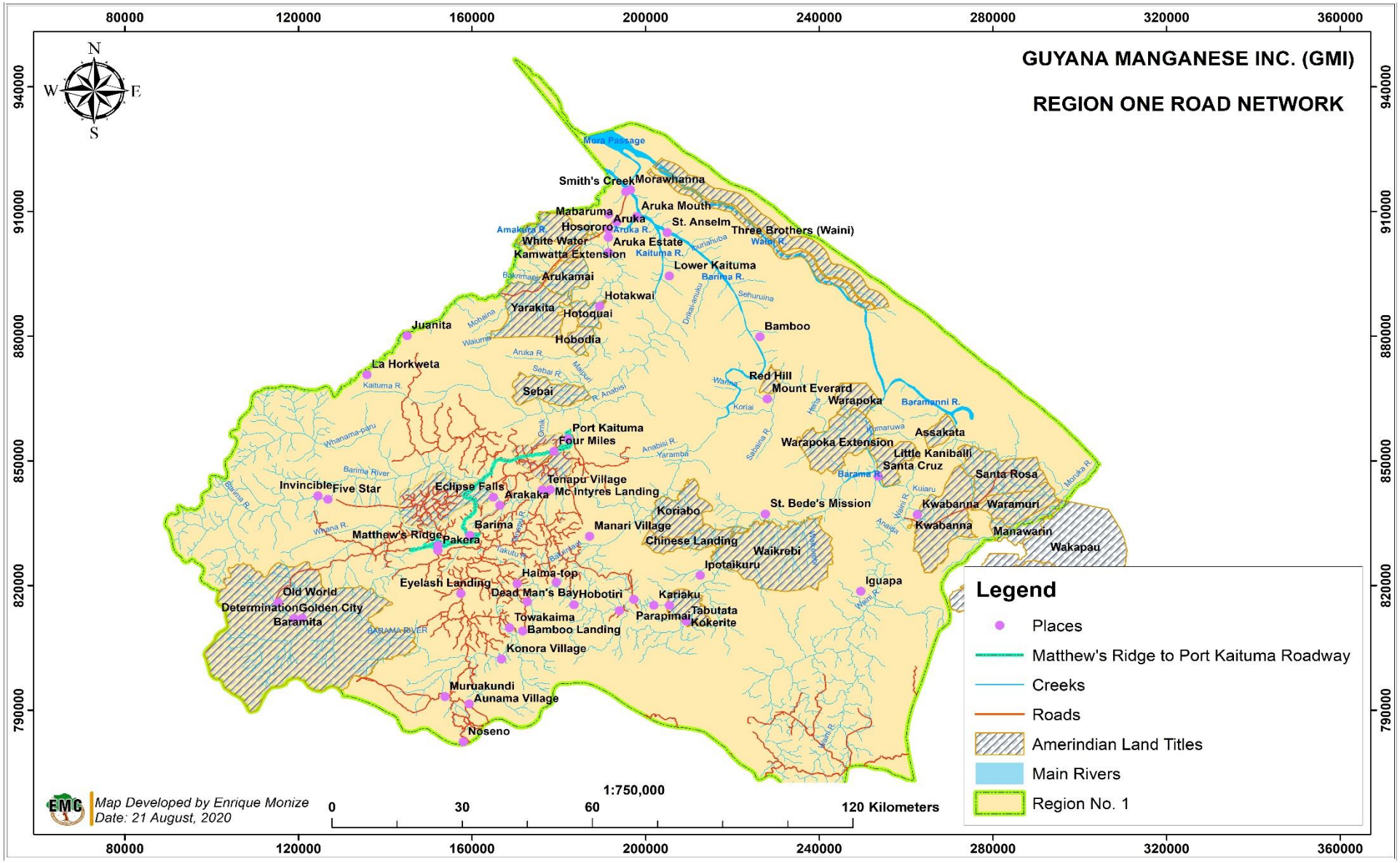


Figure 15-1: Road Network in Region 1

15.2.1 Road Transportation Network in the AoI

The Matthew's Ridge to Port Kaituma Public Road, inclusive of the bridge across the Barima River passing through the Eclipse Falls community, which was constructed to support manganese mining operations in the 1960s will also be used by GMI to transport processed ore from Matthew's Ridge to the Marine Terminal in Port Kaituma. This 75 km journey can take one and a half hour in good weather and on a fair road or two or more hours in poor road conditions and/or in the rainy season. The use of the Matthew's Ridge to Port Kaituma road as a haul road for ore will result in direct interactions with four of the five communities in the primary and secondary AoI, namely Matthew's Ridge, Eclipse Falls, Four Miles and Port Kaituma. GMI's ore transportation route from the processed ore stockpiles to the Marine Terminal in Kaituma is presented in Figure 15-2. The community bypass road which were constructed by GMI in Port Kaituma and Matthew's Ridge are also shown in Figure 15-2 and discussed further below.

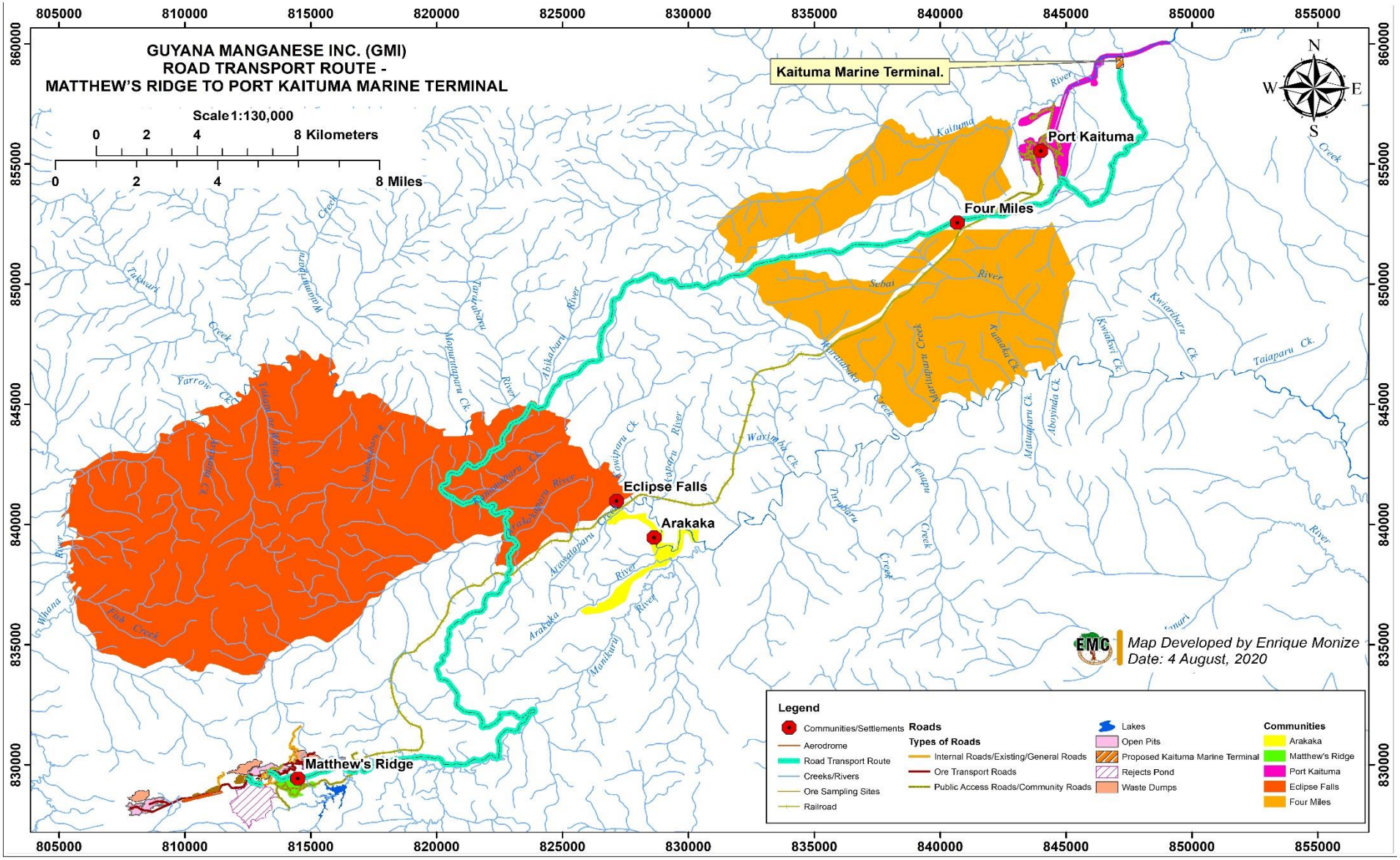


Figure 15-2: Transportation Route to be Used by GMI to Haul Processed Ore from Matthew's Ridge to Port Kaituma

This laterite capped roadway is also the primary mode of overland transport for the communities in the primary and secondary AoI to travel between communities in the Matarkai sub-district, as well as to access communities outside of the sub-district such as Baramita.

15.2.1.1 Road Network in Port Kaituma

Port Kaituma is a network of nine small settlements including Citrus Grove, Fitzburg, Compound, One Mile, Turning Basin, Teacher's Quarters, Oronoque and Four Miles which is a titled indigenous village. Canal Bank, the ninth community within Port Kaituma, is located along the river transportation route of the project. Travel within Port Kaituma may be achieved by bus, pickup trucks or ATVs. While some residents own private transportation majority of the resident rely on publicly available transportation, mainly minibuses and hire-care, to travel within Port Kaituma and to other communities within the AoI. However, both of these options may be considered relatively expensive for routine or frequent travel particularly out of Port Kaituma. There is a distributor of Honda ATVs in Port Kaituma along with another distributor of a lesser known brand. The availability and high volumes of vehicle sales in the Region is a good indicator of the high demand for this type of vehicle used in the Region mainly by miners. There are numerous four-wheel drive vehicles and lorries used for carrying fuel and other heavy items to mining camps both north-west and south of Port Kaituma.

Port Kaituma may be considered as the starting point or ending point of the Matthew's Ridge to Port Kaituma Road. The public roadway leads southwest out of Port Kaituma and directly passes through some of the communities of Port Kaituma, including the Four Miles which is a titled indigenous village. The roadway thence passes through Eclipse Falls before continuing to the Four Corners Junction with connecting laterite roads south-east leading to Arakaka and south-west leading to Matthew's Ridge. The roadway continues further south of the Four Corners Junction until it connects to the border between Regions 1 and 7.

The NDC for the Matarkai sub-district has a 24-hour Toll Booth at the entrance to Port Kaituma (Figure 15-3). Tolls are levied on a variety of vehicles and as of July 2020, the toll structure was: ATVs had the lowest toll of GYD$ 1,000, trucks had a toll of GYD$ 12,000; cars had a toll of GYD$ 3,000; canters and SUVs had tolls of GYD$ 5,000; and excavators and other heavy machinery had the highest tolls of GYD $ 75,000. Currently, these tolls are not levied on any of GMI's vehicles because the company and the NDC have entered into a MoU under which the tolls would be waived by the NDC and GMI will conduct internal repairs to the roadways in Matthew's Ridge. Due to the restrictions of the COVID-19 pandemic, the EIA team could not conduct traffic counts at several different sections of the Matthew's Ridge road. However, data recorded by the NDC Toll Booth serves as a reliable indication of traffic which typically traverses the Matthew's Ridge to Port Kaituma roadway although there are two limitations. Firstly, data is not collected for mini-buses entering Port Kaituma. Secondly, data would not be collected for vehicles traversing specific sections of the roadway such as vehicles travelling through Matthew's Ridge en-route to Arakaka or Eclipse Falls and also does not capture trucks used by other companies to conduct repairs of the laterite road between the Four Corners Junction and the Toll Booth. Although it is likely that these will result in increases in traffic along the roadway, these increases are expected to be marginal. As seen in Table 15-2, a total of 6.854 vehicles entered Port Kaituma and most of these were light vehicles, ATVs, cars and SUVs. More than 70 percent of the vehicles recorded by the station were these light vehicles. Trucks were the most frequently recorded heavy vehicle representing almost 99 percent of the heavy vehicles recorded by the Toll Booth.

Table 15-2: Traffic Count of Vehicles Entering the Port Kaituma in 2019

Month	ATVs	Cars	SUVs	Canter	Trucks	Tractor	Excavators and Other Heavy Machinery	Total
January	180	155	138	0	168	0	3	**644**
February	76	194	145	0	122	0	0	**537**
March	81	165	135	0	154	0	0	**535**
April	69	172	142	5	147	2	4	**541**
May	92	168	131	2	119	1	1	**529**
June	112	157	122	4	134	0	0	**583**
July	135	142	138	7	161	0	0	**533**
August	73	134	125	12	176	0	2	**522**
September	143	127	114	9	192	0	5	**590**
October	156	164	142	14	187	0	1	**664**
November	166	144	153	19	175	1	0	**658**
December	129	123	137	6	139	0	3	**537**
Total	**1,412**	**1,845**	**1,622**	**78**	**1,874**	**4**	**19**	**6,854**

Figure 15-3: NDC Toll Booth at Four Miles

During the construction phase of the project, GMI established its base in Port Kaituma at the log pond area which was previously established by BCL. This site is accessed by traversing the main road in Port Kaituma and then following a branch of this road to the log pond facility at Oronoque. These roads also pass through the Four Miles Village. This facility was actively used during the construction phase of the project including for the storage of heavy machinery. The road is used by the residents of Port Kaituma, and in particular, by pedestrians, including school children. During rainy conditions, this road is typically in a poor condition as seen in Figure 15-4.

Figure 15-4: Road Leading from the Log Pond Facility (January 2020)

In light of concerns of safety, dust generation, and damage and maintenance of infrastructure, during the construction phase of the project GMI constructed a 9.7 kilometer road to lead to the Marine Terminal and bypass most of the settlements in Port Kaituma. The turn off junction for the bypass road is located along the main road within the boundary of the Oronoque settlement and was deliberately chosen to bypass the main community settlement at Port Kaituma. This will eliminate the concerns associated with traversing through the community and using the community road. Figure 15-5 shows a section of the bypass road constructed by GMI while Figure 15-6 shows the current roads leading to the community and the road constructed by GMI for their use to access the Marine Terminal.

Figure 15-5: A Section of the GMI Bypass Road to the Kaituma Marine Terminal (January 2020)

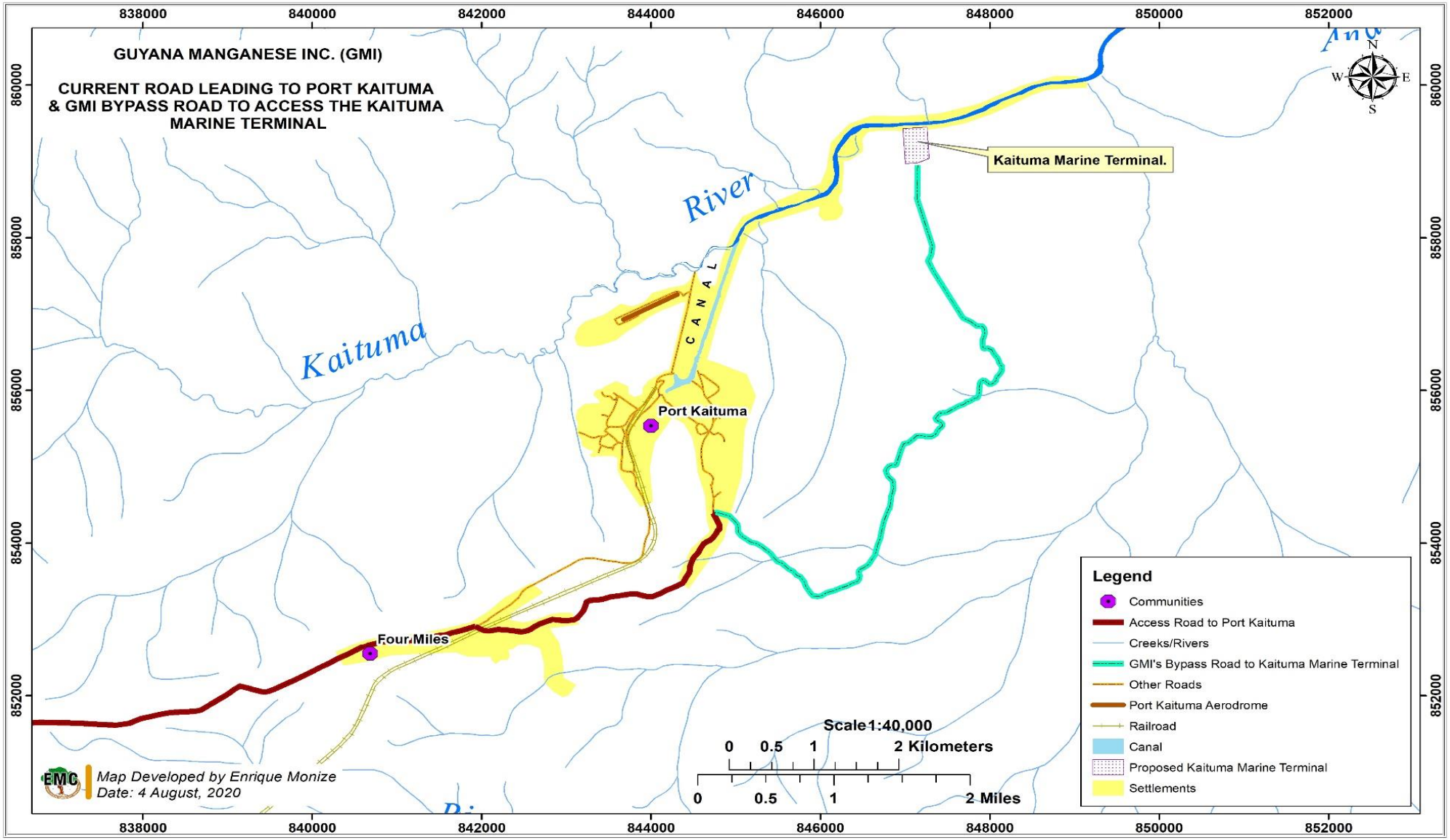


Figure 15-6: Public Roads Leading to Port Kaituma and Bypass Road Constructed by GMI

15.2.1.2 Road Network in Matthew's Ridge

The public road transportation network in Matthew's Ridge heads northeast to the Four Corners Junction and continuing further north leads to Eclipse Falls, Four Miles and ultimately, to Port Kaituma. The road network heading west and southwest out of Matthew's Ridge leads to the Matthew's Ridge airstrip and continues to Baramita and mining areas such as Chinese Landing. Neighbouring communities and mining areas are accessed by buses, pickup trucks or ATVs. Commute time varies with the condition of the road. For example, Arakaka is located 23 killometers east of Matthew's Ridge and travel time varies from 45 minutes to 1 hour depending on the weather and condition of the road. While some residents own private vehicle for transportation, most of the residents rely on publicly available transportation. There are eight residential areas in the community namely: Rail-End, Garrison Hill, Hell Hill, Heaven Hill, Hole, Flats, Pakera and Minab each of which is connected by internal road networks. Residents move around the community principally as pedestrians or using ATVs, buses or pick-up trucks. In recent years, GMI has undertaken periodic repairs of the road to Port Kaituma and Arakaka. As previously mentioned, the company also made commitments in a MoU with the NDC to support with the repairs and maintenance of internal roads in the Matthew's Ridge community. However, according to the RDC and the NDC these obligations are not being totally fulfilled (EMC Personal Communication 02, 15, 17 and 18).

The road linking GMI's processing plant in Matthew's Ridge to the public roadway leading to Port Kaituma passed through the Matthew's Ridge community. In light of considerations of safety, dust generation, and damage and maintenance of infrastructure, during both the construction and operational phases of the project, GMI constructed a road from the processing plant that follows the alignment the old railway and ultimately connects to the Matthew's Ridge to the Port Kaituma roadway in the vicinity of the pump house. The alignment of this bypass road is presented in Figure 15-8, while a section of the roadway is shown in Figure 15-7 (left).

In addition, the existing access road to the Matthew's Ridge airstrip and the communities further west, such as Baramita, passed very close to GMI's processing plant. To avert shared used of this roadway by community traffic, including pedestrians, light vehicles and heavy vehicles, GMI co-opted the previous public road as one of its internal roads and alternatively, constructed a bypass road for community use. This road was completed during the construction phase of the project and a section of the roadway is shown in Figure 15-7 (right). In addition, GMI is constructing a bypass road which will be used by trucks and other company traffic traversing to and from the Hill 9 mine so as to reduce the exposure of public traffic to GMI's traffic for another section of the road which leads to the airport. This rerouting of the access road at the processing plant and the bypass being constructed by GMI to and from Hill 9 are shown in Figure 15-9.

Figure 15-7: Newly Constructed Bypass Road around the Matthew's Ridge Community (left) and around the Processing Plant to the Airstrip (right) [July 2020]

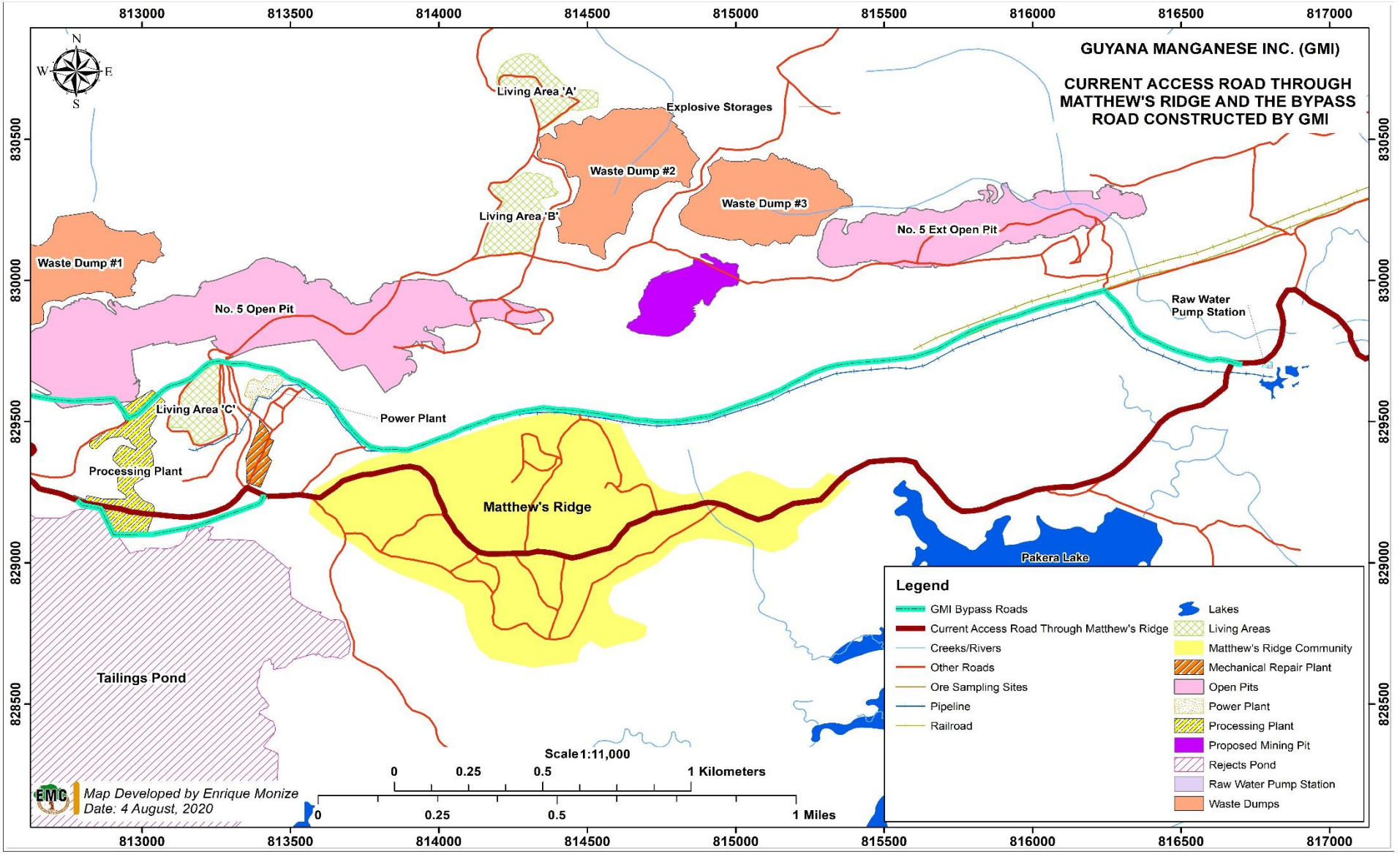


Figure 15-8: Bypass Road Connecting to the Matthew's Ridge to Port Kaituma Public Roadway

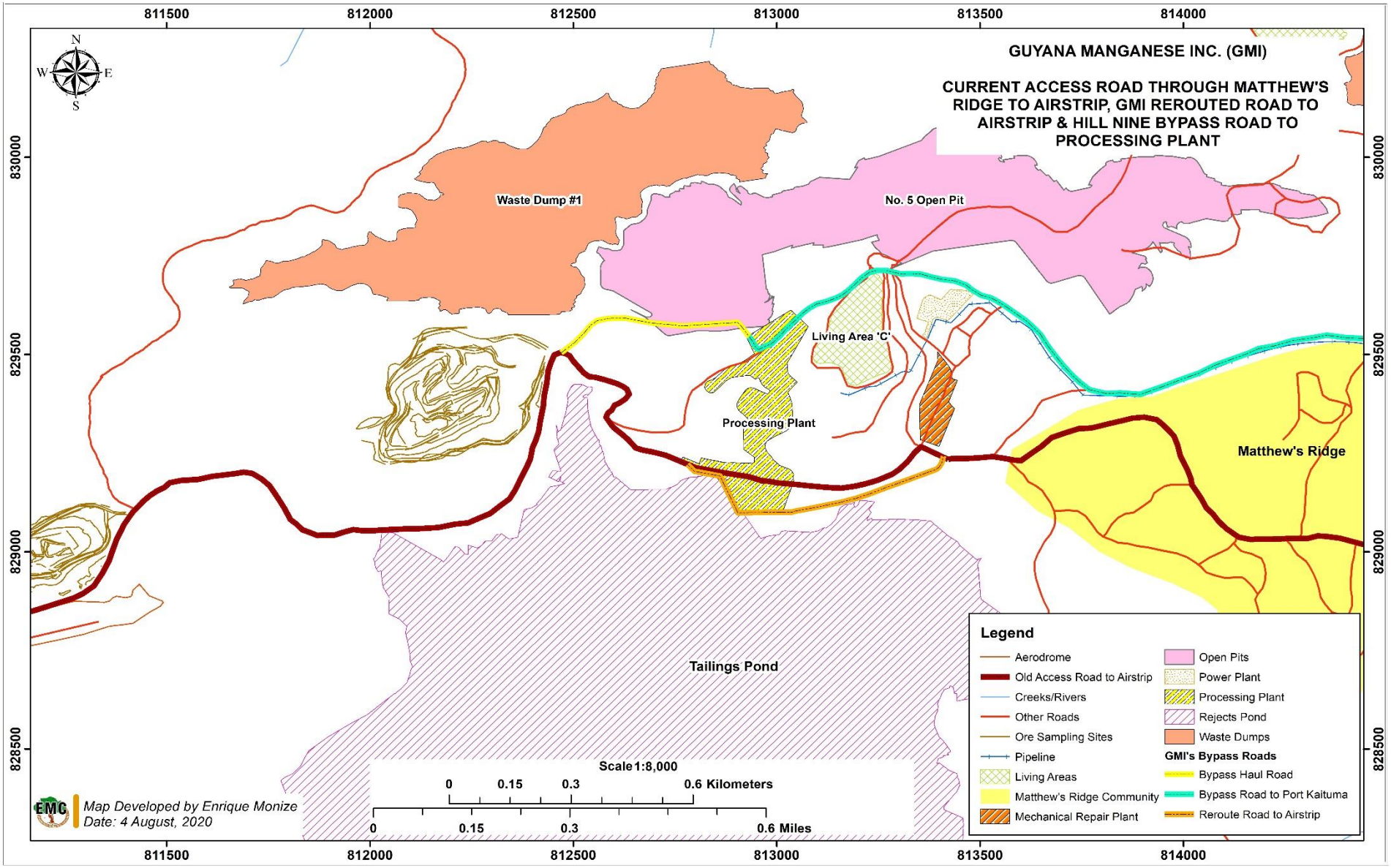


Figure 15-9: Bypass Roads Heading West of GMI's Operations to the Airstrip and Communities Beyond

15.2.1.2.1 Road Transportation in Eclipse Falls

The public road and Eclipse Falls Bridge connecting to Matthew's Ridge, Arakaka and Port Kaituma pass through the Eclipse Falls community. Maintenance of this infrastructure is the responsibility of the NDC. While some residents own private transportation majority of the residents rely on publicly available transportation mainly in the form of buses. Secondary school students from Eclipse Falls also use publicly available transportation to travel to Port Kaituma to attend school. Bus fares for adults from Eclipse Falls to the waterfront of Port Kaituma are GYD$3,000 and to Matthews Ridge GYD$5,000 per person. One-way hires to Port Kaituma are also expensive: cars charge GYD$15,000 and buses GYD$30,000. A return trip on a hired bus costs GYD$40,000. The community does not own a communal vehicle.

Residents located in proximity to the road are frequently challenged by significant dust emissions from which vehicles traverse the road particularly in the dry seasons. There are also concerns that increased traffic and heavy vehicles using the roads will impact the safety of road users, in particular children walking over the bridge (Figure 15-10).

Figure 15-10: Heavy Vehicles passing through the Eclipse Falls Village (left) and on the Eclipse Falls Bridge (right) [July 2020]

15.2.1.2.2 Road Transportation in Four Miles Village

Road network is the main mode of transportation and the public road connecting Port Kaituma to Matthew's Ridge passes through the Village. Some residents own private transportation but majority rely on publicly transportation mainly in the form of buses. However, fewer buses operate when the roads are in poor condition during the rainy season. Primary and secondary school students from Four Miles village also use publicly available transportation to travel to Port Kaituma to attend school. Bus fares for adults are GYD$500 from Four Miles to Port Kaituma while children pay a fare of GYD$100. Privately owned vehicles include pickup trucks and ATVs. The Village Council does not own a community vehicle.

Residents located in proximity to the road are frequently challenged by significant dust emissions generated by vehicles traversing the road, particularly in the dry seasons. There are also concerns that increased traffic and heavy vehicles using the roads will impact the safety of road users. A section of the roadway passing through the Four Miles community is shown in Figure 15-11.

Figure 15-11: A Section of the Road Passing through the Four Miles Community

15.2.1.2.3 Road Transportation in Arakaka

Road network leading out of Arakaka meets the Port Kaituma and Matthew's Ridge roadway at the Four Corners Junction. Travelling north of the Four Corners Junction leads Port Kaituma and west to Matthew's Ridge. Residents typically travel by buses, pickup trucks and ATVs. Arakaka also has a community bus. Only a few residents own private transportation and majority rely on publicly available transportation using either the community bus or taxi for travel within the community or to neighbouring areas. The cost of transportation internally in Arakaka is GYD$ 1,000 per passenger and GYD$ 3,000 per passenger using the community bus to Matthew's Ridge. A section of the roadway within Arakaka is shown in Figure 15-12.

Figure 15-12: A Section of the Roadway within Arakaka

15.2.2 River Transportation Network in the AoI

Historically, the manganese ore was exported from Port Kaituma to Trinidad via two ships which were

rehabilitated as barges. The Ambrosio and the Inverrosa, were converted into manganese carriers as part of the project. They made the trip from Port Kaituma to Chaguaramas on a regular four-day cycle for much of the 1960s. With a displacement of just under 3,000 tons, they were originally built in the mid-1920s with a shallow draft to ship oil across shallow sand-bars at the mouth of Lake Maracaibo in Venezuela. The ability to slip over sand bars in very shallow water was essential to being able to get across Waini Bar at the mouth of the River.

The river transportation route was specially created for the export of manganese in the 1960s by creating the Kaituma Canal and establishing a turning basin and wharfing facilities therein, and also dredging of the Mora Passage and sections of the Barima River. The river transportation route created for manganese export in the 1960s will also be used by GMI to export manganese to Trinidad. Project barges will travel out of Port Kaituma via the Kaituma River and head west along the Barima River at its confluence. Vessels will then travel through the Mora Passage and the Waini Estuary before entering the Atlantic Ocean. This river transportation route will interact directly with communities in the primary and tertiary AoI of the project including the Canal Bank settlement in Port Kaituma, as well as the communities of Lower Kaituma, St. Anselm, Aruka Mouth, Smith's Creek and Morahwanna. In addition, GMI has acquired land on the eastern bank of the Kaituma Canal, approximately 5.5 kilometers downstream of the existing turning basin, for the construction of a Marine Terminal. GMI plans to dredge a new turning basin in the Kaituma Canal adjacent to the Marine Terminal. The location of the Marine Terminal as well as the route to be used for river transportation of ore and the communities located along this route can be observed in Figure 15-13.

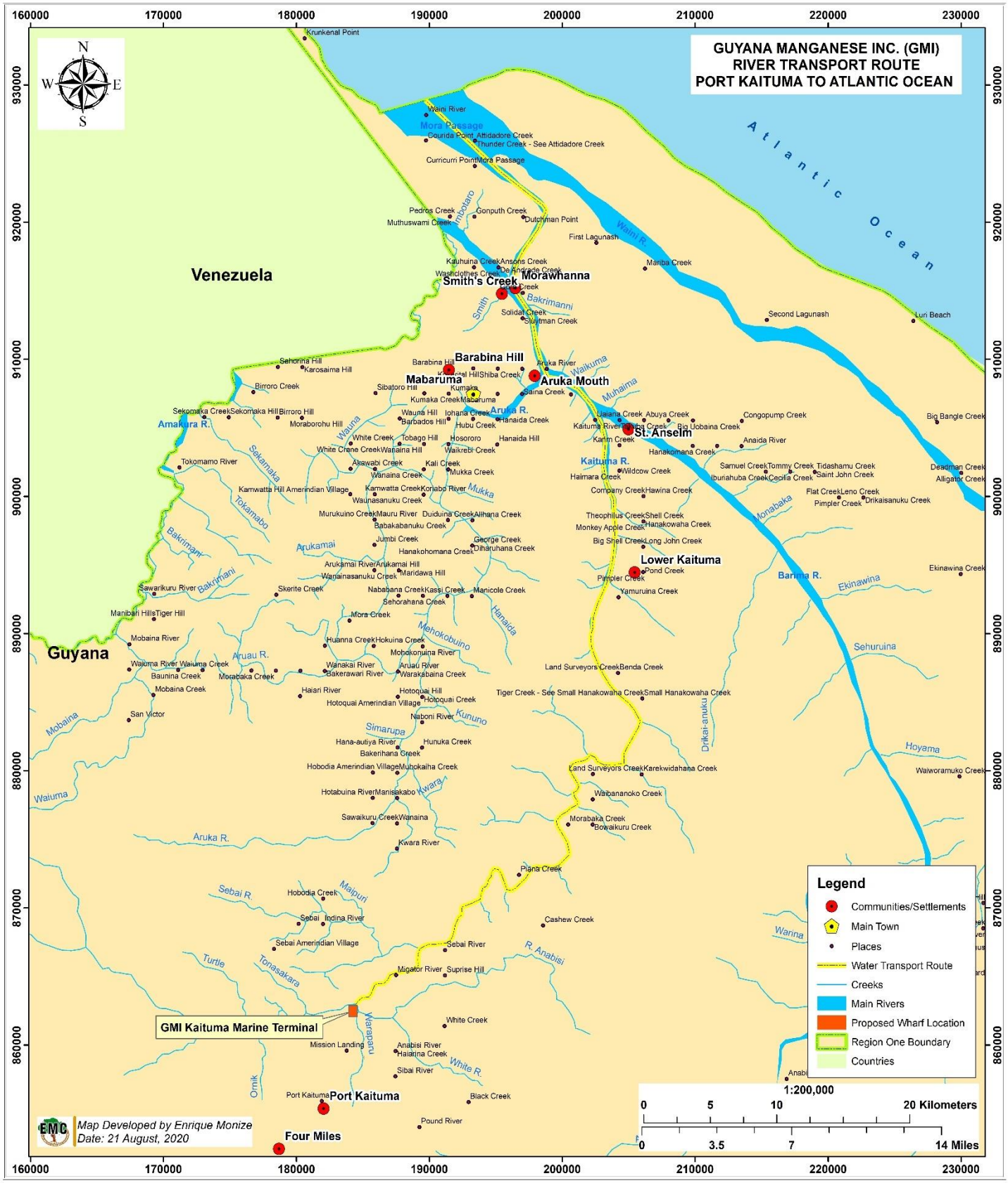


Figure 15-13: River Transport Route and Communities Located along the Route

This river transportation network is essential to the lives and livelihoods of the settlements located along the river transportation route and beyond. Within the primary AoI of the project, river cargo is one of the principal methods through which Port Kaituma and the other communities in the Matarkari sub-district (Matthew's Ridge, Arakaka, Eclipse Falls, Four Miles, etc.) are supplied with food, fuel and other essential supplies imported from Georgetown and Venezuela. These vessels travel into the Kaituma Canal from the Atlantic Ocean, through Waini Point, the Mora Passage and the Barima River before entering the Kaituma River.

In Port Kaituma the existing river transportation infrastructure comprises of two dedicated landing areas (Figure 15-14). A local office of the Maritime Administration Department (MARAD) was recently established at Port Kaituma to regulate vessel landing and docking at the Kaituma Landing. The two landing areas in Port Kaituma facilitate passenger travel and cargo imports, specifically:

- Imports of fuel and other cargo including food items and vehicles into Port Kaituma. Many communities depend on these imports including Four Miles, Eclipse Falls and Matthew's Ridge. Approximately seven cargo vessels and 12 fuel boats also are considered frequently landed vessels by the Chairperson of the NDC (EMC Personal Communication 17). A tug and barge also arrive on a fortnightly basis to transport vehicles into Port Kaituma. These vessels enter the Region from the Atlantic Ocean via the Waini Point, Mora Passage, the Barima and Kaituma Rivers then into the Kaituma Canal.
- Fortnightly ferry service operated by the Government's Transport and Harbours Department operating the Georgetown to Port Kaituma route utilising the MV 'Barima', the MV 'Kimbia' or MV 'Lady Northcote' vessels. These vessels enter the Region from the Atlantic Ocean via the Waini Point, Mora Passage, the Barima and Kaituma Rivers then into the Kaituma Canal. Due to social distancing restrictions of the COVID-19 pandemic, the ferries have been operating at half of their passenger capacity recently.
- Daily small passenger vessels from Mabaruma, Moruca and Arakaka in Region 1 and Charity in Region 2. However, passenger boats from Port Kaituma occasionally travel as far as the Supenaam River up the Essequibo River. The operation of all of these vessels were temporarily halted due to safety precautions associated with the COVID-19 pandemic. The final leg of passenger boats from Moruca and Charity enter the Region either from the Atlantic Ocean via the Waini Point, or from Moruca via the Moruca, Baramani and Waini Rivers, then into the Mora Passage, the Barima and Kaituma Rivers then into the Kaituma Canal. Passenger boats from Mabaruma travel to the confluence of the Aruka and Barima Rivers before heading into the Kaituma River and Kaituma Canal. Boats from Arakaka travel northbound on the Barima River before entering the Kaituma River and then into the Kaituma Canal. Boats from Arakaka also travel upriver of the Barima to Eclipse Falls and beyond.
- Four community owned-boats operates in Port Kaituma.

Figure 15-14: Landing Areas for Passenger and Cargo Vessels in Port Kaituma

There are approximately 300 to 400 houses located on Canal Bank with each household owning at least one boat for their transportation needs. These boats are typically canoes and small boats. Residents who can afford it use small outboard engines of 5, 10 or 15 horsepower. These vessels are used by residents on a daily basis to travel to Port Kaituma or to other homesteads or farmlands located along the Canal Bank. Children also use small boats, typically canoes to travel to school. The use of these small vessels in the Kaituma Canal is shown in Figure 15-15. In addition, residents engaged in agriculture to transport their produce to the markets in Port Kaituma on Wednesdays and Saturdays.

Residents from the Canal Bank and Port Kaituma frequently fish in the Kaituma Canal for sustenance. In addition, operators of the fuel boats also catch fish in the Kaituma Canal. Residents have noted that fish caught sometimes smell and taste of diesel and believe this may be due to fishing by fuel boat operators. On weekends, residents from communities in Port Kaituma such as Fitzburg and Oronoque among others also visit the Canal Bank for recreational purposes including swimming. In particular, there is a small resort called Dawn's Resort on the western bank of Canal Bank which is frequented by the locals particularly on weekends.

Figure 15-15: Small Vessels in the Kaituma Canal

Settlements in the tertiary AoI also significantly depend on the remaining section of the river transport route for their lives and livelihoods. The section of the Barima River from Aruka Mouth to Morahwanna, and to a lesser extent the Mora Passage is especially busy on Tuesdays and Saturdays which are market days at the Kumaka waterfront in Mabaruma. According to the Toshao of Smith's Creek, approximately 60 vessels use the Barima River passing Smith's Creek on these market days. Specifically, river traffic in the tertiary AoI includes:

- Approximately 15 boats supplying fuel purchased from Venezuela and transported via the Mora Passage and Barima River. These vessels dock at Waini Point or at Morawhanna before travelling on to Port Kaituma or other areas with fuel.

- Fortnightly ferry service operated by the Transport and Harbours Department into Mabaruma or Port Kaituma via the Waini Point, Mora Passage and the Barima River.

- The community of St. Anselm has approximately 100 households each of which has at least one boat for its transportation needs. Small-scale farmers and fisherfolks from St. Anselm also take produce to the Mabaruma market in Tuesdays and Saturdays for sale. Similarly, residents of Lower Kaituma also have small vessels owned by each household and transport produce to the market in Mabaruma on Tuesdays and Thursdays. Students from St. Anselm also travel to Mabaruma or Hosororo to attend school. Finally, residents from At. Anselm use the river transportation network to deliver harvested manicole (heart-of-palm) to the AMCAR factory.

- Smith's Creek and Morahwanna Villages see a combined vessel fleet of approximately 100 comprising 2 large fishing vessels (trawlers), 14 artisanal fishing boats, 20 fuel boats, 60 canoes

and other small boats for transportation, based in the vicinity of the communities since Morawhanna is a the first point for administrative services[158] within the Region and a key trading post. Smith's Creek has a one 17-seater school boat which transports students to school in Mabaruma and Hosororo and three fishing vessels.

- The peak days for traffic in the Barima River in the vicinity of Smith's Creek coincide with market days at Kumaka which occur on Tuesdays and Saturdays. On those days, vessel type and quantity in the Barima River are estimated as follows:
  - 13 fuel boats.
  - 15 fishing boats.
  - 30 small canoes.

  River traffic is significantly lower on non-market days with an estimated 8 vessels traversing the Barima River in the vicinity of Smith's Creek.

- Residents from Almond Beach, Father's Beach, Imbotero and communities further afield bringing produce, such as crabs, to sell in the market at Mabaruma via the Waini Point, Mora Passage and the Barima River.

- Fisherfolks from several of the coastal communities of Region 1 travel to Waini Point for fishing. In addition, some larger artisanal fishing vessels from Charity in Region 2 also fish along the Region 1 coastline, sometimes in the vicinity of Waini Point.

15.2.3 Air Transportation

Region 1 has numerous airstrips providing access to its communities. However, two of these airstrips are located in Matthew's Ridge and Port Kaituma. Other main airstrips within the Region includes Mabaruma and Bimechi. The airstrip at Matthew's Ridge is approximately 10 minutes from GMI's the administrative area and approximately one hour and fifteen minutes from Eugene Correia International Airport (ECIA) at Ogle. The airstrip is managed and maintained by the Guyana Civil Aviation Authority (GCAA) and is opened to private parties, domestic charters and the Guyana Defence Force. Several private operators offer daily return flights to Matthew's Ridge from the ECIA. Chartered flights also operate this route. During the exploration and construction phases of the project, GMI chartered flights to deliver food from Georgetown to its operations in Matthew's Ridge. The Matthew's Ridge airstrip can be observed in Figure 15-16.

In Port Kaituma, the airstrip is approximately 15 minutes to either the log pond facility of the Marine Terminal that latter of which is access by the bypass road. The Port Kaituma airstrip is accessible by flights originating from the ECIA. Local air service operators provide daily return flights from the Eugene F. Correia International Airport. The Port Kaituma airstrip was temporarily closed in 2020 to facilitate rehabilitation and renovation an travelers were using the Matthew's Ridge Airstrip instead.

[158] The Coast Guard, Police and the Guyana Revenue Authority are based in Morawhanna.

Figure 15-16: Matthew's Ridge Airstrip

15.3 Impact Assessment – Transportation

There will be positive and negative impacts from the project activities of GMI. The positive impacts will directly and indirectly benefit the local communities, Region 1 and the Guyanese nation. The negative impacts present opportunities for GMI and the Guyanese community to act and mitigate or reduce the scale of these impacts.

15.3.1 Potential Impacts of Road and Wharf Rehabilitation and Construction

As previously discussed, the existing public road will be utilised to haul ore from the processing plant at Matthew's Ridge to the Marine Terminal in Port Kaituma. According to the Ministry of Public Infrastructure (MOPI), the Government has engagements with two private contractors to maintain different sections of the Matthew's Ridge to Port Kaituma roadway (EMC Personal Communication 12). However, to facilitate the ease of ore transport, GMI will upgrade the laterite surfaced road to more exacting engineering specifications for safe and efficient concentrate transport, material supply and personnel movement, as well as for use by the general public. The upgrades will result in an 8 meter dual-lane road and gradients not exceeding 9 percent, and will also have a minimum turning radium of 15 meters. In some sections, there will be widening of the road, the straightening of curves, the creation of improved sight lines and the installation of safety signage. Drains and culverts have already been installed along the roadway with some being done by the Government contractors and others by GMI. GMI will continue to work with the local contractors to ensure that these drainage features are maintained. GMI's rehabilitation efforts have been ongoing throughout the construction phase of the project including by replacing the top layer of laterite, levelling the road with a grader and laying of conduits. GMI will also refurbish and reinforce the bridge across the Barima River at Eclipse Falls with an abutment bridge. This will include cleaned-up, significant repair, and strengthened to achieve its original safe and efficient load limits. The structure will be reinforced by building a pillar at 30 meters from the Matthew's Ridge end and a second layer of bailey structure for 42.7 meters long from the Port Kaituma end.

Maintenance of this haul road, bridge and drainage features will be done consistently by GMI throughout the 13 years of project life. These initiatives will contribute positively to the Region and the communities since the improved roadway will be utilised by all, which will improve travel time and safety, and reduce the maintenance cost for vehicles. This will contribute to improving the economic wellbeing of residents and other personnel. Further, it will allow for Regional and Government authorities to divert and utilise funds which would have been used for the road maintenance for other areas of development for the Region. GMI will also allow share use of the bypass roads constructed

in Port Kaituma and Matthew's Ridge. An improved roadway also has the potential of boosting development of other industries including tourism, education, transportation and agriculture. Potential impacts associated with GMI's rehabilitation of the Matthew's Ridge to Port Kaituma public road are **positive, direct, long-term** and **localised**. These impacts are of **moderate significance** and are **certain** to occur throughout the lifetime of the project.

The NDC and GMI have entered into a formal MoU under which the NDC waived tolls for GMI's vehicles entering Port Kaituma and GMI committed to repairing and maintaining the internal roads and bridges in Matthew's Ridge. However, the NDC has shared its dissatisfaction with GMI in fulfilling its obligations under the MoU and is actively considering withdrawing from the MoU (EMC Personal Communication 17) and levying half of the existing toll on GMI's vehicles entering Port Kaituma. The NDC's consideration and decision to withdraw from the MoU are also supported by the Regional Administration of Region 1 (EMC Personal Communication 18). The NDC has also indicated that BCL, when it was operational, and other companies currently operational within the Matarkai sub-district more actively fulfil the commitments undertaken and are willing to contribute to community development (EMC Personal Communication 15). In addition, concerns were also raised that when there is rehabilitation of the internal roads the materials are not the appropriate gradation of stone and that large boulders which are used to fill potholes are easily displaced (EMC Personal Communication 13). The potential impact of non-fulfilment of the MoU are **negative, direct, short-term** and **localised**. These impacts are of **moderate** significance and are **likely** to occur during the project. Non-fulfillment of the MoU with the NDC is a **Medium Risk** of the project. However, GMI has contended that the possible reason for this view by the NDC and RDC is limited communication between GMI the councils since a lot of work was done in the communities by GMI in relation to the fulfilling of social responsibilities. GMI plans to improve on this communication in the near future.

Road construction and maintenance can contribute to traffic delays and affect road safety and will have to be properly managed. Although delays will lead to frustrations, it is unlikely that there will be significant delays or traffic build up given the low volume of traffic which typically uses the road. During the rehabilitation of the road connecting Matthew's Ridge to the Four Corners Junction, stakeholders reported negative experiences associated with project activities in particular unsafe storage of road construction materials that blocked sight lines as well as the absence of any traffic management measures (EMC Personal Communication 13). However, these concerns were not widespread. In addition, these actions are entirely mitigable if appropriate practices are followed to stockpile materials and measures are put in place to manage traffic during the construction process. These adverse impacts will be **direct, moderate, short term** and **localised**. These impacts are of **minor** significance and are **unlikely** to reoccur during the project lifetime if appropriate mitigation measures are put in place. As a result, potential impacts of lowered road safety or traffic delays during road rehabilitation are **Low Risks** of the project.

During road rehabilitation and construction, there are risks of hydrocarbon spills as well as dumping of garbage by construction crews contaminating soils and adjacent water streams. As discussed in Chapter 12 – Biological Resources, accidental spills of lubricants and fuel and other contaminants can adversely harm aquatic fauna. In addition, many settlements in the project AoI depend of surface water flows for domestic purposes, in some cases including drinking, and contamination of these sources could result in adverse health outcomes. However, any spill of hydrocarbon from transport equipment will be small and can easily be contained and cleaned up. Garbage generation by transport crews will be minimal and workers will be made aware to the required practices for disposal. As such, these potential impacts are **negative, direct, long-term** and **localised** of **moderate significance** but may r**arely** occur. Therefore, contamination of surface water flows during the construction activities is a **Low Risk** of the project.

As discussed, in Chapter 12 – Biological Resources, construction of project transportation infrastructure could adversely impact flora as well as terrestrial and aquatic fauna. These include:

- Clearing of secondary growth vegetation posing impacts of loss of habitats and intensification of habitat fragmentation.
- Clearing of mature forests resulting in the creation of a new forest edge, vegetation clearing creating a barrier to the dispersal and movement of some animals.
- Loss of aquatic habitats from dredging the Kaituma Canal,
- Construction of culverts and other drainage features modifying migration and spawning patterns of fishes.
- Wildlife disturbances, collisions with construction traffic, and hunting by construction crews.

Detailed discussions, impact ratings and risk rating of these impacts is discussed in Chapter 12.

Construction of the 9.7 kilometers bypass road at Port Kaituma to access the Marine Terminal will present the opportunity for persons to access areas which were previously difficult to access. This can result in an increase in activities in this area, including farming, mining, hunting and fishing, which can in-turn affect the resources of the area. However, the GFC has indicated that the area in which the Port Kaituma bypass road was constructed is located within heavily degraded forests, due in part to the extensive agricultural activity in the 1960s and 1970s, and that the bypass road does not pass through any forest concessions. For evidence observed during the field work aspect of the EIA, persons were already accessing these areas for farming, artisanal mining and hunting, but the access was challenging. Persons accessing the areas along this access road are expected to do so for sustenance or livelihood purposes only. As such, impacts for the creation of this access is expected be **positive, direct, long-term and localised** of **minor significance** but are **certain** to occur. These impacts present a **Medium Risk**, which is positive, especially since it can contribute to improved livelihood.

15.3.2 Potential Impacts from Increased Traffic and Shared Use of Roads

GMI will have a fleet of 30 25-ton haul trucks to transport the ore from the processing facility to the Marine Terminal. During the dry seasons, haul trucks will make two return trips per day. Each truck making 2 return trips will result in an additional 60 return trips or 120 one-way trips per day. This is a significant increase in heavy traffic traversing the Matthew's Ridge to Port Kaituma road. During the wet season, it is anticipated that trucks will make one return trip per day resulting in 30 return trips or 60 one-way trips per day. Light vehicles belonging to GMI are also expected to make occasional trips between the two project locations. As a consequence, the project will contribute to a significant increase in traffic entering Port Kaituma and by extension, travelling along the Matthew's Ridge to Port Kaituma public road. In September 2019, 192 trucks were recorded entering Port Kaituma by the Toll Booth with an average of approximately 6 trucks entering per day. Moreover, in October 2019, the highest number of all vehicle classes were recorded entering Port Kaituma with 664 vehicles for a daily average of approximately 22 vehicles. As a consequence, during the dry season there is expected to be a 10-fold increase in heavy vehicles entering Port Kaituma per day while in the wet season the increase is expected to be 5-fold.

Increased traffic is likely to be associated with several potential impacts. In particular, dust generated when vehicles traverse the laterite road is expected to increase. According to feedback provided by representatives of the Guyana Geology and Mines Commission (GGMC), during the dry seasons, dust emissions from the Matthew's Ridge to Port Kaituma public road result in considerable changes in daily life of the residents of Eclipse Falls who were reported to have to wait until evening and nights, when traffic is lower, to hang out their laundry (EMC Personal Communication 10). According to the Chairperson of the Eclipse Falls Community Development Council, dust covers the roofs of houses and hinders rainwater collection because the dust has to be washed off of the roof surface before rainwater collection can begin. Residents at Eclipse Falls also suggest that dust emissions may lead to illnesses such as cold and flu, especially among children (EMC Personal Communication 20). Dust

emissions were also reported to cover internal surfaces of homes in Four Miles Village (EMC Personal Communication 19).

Increased emissions of dust generated by project vehicles are anticipated to result in several potential impacts. Existing challenges of managing dust levels from the road during the dry season will be amplified for residents of Eclipse Falls. GMI has made provisions for a watering truck to dampen the road during dry season from the operational site in Matthew's Ridge to the Four Corners Junction, and in Port Kaituma from the Toll Booth to the Marine Terminal. GMI also plans to dampen the community roads in Port Kaituma and Matthew's Ridge as part of its Corporate Social Responsibility. However, there are no provisions for wetting the sections of the road which project vehicles will use to pass through Eclipse Falls on return trips between Matthew's Ridge and Port Kaituma since this pose significant logistical challenges given the distance of the community from GMI's operational bases in Matthew's Ridge and Port Kaituma. These challenges include refueling water trucks and locating an appropriate source of water. However, GMI will construct and maintain at least one speed bump on the road passing through Eclipse Falls to reduce the speed of project and non-project vehicles passing through the community so as to reduce dust levels generated from the road. Drivers of GMI's vehicles will also be required to transit through the community at lower speeds and GMI will also patrol the area and liaise with residents to ensure that there is compliance with this policy. Defaulting project drivers will be subject to disciplinary measures.

Road wetting is expected to be done daily during the dry season. Increased net radiation and evaporation during the dry seasons in combination with the frequent passages by vehicles may result in rapid drying of the road therefore still exposing communities such as Four Miles to dust emissions. Increased dust generated along the Matthew's Ridge to Port Kaituma road is also likely to reduce visibility for all road users, including pedestrians, and therefore create unsafe driving conditions. Increased dust levels could also lead to adverse impacts to biodiversity. The potential impacts associated with dust emissions are **negative, direct, short-term** and **localised** of **moderate significance** but are **certain** to occur. As such, dust emissions associated with increased traffic is a **High Risk** of the project.

Increased traffic could also contribute to unsafe road use conditions and an increase in vehicular accidents along the roadway. GMI will share use of the road transportation infrastructure with local communities, in particular the communities located in the Matarkai sub-district. Although GMI's vehicles will increase road traffic, it is unlikely to result in traffic jams or create significant delays in commute times. However, there are potential adverse impacts associated with increased traffic. There have been reports of GMI's vehicles traversing the roads through Four Miles and Eclipse Falls at relatively high speeds. In addition, the Toshao of the Four Miles village indicate that speed and unsafe driving practices caused two separate accidents of GMI's vehicles overturning on the public road which passes through the Village (EMC Personal Communication 19). This concern was reiterated by a Councilor from Four Miles during a discussion with the EIA team during the July 2020 field trip to collect data related to the physical baseline. The Chair of the Eclipse Falls CDC shared concerns about heavy vehicles frequently using the roads and bridge in the community which are also used by pedestrians and school children (EMC Personal Communication 20). School children from both Eclipse Falls and Four Miles are both pedestrians in their village and also use local minibuses to travel to Port Kaituma to attend primary and secondary school. Project vehicles using the roads, especially at nights, will also increase the probability for vehicular incidents. These risks are further increased if other heavy vehicles are using the roads passing through these communities at the same time. However, there will be no ore transport at nights. GMI conducts safety training regularly and employees who breach the safety policy face disciplinary actions. Drivers will also work on a shift system to reduce fatigue. GMI will also avoid transporting ore during the morning peak traffic periods. As previously discussed, GMI will also rehabilitate sections of the road to make them wider and safer. Potential impacts of unsafe road use and increase accidents are **negative, direct, long-term** and **localised**. Given that these accidents could potentially result in a loss of life, these impacts are

considered to be of **major significance**. Although these impacts can be mitigable, they have already occurred and are **likely** to reoccur during the project lifetime. As such, unsafe road conditions and the potential for increased vehicular accidents are **High Risks** of the project.

As previously discussed, GMI will allow share use of project roads including the bypass roads constructed in Port Kaituma and Matthew's Ridge. This will likely result in pedestrians as well as a range of non-project light vehicles, such as ATVs and SUVs utilising these roads. Shared use of the project road is expected to result in **positive, direct, long-term** and **localised** socio-economic impacts of **moderate significance**. For example, small-scale commercial agriculture and mining have already commenced on the lands adjacent to the bypass road in Port Kaituma. Nonetheless, shared use of project roads is also anticipated to result in adverse impacts. In particular, community traffic will also be using the bypass roads even though these roads were constructed specifically to prevent incidents or road accidents with community traffic and pedestrians. Moreover, according to GMI's mining method, manganese ore from the previously used tailings pond will be mined and therefore will have to be transported to the processing plant. Although GMI has put several measures in place to avoid mines machinery and vehicles from interacting with community traffic, such as the bypass road for ore coming from Hill 9 to the wash plant, there is currently no alternative to using the public road leading south-west of Matthew's Ridge to transport ore from the tailings pond to the processing plant, or from Hill 9 to the commencement of the bypass. However, these potential impacts may be mitigable if safe road use practices are implemented. Potential unsafe road use conditions resulting in incidents of accidents as a result of GMI heavy vehicles interacting with community traffic are **negative, direct, short-term** and **localised** of **moderate significance** but **unlikely** to occur. As such, these are **Medium Risks** of the project.

GMI's heavy vehicles sharing use of the community roads may accelerate the deterioration of these roads. During the interview with the MOPI, concerns were raised that the axel loads of GMI's haul trucks may more than double the existing specifications of the roadway and that this could contribute to rapid deterioration (EMC Personal Communication 12). In addition, concerns were also raised that GMI's heavy vehicles accelerating the deterioration of the road leading to the log-pond facility in Port Kaituma which was previously used by school children but was frequently impassable during the wet seasons (EMC Personal Communication 15 and Minutes of Public Scoping Meeting in Port Kaituma). GMI plans to rehabilitate the road in the area of the log pond. Concerns were also raised that GMI's vehicles were blocking the shoulders of the road leading to the log pond and this created further difficulties for pedestrians but this issue has since been addressed and all equipment was moved from the road shoulder. In addition, once the Marine Terminal is constructed GMI will no longer use this facility. Concerns were also raised that GMI's heavy vehicles were contributing to the deterioration of community infrastructure in Matthew's Ridge (Minutes of Public Scoping Meetings in Matthew's Ridge) but this has been addressed by the construction of the bypass road connected to the public road. The potential impacts of GMI's vehicles contributing to deterioration of roads used to haul ore are **negative, direct, long-term** and **localised** of **minor significance** but **unlikely** to occur. As such, these are **Low Risks** of the project since the company will continuously maintain the roads

There are also potential impacts of accidents involving project vehicles and machinery using internal project roads in an unsafe manner. The roads will be used by multiple project vehicles including those of GMI's hauling, mines and administrative fleets. GMI will use its internal roads to transport workers, equipment, fuel, and explosives to the mines and carrying mined materials away to the stockpiles. Internal roads will also be used by trucks taking waste rocks to the waste dumps. There are risks of accidents or incidents associated with the shared use of internal including where there may be blind turns and steep gradients. These potential impacts are expected to be **negative, direct, short-term** and **localised** of **moderate significance** but **unlikely** to occur during the lifetime of the project.

During periods of heavy rainfall, the haul roads and access roads can become slushy and water with extremely high sediment loads can flow directly into nearby waterways. Storm water runoff could

potentially adversely impact nearby waterways by increasing turbidity and total solids of the surface flows. However, based on the findings of the 2020 baseline assessment (as outlined in Chapter 8 – Water Resources), water quality of rivers and creeks intersecting the roadways was generally acceptable. It is unlikely that GMI's overland vehicle fleet will significantly change these results given that only one return trip will be made daily by the hauling fleet for ore transportation from Matthew's Ridge to Port Kaituma during the wet seasons. GMI plans to install turn out drains leading to vegetative areas which will assist in the trapping of sediments contained in the runoff. Given the measures that are in place, it is anticipated that surface water contamination from runoff has potential impacts that are **negative, direct, localised** and **short-term**. Given the low vehicular density of GMI's overland ore transportation schedule during the wet season, surface runoff from project activities of **negligible significance** but are **likely** to occur. This results in **Low Risks** of the project activities.

Surface water and soils may be negatively impacted by accidental spills during the overland transportation of fuel and other hazardous materials. Large-scale spills of fuel while in transit may contaminate soils and surface water bodies adjacent to the road transportation route potentially impacting residents in the primary AoI located in Port Kaituma, Canal Bank and Matthew's Ridge and in settlements located along the secondary AoI (Eclipse Falls and Arakaka) who depend on these waterways, in particular the Barima River, for water or their livelihoods. However, these impacts can be mitigated. Nonetheless, these potential impacts will be **direct**, **negative, local** and **long-term** of **moderate significance**. Given the mitigation measures in place, these potential impacts will **rarely** occur during the project lifetime. As such, contamination of waterways from accidental discharges are a **Low Risk** of project activities.

As discussed, in Chapter 12 – Biological Resources, overland transportation of manganese ore and other materials could adversely impact flora as well as terrestrial and aquatic fauna. These include:

- Dust accumulation on plants has been found to impair biological functions including metabolism and photosynthesis, stunt growth, make them more susceptible to disease, and even cause mortality.
- Road kill of wildlife may also be prevalent if drivers and vehicle road users are not educated on cautionary driving to prevent road accidents with wildlife.
- The occupation of work camps and accommodation by workers may promulgate the presence of synanthropic species.
- Physical disturbance and noise produced may create additional stresses on wildlife, which may lead to some species displacement.

Detailed discussions, impact ratings and risk rating of these impacts is discussed in Chapter 12.

15.3.3 Potential Impacts from River Transportation

Transportation of ore from the Marine Terminal in Port Kaituma will be facilitated by three 3000-tonne self-propelled ocean-going barges that will be 86.8 meters in length, 18 meters in width and 5.2 meters in height. Ore shipment will share the use of river transportation route with people residing on the banks of the Kaituma Canal, Kaituma River, Barima River. This includes settlements at Canal Bank, Lower Kaituma, St. Anselm, Smith's Creek, Morahwanna and Aruka Mouth. The RDC Chairperson has shared dissatisfaction that GMI is yet to engage local communities about the project in particular communities located along the river transport route about the project's intended use of the river transportation network (EMC Personal Communication 18). From the Barima River, the river transportation route continues through the Mora Passage and Waini Point before eventually reaching the Atlantic Ocean.

Residents from the communities along the river transportation routes use these waterways on a daily basis, typically using canoes or other small vessels fitted with outboard engines, for transportation of

people from their homes to other villages or economic hubs in Port Kaituma and Mabaruma. Children from these communities also travel on a daily basis to attend school in Mabaruma and Port Kaituma. Small individual or communal vessels are also used to transport produce from small-scale farmers to markets in Port Kaituma (on Wednesdays and Saturdays) and Mabaruma (on Tuesdays and Saturdays), and harvested manicole to AMCAR. Most residents also frequently fish in the rivers for subsistence purposes and artisanal fisherfolks catch fish for sale in local markets. As previously mentioned, these markets are accessible for local communities only by river. In addition, several large vessels use these waterways, including ferries plying the Georgetown to Mabaruma and Georgetown to Port Kaituma routes, and fuel and cargo boats which also transport food supplies from Venezuela and Georgetown into Mabaruma and Port Kaituma. In general, the section of the river transportation route from the Aruka Mouth community (at the confluence of the Aruka and Barima Rivers) and Morahwanna is typically busy, especially on Tuesdays and Saturdays which are market days in Kumaka. Finally, Waini Point is one of the most popular fishing grounds in Region for artisanal fisherfolks from several communities travel to this area to fish, including fisherfolks from the tertiary AoI of the project.

The risks of accidents involving smaller vessels are likely to arise if GMI's barge encounters another large vessel en route in the narrower waterways such as the Kaituma River. To avert risks, small vessels may have to wait to pass thereby increasing commute times. Small vessels may also have to wait for wave actions created by the barge to pass before continuing on course so as to prevent dangerous rocking or sinking of vessels. There are also risks associated with collisions with other large vessels in the river transportation route. These risks are increased if project vessels will be in the waterways at night. As such, these potential impacts are **negative, direct, short-term** and **localised** of **moderate significance**. However, if GMI develops appropriate safety measures and engage with local communities on the barging schedule these potential impacts are **unlikely** to occur during the project lifetime. This results in **Medium Risks** from the project activities. Further, the Barima River Mora Passage and Waini Mouth are much wider and can accommodate multiple large vessels passing each other at the same time.

GMI will construct a Marine Terminal which will also consist of a new turning basin, moorage, wharf for ocean-going barges, loading, weighbridge, administrative facilities and storage yard. The storage yard will stock two heaps of concentrates of approximately 30 days production hauled by trucks from the production site at Matthew's Ridge. A revetment constructed of steel sheet pilings, tied into the bank, will stabilize the slope of the river which will be protected with gabion baskets for shore-slope protection. The compound will be excavated of soft swamp peats, pegasse, and silts and refilled with sand, loam and laterite that will then be topped off with quarry crusher-run followed by timber half-logs on the surface. The site will house administrative offices, a dormitory, workshop, water and sewage treatment facilities, fuel tanks, generator and transformer. The entire compound will benefit from open fencing, lighting and security monitoring. GMI plans to create a new turning basin in the Kaituma Canal adjacent to the location of the Kaituma Marine Terminal. In the short term, the dredging will drastically increase the turbidity of the water preventing adjacent residents on the Canal Bank from safely utilising the water until the water settles again. It is expected that the movement of the barge will disturb the water in the Kaituma Canal and increase sediment loads during the weekly trips especially in the dry seasons when water levels may be lower. These impacts will be **negative, direct, short-term** and **localised** of **minor significance** and **likely** to occur. As a result, project activities increasing the sediment loads of the Kaituma Canal are **Low Risks** of the project.

River transportation may also adversely impact surface water quality by discharges and accidental spills. This includes large-scale spills of fuel or accidental discharges of sewage from the barge while in transit along the river transportation route potentially impacting residents in settlements located along the tertiary AoI (St. Anselm, Lower Kaituma, Aruka Mouth, Smith's Creek and Morawhanna) and along the Canal Bank who depend on the Canal and Rivers for water or their livelihoods. In addition, accidental discharge of fuel could have adverse impacts on aquatic biodiversity in particular in the

vicinity of the Mora Passage which is being considered as a protected area. However, these impacts can be mitigated. Nonetheless, these potential impacts will be **direct**, **negative, local** and **long-term** of **moderate significance**. Given the mitigation measures in place, these potential impacts will **rarely** occur during the project lifetime. As such, contamination of waterways from accidental discharges are a **Low Risk** of project activities.

As discussed, in Chapter 12 – Biological Resources, river transportation of manganese ore and other materials could adversely impact aquatic ecosystems and fauna. These include incremental increase in temporary avoidance behaviour and displacement of aquatic fauna and contamination of surface waters with potential impacts for aquatic biodiversity. Detailed discussions, impact ratings and risk rating of these impacts is discussed in Chapter 12.

15.3.4 Potential Impacts from Air Transportation

The project will utilise airstrips at both Matthew's Ridge and Port Kaituma for the transportation of staff and cargo, as needed. For the transportation of workers, GMI generally utilises the daily scheduled flights by the air service operators from the ECIA. However, on a weekly basis GMI also charters a flight to deliver food supplies and other essential supplies to the Matthew's Ridge airstrip from where it is collected and transported by road to the operations in Matthew's Ridge. Staff travelling out of Matthew's Ridge also use this flight. Given that GMI will focus on recruiting most its workforce from local communities in the Matarkai sub-district, it is not anticipated that the project will contribute to any notable increases in passenger air travel. In addition, GMI may also expand local procurement of goods and services thereby requiring fewer or less frequent cargo flights. Should either airstrip in Matthew's Ridge or Port Kaituma be closed for renovation, the project may use the other with marginal inconvenience. It is unlikely that both airstrips will be closed at the same time. Overall, GMI's activities are not expected to significantly increase air traffic in the area or contribute to wear and tear of the local airstrips. On the other hand, charters of flights to transport personnel or deliver essential supplies may support local air service operators to increase revenues. As a consequence, the impacts associate with air transportation of the project are generally **positive, direct, short-term** and **regional** of **minor significance** and **certain** to occur.

15.3.5 Potential Impacts from Transportation of Explosives

GMI estimates that the operations will require an annual explosive consumption of 356 tons with 10,890 detonators, 159,720 meters of Nonel cord and 1,320 exploders. The importation, transportation and storage of explosives will require permission from the Minister of Home Affairs. Explosives aboard ships will have to be declared to the Harbor Master who will board the vessel for inspection at Port Georgetown. The movement of explosives from the place of importation to the storage facility will require supervision by the appointed rank of the Guyana Police Force. Explosives are required to be packed in marked packages of less than fifty pounds for transportation in a manner to prevent their escape. There are specifications for the shipping of detonators in packages of more than one thousand, three thousand and five thousand. Explosives and detonators will also have to be transported to the mine site when blasting activities have to be conducted, three to four years after the commencement of mining. Potential impacts of unplanned or accidental detonation during transportation can be fatal for the handlers and are **direct, negative, long-term** and **local**. These impacts can be mitigated by careful handling during transportation. These impacts are of **major significance** but will be **rare**. As such, accidental detonation during transportation is a **Medium Risk** of the project.

15.3.6 Cumulative Impact Assessment

As discussed above, during the dry season, 30 haul trucks making two return trips per day in addition to occasional trips using other project vehicles. Each truck making 2 return trips will result in an

additional 120 one-way trips per day. This is a significant increase in heavy traffic traversing the Matthew's Ridge to Port Kaituma road. The increase in total road traffic frequently traversing the public road connecting Matthew's Ridge to Port Kaituma is expected to significantly intensify both the existing levels of dust generated when vehicles traverse the road as well as the dust emissions expected to be generated from project vehicles. As previously indicated, GMI has put measures in place to wet certain sections of the road during the dry season, these measures will not cover the public road between the Four Corners Junction and the Toll Booth in Port Kaituma. As such, road users, including users of light vehicles such as ATVs, and the residents of Eclipse Falls are expected to be exposed to significant amounts of dust. This potential impact is expected to be **direct, negative, long-term, cumulative** and **localised** of **moderate significance** and are **certain** to occur. Cumulative emissions of dust from vehicles traversing the Matthew's Ridge to Port Kaituma road are **High Risks** of the project.

Project related traffic traversing the public road connecting Matthew's Ridge to Port Kaituma will increase the total number of vehicles which use this road routinely. Community traffic along this public road includes a range of light and heavy vehicles including ATVs, cars, buses and trucks. Pedestrian traffic is found along sections of the road which pass through settlements such as Eclipse Falls. Increased traffic along the road increases the risks associated with incidents and accidents including vehicular collisions. GMI has developed and will continue to implement mitigation measures to reduce risks of incidents or accidents occurring between project and non-project vehicles. These measures include adherence to speed limits and rules for right-of-way which are expected to significantly mitigate the risks of these impacts. Potential impacts of increased road accidents on the Matthew's Ridge to Port Kaituma public road between project and non-project vehicles are **direct, negative, long-term, cumulative** and **localised** of **moderate significance** and are **unlikely** to occur and are therefore **Medium Risks**.

15.4 Mitigation and Monitoring Measures – Transportation

As previously discussed, GMI has already instituted several measures to reduce the potential risks associated with project transportation. These measures include:

- Rehabilitate the Matthew's Ridge to Port Kaituma public road through the installation of drainage features, widening some sections of the road, reducing gradients, installing turning mirrors and improving sight lines.
- Reinforcing and refurbishing the Eclipse Falls Bridge.
- Constructing bypass roads at Port Kaituma and Matthew's Ridge to divert traffic from the residential areas.
- Rerouting the access road to the airport at Matthew's Ridge away from the processing plant area to reduce safety risks.
- Facilitating shared use of project bypass roads in Matthew's Ridge and Port Kaituma.
- Restricting river dredging to the turning basin adjacent to the Marine Terminal.
- Ensuring that barge captains and crews are certified by MARAD.
- Transporting explosives and detonators separately to the storage bonds and mine sites as well as ensuring that all legal requirements are followed during transport.
- Training for drivers in safe and defensive driving.
- Putting measures in place for road wetting in Matthew's Ridge and Port Kaituma.
- Developing methods to cover manganese ore being transported by haul trucks and barges.
- Ensuring that all project vehicles and machinery are serviced and have road-worthy tyres.

In addition, the following mitigation and monitoring measures should also be implemented to minimise risks associated with project transportation:

- Engage with local authorities, including the RDC, and the Maritime Administration Department to determine the barging schedule. The schedule should aim to avoid shipment of ore and other materials such as fuel on particularly busy days such as Tuesdays, Wednesdays and Saturdays which are market days in Mabaruma and Port Kaituma.
- Dispatch notices to communities and local authorities on the barging schedule, once developed. The RDC should be enlisted with helping to build awareness of the barging schedule for communities located outside of the tertiary AoI but from where fisherfolk typically travel to Waini Point to fish.
- Ensure that barges are well lit with flashing lights, yellow lights and loud horns for early warning to river traffic. Functional checks should be done to each system before the barge departs from the Kaituma Terminal and reenters the Waini River. GMI should also host awareness sessions with local communities to build their awareness of these safety and alarm systems.
- Institute measures to facilitate safe river transportation including reducing speed when traversing through communities, having a lookout for river crafts that may be in danger and rules for yielding.
- Engage with the Ministry of Public Works to discuss rehabilitation activities which have been completed on the roadway, the bypass roads which were constructed and the design specifications which were followed.
- Install safety signage on the roadways including roadways which may intersect with heavy vehicles and mines machinery.
- Institute measures to facilitate safe road transportation including reducing speed when traversing through communities and rules for yielding with respect to non-project heavy and light vehicles.
- Implement a programme to monitor water and air quality as is outlined in Chapters 8 and 10 respectively.
- Engage with the NDC, RDC, MARAD and GWI before dredging of the new turning basin again. In addition, GMI should engage with MARAD and the NDC to develop an indicative dredging schedule for the turning basin.
- Engage with residents to receive feedback and recommendations on how project transportation can be improved. Residents should also be briefed on the road and river safety rules which GMI will adopt in project transportation and be provided with recommendations on how they can also contribute to road and river safety.

Table 15-3: Summary of Impacts and Mitigation Measures

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelih ood			
Rehabilitation of Matthew's Ridge to Port Kaituma Public Road	Compliance with Local Legislation and Regulations	Replacing road surfaces, widening of the road, improving sight lines, installation of drainage features	Positive, Direct, Long-term, Localised	Moderate	Certain	N/A	Engagement with Ministry of Public Works on design specifications and works already undertaken	Periodic meetings with residents and local authorities to receive feedback and recommendations
Construction of Port Kaituma Bypass Road	Compliance with Local Legislation and Regulations	Increase access to previously inaccessible areas	Positive, Direct, Long-term, Localised	Minor	Certain	N/A		
Maintenance of Matthew's Ridge Internal Roads	Compliance with Local Legislation and Regulations	Non-fulfillment of MoU with the NDC	Negative, Direct, Short-Term, Localised	Moderate	Likely	Medium	Fulfilling all obligations made to local authorities	
Road Rehabilitation and Maintenance	Compliance with Local Legislation and Regulations	Improper storage of material stockpiles, inadequate traffic management	Negative, Direct, Short-Term, Localised	Minor	Unlikely	Low	Adherence to Operational Controls Development of Grievance Redress Mechanism	
Contamination of soils and surface water during construction of transportation infrastructure	Compliance with Local Legislation and Regulations	Spills of fuel and waste oil, improper disposal of garbage	Negative, Direct, Long-Term, Localised	Minor	Rare	Low	Adherence to Operational Controls	Development of water quality monitoring programme

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelih ood			
Heavy vehicles transporting ore or other supplies; Other project vehicles	Compliance with Local Legislation and Regulations	Increased traffic resulting in greater dust emissions from laterite roads	Negative, Direct, Short-Term, Localised	Moderate	Certain	High	Adherence to Operational Controls	Development of air quality monitoring programme
Heavy vehicles transporting ore or other supplies; Other project vehicles	Compliance with Local Legislation and Regulations	Increased traffic contributing to increased frequency of vehicular incidents and accidents	Negative, Direct, Short-Term, Localised	Major	Likely	High	Training to Drivers on Safe and Defensive Driving; Developing rules for road safety Installation of safety signage along the road Installation of mile markers Engaging with communities on proper and safe use of the roads	Periodic meetings with residents and local authorities to receive feedback and recommendations
Project Transportation	Compliance with Local Legislation and Regulations	Shared use of project bypass roads contributing to socio economic development	Positive, Direct, Long-term, Localised	Moderate	Certain	N/A		

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelih ood			
Project Transportation	Compliance with Local Legislation and Regulations	Shared use of project bypass roads contributing to increased accidents and incidents	Negative, Direct, Short-Term, Localised	Moderate	Unlikely	Medium	Training to Drivers on Safe and Defensive Driving; Developing rules for road safety Installation of safety signage along the road Engaging with communities on proper and safe use of these roads	Periodic meetings with residents and local authorities to receive feedback and recommendations
Project Transportation	Compliance with Local Legislation and Regulations	Heavy vehicles and machinery contributing to road deterioration	Negative, Direct, Short-Term, Localised	Minor	Unlikely	Low	Engage with the Ministry of Public Works to develop a schedule of maintenance activities which can be conducted by GMI	Monitor conditions of roads used by the project
Heavy vehicles transporting ore or other supplies; Other project vehicles	Compliance with Local Legislation and Regulations	Slush generated from wet laterite road contaminates surface runoff during the rainy seasons	Negative, Direct, Short-Term, Localised	Negligible	Likely	Low	Adherence to Operational Controls	Develop a water quality monitoring programme

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelih ood			
Accidental Discharges and Spills	Compliance with Mining Act and GGMC Codes of Practice; GGMC Environmental Effects Programme EPA permit, IFC guidelines	Spills of fuel, oil and sewage contaminating and elevating oil and grease levels in Port Kaituma Marine Terminal, and along road and river transportation routes	Negative Direct, Long-Term and Local	Moderate	Rare	Low	Adherence to Operational Controls	
Barging of manganese concentrates	Compliance with Local Legislation and Regulations	River incidents and accidents involving collisions with small and large vessels	Negative Direct, Short-Term and Local	Moderate	Unlikely	Medium	Development of barging schedule in consultation with MARAD, local authorities and residents Notices of barging schedule Instituting safety measures for barging which will be checked before leaving the Terminal Development of a Grievance Redress Mechanism	Engaging with communities in the tertiary AoI receive feedback and recommendations

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelih ood			
Transportation of Explosives	Compliance with Local Legislation and Regulations	Accidental detonation during transport	Negative Direct, Long-Term and Local	Major	Rare	Medium	Separate transportation of explosives and detonator Inspection by the relevant authorities Armed escort from the Guyana Police Force	
Air transportation	Compliance with Local Legislation and Regulations	Increased revenues for local air service operators	Positive, Direct, Short-Term, Regional	Minor	Certain	N/A		
Cumulative Impacts								
Overland Transportation	Compliance with Guyana Regulations; IFC and WHO air quality guidelines; Best practices for equipment maintenance	Emissions to particulate matter as dust generated by project and non-project vehicles traversing the laterite roads	Negative, Direct, Long Term, Localised, Cumulative	Moderate	Certain	High	Road wetting in Matthew's Ridge and Port Kaituma	Monitoring of air quality parameters for PMs on project roads including the Matthew's Ridge to Port Kaituma public road Engage with residents of Eclipse Falls

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelih ood			
Overland Transportation	Compliance with Guyana Regulations; IFC and WHO air quality guidelines; Best practices for equipment maintenance	Increased risks of road incidents and accidents of project and non-project vehicles sharing road use	Negative, Direct, Long Term, Localised, Cumulative	Moderate	Unlikely	Medium	Staff training on defensive driving Host awareness sessions with communities to inform them of Right-of-Way procedures for road use	

Chapter 16 – Hazardous Waste and Other Waste Management

Waste management is a critical aspect of the construction, operation and closure of the project at Matthew's Ridge and Port Kaituma. This chapter examines how waste is currently managed in these two locations in the primary AoI and also considers waste generation and management by GMI during the construction phase of the project. It also assesses potential impacts of disposal and management of different waste streams. Finally, it outlines the measures which GMI has taken, plan to implement and should consider to mitigate and manage these impacts during the operational phase.

16.1 Administrative Framework – Hazardous Waste and Other Waste Management

Table 16-1 summarises the legislation, policies, strategies, and international treaties that are relevant to waste management related to the planned Project activities.

Table 16-1: Legislation, Policies, Strategies and International Treaties

Title	Description	Applicability to the Project
Legislation		
Environmental Protection Act (1996)	Provides for the management, conservation, protection and improvement of the environment and has provisions for the prevention or control of pollution.	Ensure sustainable use of natural resources and the sites on closure of the Project. The Act is also enforced by Regulations which ensure protection of air and water and that requires proper waste management.
Litter Enforcement Regulations (2013)	Stipulates it is an offence to place litter in a public place; permit or cause another person to litter a public place; or have litter on private premises that pose a health risk.	GMI will need to carefully manage solid and domestic waste that is created by the Project. On site disposal locations and methodology will have to be developed.
Environmental Protection Hazardous Waste Regulations (2000)	Requires facilities that generate, treat, store, dispose or transport hazardous waste to notify the EPA and apply for authorisations. The Regulations also outline the requirements for reporting, emergency preparedness plan, list of hazardous characteristics and hazardous waste to be controlled.	GMI will be required to implement the most appropriate methods for the handling, storage and disposal of hazardous waste generated by mining, ore processing, concentrate transport and port operations. Domestic waste, waste oils from electricity generation and mobile equipment, and demolition and construction debris will also require management.
Mining Act and Regulations (1989)	Provides Regulations that are applicable to medium and large-scale mining.	Includes provisions for waste disposal, effluents, tailings dams and Bonding and Closure Planning to be completed 1 year after start of operations.
Mining (Amendment) Regulations (2005)	Promotes enforcement of environmental standards in the sector and other measures	The Regulations will apply throughout the project and GMI will be required to comply with its provisions.

Title	Description	Applicability to the Project
	relating to the management mining waste, water quality, etc.	
Codes of Practice		
Guyana Mining Regulations and Codes of Practice	Outlines 10 new codes of practice although the original focus was small scale mining. These Codes of Practice were developed under the Mining (Amendment) Regulations.	The Codes of Practice include guidance for reclamation, tailings, mine waste, quarrying, small dams and reclamation. The Codes should be applied to ensure that upon closure, the Project site is not in a condition that represents liabilities to local persons or to Guyana.
International Treaties and Protocols related to Waste Management		
Montreal Protocol on Substances that Deplete the Ozone Layer (1987; with revisions).	Aims to phase out the use of several groups of halogenated hydrocarbons that may deplete the ozone layer.	A schedule to achieve phasing out of ozone depleting substances by 2030 was developed and is being implemented by the National Ozone Action Unit. Guyana acceded to the Protocol in 1993.

16.2 Baseline Conditions – Hazardous Waste and Waste Management

The NDC of the Matarkai sub-district has been working with oversight and collaboration from the RDC for Region 1, the Ministry of Communities and the EPA to develop waste management systems in the sub-district. The Ministry has direct oversight of waste management activities of the RDC and NDC. The EPA also has the authority to permit waste disposal areas. To date, emphasis has been on the two principal project locations of Matthew's Ridge and Port Kaituma both of which have community dumpsites which were established and managed by the NDC. However, it is not known whether these dumpsites have been permitted by the EPA. In the other communities within the secondary and tertiary AOI residents typically burn the waste that is generated on an individual basis or collectively.

16.2.1 Waste Management in Port Kaituma

The NDC has established a dumpsite for the disposal of waste in Port Kaituma. This dumpsite is intended to be used for the disposal of all categories of waste generated by residents and businesses. The NDC has a garbage collection system comprising of a tractor and trailer that collects garbage for a fee. However, the access to the dumpsite is not restricted and residents and business people can transport garbage directly to the dumpsite. This dumpsite is located near to Four Miles, which is a titled indigenous village. According to the Toshao, this dumpsite is a nuisance to the Village as it attracts pests, like flies and vermin, and poses health threats. Villagers also believe that this dumpsite contributes to some of the illnesses commonly experienced including diarrhea. In addition, although waste at the dumpsite is intended to be burnt, often times the waste dumped is not consolidated and garbage is not completely burnt and this also contributes to the challenges encountered by the community (EMC Personal Communication 19). Sewage is typically disposed of into pit latrines or into septic systems some of which are equipped with filter beds.

Given these challenges, the MoC has been working in collaboration with the NDC to identify a new site for the disposal of waste in Port Kaituma. In this regard, the MoC has provided the NDC with a list of criteria which the new dumpsite should satisfy. However, the process of identifying the new site has been challenging because of overlapping land uses in these areas, in particular on lands which are

being considered for agricultural development. The MoC is continuing to work with the EPA to develop the guidelines to be used to select potential waste disposal sites (EMC Personal Communication 13). Although there is a dumpsite operated by the NDC in Port Kaituma, improper dumping of garbage is widespread in Port Kaituma. Improper dumping of garbage is most significant in the waterfront areas of the Port Kaituma commercial district. During field visits in January and July 2020, significant quantities of waste were observed in the commercial district particularly in the vicinity of the existing turning basin and along the banks of the Kaituma Canal (Figure 16-1). In addition, residences and small business along the waterfront area also store waste oil in IBC totes and spills were observed in the soils and along the banks of the Canal. As seen in Figure 16-2, oily slicks are observed on the surface of water in the Kaituma Canal and this could be attributed to the poor practices discussed above as well as fuel from the engines of boats used in the Region. According to the MoC, these practices are unauthorised, unsanitary and provide breeding grounds from a range of vectors. In addition, the MOC shared concerns about the sanitation of the water in the Kaituma Canal because of raw sewage being discharged into the Canal, in particular from residences located along Canal Bank. According to the MoC, the disposal of all types of waste in Port Kaituma should be well regulated (EMC Personal Communication 13).

Figure 16-1: Improper Disposal of Waste in Port Kaituma at the Turning Basin in January 2020 (Left), and in July 2020 (Centre and Right)

Figure 16-2: Oily Residue in the Kaituma Canal

Residual Waste Generated by the Previous Manganese Mining Operations

The historic concentrate transportation corridor is composed of a narrow-gauge railway, a rail car unloading and barge loading facility at a turning basin at the top end of a purpose-built canal connecting with the Kaituma and Barima Rivers and an ocean port. The rail-to-barge transfer site has since grown into the significant settlement of Port Kaituma. Some derelict transfer station infrastructure remains in place, but will not form part of the GMI Project. The elevated dredge-created sand banks

along the canal became unorganized locations for homes and small farms now commonly referred to as Canal Bank.

Waste Generated During the Construction Process

During the construction phase of the project, GMI completed construction of a 9.7-kilometer bypass road in Port Kaituma which required the clearing of secondary vegetation as well as forested lands. All cleared vegetation was stockpiled at various sections along the roadway. GMI also dredged the Kaituma Canal adjacent to the location of the Marine Terminal. The canal spoils were removed by a 320 Caterpillar Long-Reach excavator at the edge of the proposed wharf. The quantity of sludge-like material excavated from the canal is not known. The overall length of the front that was cleared extends 130 meters and the local depth of the canal was increased from 3.5 to 4.8 meters. The excavated sludge was used as a site fill for the land acquired by GMI to be used for the construction of the Marine Terminal.

16.2.2 Waste Management in Matthew's Ridge

In August 2019, the MoC and NDC visited Matthew's Ridge to evaluate possible locations for the establishment of a waste disposal site and earmarked a site in the Pakera Bond. This site was subsequently developed by the NDC with support from a local businessman (EMC Personal Communication 13). The EIA team visited this waste disposal site in July 2020 and observed that scrap metal and other waste are placed in the vicinity of the pit (Figure 16-3). Prior to the establishment of this dumpsite, waste from the local Matthew's Ridge community was poorly managed with a large proportion of domestic garbage loosely disposed in one or more locations west of the principal project facility locations and east of the airport. In Matthew's Ridge, sewage is typically disposed of into pit latrines or into septic systems some of which are equipped with filter beds.

Figure 16-3: Waste Disposal Pit in Matthew's Ridge (Left) and Scrap Metal Dumped in the Vicinity (Right)

Residual Waste from the Previous Manganese Mining Operations

The GMI project components are mainly situated on disturbed land at Matthew's Ridge on the resources and basic infrastructure developed for previous manganese mining which was in operation during the early 1960s. Derelict and recoverable buildings and some equipment (old electricity generators) remained at the Matthew's Ridge site. The previous owner, Reunion Manganese (RMI) had conducted extensive exploration, testing and project concept development. While doing so, RMI had cleaned up the site and rehabilitated several structures. Specific operational site placements have

been made which has resulted in the relocation of processing facilities with the construction of a new modern processing plant since the old plant is corroded, dilapidated and beyond repair, with squatting encroachment on ore stockpile and waste disposal areas.

Excavated mine waste rock, soils and discharged process tailings (rejects) from former operations represented the major inventory of waste present at Matthew's Ridge. During the six-year manganese mining operations that ended in 1968, approximately 1.5 million tons of manganese concentrate was mined from over 6 million tons of ore. Waste rock and soil from the mine pits exceeded 8 million tons. Waste rock and overburden soils was historically dumped at convenient locations near mine pits without provisions for preventing erosion or providing slope stability.

In addition, approximately 5 million tons of tailings had been discharged as a dilute slurry just outside the process plant into a low, relatively flat area southwest of the process plant. The historic tailings facility is generally well defined with self-established low shrub and grass vegetation contrasting with the nearby dryland forest. This tailings deposit will be the base location for the new GMI tailings management facility (Figure 16-4 [Left]). An earth dam had been constructed on a down gradient to reclaim decanted tailings water for the concentration process. As a result of dense particle segregation, a significant manganese mineral resource in tailings had developed immediately adjacent to the original process plant (Figure 16-4 [Right]). Some of the coarse tailings of low manganese concentrations have been used for several purposes of the most frequent were road rehabilitation and airport runway topping. GMI plans to recover some of this tailings material as ore.

Figure 16-4: Historic Tailings Deposit (Left) and Exposed Tailings Beach with Residences in Proximity (Right)

The chemical components of the ore in the historical tailings pond of Matthew's Ridge are shown in Tables 16-2 below and the following components were measured:

- Manganese (Mn)
- Silicon Dioxide (SiO_2)
- Aluminimum Oxide (Al_2O_3)
- Iron (Fe)
- Phosphorous pentoxide (P_2O_5)

Table 16-2: Average Grade of Ore at Different Elevations in the Tailings Open Pit[159]

Elevation (Meters)	Average Grade of Ore (Percent)				
	Mn	***SiO_2***	***Al_2O_3***	***Fe***	***P_2O_5***
144 to 138	21.07	26.73	18.88	8.14	0.081
138 to 132	26.06	20.13	16.46	8.05	0.089
132 to 126	25.22	21.42	16.53	8.84	0.105
126 to 120	20.32	24.90	16.78	8.74	0.113
120 to 114	20.05	24.16	16.24	9.04	0.118
114 to 108	19.18	25.83	16.09	8.75	0.117
108 to 102	17.43	29.50	16.09	8.40	0.118
102 to 96	18.03	30.90	16.34	8.62	0.112
96 to 90	20.56	29.73	16.17	8.54	0.107
90 to 84	20.78	30.42	15.64	8.59	0.094
84 to 78	15.41	35.02	17.64	8.36	0.081
78 to 72	12.84	38.29	19.40	8.18	0.071
72 to 66	11.10	42.06	19.42	8.29	0.067
Average	17.78	32.67	16.82	8.47	0.091

Waste Generated During Project Construction

The Matthew's Ridge mine and processing sites were generally clear of domestic and significant amounts of industrial waste before Project construction began in 2019. "Housekeeping" throughout the preparation and construction phases had been maintained at a reasonably high standard by GMI as well as the previous owner RMI. Normal waste management practices, suitable for construction activities are being practiced at Matthew's Ridge. Scrap metal including derelict vehicles are kept in a designated area in the vicinity of the old wash plant (Figure 16-5 [Left]). Metal and wood waste from the ongoing construction activities are stored in a designated area and these materials are scavenged for use in the construction (Figure 16-5 [Right]). In addition, spent tyres are being used for road definition (Figure 16-6).

Figure 16-5: Scrap Metal Storage Area (Left) and Consolidated Storage of Construction Waste (Right)

[159] Zhongye Changtian International Engineering Company Limited, 2018. Bosai Minerals Group Company Limited Matthew's Ridge Manganese Project Guyana. Volume 1: Feasibility Study Report. Section 3.4.2. Page 104

Figure 16-6: Use of Spent Tyres for Road Definition along the Matthew's Ridge Airport Bypass Road

Construction activities also involve the construction of tailings embankments which are being established outside of the original tailings containment footprint. Vegetation cleared during these construction activities will be removed and stockpiled for future use in mine reclamation. Marketable timber will be recovered for use or transfer to the designated, licensed forestry concessionaire for the area. Small quantities of saprolitic soils were excavated for the construction of roads, buildings and the preparation of pits for mining. The total volume of topsoil that has been excavated as part of construction activities are not easily quantifiable as there are areas that have previously been stripped for extraction of ore and also areas where the topsoil was previously covered or removed for development. In instances where small quantities of topsoil were extracted, it is being used as fill material.

Hazardous waste generated during the construction process include used batteries and waste oil. During the construction process, used batteries are being stockpiled within a designated area in the workshop (Figure 16-7 [Left]) and will be sold to a dealer authorised by the EPA when a significant quantity has accumulated. The current stock of waste oil includes waste oil which was generated and stockpiled by RMI during their operations in Matthew's Ridge. Waste oil generated during the construction phase is stored in drums and is kept in a consolidated area in the vicinity of the old wash plant (Figure 16-7 [Right]). However, improvements are required in the storage of waste oil to prevent spills or leaks.

Figure 16-6: Consolidated Storage of Used Batteries (Left) and Area for Waste Oil Storage (Right)

Wastewater generated during the construction phase of the process were generated by sanitary facilities and from the kitchens. The toilets are connected to septic tanks. Fat/solids traps are installed on the drainage for the wastewater from kitchens.

Histoplasmosis Outbreak of 2019

In 2019, there was an outbreak of histoplasmosis of GMI workers in Matthew's Ridge which resulted in two fatalities. According to the report prepared by the CMO of the outbreak, on March 28, 2019, the Ministry of Health was notified by the District Medical Officer of the Pakera District Hospital of an unusual illness among the workers of GMI[160]. The workers were clearing the old mining tunnels that were filled with decades of bat droppings and other debris which were determined to have been contaminated by histoplasmosis spores. Following the incident, GMI sealed the tunnels and buried all of the materials removed from the tunnels which are expected to have been contaminated by the spores which caused histoplasmosis. The burial site is located in storage yard for raw ore.

16.3 Impact Assessment – Hazardous Waste and Waste Management

This section assesses the potential impacts of the management of waste generated by the Project, and the risks associated with these impacts on planned project activities, local communities and the natural environment. There are three primary waste streams associated with project activities namely:

Non-Hazardous Waste

- Mine waste namely waste rocks, soils and tailings both from the historical mining activities and GMI operations. The mine waste are considered as non-hazardous since the manganese resource mineralization is generally associated with weathered soils, and as discussed further below, waste rocks, soils and tailings are neither acid generating nor metal leaching.
- Mine water discharges.
- Demolition waste from the historical mine facilities and construction waste generated at the project locations over the 2019 to 2020 period.
- Operational waste including wood, containers, metal, plastics and tyres among others.
- Dredge spoils from the Kaituma Canal.
- Food and domestic waste.

[160] Dr Shamdeo Persaud, Chief Medical Officer, April 2019. Final Report: Outbreak of Febrile Illness at Guyana Manganese Incorporate, Matthews Ridge, Region 1 Guyana. Page 1, Paragraph 1.

- Wastewater from domestic sources including liquid discharge from septic system, hauled sewage and kitchen wastewater.

Hazardous Waste

- Contaminated oils, lubricants and filters.
- Used lead acid batteries.
- Chemical waste.
- Used safety supplies.
- Explosives residue.
- Sewage sludge.
- HCFC-22 refrigerants, if present.
- PCB-contaminated transformer oils and ballasts, if present.

Potentially Hazardous Waste

- Scrap metal particularly retired vehicles and machinery.
- Soils contaminated by hazardous materials or waste.
- Electronic waste.
- Open containers such as spent tyres that hold rain water (malaria mosquito risk).

16.3.1 Potential Impacts of Management of Non-Hazardous Waste

16.3.1.1 Mine Waste

The largest quantities of waste material to be managed by the project are mine waste comprising waste rock and soils, and tailings (also known as rejects). Tailings will be deposited in roughly the same location as historical tailings. Based on GMI's Mining Plan, one million tons, of the 5 million tons of tailings in the historical tailings pond, are identified as a mineral resource that will be fed to the new process plant over the first 4 years of operations. After the ore thickening process, material consisting of manganese and rock slimes are pumped out as tailings. Water from the thickeners is flocculated and recycled to processing. The flocculant will clump together floating particles in the water to sink to the bottom. The concentrated residue will then be pumped to the tailings pond where it will be settled out and the clean water recirculated for use via a pump to be placed within the pond. Discharge from the processing plant will comprise a 40 percent solids slurry and over the 13-year project lifetime, it is estimated that 14 million tons of tailings will be generated. The tailings will be discharged upstream into an engineered containment area referred to as the Tailings Pond. This containment area will serve as a reservoir and will accommodate 9.28 million cubic meters of tailings. It will cover an area of 2.38 square kilometers and will initially comprise seven tailings dams with earth-rock embankments that will have maximum heights of 10 meters. These embankments are referred to as monoliths. The design of the Tailings Pond and the location of the seven monoliths are presented in Table 16-7.

Failure of the dam along the Tailings Pond can also result in effluent being discharged into the environment, which can contaminate nearby soils and water bodies. However, based on the dam construction specifications, the containment area will be sufficiently robust to retain the tailings. In addition, a 24-hour monitoring station will be at the tailings pond to monitor piezometric pressures, water levels, signs of displacement and to carry out water releases via the spillway as necessary. Further, the manner in which the tailings will be discharged into the facility, and the constant reuse of water from within the pond render dam failure unlikely. Effluent discharges, if untreated and whether accidental or planned, have the potential to increase the background concentration of manganese, other residual heavy metals, trace into soils and surface waters in the vicinity of the processing plant and the tailings pond. This impact from effluent discharges will have a **direct**, **negative**, **localised** and **short-term**. These impacts are expected to be of **moderate significance** and are **unlikely** to occur during the life of the project. These are therefore **Medium Risks** of project activities.

Although the ratio of mine waste to ore is low (<1.3:1) it is estimated that 42 million tons of saprolitic soils and transition material as well as hard rock will be produced during the 13-year mine lifetime. This material will be hauled out of the mine pits and deposited in waste piles, close to the mine pits. Waste will also be used to backfill mined-out areas. Some of the less weathered material will be crushed and used for haul road construction during mining. The establishment of mine waste piles inherently present social and environmental risks. As previously discussed, waste rock and overburden soils had been historically been dumped at convenient locations near mine pits without provisions for preventing erosion or providing slope stability. As part of the activities to prepare for the mining of these pits, these abandoned waste dumps will be rehabilitated and most of the materials contained in these abandoned waste pits will be removed. GMI's waste piles will be designed for long-term stability and natural re-vegetation utilising 2 cubic metre capacity hydraulic mine excavators loading 25 tonne trucks. Waste dumps and backfill sites will also be profiled by bulldozer to prevent slippage and soil erosion. The long-term stability of mine waste piles can be achieved, but constructed measures, such as terraces and storm water drains, should be implemented to limit instability.

Initially there will be four waste dumps as seen on Figure 16-8. As discussed in Chapter 9 – Soils and Geology, the angles of the ramps and overall slopes of waste dumps should be 10 degrees and 21.9 degrees respectively. These angles have been qualitatively assessed and should reduce the risk of landslides in the waste dumps. The possibility of landslides may be increased by the subsidence land subject to significant loads such as waste stockpiles. Potential impacts of any scale of landslide would be a **direct, negative, localised** and **long-term**. However, with careful monitoring and design parameters any landslides should be **minor in significance** but are still **likely to occur** given the many factors which may act as triggers, as such, making this a **Medium Risk** of this project.

According to the Pre-Feasibility Study prepared by RMI, tests for acid rock drainage and metal leaching confirmed that old and future process tailings do not represent the potential to leach metals above IFC guidelines or generate acid as defined by the guidance criteria of the Global Acid Rock Drainage Guide (GARD; INAP 2012). This is due to the fact that most of the sulfides which may cause acid mine drainage have already been chemically removed by the prolonged oxidizing conditions which have prevailed during the deep weathering of the strata. As discussed in Chapter 9 – Soils and Geology, the potential impacts of acid mine drainage are **negative, direct, localised, short-term;** of **minor significance** and **unlikely to occur.** As such, it is a **Low Risk** of this project.

16.3.1.2 Mine Water Discharges

The creation of the mining pits will intercept surface water flows resulting in water flowing into the pits. As mining within the pits progress deeper, ground water flow will also be intercepted, resulting in in-pit flow and accumulation. Rainfall will also accumulate within open mining pits. Discharges of unsettled water from the mining pits can result in water with high sediment loads flowing into waterways resulting in sedimentation and discolouration. GMI will install perimeter drains around the mining pits to prevent the inflow of water. This water will then be directed to a collection/sedimentation pond. Water within the pits will be channeled into sumps located within the pits and allowed to settle before being pumped out of the pit. Pumps installed in the sumps will be used to dewater the pits by pumping water out of the pit to an external collection/sedimentation pond for further settlement. GMI plans to direct this water to the tailings pond so that it will contribute to the water supply for the processing plant. This will reduce the possibility of contamination from mine water discharge while increasing the water supply available to the company. Any mine discharge which will not be directed to the tailings pond will be discharged through settling ponds. Discharge of unsettled water into the environment contributes to sedimentation and discolouration of the waterways. However, given the planned measures to be implemented by GMI, these impacts are expected to be of **moderate significance** and are **likely** to occur during the life of the project. These are therefore **Medium Risks** of project activities.

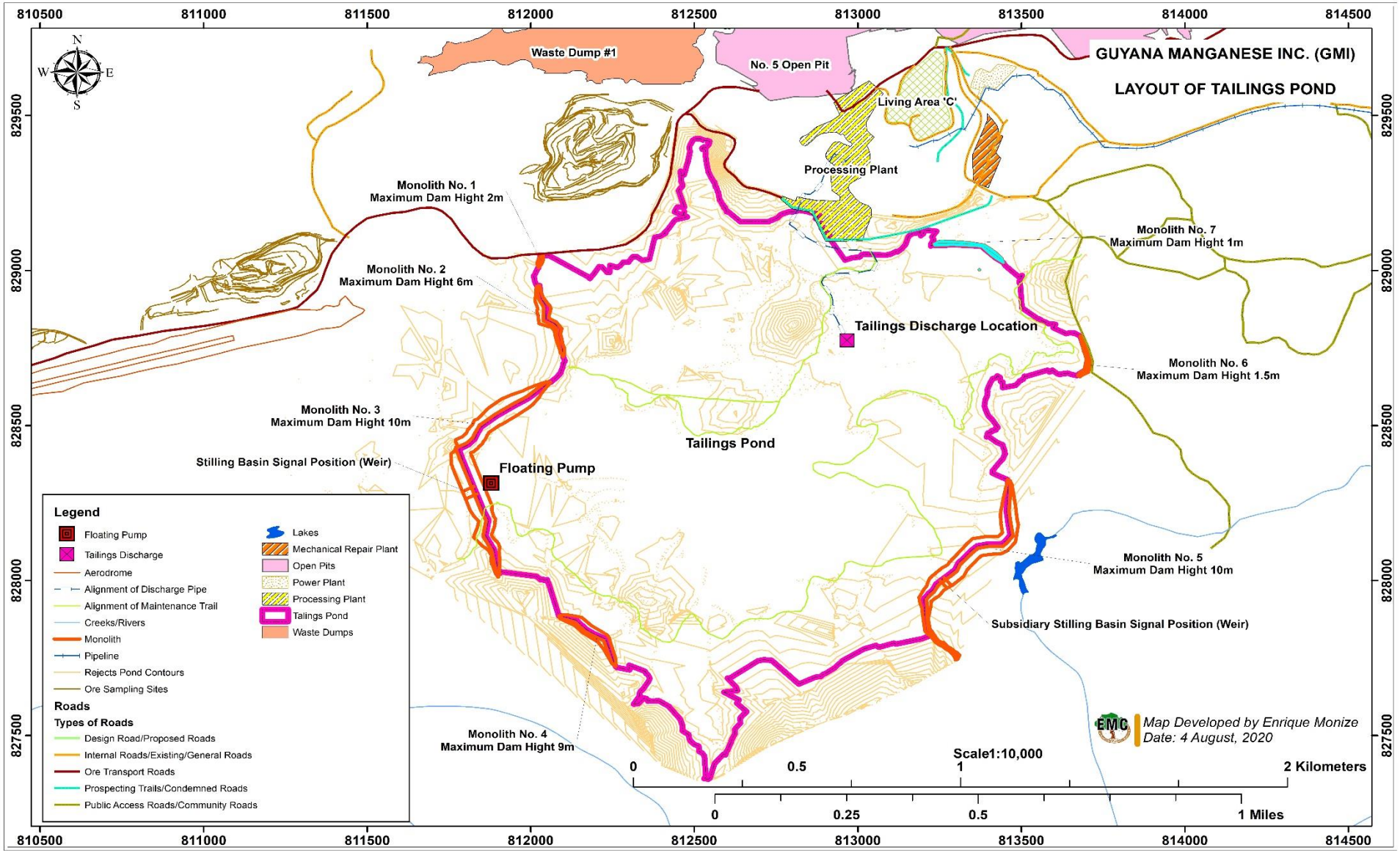


Figure 16-7: Tailings Rejects Pond

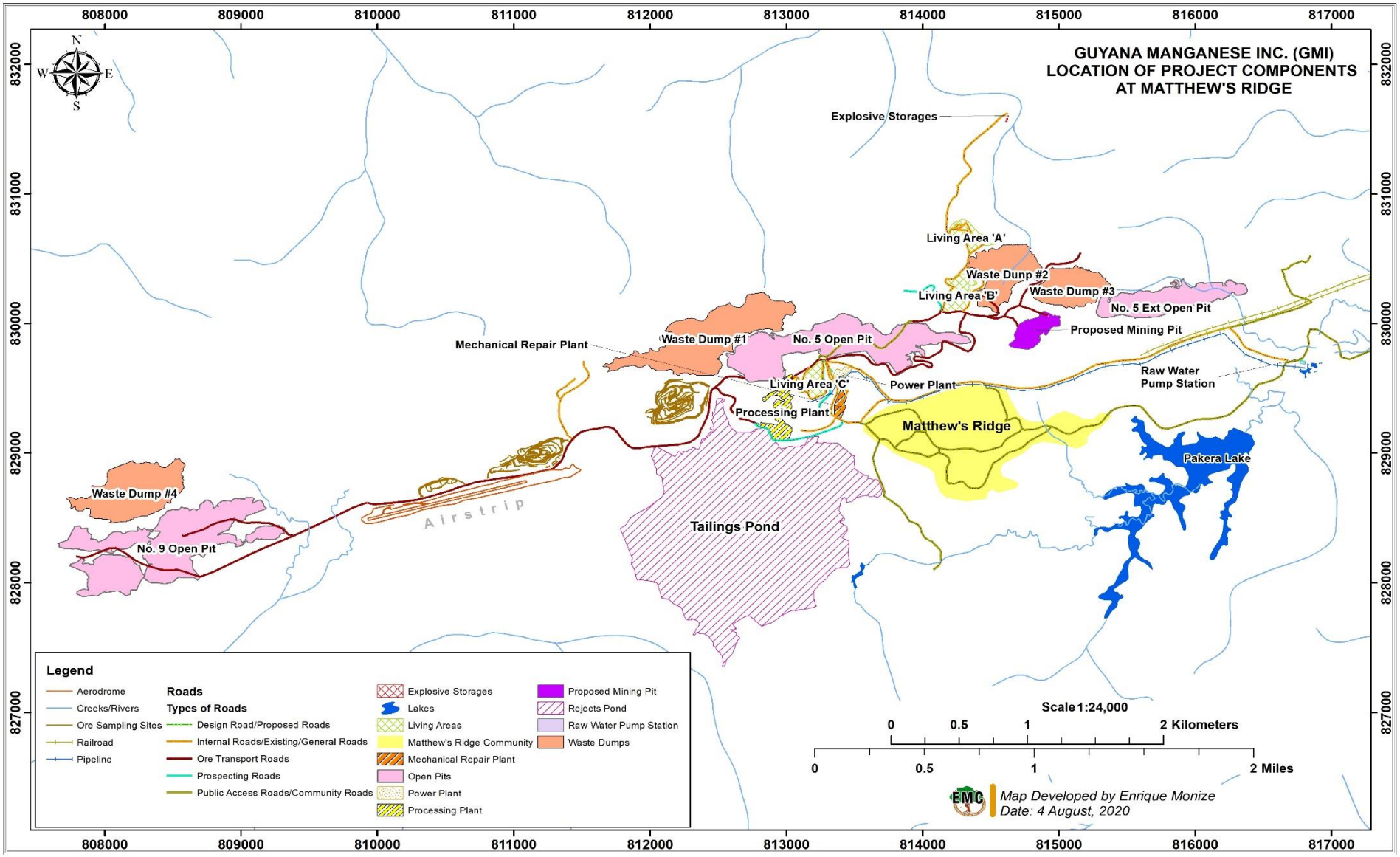


Figure 16-8: Layout of Project Facilities Showing the Relative Positions of the Waste Dumps and Rejects Ponds to other Project Components

16.3.1.3 Demolition, Construction and General Solid Waste

The waste generated from the demolition, construction and operational processes are expected to comprise primarily of scrap metals, wood, plastics and tyres among other waste. Proper management of these waste are essential in ensuring that the project facilities are aesthetically pleasing and that waste management practices do not pose risks for health and safety. As previously discussed, waste management practices and "housekeeping" during the construction phase of the project has been good. In addition, during the operational phase of the project, GMI will implement the following measures to continue to properly manage these waste:

- Scrap metals and inert debris from old structures will continue to be stored at designated location or scrap yard. This will also include major scrap items such as the derelict generators from the previous mine activities as well as retired machinery during the current mining activities. When needed, scrap metals may be scavenged to help in the reconstruction or rehabilitation efforts as needed. If the restrictions on sale of scrap metals are lifted, GMI will also consider selling scrap metals to contractors. However, recycling of scrap metals may be challenging because of the remote location of the project and the potentially high costs associated with their transport.
- Wood waste will continue to be stored in a designated location. Wood waste will be sorted and will be scavenged to support reconstruction or rehabilitation of old buildings and furniture. Damaged or unwanted wood will be taken to landfill location used to aid in reclaiming process to refill land.
- Plastic waste will be stored in a designated waste disposal area/pit which will be covered with overburden when filled. Empty plastic containers will be stored in a designated location and will be donated or sold to community members or other interested persons.
- Defective of damaged safety supplies and equipment will be stored in a designated area to which only authorised personnel will have access. All supplies and equipment will be damaged beyond use or repair before being transferred to a waste disposal site.
- Cardboard and paper waste will be disposed of in a designated waste disposal area/pit which will be covered by overburden when filled.
- Spent tyres are already being used for road definition. During the operational phase of the project, these tyres will be painted and filled with overburden and will be placed at the side of the road to promote road safety.
- Other waste generated from the demolition and construction process such as concrete, empty paint containers, spent tools, etc. will be disposed of in a designated waste pit which will be filled with overburden.

GMI has maintained a good standard of housekeeping during the construction phase of the project and has designed measures to mitigate the potential impacts of poor management of waste generated by the demolition, construction and operational phases. However, it is expected that significant quantities of waste will be generated during the operational phase of the project and more than one scrap-yard or laydown facility will have to be created and this increases the potential adverse impacts on aesthetics and health and safety. The proper management of these types of waste can mitigate or minimise adverse impacts during the operational phase of the project. However, the non-biodegradable waste streams are likely to be a legacy of the project. More particularly, given the challenges associated with transporting scrap metals from the project location there may be significant accumulated scrap metals remaining on location when the project is decommissioned. Some of this could be donated to the Training Center within the community. Usable parts could be dismantled and sold to interested parties, such as miners. Usable equipment and components can also be donated to the government or regional authorities. Potential impacts of management and disposal of demolition, construction and operational waste are **negative, direct, long-term** and **localised** of **moderate significance** and are **likely** to occur. As such, these are **Medium Risks** of project activities.

16.3.1.3.1 Dredge Spoils

The spoils from dredging of the Kaituma Canal were used as material fill for the Marine Terminal. Based on the 2020 water quality baseline, the physio-chemical characterization demonstrated that the water quality in the vicinity of the Marine Terminal was good. As a result, the sludge excavated from the Kaituma Canal is not expected to be acidic or contain oily residues or contaminants that may leach into soils. However, mercury contamination of the Kaituma Canal recently occurred as a result of the release of effluent from small-scale gold mining into tributaries of the Kaituma River and the Canal. Some mercury compounds are soluble in water and GWI authorised the resumption of domestic use of water from the Kaituma Canal in the period following contamination. As a result, it is also unlikely the excavated sludge was contaminated by mercury. Nonetheless, should excavation of the Kaituma Canal adjacent to the Marine Terminal be required, GMI should ensure that the Maritime Administration (MARAD) and GLSC are engaged to provide recommendations on the disposal of the dredge spoils. Given the small area of the Canal being dredged, significant quantities of spoils are not likely to be generated during the project lifetime. Potential impacts of soil contamination from the disposal of dredge spoils are **negative, direct, long-term** and **localised** of **minor significance** and is **unlikely**. As such, these are **Low Risks** of project activities.

16.3.1.3.2 Food Waste

During the construction process, food waste were collected on a daily basis and disposed of with regular waste. During the operational phase of the project, a disposal pit will be established and maintained into which food waste will be disposed directly. The pits will be covered to avoid flies and rodent infestations as well as malodour from leachate. When the maximum capacity is reached, the waste pit should be covered with at least 0.3 meters of soil and a suitable site will be identified for the construction of another pit. Leftover food can be donated to local farmers to be used for poultry rearing purposes or planting where foods like onion skins, eggshells and vegetable scraps can be mixed with soil and used as composts for soil enrichment. Potential impacts from the disposal of food waste include waste serving as attractant for pests and vectors as well as the generation of malodours as the waste biodegrade. However, these impacts can be managed if proper disposal techniques are followed. These potential impacts are **negative, direct, short-term** and **localised** of **minor significance** and is **likely**. As such, these are **Medium Risks** of project activities.

16.3.1.3.3 Domestic Wastewater

Domestic wastewater will be generated principally from the sanitary facilities such as toilets and bathrooms and from the kitchens. As previously discussed, all of the toilets are connected to septic systems which are fitted with soak-away systems to prevent the discharge of solids. This will prevent significant accumulation of liquid waste in septic systems but if sewage has to be hauled a third-party contractor will be hired. As such, the discharge of most liquid sewage generated onsite will be filtered prior to discharge into the environment or will be collected by a third party. The kitchen facilities are fitted with a fat traps. The impacts of improper disposal of domestic wastewater are **negative, direct, short-term** and **localised** of **moderate significance** and is **unlikely** to occur. As such, these are **Medium Risks** of project activities.

16.3.2 Potential Impacts of Management of Hazardous Waste

16.3.2.1 Spent Oils, Lubricants and Filters

Spent oils, lubricants and filters will be an inevitable byproduct of any project activities which require the combustion of fuel. During the construction phase of the project, waste oils generated from fuel combustion were collected in drip containers and stored in drums. GMI attempted to consolidate the storage of the waste oil generated during construction with the waste oils which were inherited from

RMI operations. However, as previously discussed the storage conditions can be improved and the risks of spills in the current storage area remains high. During the operational phase, spent oils from the generator sets and mobile equipment will be collected and stored in a modified wheeled tanker at Matthew's Ridge and in drums at the Marine Terminal. Waste oil will be pumped into the tanker to prevent spillages during transfer. Options for final use of these waste oils are still being considered and include contracting the transport of the waste oils to Bosai operations in Linden to be mixed with heavy fuel oils and burned in the kiln, contracting the transport to another recycling facility or providing to chain saw operators. Ultimately, disposal of waste oils may involve a combination of these approaches. On-site uses, such as use as a dust-inhibitor, will be avoided. There are risks of spillages when significant quantities of waste oils are consolidated in storage without a secondary bunded containment. These risks may be amplified if waste oils will be transported over significant distances over existing road and river transportation networks. Potential impacts of spills resulting from improper collection, storage or transport of waste oil are **negative, direct, long-term** and possibly **regional**. Potential spills will be of **major significance** but are **unlikely** to occur if proper collection, storage and handling practices are maintained. As such, these are **Medium Risks** of project activities.

Used oil filters will be drained and the waste oil collected from these sources will be consolidated in storage. When completely drained, used oil filters will be disposed of with general solid waste. This will prevent discharge of waste oils from disposed used filters. Potential impacts of waste oil leaks from used oil filters are **negative, direct, long-term** and **localised** of **moderate significance** but are **unlikely** to occur if mitigation measures are fully implemented. As such, leaks from used oil filters are **Medium Risks** of project activities.

16.3.2.2 Used Batteries

Used batteries are another category of inevitable waste which will be generated from the use of mines machinery and project vehicles. As previously discussed, used batteries were being stored in a consolidated area during the construction phase of the project. During the operational phase, GMI will designate a storage area to house all batteries. Lead-acid batteries will be sold to an EPA authorised dealers only. Dry-cell batteries will also sold to an EPA authorised dealer but may also be disposed on site. Potential risks of improper storage and disposal of used batteries leading to leaching and environmental contamination are **negative, direct, long-term** and **localised** of **moderate significance** but will **rarely** to occur if the mitigation measures which are already being implemented are scaled-up. As such, these are **Low Risks** of project activities.

16.3.2.3 Chemical Waste

During the operational phase of the project, GMI will designate a location for all chemical waste generated from project activities. The area selected will be one of relative low foot and vehicle traffic within the compound and will always be locked and monitored. Only authorised personnel will have access and safety signage will be installed in the area. Within this storage area, chemicals will be segregated based on their hazardous characteristics to ensure their safety. Storage will also be guided by the Safety Data Sheet (SDS) so as to determine the best methods of storage. Only minor amount of chemical waste are expected to be generated, mainly from the laboratory. Potential impacts of chemical spills are **negative, direct, long-term** and **localised** of **moderate significance** but will **rarely** to occur given the mitigation measures which will being implemented. As such, these are **Low Risks** of project activities.

16.3.2.4 Explosive Waste

GMI has developed a waste management protocol for the management of the explosive residues which may remain after blasting activities in particular misfires, and for explosives that are considered defective and unsuitable for use. This includes the following key measures:

- Identification of an appropriate location for disposal. The site should allow for appropriate segregation of these materials, from people, plants and property. Hot water should not be allowed in the disposal area.
- The disposal area should be a sandy location, and at a critical depth since rocks, mud and other debris may cause an explosion.
- Police officers should be on-site while particulars are removed.
- Only trained personnel should be involved in retrieval of possible misfires and disposal of defective explosives.
- Explosive materials should keep away from flame, sparks, heat, or igniting of solvent vapors.
- Avoid excessive force in recovering, collecting, and handling explosives for disposal.
- There should be no cross-contamination of explosive.
- Staff should wear appropriate PPES to conduct this task and avoid the buildup of dirt, oil on soles of footwear.
- Ensure electrical isolation.
- Ensure the area is clean at all times to prevent unwanted initiations.
- Burn in small quantities at a time so as to prevent transportation of large quantities of explosives.

Potential impacts of uncontrolled disposal of explosive residues may also involve unwanted detonation and are **negative, direct, long-term** and **localised** of **moderate significance** but will **rarely** occur given the mitigation measures which will being implemented. As such, these are **Low Risks** of project activities.

16.3.2.5 Sewage Sludge

During the operational phase of the project, sewage sludge will be removed from the septic systems by a contractor on an as needed basis. Sludge will be disposed and covered with soil in a mine waste pit which will be excavated and dedicated for this purpose. Future excavation of this waste pit for project activities will be prohibited. Sludge will not be treated prior to disposal and may contain harmful components such as pathogenic organisms, organic compounds, heavy metals and excess phosphorus and nitrogen. These effects can be immediate or time-delayed and could potentially be harmful as a result of its leaching capability. In addition, untreated sewage sludge could also be a biohazard if it is discharged from the barge. Potential impacts associated with the disposal of sewage sludge are **negative, direct, long-term** and **localised** of **moderate significance** and are **unlikely** to occur given the management measures which will being implemented. As such, these are **Medium Risks** of project activities.

16.3.2.6 Histoplasmosis Contaminated Soils

In 2019, GMI sealed the tunnels from which bat droppings and debris infected with the spores which caused the histoplasmosis outbreak. Subsequently, GMI ceased all operations to excavate tunnels which were not yet explored. Although the infected materials were buried, the spores may be released again if the area is disturbed in the future. Given that the infected materials were buried in areas to be used by the project as a raw ore storage yard, it is not likely that the buried waste will be disturbed. As a result, potential impacts of another histoplasmosis outbreak are expected to be **negative, direct, short-term** and **localised** of **moderate significance** but will **rarely** occur during the lifetime of the project. Potential increases in vector borne diseases are a **Low Risk** of the project.

16.3.2.7 CFC-22 and PCB-Contaminated Transformer Oils or Light Ballasts

At the national level, the Government of Guyana has undertaken international commitments to phase out ozone depleting substances like the CFC-22 refrigerants. PCB contaminants may come from

contaminated transformer oils or light ballasts. GMI will store all light ballasts in a drum which will be dumped at a mined-out location and which will be backfilled. Although it is unlikely CFCs and PCB contaminants will be in mine waste, potential impacts of contamination from the improper disposal of these materials **negative, direct, long-term** and **localised** of **moderate significance** but will **rarely** occur if appropriate mitigation measures are implemented. As such, these are **Low Risks** of project activities.

16.3.3 Potential Impacts of Potentially Hazardous Waste

Hazardous waste can also potentially develop on site if some types of non-hazardous waste are not treated properly prior to or during disposal. Table 16-3 below outlines the four main sources of potentially hazardous waste which may be generated from the planned project activities.

Table 16-3: Sources of Potentially Hazardous Waste

Waste Stream	Potential Hazardous Characteristics
Scrap Metal: Retired Vehicles and Machinery	Improper drainage of lubricants and fuel prior to lay-down.
Soils	Contamination by hazardous materials such as fuel or hazardous waste such as spent oils.
Open Containers and Spent Tyres	Collect and hold rain water becoming a breeding ground from vector breeding.
Electronic Waste (E-Waste)	Parts of some electronic devices, such as computers and cellphones, contain toxic compounds which leach as they decompose.

Scrap metal, particularly retired vehicles and machinery, can become classified as hazardous waste if the lubricating oils, waste oil, fuels and any other hazardous materials and waste are not drained or otherwise removed before the scraps are retired. Under circumstances where vehicles and machinery are retired without these measures being undertaken, these hazardous materials and waste are likely to leak out as these materials degrade in lay-down. Leaks and spills of hazardous materials and waste are entirely mitigable if proper measures are followed in the pre-retirement period. The potential impacts are **negative, direct, long-term** and **localised** of **moderate significance** but will **rarely** occur if appropriate mitigation measures are implemented. As such, these are **Low Risks** of project activities.

Soils contaminated with fuel (diesel) and spent oil may occur although the extent are expected to be minimal. However, inherent in some of the planned project activities are risks of large spills of hazardous materials and waste:

- Large-scale spills of fuel as well as other hazardous materials and hazardous waste while in transit into soils adjacent potentially impacting residents within the AoI.
- Large-scale spills of fuel in storage at Port Kaituma and Matthew's Ridge.
- Accidental discharges of large quantities of hazardous waste, such as waste oil and grease, from consolidated storage areas into soils within the entire project AoI.

However, should a spill occur on site or on the haul roads, it is to be cleaned up by excavating the associated soil and transported to Matthew's Ridge for disposal in low permeability mine waste. The details of each clean-up will be spill site specific and will be subject to regulatory review. GMI has planned several intensive measures to prevent large spills from occurring. These potential impacts will be **direct**, **negative, local** and **long-term** of **moderate significance**. Given the mitigation measures in place, these potential impacts will **rarely** occur during the project lifetime. As such, contamination resulting from large-scale accidental discharges are a **Low Risk** of project activities.

On the contrary, small-scale spills are likely to occur from most project activities may happen relatively frequently as a result of poor handling practices by employees. For example, high-risk areas for frequent small-scale spills include the vicinity of fuel storage dispensers during the loading and offloading processes. The cumulative effects of these discharges may cumulatively increase the concentration of hydrocarbons in soils. Potential impacts of contamination from relatively frequently small-scale spills are **direct**, **negative, localised** and **long-term** of **minor significance** but **likely** to occur throughout the project lifetime even if all mitigation measures are deployed. As such, contamination resulting from large-scale accidental discharges are a **Medium Risk** of project activities.

Open containers and spent tyres may collect and pool rain water and inadvertently become breeding grounds for vectors which are prevalent in the project locations including the anopheles mosquitoes that cause malaria and the sand flies that cause leishmaniasis in Matthew's Ridge. However, these impacts are entirely mitigable if empty containers and spent tyres are properly stored. These potential impacts will be **direct**, **negative, localised** and **long-term** of **moderate significance**. Given the waste management systems which are in place, these potential impacts will **rarely** occur during the project lifetime. As such, open containers and spent tyres becoming breeding grounds for vectors are a **Low Risk** of project activities.

During the lifetime of the project minimal quantities of electronic waste including computers, cellphones, GPS units and other devices will be generated. Some components of these devices may contain hazardous compounds including lead which may leach as they degrade. These components should be removed prior to disposal of the non-hazardous compounds with general solid waste. Devices are frequently unique and the components containing toxic compounds are likely to vary by device. As such, devices will have to be individually examined to determine whether the device includes any potentially hazardous components which must be removed for separate disposal prior to disposal. These potential impacts will be **direct**, **negative, localised** and **long-term** of **negligible significance** and are **likely** to occur during the project lifetime. As such, contamination resulting from electronic waste is a **Low Risk** of project activities.

16.3.4 Cumulative Impact Assessment

GMI will generate several waste streams throughout the implementation of the project as discussed above. Liquid waste from processing plant, tailing discharge and domestic and sanitary wastewater discharges are unique to GMI within the project footprint at Matthew's Ridge and will be generated from no other sources. Similarly, other mine waste including waste rocks and soils will only be generated by GMI within the project footprint and the wider AoI. During the construction and operational phases of the project, GMI will generate significant quantities of general solid waste from demolition, construction and project implementation and will create waste stockpiles for opportunistic scavenging or waste pits for disposal within the project footprint. All hazardous waste will be stored onsite and GMI is exploring options for their ultimate disposal including incineration or transportation out of Region 1. Currently, there are no other existing or potential projects which will generate these types of waste or will require using similar methods. GMI will manage all waste produced by its operation separately from the communities' waste management facilities. As a consequence, no cumulative impacts are anticipated to occur from the management of hazardous and other waste generated by the project.

16.4 Mitigation and Monitoring Measures – Hazardous Waste and Waste Management

Mine waste – soils and rock, represent the largest single amount of waste generated by the project. The second largest quantity of waste material is the process tailings (rejects). Haphazard mine waste disposal can result in waste pile instability, excess land and forest disturbance and continuous erosion.

Hazardous waste management can be safely accomplished if management plans are rigorously followed and are adjusted as experience is gained. The risks involved in transport of waste oil and acid-containing batteries off site to the final destinations justifies spill management protocols. To a limited extent sewage sludge, represent biological hazardous hazards that must be considered in handling/storage in advance or destruction or disposal. As discussed above, GMI has put several measures in place to manage these waste including:

- Detailed planning for each waste pile, minimizing forest encroachment and maximizing stability, and providing desirable aesthetics on pile completion.
- Completing removal and stockpiling of organic material and fertile soils in advance of waste pile construction.
- Terracing of embankments, with rock-armoured storm water drainage channels.
- Putting operational protocols in place to monitor mine waste management and modify waste pile development to achieve final objectives.
- Designing the Tailings and Water Retention Dam using an advanced engineering design and as-designed aspects minimize environmental impact and risk of instability. The performance of the facility – tailings distribution, dewatering and embankment stability will also be subject to close monitoring, on a 24-hour basis, by GMI.
- Developing a Waste Management Plan which outlines the potential management strategies for several general solid waste, hazardous waste and wastewater streams some of which were already being implemented during the construction phase of the project. These include:
    - Establishing waste disposal pits for separate disposal of plastics, cardboard and food waste.
    - Establishing stockpiles of wood and creating lay-down yards for scrap metal which will allow for opportunistic scavenging for reuse.
    - Constructing and rehabilitating of all septic systems to meet the GNBS guidelines.
    - Dedicating a waste pit for the disposal of sewage sludge. Ensuring only commercial contractors remove and discharge sludge.
    - Storing used batteries in a designated area which is impervious and bunded. Sale will only be to EPA authorizes dealers.
    - Consolidating storage of waste oil into impervious bunded secondary containment areas which are connected to oil/water separator.
    - Providing training to workers on proper handling and management methods.
    - Avoid procurement of refrigerants and other materials that contain CFC-22 and PCBs.
    - Development of procedures to respond to large spills.
    - Using spent tyres as a road safety measure.
    - Installation of fat traps on the drainage through which all wastewater from the kitchen facilities at Matthew’s Ridge and Port Kaituma flow.

GMI should also implement the waste management strategies listed below:

- Install an incinerator on site which could be used for the disposal of multiple hazardous and non-hazardous waste including general solid waste and waste oils.
- Engage with the NDC of the Matarkai sub-district to determine the location of waste dumps which will be created on site. In addition, the NDC should be informed of all non-biodegradable waste which will be buried with mine waste.
- Engage with MARAD and GL&SC on the disposal of any future dredging spoils.
- Develop a Chain-of-Custody Procedure for hand-over hazardous waste which will be disposed by contractors.
- Engage with the National Trust of Guyana to determine whether any of the intact demolition waste, such as skeleton frames of process or ore transport infrastructure, may be of cultural value.
- Create a routine for the examination of all waste disposal on-site at least once per week.

- Continue to examine options for the disposal of waste oils.
- Profile top surfaces of the waste pile on completion to facilitate closure actions (e.g. re-vegetation).
- Install barriers to limit undesirable public access to a closed-out site.
- Consider options for potentially using mined out pits for mine waste disposal. This action could modestly reduce the size and extent of mine waste piles. However, the extensive distances between proposed pits and the potential for sterilization (isolate by covering) residual manganese resources in each it, suggests this option may have low economic potential.
- Consider options for improved tailings management throughout the lifetime of the project. If warranted, as a result of monitoring, the following modifications to operating procedures could be considered:
    - Increase in slurry discharge density from 40 percent solids (higher densities lessen fine-coarse particle segregation and the generation of slime ponds) by changing the thickening methods in the plant.
    - Frequent relocation of tailings discharge points within the facility.
    - Discharge of tailings from embankments – this could increase embankment stability by removing pond water from the edge of the embankment.
    - Deposit a fraction of tailings in one or more mined-out pits. The use of a mined-out pit for tailings disposal. This is an acceptable strategy and was practiced by Omai, Guyana in 2004. However, it may be limited at Matthew's Ridge by the potential to sterilize mineral resources and the expected need to construct and operate a water treatment plant.

Table 16-4: Summary of Impacts and Mitigation Measures

Impact Producing Activity or Incident	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
Tailings management	Compliance with Guyana Regulations and codes of practice Best practices for mine operations	Failure or escape of tailings from the Tailings and Water Retention Dam	Direct, Negative, Localised, Short-Term	Moderate	Unlikely	Medium	Adherence to Operational Controls	Monitoring lateral distribution and settling of solids, instability of engineered structures
Dumping of mine waste (rocks and soils)		Landslides and subsidence under load of mine waste	Direct, Negative, Localised, Short-Term	Minor	Likely	Medium	Adherence to Operational Controls	Monitoring of land stability in waste dumps
Management of mine waste		Acid Mine Drainage	Direct, Negative, Localised, Short-Term	Minor	Unlikely	Low	N/A	Development of a water quality monitoring programme
Discharge of mine water		Sedimentation or discolouration of waterways	Direct, Negative, Localised, Short-Term	Moderate	Likely	Medium		
Management of general solid waste		Significant accumulation of non-biodegradable waste on site	Direct, Negative, Localised, Long-Term	Moderate	Likely	Medium	Establishment of waste-disposal pits and scrap yards Engage the NDC on determining a location for these pits	Management of waste disposal pits, covering as necessary and establishing new pits

Impact Producing Activity or Incident	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
							Installation of an incinerator	
Dredging of the Kaituma Canal		Improper disposal of dredge spoils	Direct, Negative, Localised, Short-Term	Minor	Unlikely	Low	N/A	Engagement with MARAD and the GL&SC on disposal of dredge spoils
Disposal of Food Waste		Improper disposal of food waste attracts pests/vectors and leads to malodours	Direct, Negative, Localised, Short-Term	Minor	Likely	Medium	Creation of covered pit for the disposal of food waste Donating waste to community members for poultry rearing or composting	Routine monitoring of conditions at the disposal pit
Discharge of Domestic Wastewater	Compliance with Guyana Regulations and codes of practice Best practices for mine operations	Discharge of unsettled sewage; discharge of unfiltered kitchen wash water	Direct, Negative, Localised, Short-Term	Moderate	Unlikely	Medium	Upgrading all septic systems to meeting GNBS specifications Installation of oil/water separators for kitchen wash water	Routine monitoring of fill capacities of septic systems and oil/water separator to determine when cleaning is required
Project Construction and Operations		Spills from the improper collection and storage of waste oils	Direct, Negative, Long-	Major	Unlikely	Medium	Store all waste oil in an impervious bunded	Monitor condition of the bund and arrange for repairs as necessary

Impact Producing Activity or Incident	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
		including on long transport trips	Term, Regional				containment with an attached oil/water separator	
Project Construction and Operations		Spills and leaks from used oil filters	Direct, Negative, Long-Term, Localised	Moderate	Rare	Low	Drainage of used oil filters before disposal with general soild waste Establish a drainage rack	
Project Construction and Operations		Improper disposal of used batteries	Direct, Negative, Long-Term, Localised	Moderate	Rare	Low	Consolidate storage of used batteries in an impervious covered area Only sell to EPA authorised dealers	Monitor the stockpile of used batteries to determine when sale is necessary
Project Construction and Operations		Spills of used chemicals	Direct, Negative, Long-Term, Localised	Moderate	Rare	Low	Consolidate storage of chemical waste in a restricted storage area Explore options for	

Impact Producing Activity or Incident	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
							destruction of chemical waste locally (in Georgetown)	
Sewage Management		Biohazards arising from disposal of untreated sewage sludge	Direct, Negative, Long-Term, Localised	Moderate	Unlikely	Medium	Sewage sludge removed and disposed only by commercial contractors	Monitor fill capacities of the septic systems
Raw Ore Storage		Disturbance of materials contaminated with histoplasmosis spores	Negative, Direct, Short-Term, Localised	Moderate	Rare	Low	Create ore stockpile over the area where contaminated materials were buried to prevent accidental excavation	
Project Construction and Operations		CFC-22 or PCBs contaminants	Negative, Direct, Long-Term, Localised	Moderate	Rare	Low	Avoid procurement of materils containing CFC-22 and PCBs	Monitor materials on-site to determine whether any contain these compounds
Project Construction and Operations		Potential for Scrap Metals becoming Hazardous	Negative, Direct, Long-Term, Localised	Moderate	Rare	Low	Draining all hazardous materials and chemicals prior to lay-down	Monitor laydown yard for spills

Impact Producing Activity or Incident	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
Transportation of hazardous chemicals and waste		Large spills of hazardous chemicals or waste	Direct, Negative, Long-Term, Localised	Moderate	Rare	Low	Adherence to Operational Controls	
Transportation of hazardous chemicals and waste	Compliance with Guyana Regulations and codes of practice Best practices for mine operations	Frequent small spills of hazardous chemicals or waste	Direct, Negative, Long-Term, Localised	Minor	Likely	Medium	Proper fuel handling practices Use of drip trays	Training in proper handling practices
Disposal of general soild waste		Open containers and used tyres becoming breeding grounds for vectors	Direct, Negative, Long-Term, Localised	Moderate	Rare	Low	Cover all containers Fill tyres with overburden before using on the roads Bury excess tyres in mine waste dumps	Monitor waste disposal areas to determine whether any water accumulation is occurring
Disposal of Electronic Waste		Leaching of toxic compounds from improper disposal	Direct, Negative, Long-Term, Localised	Negligible	Likely	Low	Monitor materials on-site to determine whether any components contain toxic compounds	N/A

Chapter 17 - Landscape and Aesthetics

This section summarises the visual and aesthetic conditions of the Project baseline and analyses the expected impact of the Project during construction, operation and on closure. It also proposes measures which can be implemented to mitigate the risks which the project presents to the landscape and aesthetics of the project area. It is generally accepted that a clean, neat, stable and naturally vegetated landscape is desirable during the Project operations and on closure.

17.1 Relevant Policy Regulations and Guidelines in Guyana

There are a wide range of policies, strategies, legislation, and agreed-to international protocols in effect in Guyana and these are detailed in Chapter 3 of this document. Table 17-1 summarises those that are relevant to the landscape and site aesthetics aspects of the GMI Project.

Table 17-1: Legislation, Policies, Strategies and International Treaties

Title	Description	Applicability to the Project
Legislation		
Environmental Protection Act (1996)	Provides for the management, conservation, protection and improvement of the environment and has provisions for the prevention or control of pollution.	Ensure sustainable use of natural resources and the sites on closure of the Project. The Act is also enforced by Regulations which ensure protection of air and water, and that requires proper waste management.
EPA Litter Enforcement Regulations (2013)	Prevents litter aggregation on public and private lands.	The Project must ensure that effective and acceptable waste management systems are in place throughout the project lifetime.
Mining Act (1989) and Regulations	Provides Regulations that are applicable to medium and large-scale mining.	Includes provisions for waste disposal, effluents, tailings dams and Closure Planning and Bonding to be completed 1 year after start of operations.
Mining (Amendment) Regulations (2005)	Promotes enforcement of environmental standards in the sector and other measures relating to the management mining waste, water quality, mine reclamation and closure, etc.	The Regulations will apply throughout the project and GMI will be required to comply with its provisions.
Policies and Strategies		
National Action Plan to Combat Land Degradation	Provides general guidance to minimise land degradation and leave the mine and other infrastructure locations in good condition on closure.	Encourage proactive and preventative actions rather than reactive
Mining Codes of Practice (Draft)	Outlines 10 new codes of practice although the original focus was small scale mining. These Codes of	The Codes of Practice include guidance for reclamation, tailings, mine waste, quarrying, small dams, and reclamation.

Title	Description	Applicability to the Project
	Practice were developed under the Mining (Amendment) Regulations.	The Codes should be applied to ensure that upon closure, the Project site is not in a condition that represents liabilities to local persons or to Guyana.
International Protocols		
United Nations Convention on Biological Diversity	Focuses on promotion of sustainable development, in particular the conservation of biodiversity.	Landscaping and construction activities that are detrimental to biodiversity should be identified and steps should be taken to reduce the impact.
United Nations Convention to Combat Desertification	Establishes a voluntary target setting programme that allows Parties to establish national targets and associated measures to achieve land degradation neutrality.	Guyana voluntarily undertook the Target Setting Programme in 2016 and established the target of having no net loss for the whole land area of the country and all its land cover classes by 2030 as compared to the 2000-2010 baseline.

17.2 Baseline Conditions – Landscape and Aesthetics

The GMI Manganese Project contains some unique pre-operational physical characteristics. For over 50 years the mines and processing properties at Matthew's Ridge had been transformed into an abandoned, poorly closed-out mine site after several years of operations. Off the minesite, the concentrate handling infrastructure – the railway, the fresh water port facilities and a purpose-built canal also had been abandoned. Components at the mine site and along the concentrate transfer corridor had been salvaged by various parties but a purpose-built canal became a sustaining feature of the community of Port Kaituma.

Some structures constructed in the early 1960's by the original operator in particular at the Matthew's Ridge mine site and to a lesser extent at Port Kaituma remained intact. Some buildings at the mine site remained serviceable and were upgraded and occupied by Reunion Manganese Incorporated (RMI) exploration crews from 2011 to 2016. Scrap and much of the derelict equipment was salvaged and removed from the mine site by RMI. Mine site roads and drainage ditches were improved by RMI and more recently by GMI, and state-of-the art communication towers were installed on a high point by a major mobile and data provider in Guyana. The tower site is shared with rehabilitated GMI office and accommodation facilities (Figure 17-1).

Figure 17-1: Communication Towers, Staff Accommodation Matthew's Ridge (August 2018)

Following acquisition by GMI in 2017, the mine site infrastructure has been steadily improved, resulting in a clean, safe and visually-attractive condition. GMI advanced development of several RMI initiatives in maximizing the use of residual infrastructure, some of which had been in poor condition at the mine site. Examples are the old workshops, the power plant building and the railway maintenance facility shown in Figure 17-2.

Figure 17-2: Matthew's Ridge Mine Site Infrastructure, August 2018

Some other old structures exist, and will remain in place but are not part of the Project – the skeleton of the process plant at Matthew's Ridge (Figure 17-3) and original concentrate transfer facilities at Port Kaituma. A new process plant is being constructed at a site west of the original plant (Figure 17-4) and a completely new port and wharf are to be built on the west bank of the canal about 5 km downstream from Port Kaituma.

Figure 17-3: Skeleton of Former Processing Plant at Matthew's Ridge

Figure 17-4: New Process Plant Location (2019)

17.2.1 Matthew's Ridge

The Matthew's Ridge site is an extensively disturbed "brownfields" site. Recent illustrations of the site conditions at Matthew's Ridge are shown below in Figures 17-5 to 17-8.

Near the east end of the Project assets, and on the highest hill, staff accommodation is situated along with two communication towers as shown in Figure 17-1. The communication towers are not owned by GMI. The largest structure at this location is the recently rehabilitated guest house, known as "Guyana House". This location is a demonstration of good landscape preservation and achievement of desirable aesthetics - clean, neat, green and passively powered.

Figure 17-5: Rehabilitated Guest House ("Guyana House") at Matthew's Ridge

Several mine pits were exploited during the previous operations. As shown in the example in Figure 17-6, mine waste soils and rocks were conveniently dumped over the edge of the hills adjacent to the

pits. These waste have been susceptible to erosion and have naturally vegetated to some extent by shrubs and grasses.

Figure 17-6: Example Historical Mine Excavation and Mine Waste Disposal

A larger, abandoned Matthew's Ridge mine pit is shown in Figure 17-7. Mine slope erosion and modest amounts of natural re-vegetation are evident. All of the previously mined sites will be subject to further development during the 13-year GMI Project. Two white exploration drill casings are evident in Figure 17-7 (yellow arrow, centre right).

Figure 17-7: Abandoned Mine Pit Development at Matthew's Ridge

Subsequent to the impacts of the mining-related activity of the 1960's, the Matthew's Ridge mineralized resource locations have been subject to extensive exploration activity as shown in Figure 17-8 in the bottom-right and top-left sections of the photograph. This Figure also provides a

perspective on the proximity of village accommodation (centre and top-centre sections) and previous tailings deposition (centre and right sections).

Figure 17-8: "Brownfield" Conditions at Matthew's Ridge Resulting from Recent Exploration

A significant feature resulting from previous mining activity is the 50+ year old tailings (rejects) deposit that extends from the northwestern edge of the Matthew's Ridge community to close to the airport (black arrow, top centre, right) as shown in Figure 17-9. The tailings footprint is characterized by low profile vegetation and some surface ponding of water in the western zones close to the airport.

Figure 17-9: Former Tailings Deposit – Perspective Looking West

17.2.2 Transportation Corridor, Port Kaituma and Kaituma Canal

Features that remain in place from historical operations include a 48-km railroad corridor from Matthew's Ridge to Port Kaituma, a concentrate handling and transfer to barge facility at Port Kaituma and an approximately 10 km man-made canal that was excavated to permit transport on the Kaituma River to the Barima River and subsequently on to an ocean-side barge off-loading location.

The residual port and rail facilities are unserviceable. The Project will transport supplies into Matthew's Ridge and concentrate out from the processing plant by an upgraded existing road and a strengthened Barima River bridge. A new transfer port and wharf are to be constructed 5-km downstream from Port Kaituma.

17.3 Assessment of the Impact of the Project on Landscape and Aesthetics

The following assesses the potential impacts and potential risks of the proposed Project on the landscape and visual aesthetics at Project sites during construction, operations and on closure. A matrix-based Environmental Impact Analysis approach that was outlined in Chapter 7 is adapted here. The new Project is described in detail in Chapter 4 – "Comprehensive Description of the Proposed Project". Important aspects related to local Landscape and Aesthetics are outlined and presented in Table 17.2.

Table 17-2: Project Impacts on Landscape and Aesthetics

Major Project Activities	Features	Potential Impact on Landscape and Aesthetics	General Details
Cleaning up of old infrastructure at Matthew's Ridge	Removal of unusable scrap, repurposing existing structures	Positive	General revitalization of several structures
New infrastructure	New accommodation, power plant, processing plant	*Generally positive:* removal or repurposing on closure assumed	New facilities that meet Project requirements and modern performance criteria
Mining and mine waste management	Open pit mining at 9 or more locations	*Perceptibly negative:* Permanent land disturbance;	Significantly expanded mine sites and pits, large waste soil/rock piles constructed in formerly undisturbed locations
Tailings (rejects) containment	New tailings facility constructed on expanded original tailings footprint	*Perceptibly negative:* Some existing forest to be removed; relocation of several residences and small farm plots placed on or near old tailings; seven dams as high as 10 metres.	Intrusive feature in local landscape. Unlikely to significantly naturally re-vegetate to dryland forest as demonstrated by former tailings facility

Major Project Activities	Features	Potential Impact on Landscape and Aesthetics	General Details
Ore transportation within and out of Matthew's Ridge	Dedicated bypass roads constructed to prevent interaction between community traffic and heavy project vehicles/machinery.	*Generally positive:* Some clearing of secondary vegetation.	Construction of two bypass roads around the processing plant and bypassing the main Matthew's Ridge settlement.
Matthew's Ridge to Port Kaituma Road and Eclipse Falls Bridge over the Barima River	Upgrade road and bridge to permit continuous use by the Project vehicles and by the public	*Perceptibly positive:* Current road becomes impassible and dangerous in wet seasons.	Resurfacing and widening road surface with drainage and improved siting on curves to permit reliable and safe two-way transport. Reinforcement of the bridge to sustain heavy axel loads.
Shipping port on canal and access road	Dedicated bypass roads completed in Port Kaituma road; Marine Terminal to be constructed on canal west bank, downstream from Port Kaituma	*Marginally negative short-term impact:* Some disturbance of former agricultural lands, forest and canal bank residences.	Three unregulated canal bank residences have been resettled by GMI. The Port Kaituma Bypass Road passes through lands which were heavily degraded due to historical, extensive agricultural activities. Intersection of forested lands has occurred.

Overriding all of this risk assessment, there are 3 realities and considerations:

1. Mining and mineral processing are inherently land-disturbing activities and complete re-establishment of original land form and biological features at the end of mining is not possible;
2. Perception is related to reality – if it looks bad or "messy", there may be unnecessarily negative environmental or personal safety risks; and
3. The remediation of historical disturbance of landscape is not a prime responsibility of the new GMI manganese Project.

17.3.1 Matthew's Ridge

At Matthew's Ridge, 9 mine sites and associated pits will be developed over the life of the Project. This will include the expanding mine activity at former site of mining activity.

In general, following the end of operations in 1968, mining, plant and infrastructure sites as well as the tailings (rejects) were overgrown with limited amounts of secondary vegetation. No reclamation activities had been undertaken and abandoned structures were subject to salvage and vandalizing over many years. Significant "cleanup" and remediation had been implemented in recent years by RMI – the previous licensee, and has continued by GMI since 2017.

The site at which the new processing plant is being constructed was not forested and was covered with secondary vegetation. There was no human-assisted re-vegetation of either the mine pits, waste

rock/soil piles or the wide-spread tailings material. Several residences had been established in proximity to the tailings deposit (Figure 17-8, above).

17.3.1.1 Mine Site Infrastructure

As was previously stated the infrastructure remaining from the previous mining operation was left in a state of disrepair, resulting in unsightly structures within the project areas. To facilitate GMI's Project, some of these derelict structures were removed completely and replaced, while others were refurbished. This has resulted in improving the aesthetics of the area. For example, the Guyana House (Figure 17-1) which is completed, and the building of the revitalized power plant and the process plant, which are in progress as shown in Figures 17-10 and 17-11. In addition, Figure 17-12 shows the before and after rehabilitation situation of the pump station, which is located along the main road just out of Matthew's Ridge. In addition, unusable materials and other waste were also removed from project areas and disposed of. Further, the clearing of secondary vegetation in some of the project areas has also improved the area aesthetics, such as along the old rail corridor to construct the community Bypass Road and to re-establish the water pumping pipeline connecting the pump house at the Pakera Lake reservoir to the new processing plant. As such, the impacts from the removal or rehabilitation of old project infrastructure and construction of new facilities are **positive, direct, long-term** and **localised** of **moderate significance** and **certain** to occur.

Figure 17-10: Matthew's Ridge Power Plant Reconstruction (July 2020)

Figure 17-11: Process Plant Construction (April 2020)

Figure 17-12: The Pump Station before (left [August 2018]) and after (right [July 2020]) Rehabilitation

17.3.1.2 Mine Pits, Mine Waste Piles, Tailings

Open pit mining will occur in 9 locations over the 13 years of Project operations. Waste soil and rock will be excavated at a rate of approximately 1.3 times the annual rate of ore production (2.6 Mt of waste, 2 Mt of ore) and the mine waste will be stored initially in 4 or more locations. These are two of the three major activities that will result in permanent alterations to the landscape at Matthew's Ridge. A plan view of the actual mine pits (3 pink items) and proposed, associated waste piles (4 orange items) are shown in Figure 17-15. The mine open pits are in already disturbed locations and the waste piles are in previously undisturbed locations.

The third major mine-related activity that affects landscape and site aesthetics is the storage of tailings (rejects). The site of the historical tailing facility will be expanded by a limited amount for the construction for a new tailings facility which is shown in Figure 17-13. 3 houses, 7 camps and 8 farm sites will be affected by the construction of the tailings facility. The details concerning removal and relocation are discussed in Chapter 21 of this document. The tailing pond will be defined by 7 separate earth-filled embankments each topped to a maximum height of 10 meters which is equivalent to 86 metres ASL (above mean sea level) at Matthew's Ridge. A modest amount of second growth forest will be cleared to establish this new facility.

While GMI Project will affect landform within the project areas, it will also allow for the rehabilitation of the previous used areas. For example, there are abandoned mined pits which will be mined, and for some of these pits mine waste soils and rocks which were conveniently dumped over the edge of the hills adjacent to the pits will be removed. Mining will allow for these areas to be rehabilitated through improved mining and rehabilitation practices. Likewise the tailings pond area will be reused and it is expected that this will be properly closed out at the end of the mine life. GMI will be required to prepare a Closure and Reclamation Plan to ensure the sites are progressively reclaimed during the project life and closed out in an acceptable manner at the end of the project. As such, the potential impacts are **negative, direct, long-term** and **localised** of **moderate significance**. The potential impacts are **likely** to occur during the project lifetime and results in **Medium Risks** to the project.

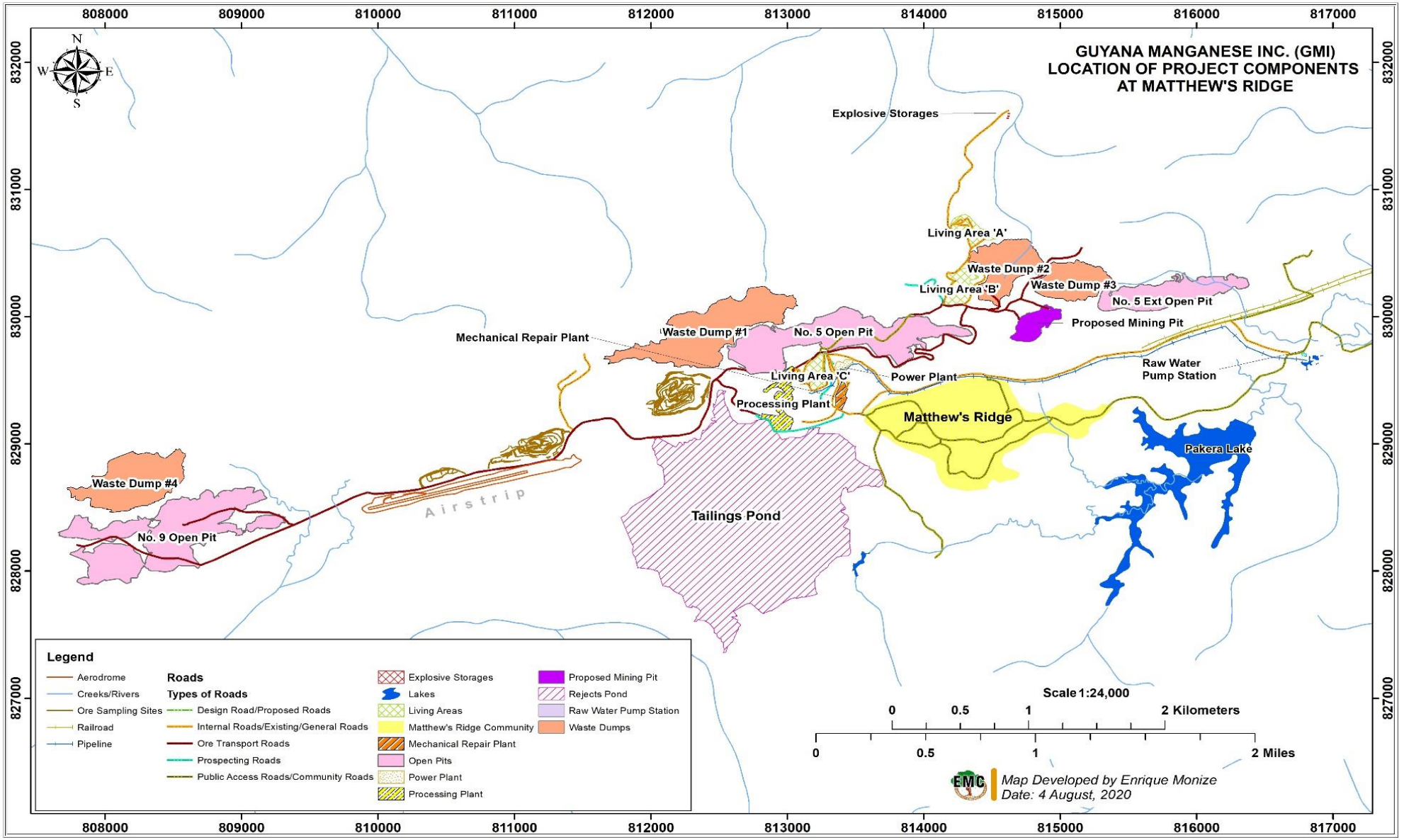


Figure 17-13: Facilities Layout at Matthew's Ridge

17.3.1.3 Community Infrastructure

When the previous mining operation ceased the area subsequently progressed into a depressed state, since there were no major economic and employment opportunities to sustain the livelihood of the population. Private property such as homes and community infrastructure such as roads eventually degraded and were in a derelict state. The resuscitation of manganese mining in Matthew's Ridge will create a number of new direct and indirect economic opportunities. In particular, economic development may be stimulated by increased disposable income by GMI employees and economic development created resulting in increased sale of good and services for the project. Increased disposable income may also be used for home repairs and positively contribute to the aesthetics of houses in the community, as well as other forms of livelihood improvements.

GMI intends to contribute directly to the improvement on the community infrastructure such as the roads within Matthew's Ridge, which has already commenced. GMI will also improve the Matthew's Ridge to Port Kaituma roadway by resurfacing and widening the road surface with drainage and improving siting on curves to permit reliable and safe two-way transport. Further, the Company will reinforce the Eclipse Falls bridge.

These efforts will improve the general aesthetics of these areas and as such the impacts are considered **positive, direct, long-term** and **localised** of **moderate significance** and **certain** to occur.

17.3.2 Port Kaituma

The Kaituma Marine Terminal is detailed in Chapter 4 and shown in Figure 4-10. This 125m by 300m facility will be principally constructed on the soft ground remaining behind the original canal sand banks. A sturdy foundation composed of timber and crushed aggregate is planned. A small amount of local landscape (4 hectares) has been permanently modified to create this facility. Details of this are discussed in Chapter 21, Land Acquisition, Resettlement and Livelihoods.

GMI plans to construct a modern marine terminal which will change the aesthetic of the immediate area which consists of mainly houses and farmlands. The impacts may perceptively be **negative, direct, long-term** and **localised** of **moderate significance** but are **likely** to occur during the project lifetime. This results in **Medium Risks** from the project activities. Construction of the Port facility has been delayed due to restrictions on international travel as a result of the COVID-19 pandemic. The July 2020 site conditions are illustrated in Figure 17-14.

Figure 17-14: Port Kaituma Site (July 2020)

17.3.3 Cumulative Impact Assessment

As discussed above, the project will invariably change some aspects of the landscape within the project footprint in Matthew's Ridge and Port Kaituma. Existing or previous small-scale gold mining activities have degraded lands within a 10 to 20-kilometer radius of the AoI at Matthew's Ridge and are visible during both in-bound and out-board flights from the Matthew's Ridge airstrip (Figure 17-15). During the operational phase of these project, when there are multiple active open pits and waste dumps there is potential to lower the aerial aesthetics of Matthew's Ridge. However, these impacts are likely to be significantly reduced after mine rehabilitation has occurred following the closure and decommission of this project. These potential impacts are **direct, negative, long-term, cumulative** and **localised** of **negligible significance** and are **almost certain** to occur. As such, they are **Low Risks** of the project.

Figure 17-15: Degradation of Surrounding Lands Visible on Aerial Approach

17.4 Mitigation and Monitoring Measures – Landscape and Aesthetics

In general, the design and implementation of the Project will result in a positive influence on landscape features and visual aesthetics, since it will correct some of the existing situations from the previous operations such as the abandoned mining pits, overburden dumps, tailings pond and buildings. Ideally, a mining operation as a temporary use of land, should not impose any permanent constraints on the options for future beneficial use of the site, nor have any permanent effects on the local water resources, biodiversity and overall landscape quality or associated socio-economic development. The following measures are being implemented and will continue to be implemented by GMI to manage the landscape and aesthetics of the project:

- Maintaining a high standard of “housekeeping” and site stability. An example of this is facility of storm water management. Concrete-lined trenches and ditches and measures to ensure slope stability are extensive as shown in Figure 17-16, which demonstrates the application of shotcrete to an excavated slope.
- Minimising the project footprint to previously used or brownfield sites as far as possible including the footprint of the Tailings and Water Retention Dam to the previously used tailings pond.
- 24-hour monitoring of the Tailings and Water Retention Dam for detrimental impacts such as breaches.
- Minimising vegetation clearance to construct waste dumps.
- Stockpiling topsoils and organic material to assist in reclamation and revegetation.

Figure 17-16: Concrete-lined Storm Water Trench and Slope Stabilization

In addition, GMI should implement the following mitigation and monitoring measures to ensure that risks associated with landscape and aesthetics:

- Build slope-stable waste piles so as to achieve a desirable condition and perspective at the end of the mine life. Slopes should be terraced for stability and should include rock-reinforced storm water drainage channels.
- Incorporate the following mitigation and monitoring measures into tailings management:

  - Poor lateral distribution of the solids and settling characteristics, *(frequent moving of discharge points, change in concentration of the tailings in the plant);*
  - Instability of engineered structures – dams and spillways, *(mitigation following frequent inspection by experts);*
  - Physical risk to local citizens and wildlife, *(fencing, barriers and security); and*
  - Poor profiling for a stable, self-revegetating condition on closure (*planning, monitoring and management modification).*
- Engage with local stakeholders periodically to achieve a mutually desirable result for positive mine aesthetics bearing in mind the rubric “if it looks good, it must be good”.
- Ensure that there is progressive reclamation throughout the life of the mine with annual monitoring to check on the status continuous mine rehabilitation.
- Undertake measures to be taken to mitigate the risks of non-rehabilitation of the mine:
  - Development of the mine Closure and Decommissioning Plan in keeping with the national regulations. This Plan is anticipated to demonstrate that closed out Matthew’s Ridge and Port Kaituma facilities will represent minimal long-term deleterious legacies. The Plan should be updated as the operations progress.
  - Ensure that there is a budget allocation from GMI to take care of mine closure.
  - Ensure that progressive reclamation occurs throughout the mine life.
- Prepare the Closure and Decommissioning Plan shortly after operations begin. The Plan should be prepared in consultation with local stakeholders and relevant regulatory authorities like the EPA and the Guyana Geology and Mines Commission and should be continuously updated as operations progress. The principal issues relating to the project which should be addressed by the Plan includes:
  - Removal of all machinery and equipment from the site.
  - Dismantling of all buildings and structures.
  - Closing out of haul roads.
  - Restoration of watercourses, if practical or required.
  - Rehabilitating overburden/waste rock stockpiles.
  - Addressing pit voids.
  - Provisions for progressive reclamation of mined-out sections of the pits.
  - Clean (non-acid generating) mine waste rock is typically a potential valuable resource in aggregate-poor regions such as Matthew’s Ridge. For public safety reasons, access to the broken rock resources will be limited during operations, but provisions should be incorporated into the Closure Plan for post-operational access to this resource.

Table 17-3: Summary of Impacts and Mitigation Measures

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring/notes
			Type	Signifi-cance	Likelihood			
Cleaning up of old infrastructure at Matthew's Ridge (MR) and construction of new infrastructure	EPA Act, EPA Litter Regulations, National Action Plan re Land Degradation, Guyana Mining Codes of Practice, Best Industrial Practice	Scrap and junk removal, some structures renewed; attractively designed infrastructure	Positive, direct, long term, localised	Moderate	Certain, (complete)		Continue during operations and on closure Continue with neat and small footprint	Critical component of waste management. Some old waste components requiring responsible disposal. Robust housekeeping and construction waste management
Mining and mine waste management (including tailings containment)		Open pit mining at 9 locations, waste rock/soil at 4 dumps, new tailings facility built over old facility	Negative, direct, long term, localised	Moderate	Likely	Medium	Minimise footprint Consider alternatives including pit backfill	Essential component of project; cannot be significantly changed Technical review of embankment construction and tailings deposition during operations and on closure
Bypass roads in Matthew's Ridge, Matthew's Ridge to Port Kaituma road and Eclipse Falls Bridge		Upgrade road and bridge to permit continuous passage by Project vehicles and by public	Positive, indirect, long-term, localised	Moderate	Certain		Continuous maintenance	
Shipping port on canal and access road		Modest degradation of historically altered landscape	Negative, direct, long term, localised	Moderate	Likely	Medium	Minimise footprint	

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring/notes
			Type	Signifi-cance	Likelihood			
Cumulative Impacts								
Open pit mining and dumping of overburden rocks and soils	EPA Act, EPA Litter Regulations, National Action Plan Land Degradation, Guyana Mining Codes of Practice, Best Industrial Practice	Degradation of lands from project and on-going small and medium scale gold mining creates negative aesthetics on aerial approach	Negative, direct, long term, localised, cumulative	Negligible	Almost Certain	Low	Preparation and implementation of a Closure and Decommissioning Plan	

Chapter 18 - Cultural Heritage

This Chapter describes the known and potential heritage sites within the project areas at Matthew's Ridge and Port Kaituma as well as along the overland and river ore transport routes. In addition, it assesses potential impacts to cultural heritage from project activities and assigns risk ratings to these impacts. Further, it presents measures to mitigate and manage the risks associated with damage or loss of cultural heritage sites or artefacts.

18.1 Administrative Framework – Cultural Heritage

Table 18-1 summarizes the legislation, policies, strategies, and international treaties that are relevant to the planned project activities.

Table 18-1: Legislation, Policies, Strategies and International Treaties

Title	Description	Applicability to the Project
Legislation		
National Trust Act (1972)	Provides for the preservation of monuments, sites, places, and objects of historic interest or national importance. The Act also establishes the National Trust of Guyana to promote the permanent preservation of buildings of national interest or architecture, archaeological, historic or artistic interest and places of national interest, importance or beauty.	The Act requires that any cultural or archaeological chance finds during project implementation should be reported to the National Trust of Guyana. In such an event, the company and the National Trust of Guyana will have to work together to manage the resources found.
Amerindian Act (2006)	Recognizes the rights of indigenous peoples and communities and provides for participatory governance. The Act supports and encourages their right to preserve a traditional culture, cultural landscapes and traditional knowledge and languages as a minority group.	Supports the conservation of indigenous cultural heritage and patrimony. Under the Act, the management, conservation and protection of cultural lands, artefacts and natural resources are within the remit of the Village Council and provides for collective decision making with regard to research and development.
The Environmental Protection Act (1996)	Provides for the management, conservation, protection and improvement of the environment and has provisions for the prevention or control of pollution. The Act also establishes the Environmental Protection Agency (EPA).	One of the responsibilities of the EPA is to work with the National Trust of Guyana to identify and evaluate the direct and indirect impact of material assets, cultural heritage and landscape.
Policies and Strategies		
The Draft National Cultural Policy of Guyana (2013)	Intends to adapt and implement locally acceptable standards to identify and inventorise archaeological and historical sites and artefacts, and to actively	Established the framework through which the Government can support the conservation and management of cultural resources.

Title	Description	Applicability to the Project
	promote and support all efforts aimed at the preservation and restoration of national patrimony.	
International Treaties and Protocols		
United Nations Educational, Scientific and Cultural Organization Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property (1970)	Parties to the Convention oppose the illicit export and transfer of ownership of cultural property by all means available to the Party. The Convention also makes provisions for reparations for the loss of cultural property as a result of illicit export or ownership transfer. Article 1 of the Convention provides a list of archeological, pre-historic, historic, literature art and science which are considered cultural property.	Prevents the export or ownership transfer of any cultural property uncovered during project implementation unless it is done in accordance with the laws of Guyana. Guyana ratified in 1972.
United Nations Educational, Scientific and Cultural Organization Convention on the Protection of World Cultural and Natural Heritage (1972)	Provided the basis for identification of UNESCO World Heritage Sites.	Presents definitions for cultural heritage and natural heritage which may apply to the project locations. The Convention would apply to the project only if the Government identifies site within the development areas for consideration as a World Heritage Site.

18.2 Baseline Conditions – Cultural Heritage

This section situates the cultural resource assessment within the regional archeological and the historical socio-cultural contexts. It is informed by a literature review of the existing research in the area and is also complemented by rapid appraisals of potential heritage sites in the project areas during field visits by the EIA team.

18.2.1 Archaeology of Region 1

Archaeological evidence suggests that the north western coastland was first occupied by the Meso-Indian or Archaic hunter-gatherers. The Western Guiana Littoral has been defined as an Archaic Tradition dating to 7,330 to 3,550 years before present (BP) and throughout this period, Guyana's northwestern coastland was constantly populated[161]. The Archaic Tradition was further divided into early, middle and late archaic periods each of which correlated with environmental changes in the littoral region.

On the coast and around the swamps of the northwest and Pomeroon areas, numerous shell middens reflect the extensive use of a variety of shellfish[162]. Archaeology also reflected the considerable use of forest and brackish water resources during the archaic period and the concomitant discovery of a range of new "ground stone" tools including axes, adzes, other wood working and plant processing

[161] Williams, D. 2004. Prehistoric Guiana. Page 4, Paragraph 6 *and* Williams, D. 1998. The Archaic Colonization of the Western Guiana Littoral and Its Aftermath. Page 6, Paragraph 4.
[162] Plew, M.G., C.A. Willson, and L. Daggers. 2012. Archaeological Excavations at Siriki Shell Mound, Northwest Guyana. Page 4, Paragrapph 6 and Plew, M.G., and L.B. Daggers. 2017. Additional Excavations at Siriki Shell Mound, Northwest Guyana, 2016. Paragraph 6, Page 4.

tools and ceramics. Among the well-known mounds in Region 1, are Barabina, Sebai, Wyva, Little Kanaballi, and Koriabo. The known archaeological sites in Region 1 are shown in Figure 17-1. Currently, there are approximately 47 documented archaeological sites in Region 1. None of these sites are located within the AoI of the project. Assessment of the known sites revealed a number of Mabaruma phase pottery (Figure 18-2). In addition, possible habitation sites particularly within the area of Koriabo along the Barama River and, Hobodia along the Aruka River were also found. The findings of the Wyva Creek Shell Mound and human remains also found at this site (Figure 18-4) are typical of the archaeology of Guyana's northwestern coast. There are no known archaeological finds within the area of influence of the project.

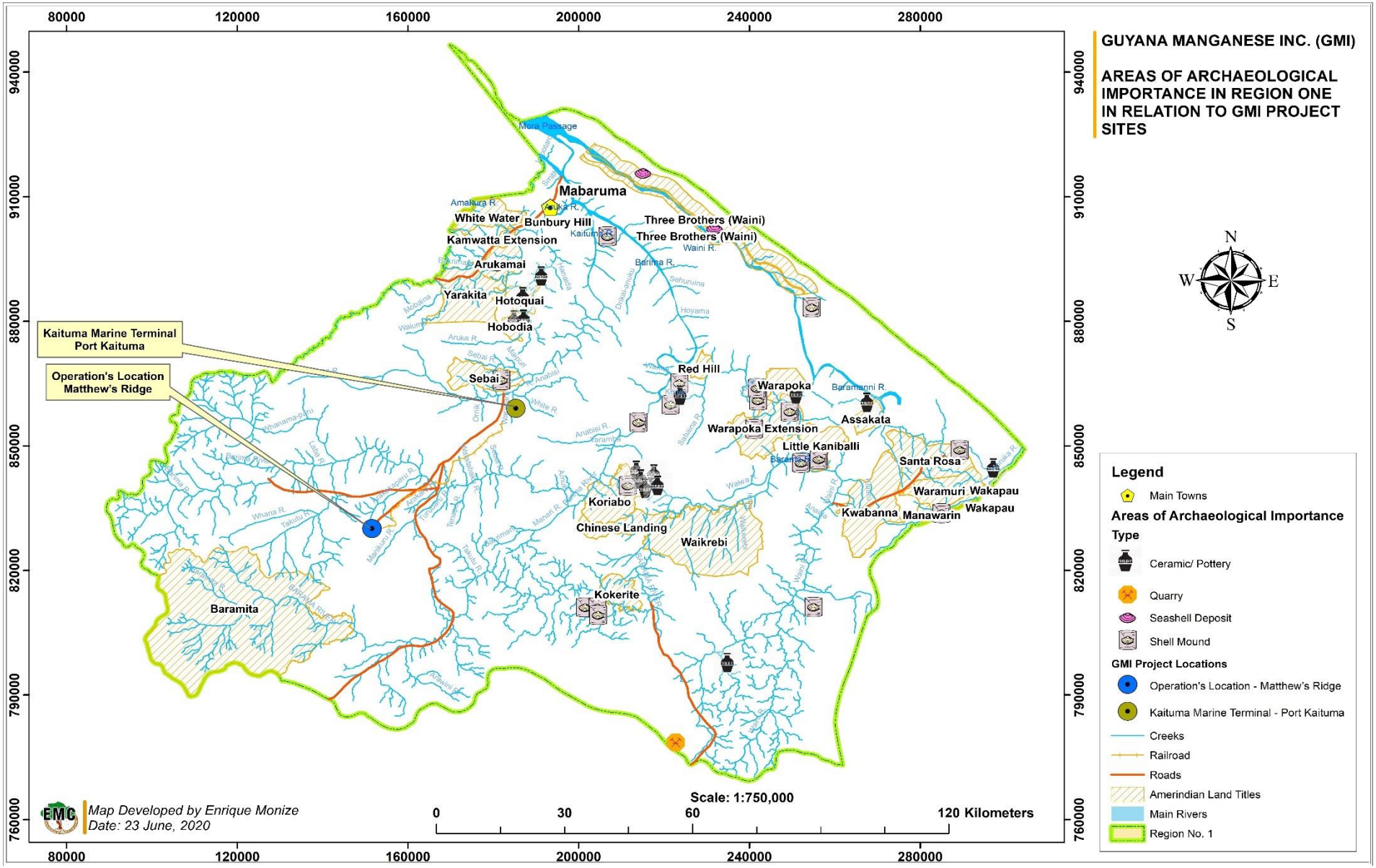


Figure 18-1: Areas of Archeological Importance in Region 1 Relative to the Project Areas

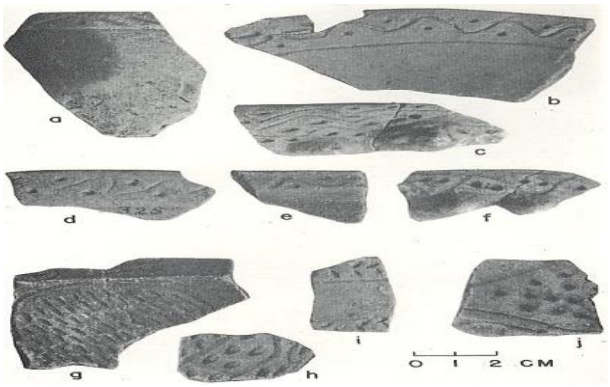


Figure 18-2: Mabaruma Phase, Kaituma Incised Pottery

Figure 18-3: Stone Tool Typical of Archaic Sites

Figure 18-4: Wyva Creek Shell Mound and Human Remains

18.2.2 The Historical Socio-Cultural Context

The GMI project is situated within two vibrant mining communities namely Matthew's Ridge and Port Kaituma. In addition, there are several native indigenous communities situated along both the overland and shipping routes. The development of both Matthew's Ridge and Port Kaituma are significantly intertwined with the history and establishment of manganese mining activities in the mid-twentieth century.

In 1954, Manganese Mines Management Limited, a subsidiary of Union Carbide, commenced mining operations in Matthew's Ridge by establishing the facilities and infrastructure required to allow for the storage and export of ore. The community settlement in Matthew's Ridge developed directly as a result of the mining activities in the areas. So significant were these developments at that national level that Matthew's Ridge was actively being considered as an area for the location of the capital of Guyana. Port Kaituma also developed into the economic hub for travel and trade that it is in the present day as a consequence of the manganese mining activities in Matthew's Ridge. Historic industrial development in Matthew's Ridge and Port Kaituma as a result of manganese mining included:

- Establishment of mine buildings and a processing plant at Matthew's Ridge the remnants of which are visible today (Figure 18-5). Moreover, GMI rehabilitated buildings from the old processing site into warehouses for their operations (Figure 18-6);

- Construction of the Guyana House (Figure 18-7) which was rehabilitated by GMI and is used to house officials and other dignitaries visiting the site;

- Construction of a 48-kilometer (30-mile) railway for the transport of ore from Matthew's Ridge to Port Kaituma. Some remnants of this railway remain visible in Port Kaituma (Figure 18-8). However, some sections of these railways were covered over during paving of roadways in Port Kaituma. A section of the railway alignment located west of the existing Matthew's Ridge to Port Kaituma public road will be used by GMI as part of the overland transport route;

- Construction of a Bailey bridge over the Barima River at Eclipse Falls which is still in use today (Figure 18-9). This bridge will also be used by GMI for overland ore transport and will be rehabilitated for this purpose;

- Creation of the Kaituma Canal and dredging of the Barima River and Mora Passage;

- Establishment of a ship loading, ore concentrate storage, fuel tankage and housing at Port Kaituma.

- The creation of the Pakera Lake as a water storage reservoir, which will also be used by GMI for water supply after rehabilitation of some components.

Figure 18-5: Remnants of the Old Processing Facility

Figure 18-6: Rehabilitation of Previous Mines Buildings

Figure 18-7: Guyana House

Figure 18-8: Remnants of the Old Railway Line in Port Kaituma

Figure 18-9: Eclipse Falls Bridge

Following the closure of the manganese mine, a considerable portion of the railway system was dismantled and repurposed. Moreover, after the cessation of manganese mining in the 1960s, the Government had undertaken activities to promote agricultural development in Matthew's Ridge and Port Kaituma. As part of the agricultural development of the Matarkai sub-district, a road was constructed adjacent to the railway line between Matthew's Ridge and Port Kaituma. In 1991, large-scale logging in the Region led to the construction of another primary haul road (well west of the railway and public road) as well as several other secondary logging roads. This infrastructure opened up the area to artisanal mining, logging and agricultural activities. Nonetheless, most of the region remains largely undeveloped and the areas surrounding the brownfield sites are covered with secondary vegetation.

Prior to the discovery of manganese, the region was home to several indigenous groups whose main economic activities were subsistence farming, foraging and fishing. In addition, Port Kaituma earned international recognition after the famed Jonestown mass suicide in 1978. This site is located approximately seven miles away from Port Kaituma and currently being considered for dark tourism and potential area for historical archaeological research. In 2009, the Government of Guyana erected a memorial plaque at the site of the Jonestown cult massacre.

The National Trust of Guyana indicated that remnants of the region's industrial history are important elements of the cultural heritage of the project development areas and highlighted the importance of involving local communities in identifying these sites (EMC Personal Communication 04). The communities of Matthew's Ridge and Eclipse Falls have displayed community ownership and phenomenological attachment to several places and environmental aesthetics with the project AoI. While these sites and structures have not been inventoried or recorded in the Guyana Gazette by the National Trust of Guyana as official heritage sites, they are believed to foster as sense of belonging and consciousness of life, changes and a reminder of experiences and achievements endured by the local population which are all important to the communities' wellbeing. Among the places of cultural importance to the community include the Eclipse Falls Bridge, the remnants of old railway system, as well as the old manganese processing plant, and the Guyana House. Some of these sites were also identified as potential cultural heritage sites by the National Trust of Guyana. The only visible buildings from the industrial history of the area within the project AoI are the dismantled structures used by the previous manganese company.

Currently, there has not been a resource assessment of the cultural, natural or archaeological heritage of these areas to definitively establish that this is the true potential of the area. However, a critical analysis of existing literature and previous archaeological investigations of the region suggest the potential could exist for certain types of archaeological finds (e.g., pottery, pottery sherds, stone implements and shell deposits, and burials of indigenous origin and or other material of historic significance could be encountered inadvertently in the project area, particularly along the access road and wharf site.)

18.3 Impact Assessment – Cultural Heritage

This section assesses the potential impacts of earth works activities, movement of equipment and personnel on the projects site and its potential threat to heritage resources. Impacts were assessed using the impact assessment methodology outlined in Chapter 7.

Heritage sites are fixed features in the environment, occurring within specific spatial confines. Any impact upon these resources will be permanent and irreversible. As previously mentioned, there are 47 known cultural heritage sites in the Matarkai sub-region. Although there are no known sites in the AoI, a combination of factors significantly increases the likelihood of inadvertent discoveries during project construction and implementation. These factors include proximity of key project components to known archaeological sites, the interaction of project infrastructure with community-owned historical heritage sites, the absence of a comprehensive assessment of the cultural, archaeological and natural heritage of the project areas and the total footprint of the project areas (such as the 18,506-hectare covered by the prospecting permit and the 9.5-kilometer bypass road at Port Kaituma). Any movement of vehicles, equipment or personnel through areas containing these artefacts could result in the permanent destruction of the artefacts and loss of heritage resources and invaluable research data. This is especially so in the case of built structures, such as the Eclipse Falls Bridge, which may require rehabilitation to be used for the project. Moreover, increased activities in the project areas also increases impacts associated with intentional looting or disturbance of known archaeological sites.

Heritage resources, if lost, are impossible to recover and the importance of these resources to people and the scientific community cannot be overstated. Impacts associated with the inadvertent or intentional destruction of heritage sites are **negative**, **direct**, **long-term** and **localised** of **moderate significance** but **likely to occur.** As a result, damage of loss of cultural property is a **Medium Risk** of the project.

Further, as previously mentioned, sections of the railway line passing through Port Kaituma were covered by pavement during road construction in the town. According to the Ministry of Public

Infrastructure, special protective measures during infrastructure construction are implemented only if the National Trust of Guyana has designated the site or structure as a heritage site (EMC Personal Communication 12). These impacts are not associated with the GMI project.

18.3.1 Cumulative Impact Assessment

As discussed above, there are no known cultural heritage sites within the AoI of the project and some ancillary project activities have requirement the dismantling or some elements of the built/industrial history of the area. Currently, there are no other existing or planned projects within or proximate areas which have been designated as cultural heritage sites. No cumulative impacts to cultural heritage are expected.

18.4 Mitigation and Monitoring Measures – Cultural Heritage

Inadvertent discovery or chance finds is defined as “the discovery of relics or human artifacts with potential archaeological or historical significance, (such as) human remains, especially in association with artifacts or articles including; pottery or pottery sherds; stone tools, shell middens or; metal, glass, burials or ceramic objects that could date to the pre-colonial or colonial era.” The following procedure should be followed in the event that archaeological materials or site are discovered during construction:

- Immediately cease all activities in the vicinity of the remains.
- Record the find location and leave all remains in place. The record should capture the site location, using standardize format established by the GMI and the National Trust of Guyana (NTG), including picture documentation and GPS coordinates of the site.
- Immediately inform the NTG of the find and establish a 30-meter (100-foot) buffer zone around the site until an archaeologist or Conservation Officer from the NTG evaluates the site and identifies a treatment method.
- The NTG should coordinate with the relevant personnel to determine the significance of the findings and assess appropriate mitigative options.
- Collaborate with the NTG to determine the appropriate course of action, if the significance of the remains is judged to be enough to warrant further actions which cannot be avoided.
- Relocation of the artefacts for preservation and security reasons may be determined as an appropriate action. The excavation of artefacts should only be recommended by the NTG or the University of Guyana and should be done by professional archaeologist using systematic excavation techniques once the site was evaluated by a heritage professional or the NTG and validated as one of archaeological significance.
- Contact the appropriate authority in the case of human remains. In addition, a coroner and/or physical anthropologist may be involved if the remains are classified as an artefact. Options for removal and burial should be considered if the location must be disturbed.
- The National Trust of Guyana should inform GMI of when work may recommence in the specific area.

In addition, to effectively safeguard indigenous and cultural heritage, GMI should also implement the following mitigation and monitoring measures:

- Engage local heritage organizations so as to train and sensitize its employees. Such training will significantly increase the probability of effectively identifying and protecting sites causing limited disruption and damage to invaluable cultural materials, if found. This training should include the development of a handbook for mine employees to simplify the site or artefact identification process with step-by-step guidelines for documentation, handling and site closure.

- Engage with the National Trust of Guyana to facilitate for a comprehensive assessment and appraisal of any structures which are of historical importance (buildings, bridges and railway). This will allow GMI, community members, and other contractors working in the area, to be provided with guidelines to manage rehabilitation and repurposing of sites while maintaining their integrity.

Table 18-2: Summary of Impacts and Mitigation Measures

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Significance	Likelihood			
Cultural Heritage								
Cultural Heritage	Compliance with Laws of Guyana and International Regulations	Destruction of and looting	Negative Direct, Long-term, Localised	Moderate	Likely	Medium	Compliance with Chance Find Procedures. Staff training in handling chance finds. Engaging with the National Trust of Guyana prior to and during rehabilitation of potential heritage sites.	

Chapter 19 - Socio-Economic Environment

This chapter describes the baseline social and economic conditions of the five settlements in the Matarkai sub-district. This includes the two key project locations of Matthew's Ridge and Port Kaituma as well as the settlements of Arakaka, Four Miles and Eclipse Falls whose residents are anticipated to have the greatest social and economic interactions with the project. It also assesses the impacts and risks of planned project activities on these settlements and also considers impacts which may arise as a consequence of planned project activities in the settlements. In addition, it recommends measures which should be followed to manage, mitigate and monitor these impacts.

19.1 Administrative Framework – Socio-Economic Environment

Table 19-1 summaries the legislation, policies, strategies, and international treaties that are relevant to the planned project activities.

Table 19-1: Legislation, Policies, Strategies and International Treaties

Title	Description	Applicability to the Project
Legislation		
Labour Act (1942 with amendments)	Provides for the regulation of the relationship between employers and employees and for the settlement of differences between them. The Act also makes provisions for payment of wages, hours of work of employees and the rights, duties and obligation of employees. It also prohibits child labour and levies penalties for breaches of the law.	GMI must ensure that all employee relations under this act comply with the relevant labour laws of Guyana.
Immigration Act (1947 with amendments)	Provides requirements respecting the arrival and departure of immigrants into Georgetown.	Requires work permits to be obtained for all expatriate employees, including those from China.
Amerindian Act (2006)	Recognizes the rights of indigenous peoples and communities and provides for participatory governance. The Act supports and encourages their right to preserve a traditional culture, cultural landscapes and traditional knowledge and languages as a minority group.	Supports the conservation of indigenous cultural heritage and patrimony. Under the Act, the management, conservation and protection of cultural lands, and natural resources are within the remit of Village Councils and provides for collective decision making with regard to research and development.
State Lands Act (1903 with amendments)	Provides for the regulation of lands, rivers and creeks belonging to the State. The Act also provides for the issuances of leases for the use of state lands for various purposes including agriculture.	Requires GMI to apply for leases for some components of the project including the Kaituma Marine Terminal in Port Kaituma. Agricultural leases were also issued in

Title	Description	Applicability to the Project
		Matthew's Ridge in proximity to the key project components.
Natural Resource Fund Act (2019)	Establishes the National Resource Fund to manage the natural resource wealth of Guyana for the present and future benefit of the people and for the sustainable development of the country.	Revenues earned by the central government are expected to be deposited into the Natural Resource Fund to be used for national sustainable development.
Strategies and Plans		
Green State Development Strategy: Vision 2040 (2019)	Outlines Guyana's 20-year plan for development that follows a green agenda defined by sustainable, low-carbon and resilient development. The GSDS also aligns with the 2030 Sustainable Development Goals (SDGs) outlined by the United Nations.	Outlines priorities for managing precious metals, minerals and aggregate resources including, among other priorities, improved management of land and water resources, managing extraction rates and streamlining revenue generation.
Guyana National Land Use Plan (2013)	Provides a strategic framework to guide land development in Guyana so as to enable resources to be used to target optimal land uses at the regional level.	Includes as one of the opportunities for development of land uses in the mining sector, the resuscitation of manganese mining at Matthew's Ridge, ore shipment from Port Kaituma and the rehabilitation of infrastructure connecting the two settlements (railway and road).
International Treaties and Protocols		
United Nations Declaration on the Rights of Indigenous Peoples	Delineates and defines the individual and collective rights of indigenous peoples including for identity, language, employment, health, education and ceremonial practices among other rights.	By adopting this declaration, the Government signaled its commitment to implement measures to safeguard and protect the rights of its indigenous populations and to uphold the principle of Free Prior and Informed Consent for any form of development which will occur within indigenous lands. Guyana adopted the Declaration in 2007.
International Labour Organisation Conventions (1966 to 2013)	Guyana became a member of the International Labour Organisation In 1966 and has since ratified 47 Conventions and one protocol. As of	Institutes protective measures for employees in Guyana which must be adhered to by the project.

Title	Description	Applicability to the Project
	2020, 40 of these Conventions and the protocol remain in force including but not limited to: ▪ Equal remuneration for work of equal value regardless of sex (C100). ▪ Non-discrimination of workers with regard to access to vocational training, access to employment and terms and conditions of employment (C111). ▪ Prohibition and elimination of child labour taking consideration of the special considerations on girls (C182). ▪ Abolition of forced labour (C029 and C105). ▪ Minimum age (C138) ▪ Minimum wage fixing and protection of wages (C095 and C131). ▪ Freedom of association, protection of the right to organise and collectively bargain (C087 and C098). ▪ Compensation for accidents and occupational diseases (C019 and C042). ▪ Migration for employment (C097). ▪ Occupational safety and health (C155). ▪ Labour Inspection Convention (C081) and Labour Inspection Protocol of 1995.	

19.2 Baseline Conditions – Socio-Economic Environment

19.2.1 Historical Overview of the Project Areas

The North West District (NWD) area served as one of the main lines of trade between indigenous groups and there is a large presence of Amerindians within the wider area. Traditionally, balata bleeding was a main activity in the NWD, with bleeders operating in the Anabisi, Hyma, Perseverance, Takutu and Tassiwini areas. A shipping terminal was established at Mount Everad to ship balata from the area.

Between 1957 and 1968 the Manganese Mines Management Limited, a subsidiary of Union Carbide Corporation, established facilities and conducted manganese mining at Matthew's Ridge, with the first

shipment of manganese made in 1961[163]. This operation employed approximately 600 persons. Manganese ore was transported to Port Kaituma via a small gauge railway, from where it was directly exported to Trinidad. However, this operation eventually ceased, leaving the area in a depressed state, since there were no major economic and employment opportunities to sustain the livelihood of the population.

The closure of the Manganese Co. in 1968 led to a period known as the Matarkai era. The Matarkai Development Authority (MDA) was established to support the Regional System and the development of the area. The government at the time, encouraging many of the employees of the company to remain in Matthew's Ridge, transformed the mining community into an agriculturally based community. During this time the facilities left behind by the company, including administration buildings, were utiliseutilised by the government as the base of the MDA and other government offices. Government tried to ensure there were activities in the area by promoting other ventures. During the 1969 to 1977 period, Government Agricultural Schemes were established in areas close to Port Kaituma. This included the construction of a Cassava Mill. Other elements of the development included the setting up of a branch of the Guyana School of Agriculture on a 10 hectare parcel of land at Arakaka, and the establishment of a 240-hectare cattle breeding station by the Livestock Development Company near Arakaka. To support agricultural development via large scale cassava production and livestock rearing by numerous private farmers and farming cooperatives a road was constructed more or less parallel to and east the railway. During the Matarkai era the community produced cash crops, vegetables and cattle for domestic use. The national goals of 1972 to 1978 to Feed, Clothe and House the Nation transformed the social and economic structure of the community. A hydropower scheme was also proposed for the Barima River. However, none of these developments were sustained and were later abandoned and the MDA initiative was subsequently dissolved due to insufficient funds. In 1981, the MDA handed power over to the Guyana Defence Force, who then used the area as a military base. This power was handed back to the MDA in 1990 after attempts were made to stimulate development in the area once again. For six years the community was governed by the MDA and in 1996, the MDA was officially dissolved. From 1996 to date, community affairs have been managed by the RDC through the NDC. Structural changes greatly intensified the dependency on gold mining in the area. From 1996 to the arrival of RMI in October 2010, there existed no other major sources of economic stimulus within Matthew's Ridge.

Between 1974 and 1978 Reverend Jim Jones of the Peoples Temple Sect established Jonestown about 10 kilometers from Port Kaituma. However, this community came to a tragic end in 1978.

In 1991, BCL was granted a twenty-five years timber cutting rights under a Timber Sales Agreement by the Government of Guyana through the GFC. This covered some 1,611,195 hectares of land, the largest forest concession in Guyana at the time. During its 25 years in operation, BCL provided employment and other economic opportunities for residents in the northern part of the concession and accounted for over one thousand jobs within the area and surrounding communities, including Port Kaituma, Matthew's Ridge and Arakaka. The income earned saw a general development and improvement in the communities. The construction of logging roads significantly assisted in the development of the area by providing easier and safer access to several areas. BCL established its main operational base at Port Kaituma. However, as its operations progressed southwards, its primary haul road was established well west of the Matthew's Ridge to Port Kaituma Railway and Matthew's Ridge to Port Kaituma Road respectively. BCL's logging road crossed the Barima River above Eclipse Fall, thence to a point near the mouth of Arunamai River, left bank Barama River. Several roads were however constructed within areas south of Matthews Ridge, with one such road extending to a point on Barama River near Kariako Amerindian Village. BCL closed operations in the areas north of Barama River around 2006 leaving a vast network of roads which facilitated extensive itinerant gold mining operations in and around Matthew's Ridge and the wider area. By the end of 2002, BCL would

[163] Geological Survey of British Guiana Annual Report 1968, Page 18

have constructed in excess of 1,500 kilometers of main and secondary access roads within the area so as to access areas that were previously inaccessible. However, most of these secondary roads were not maintained after BCL's operations in the area concluded.

In the early 1970s, Matarkai set up a portable sawmill about eight kilometers west of Matthew's Ridge to provide lumber for the new Guyana National Service Center which was established at Papaya in 1975. However, formal logging within the district did not commenced until 1991 when BCL acquired it's forest concession. It is generally felt that loggers' disinterest in the forest resources of NWD prior to 1991 is due to the fact that the density of the Greenheart species in that area is low, estimated at 1 tree per 100 hectares; likewise for the Purpleheart species it is 6 trees per 100 hectares. BCL's primary interest was plywood manufacturing and their focus wasthe species of Haiariballi, for which there were 635 trees per 100 hectares, and Baromalli at 199 trees per 100ha hectares. The specific forest type surrounding the Matthew's Ridge area is mixed forests on high hills which is generally considered non-productive. Even if there is merchantable timber, its harvesting is likely to be both challenging and dangerous due to the nature of the terrain. In the last 20 years, the extensive road network that supported BCL's logging operations, and extensive itinerant mining left the forest resources *near Matthew's Ridge* in a degraded and fragmented state. Further degradation *around Matthew's Ridge* occurred from routine harvesting of chainsawn lumber, firewood and materials for fencing and livestock pens. However, recently, in 2019, the GFC issued two forest concessions in close proximity to Matthew's Ridge.

Nevertheless, the area has been known for its widespread mining activities since Arakaka was developed in 1895 as a major local centre for the area and gold mining became the major occupation. During this period, the village had a District Commissioner's rest house, police station, dispensary and a mortuary. Three British owned mining companies operated in the area. The NWD has within the last decade or so seen a tremendous increase in gold mining activities since the gold rush period as a result of increased gold prices. Several mining operations are operating in areas such as Eyelash, Arakaka, Five Star, etc. Mining within the NWD is being done at varying scales including medium, small and even 'pork-knockers' who are freelance individual prospectors mining gold in the alluvial plains. Gold mining has seen the population of the NWD community climb sharply in recent years. The increase in persons in search of the abundant benefits from the metal has impacted the socio-economic environment both negatively and positively. Several settlements have developed within the area as a direct result of the mining operations and with this development comes opportunities for economic development. Port Kaituma, one of the most popular settlements in the NWD is a typical example of the rise in various economic activities relevant to the mining sector.

The presence of miners within these areas also spur a demand for goods and services which saw a rise in entrepreneurs. Businesses such as food shops, mechanic and spares shops, transportation services, clothing and dry goods stores, bars, hotels and fuel supply are either owned by miners themselves or by persons migrated from the coast to capitalise on the business opportunities available. Among these opportunities comes the factor of employment whereby several dredge owners provide employment to local Amerindian communities as well as employing persons from the coastal area. Payment for such labour varies and are either fixed or are based on the output from each 'wash-down'.

The land uses of the wider project area can be observed in Figure 19-1.

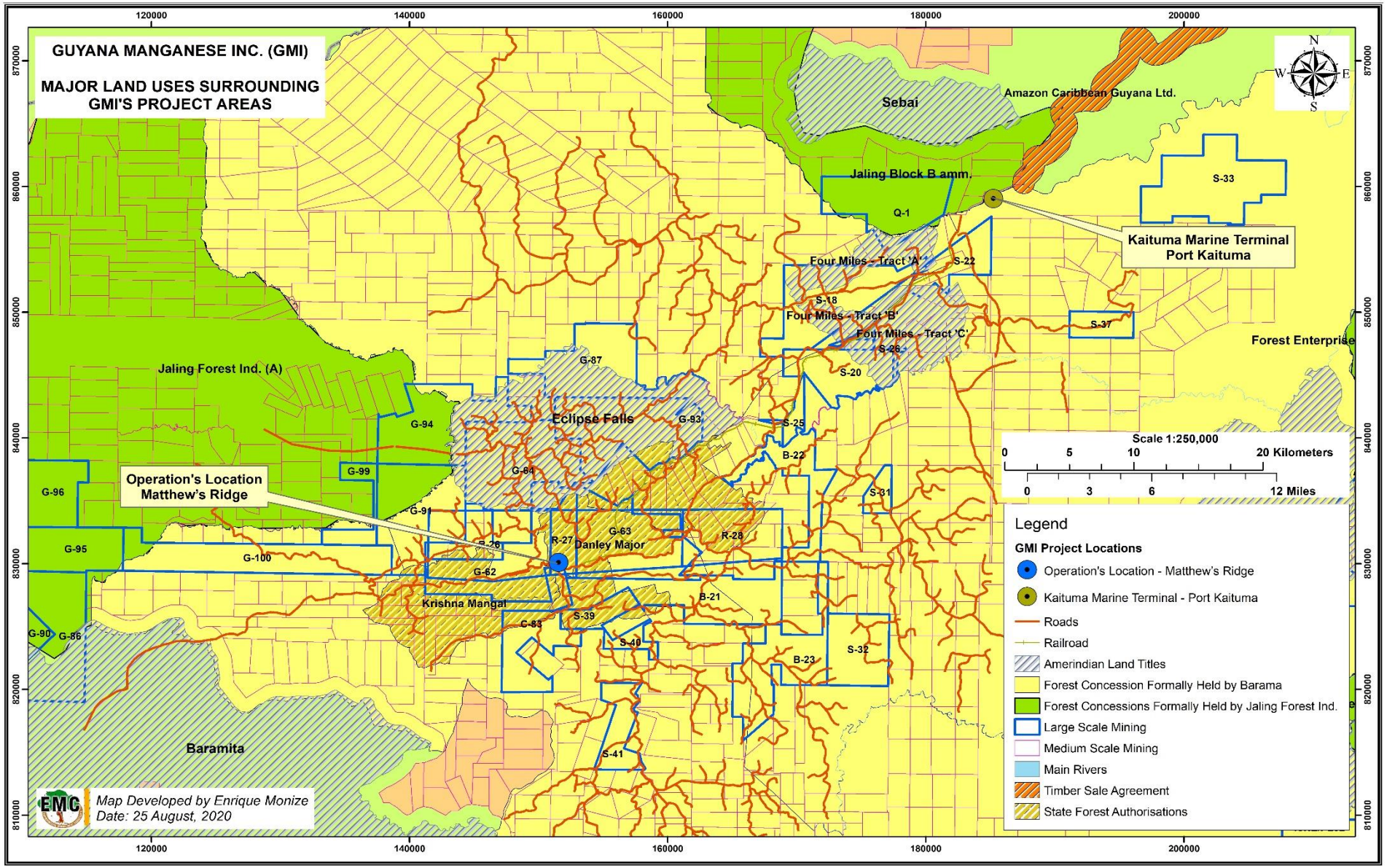


Figure 19-1: Land Uses of the Wider Project Area

19.2.2 Communities' Profile

Baseline socio-economic conditions were assessed for the five settlements that fall within the Matarkai sub-district of Region 1 namely: Matthew's Ridge, Port Kaituma, Arakaka, Eclipse Falls and Four Miles. The locations of these communities are shown in Figure 19-2. As the two primary project locations, baseline socio-economic conditions were examined for Matthew's Ridge and Port Kaituma to facilitate a comprehensive assessment of how the project and the planned project activities may impact these communities which fall within the primary AoI and the project. In addition, this section also includes detailed examination of the prevailing socioeconomic environments of the settlements within the secondary AoI, Arakaka, Four Miles and Eclipse Falls, because of the relative ease with which they may access the primary project locations, the extent to which transportation infrastructure passing through these village will be used by the project and the likelihoods of its residents becoming GMI employees or service providers. The communities were considered as secondary stakeholders.

The head office for the NDC for the Matarkai sub-district is based in Port Kaituma and administers Port Kaituma, Matthew's Ridge, Arakaka and the households located along the road network between these communities. There is also a titled Amerindian village within the boundaries of the Matarkai sub-district. Overall, the following additional community administration structures also support administration of settlements in the Matarkai sub-district:

- CDC for Canal Bank in Port Kaituma.
- CDC for Eclipse Falls.
- CDC for Arakaka.
- NDC Office in Matthew's Ridge headed by the Vice-Chair of the NDC.
- Village Council for the Four Miles indigenous village.

The socioeconomic baseline aimed to determine:

- The population, demographics, existing levels of education and main livelihood activities and their contribution to the local economies.
- Existing land uses and ownership of land.
- Community well-being through measures such as type of housing, cooking fuels used, access to potable drinking water, access to health care services, access to recreation/entertainment, waste disposal and pollution and levels of crime and violence.
- The presence of social infrastructure such as schools, recreation centers, communication, government offices and services, health facilities and transportation network.

Planned project activities requiring barge shipment of ore from the Kaituma Marine Terminal to Trinidad will require use of a river transportation network which is currently used by residents of several communities, indigenous villages and towns which constitute the tertiary AoI of this project. Five of these communities are located on the banks of the Kaituma River and the Barima River and use these Rivers as part of their daily lives and livelihoods. These five communities are Lower Kaituma, St. Anselm, Aruka Mouth, Morawhanna and the titled Amerindian Village of Smith's Creek. Although baseline socio-economic information is not presented for these communities, potential impacts arising interactions of the project barge with livelihood activities/vessels from these villages are considered in the impact assessment. However, these communities were assessed as part of the ecosystems services assessment (Chapter 13).

In the assessment of the communities within the wider project area special considerations were given to indigenous communities. There are only two indigenous communities which will have direct contact with project activities. These are Four Miles and Eclipse Falls, where the transport of ore overland from Matthew's Ridge to Port Kaituma will pass through, and where the possibility exists for much interaction between the community and the project. Four Miles is a titled Amerindian community while

Eclipse Falls has applied for title. However, these communities are located some distance away from the actual project sites, as is shown in Figure 19-3. Along the shipping route there is Smith's Creek on the left bank of the Barima River, which is a titled Amerindian community. However, it is expected that there will not be much interaction with this community and the project.

It is important to note that travel and other restrictions associated with the COVID-19 pandemic necessitated modifications of the methodology which was designed to collect baseline data from these communities. In particular, instead of stakeholder consultations via in-person meetings, focus group discussions and surveys the EIA team conducted telephone interviews representatives of key local authorities from these communities. The initial stakeholder consultation methodology and the procedures which were followed to execute the modified methodology are further detailed in Chapter 6.

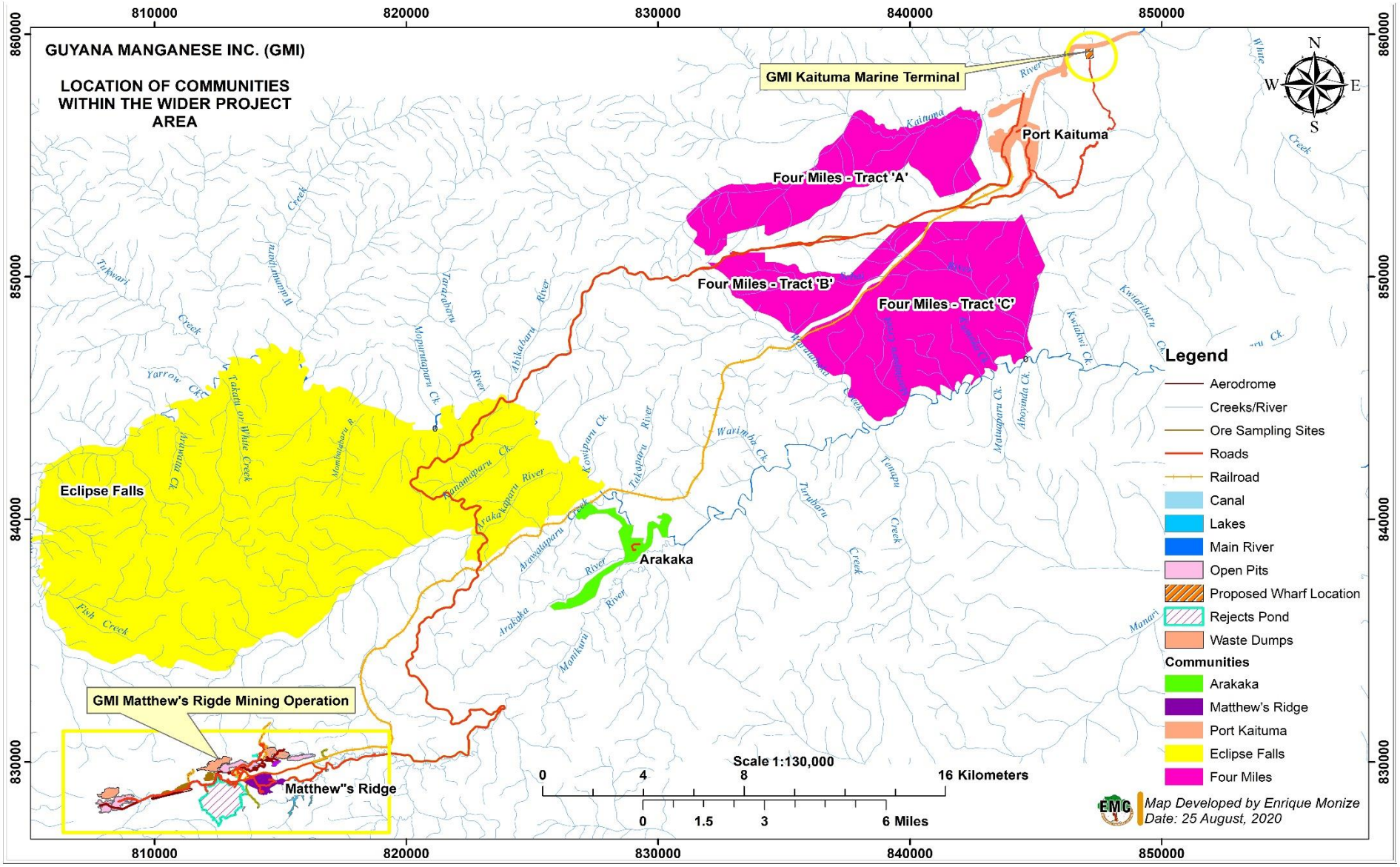


Figure 19-2: Communities within the Wider Project Area

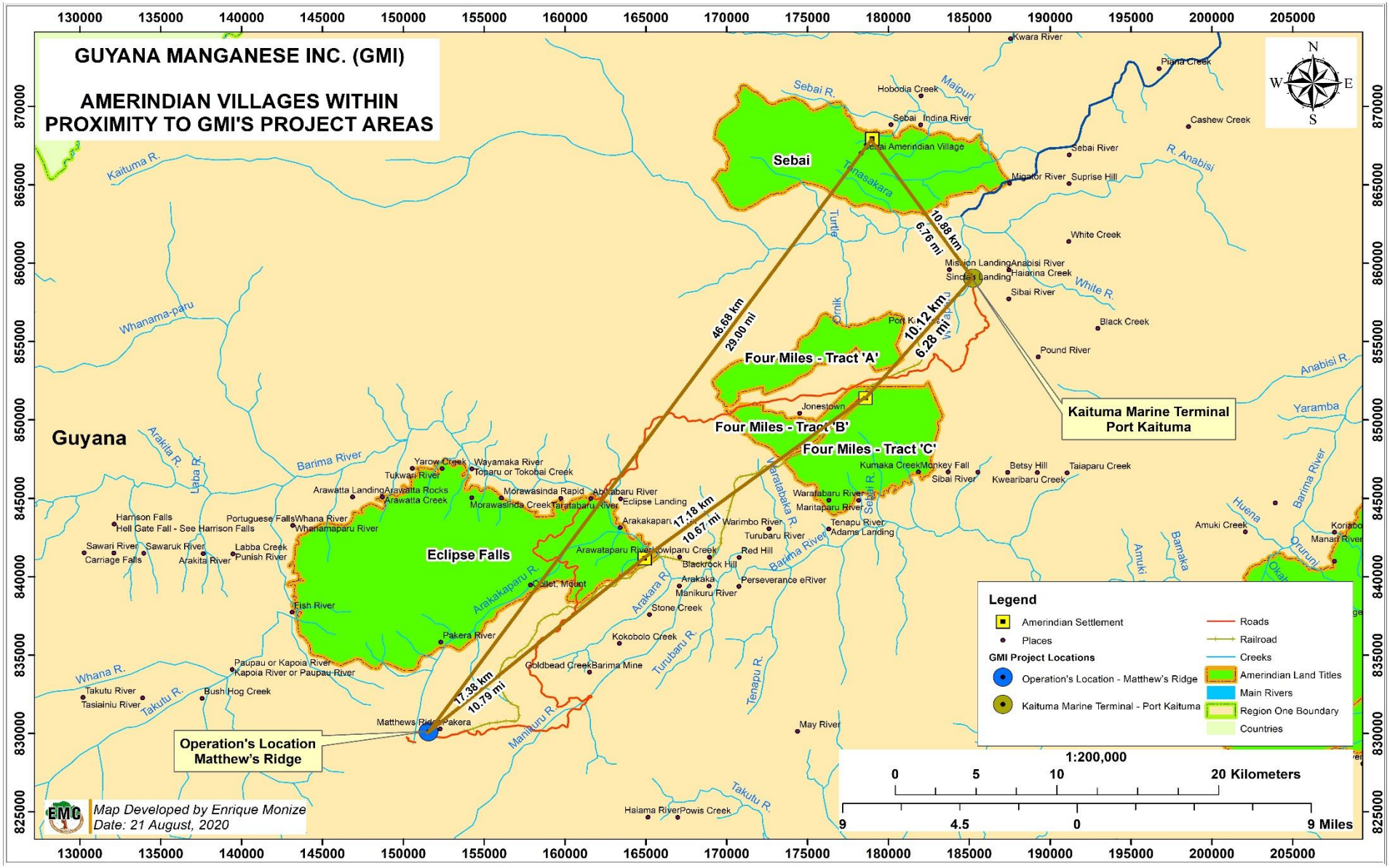


Figure 19-3: Amerindian Communities in Proximity to the Project Areas

19.2.2.1 Port Kaituma

Port Kaituma is a small town located in Barima Waini, Region 1. The community developed following the discovery and mining and export of manganese ore in Matthew's Ridge in the 1950s and 1960s. As Matthew's Ridge was not located on a navigable river, a canal was cut from the Kaituma River and Port Kaituma was constructed. At the time of the manganese mining, Port Kaituma had three separate areas. The mine managers' house and the guest house were in a large clearing separated by a short road through the forest from the main rail-head and manganese loading facility. A longer road led in the opposite direction to the area known as 'Bottom Floor' where the workers lived. As part of these development efforts, the Kaituma Canal was dredged and the dredge spoils dumped on banks of the Canal. This resulted in several residences and farmsteads being established along the Kaituma Canal. In addition, the Kaituma Canal enhanced the accessibility of Port Kaituma and currently, Port Kaituma is the main port of entry into the mining district of Region 1. Port Kaituma is managed by a NDC which comprises of a Chair and board of several councilors. In addition, the Canal Bank is also managed by a CDC.

According to the Chairperson of the NDC, both residents and the NDC welcomed the project and shared expectation that will create immense opportunities for employment for locals within the Region. Moreover, there are high expectations about GMI's contribution to the overall improvement of the Region, both by fulfilling commitments which were made to the NDC and also, by investing in the development of the community. As part of these efforts, the NDC and GMI entered into an MoU under which the NDC agreed to waive tolls levied on vehicles for overland entry into Port Kaituma if GMI were to maintain roads and the bridge in Matthew's Ridge. The NDC Chairperson and the Chairperson of the RDC have both signaled disappointment with GMI's progress in satisfying its obligations of the MoU and also of contributing to regional development (EMC Personal Communication 02, 17 and 18).

Population and Demographics

According Chairperson of the NDC, Port Kaituma (and its surrounding settlements of Oronoque, Fitzburg, etc) had a population of 3,800 persons and the Canal Bank had a population of 1,500 people in 2020. Based on the national census[164], approximately, 42.3 percent of the population is between 0 and 19 years of age, 40.8 percent between 20 and 54 years of age, and approximately 17 percent between 55 to 84 years of age. In addition, according to the NDC Chairperson, in 2020, there were approximately 300 to 400 households located along the Canal Bank (EMC Personal Communication 17). According to the national census, sixty percent of the population has attained secondary education and 28 percent has acquired primary education. Only two percent of the population has completed tertiary education.

According to the national census, the Port Kaituma population comprises of several ethnic groups as follows: 32 percent indigenous peoples, 3 percent Indo-Guyanese, 5 percent Afro Guyanese, 58 percent of mixed decent and 2 percent of the population comprising people of Chinese, Portuguese and European descent.

Religion

According to the national census, in 2012, the Port Kaituma population follow several organized religions. However; Christianity remains the most dominant. The table below provides a breakdown of the religions practiced by the Port Kaituma population.

[164] Guyana National Bureau of Statistics, 2012. Final Census Compendium 1

Table 19-2: Religions of the Port Kaituma Population

Religion	Practicing Population
Christianity	1,037
Hinduism	23
Rastafarian	10
Muslims	21
Other	1
No religion	60

Vulnerable Populations

As noted above, 36 percent of the population of Port Kaituma is comprised of indigenous peoples who are classified as a highly vulnerable group. Moreover, in Guyana and Latin America, indigenous peoples constitute a significant proportion of the rural poor population and typically live under conditions characterized by food insecurity, environmental stress, seasonal employment, dangerous employment and lack of access to services or markets, all of which contribute to vulnerability. According the estimate provided by the Regional Chairman, Venezuelan migrants account for less than one percent of the migrant population in Region 1 (EMC Personal Communication 18). In Port Kaituma, there has not been, to date, a count of Venezuela migrants. However, according to the NDC Chairperson, most of the migrants are indigenous people of Warrau origin who have established makeshift houses and tent on vacant lands along the Canal Bank (EMC Personal Communication 17). The Venezuelan migrant population include women, children and men all of whom are highly vulnerable to social discrimination, exploitation, inequality including poor education and healthcare due to poor documentation, language barriers and economic status in society. These challenges are discussed further in this chapter.

Moreover, in 2012, 43 percent of the total Port Kaituma population was younger than 14 years of age and seven persons with disabilities ranging from speech and mobility were living in the community. These populations are considered to be socially vulnerable. They may be considered as potential victims of the illicit activities in the community around them including crime. They are also vulnerable to potential life-long effects derived from lack of education, poor health care and inadequate social structures including social safety nets. The young members of female headed households are also extremely vulnerable to potential risks such as child labour, education deprivation and juvenile delinquency which may be brought about as a result of poor living conditions and minimal income generation.

Immigration

In recent years, Port Kaituma has experienced an influx of migrant Venezuelans. This influx was triggered by economic instability in Venezuela, resulting in men, women and children fleeing to seek jobs and pursue better lives for themselves and their families to care for their families. Upon entry into Guyana Venezuelans are issued with 90-day temporary stay permits which allows them to work and enroll their children into schools. According to the Inter-Agency Gender Based Violence Assessment Report (2019)[165], economic activities in Guyana is limited and Venezuelan migrants add to the stress of local economies. Venezuelan migrants are typically willing to work for much less income than the Guyanese and are constantly exposed to labor exploitation such as long working hours, low or unpaid wages, unpaid overtime, no rest or holiday, verbal or physical abuse, and sexual harassment. Due to the lack of formal economic opportunities Venezuelan women to turn to sex work (survival sex) and many of them go to Port Kaituma, Bartica and mining areas as there is more opportunity. However, as

[165] Response for Venezuelans, 2019. Inter-Agency Rapid Gender Based Violence Assessment Report. Page 11, Paragraph 3 and Page 17, Paragraph 2

of 2019, the Guyana Police Force indicated that no reports of gender-based violence had been made by Venezuelan women. Venezuelan men seek regular employment but are usually limited to unstable and exploitative options. Currently, there is a relatively large number of migrant Warrau population in Port Kaituma. As previously discussed, they have settled along the Canal Bank where they have erected small huts and tents on state land and are engaged in farming particularly subsistence farming. During telephone interviews with local authorities for communities within the Matarkai sub-district also revealed that there was local immigration into Port Kaituma. For example, the Chairperson of the CDC for Eclipse Falls indicated that the population of Eclipse Falls has been declining as people migrate to Port Kaituma, Matthew's Ridge and Arakaka to seek employment (EMC Personal Communication 20). Persons from other parts of the Region and Guyana, including the coastlands, would have also migrated to Port Kaituma to conduct mining and other economic activities.

Local Economy

The main economic activity in the community of Port Kaituma is mining both small-scale mining, including pork-knocking or freelance prospecting, and medium-scale mining. Port Kaituma is a key service and access route to the mining districts of Region 1 and people who are engaged in mining either work within the boundaries of Port Kaituma or travel outside the community to work with small- and medium scale miners. Residents who work outside of the community are often away for extended periods of time. In total, mining accounts for the employment of approximately 34 percent of the Port Kaituma population.

Another 32 percent of the population are small business owners of shops that sell groceries and household items and of businesses that provide entertainment and temporary accommodation for river travelers. Businesses in the area are supported by mining activities in Port Kaituma. As a major mining town, employment opportunities have developed in hospitality and entertainment (bars, restaurants, accommodations). Moreover, these facilities as well as shops in the community also provide employment to women in housekeeping, as servers, cooks, attendants and cashiers. There is an active commercial district in Port Kaituma including a bank, and a bustling marketplace on Wednesdays and Saturdays which has approximately 25 stalls where vendors ply who sell a variety of fresh produce, dry goods and other supplies. Residents from Canal Bank and other nearby communities bring produce to the market for sale. However, restrictions associated with the COVID-19 pandemic have reduced the frequency with which market days are now reduced to once weekly, on Wednesdays and this has negatively affected the livelihoods of the vendors.

Nine percent of the population provide mechanical repairs services and ten percent of the population are involved in other activities (teaching, health care, administrative). Only four percent of the population are involved in logging and forestry related activities and less than two percent receive remittances from abroad. In addition, several persons are employed with private companies that support the mining industry and local infrastructure including, but not limited to, International Import and Export Supplies as well as B. Sooklall Logging Investment among others. Approximately nine percent of the population are informally employed and are believed to be unemployed or work odd jobs. Given the close proximity to the Venezuelan border, and as previously discussed, the community has seen increased immigration of migrant workers and growing sex industry[166].

[166] Ibid. Page 11, Paragraph 3

Figure 19-4: A Food and Accommodation Facility in Port Kaituma (left) and Businesses and Vendors at the Waterfront Area (right)

Land Use

Port Kaituma is one of the main commercial hubs of Region 1 and has a busting commercial district which is located primarily along the waterfront of central Port Kaituma. Residential homes are located in several settlements including but not limited to Citrus Grove, Oronoque, Fitzburg and Canal Bank. Based on occupational surveys conducted by GLSC, 47 percent of households are believed to own land in the community, 22 percent of households have land leases, several percent of households are currently renting land and 20 percent are considered squatters. The land status of the remaining four percent is unknown. Agriculture is one of the primary productive uses of the land in Port Kaituma and most households cultivate crops for subsistence use, particularly households located along the Canal Bank. Many farmers also practice small-scale crop cultivation for sale in the commercial district.

The proposed location of the Kaituma Marine Terminal on Canal Bank previously comprised three small, unregulated homesteads whose occupants engaged in small-scale agriculture. According to GFC, the GMI bypass road to the wharf site passes through lands which were heavily degraded due to extensive agricultural activities in the 1960s and 1970s. Since the construction of the access road, crop cultivation has resumed in the lands adjacent to the roadway. There are no proximate forest concessions and the nearest forest concession is held by AMCAR for the harvesting of manicole palm. This resulted in highly degraded lands in some areas. Since the construction of the GMI bypass road in Port Kaituma, several activities have commenced in the lands adjacent to the bypass road including farming for commercial purposes as well as freelance prospecting for gold. However, it should be noted that Guyana's National Land Use Plan (2013)[167] identified the Matthew's Ridge to Port Kaituma area as having high potential for mining, forestry and agriculture but noted that this development is constrained by access and electricity.

Social Infrastructure and Services

Since its formative years, significant investments have been made to develop the social infrastructure in Port Kaituma. The key social infrastructure in Port Kaituma includes:

- Nursery, Primary and Secondary Schools. Secondary level students from the Four Miles indigenous village and Eclipse Falls travel to Port Kaituma to attend secondary school (EMC Personal Communication 19 and 20). There is also a training facility which provides technical skill-based training to residents in an effort to support alternative livelihood activities.

[167] Government of Guyana, 2013. National Land Use Plan. Page 134, Paragraph 6

- Road transportation infrastructure connecting Port Kaituma to other communities within the AoI including Four Miles, Eclipse Falls, Arakaka and Matthew's Ridge. Travel within the region can be achieved by bus, pickup trucks or ATVs along the red loam road. Travel time depends on the type of transportation used, the weather and condition of the road. On average it takes one to two hours to travel from Port Kaituma to Matthews Ridge via most modes of transportation. While some residents own private transportation majority of the resident rely on publicly available transportation.
- River transportation infrastructure, with two dedicated landing areas, to facilitate passenger travel and cargo imports, specifically:
    - Imports of fuel and other cargo including food items and vehicles into Port Kaituma. Many communities depend on these imports including Four Miles, Eclipse Falls and Matthew's Ridge.
    - Fortnightly ferry service operated by the Government's Transport and Harbours Department operating the Georgetown to Port Kaituma route utilising the MV 'Barima', the MV 'Kimbia' or MV 'Lady Northcote' vessels. Due to social distancing restrictions of the COVID-19 pandemic, the ferries have been operating at half of their passenger capacity.
    - Daily small passenger vessels from Mabaruma, Moruca and Arakaka in Region 1 and Charity in Region 2. However, the operation of all of these vessels were temporarily halted due to safety precautions associated with the COVID-19 pandemic.
- Airstrip for both inbound and outbound flights. A local air service operator provides daily return flights from the Eugene F. Correia International Airport. However, the airstrip has been closed recently, with flights suspended so as to execute rehabilitation of the airstrip. Passengers travelling by air to and from Port Kaituma arrive and depart via Matthew's Ridge.
- The Port Kaituma Police Station, which also provides service to the Four Miles village and Eclipse Falls. In addition, officers of several government and local organisations are also present in Port Kaituma and provide services to other communities, including communities within the AoI. These include the administrative office/headquarters of the NDC, and field offices of the Guyana Post Office, GWI, GFC and GGMC.
- Digicel cellular and data tower. However, landline services are not available. Residents and business owners also have access to satellite TV services.
- A branch of the Guyana Bank for Trade and Industry is located in the community to providing banking and other financial services.
- The Port Kaituma Regional Hospital (discussed further in the Health section below).

Figure 19-5: NDC Office in Port Kaituma

Health

In 2020, the Government of Guyana commissioned a District Hospital in Port Kaituma valued at GYD$ 959 million. The new facility has 50 beds and specialised medical practitioners including a resident internal medicine specialist and a pediatrician. The hospital is fitted with water filtration systems and as of 2019, had a functioning modern ambulance service. Prior to the commissioning of the new district hospital, there was a smaller District Hospital which had 20 beds and which was refurbished with support from the Barama Company Limited (BCL). This smaller hospital will also remain open in Port Kaituma (EMC Personal Communication 11).

Residents typically seek treatments for malaria, typhoid fever, rashes and fever and mining related injuries. While most households use mosquito nets, others preventive measures are in place by the community including fogging and education awareness. No data is available on the rate of infection of sexually transmitted diseases and how it affects the population. The Georgetown Public Hospital Corporation (GPHC) and Mabaruma Hospital are also treatment options. Emergency evacuation by aircraft to Georgetown is possible and is done with support from the NDC.

Electricity

Port Kaituma is connected to the national electric grid which provides electricity to 76 percent of households. Other residents who are not connected to the national grid use other means of electricity including generators, solar and kerosene to provide electricity for lighting, refrigeration, music, and other purposes. Generators are used mainly during daylight and early evening hours. During the night, some residents also use charged battery lamps in order to save on fuel costs.

Drinking Water

In 2018, GWI embarked on a phased approach to provide water to all residents in Port Kaituma. This water is sourced from wells located in the community. However, it is not known how these wells are recharged. In addition, water supplied to a significant proportion of residents is sourced solely from a creek which feeds into Canal Bank. Moreover, most residents along the Canal Bank utilise water from the Kaituma Canal for a variety of domestic purposes. Reliance on surface water sources has proven to be challenging because of contamination from upstream gold mining activities. In fact, GWI has previously suspended supply of water sourced from the aforementioned Creek due to contamination from gold mining activities (EMC Personal Communication 07 and 17). In addition, the use of the traditional indigenous fishing practice of fish stunning is still practiced in the Northwest Region of Guyana and may also be practiced by traditional fisherfolk in the Kaituma Canal and the creeks or streams leading to the Canal thereby resulting in contamination. As a result, approximately 80 percent of households collect rainwater for drinking with fewer households depending on surface water and purchasing filtered/bottled water. More households seek alternative sources of drinking water during prolonged dry periods when rainwater becomes scarce.

Cooking fuel

Compressed cooking gas is used by 77 percent of households in Port Kaituma, while 21 percent rely on kerosene as fuel for cooking and two percent of households rely on electricity or firewood. Compressed gas cylinders, which cost GYD$ 5,500 per cylinder, and kerosene, which costs GYD$ 200 per pint, are transported to Port Kaituma from Georgetown. Firewood used for cooking is harvested locally.

Food Resources

Port Kaituma is the main economic hub for the district and central commercial point. Small-scale crop cultivation is an important livelihood activity for residents of Port Kaituma and, in particular, residents of the Canal Bank. Moreover, crop cultivation is an important element of subsistence food supply. However, commercial livestock farming is not widely practiced in Port Kaituma. Instead, canned foods, dry goods, fish, meat and beverages, including alcoholic beverages, are some of the key food items transported from Georgetown. Food is sold in stores, small shops and at the market in Port Kaituma. As an economic hub, miners also visit Port Kaituma to purchase food items.

Housing

Structures in the community comprise of both single-storey and two-storey houses constructed elevated off the ground to avoid flooding. The living quarters typically include bedrooms, kitchen and bathroom facilities. In some cases, the bathroom and toilet facilities are outdoors. Most structures are made of wood or concrete with predominantly zinc roofing. There are few homes with thatch or shingle roofs particularly along the Canal Bank. In order to prevent placing strain on the housing resources in Port Kaituma, GMI will provide accommodation for approximately 20 employees. During the construction phase of the project, workers were based on the facility previously uses as a log pond by BCL.

Figure 19-6: Typical House in Port Kaituma

Waste Disposal

The NDC has established a dumpsite which is located close to the Four Miles village where all waste in Port Kaituma is intended to be disposed. The NDC has a tractor and trailer which collects garbage for residents with a cost attached. However, this service is not widely used and several dumpsites have developed around the commercial district where waste is routinely burned, usually in proximity to the Kaituma Canal. One of these sites is shown in Figure 19-5 below. Moreover, at the dumpsite garbage is not properly disposed and managed and has proven to be a nuisance for many residents of the Four Miles village (EMC Personal Communication 19). Sewage is typically disposed of into septic tank systems or in pit latrines.

Figure 19-7: Improper Dumping of Garbage in Port Kaituma Turning Basin

Entertainment and Recreation

Port Kaituma continues to be a major entertainment hub for the district. The community has several well-established bars and night clubs, hotels. Satellite television stations are also at the disposal of businesses and residents. There are community centers where sports activities and other games are played. However, these facilities have been temporarily closed due to restrictions associated with the COVID-19 pandemic. On weekends, residents from communities in Port Kaituma such as Fitzburg and Oronoque among others also visit the Canal Bank for recreational purposes. In particular, there is a small resort called Dawn's Resort which is frequented by the locals. In addition, there is a well-known spot of white sand beach along the Kaituma Canal which is also used for recreational purposes by persons from Port Kaituma and Canal Bank. There are also several churches of varying denominations in Port Kaituma and also along the Canal Bank.

Crime

Data collected from the Port Kaituma Police Station indicated that crime decreased by 20 percent in June 2020 as compared to June 2019. This decline was especially significant for serious crimes such as rape, physical assault and murder. Burglary, domestic violence and the trade of drugs are the primary forms of crimes committed in the community. Of particular concern to the Police Station are domestic violence, drugs and narcotics trading, and the illegal entry of immigrants. Crimes are typically committed by teens and young adults who are users of both alcohol and drugs. It is estimated the 33 percent of the Port Kaituma are users of alcohol while 27 percent of the population consume drugs or drug related products. The residents have little means to protect themselves and rely heavily on the police for safety and protection. However, the local police station has indicated that it is ill prepared to adequately address the current crime situation.

19.2.2.2 Matthew's Ridge

Matthew's Ridge is located in the Matarkai sub-region of Barima Waini, Region 1. Manganese mining has historically played a crucial role in the development of Matthew's Ridge. Manganese was first identified in 1937 at three locations in the Northwest District including Matthew's Ridge. By 1954, plans were being implemented for the manganese mining operations to commence in Matthew's Ridge by establishing the ore processing facilities and other support infrastructure and the first shipment

occurred in 1961. Although the manganese mining operations ended in 1968, areas previously mined or prepared for mining remained as brownfield sites and several components of project infrastructure remained intact. Subsequently, the Matthew's Ridge population sought various livelihoods activities developed in Matthew's Ridge with agriculture and small to medium-scale gold mining being foremost. The administration of Matthew's Ridge falls under the purview of the NDC and is represented by a Vice-Chairman of the NDC based in Matthew's Ridge.

Residents of Matthew's Ridge have high expectations of the project. The population is pleased about the resuscitation of the manganese mining operations as they believe GMI will provide job security for full time employment, especially for the younger population. During the public scoping meetings, residents indicated that the quality of life significantly declined in Matthew's Ridge following the closure of manganese mining operations in the 1960s. They expressed hopes that GMI will contribute to the economic and social development of the community including boosting infrastructural development, enhancing community safety such as installing street lights, supporting social sectors such as education and water, and providing practical and vocational training. Community members also recommended scheduling frequent meetings between the company and community members to discuss how GMI may best direct their investments to contribute to local development.

Population and Demographics

According to the national census[168], in 2012, Matthew's Ridge had a population of 1,842 persons of which 948 were males (51.5 percent) and 894 were females (48.5 percent). According to the census, the community comprised a total of 79 households with an average of three to six persons occupying each household. Approximately 53.8 percent of the population is between 0 and 19 years of age, 38.6 percent between 10 and 54 years of age, and approximately 7.6 percent between 55 to 85 plus years of age. Based on the 2012 census data, 46 percent of the population have attained secondary education and 40 percent have acquired primary education. Less than one percent of the population have had access to post-secondary or tertiary education.

The Matthew's Ridge population comprises of several ethnic group of which 42 percent are indigenous peoples, 3 percent Indo-Guyanese, 5 percent Afro-Guyanese, and 50 percent are of mixed decent.

Religion

The Matthew's Ridge population follow several organized religions. However; Christianity remains the most dominant. The table below provides a breakdown of the religions practiced by the Matthew's Ridge population.

Table 19-3: Religions of the Matthew's Ridge Population

Religion	Practicing Population
Christianity	1,697
Hinduism	25
Rastafarian	16
Muslims	12
No religion	92

Vulnerable People

As discussed previously, 56 percent of its population is comprised of indigenous peoples, mainly people of Carib descent. Indigenous peoples are classified as a highly vulnerable group and one of

[168] Guyana National Bureau of Statistics, 2012. Final Census Compendium 1

the largest groupings in the rural poor. The rural poor typically live under conditions characterized by food insecurity, environmental stress, seasonal employment, dangerous employment and lack of access to services or markets, all of which contribute to vulnerability. On the other hand, 42 percent of the Matthew's Ridge population falls within the 0 to14 years age range rendering them vulnerable to a range of societal ills. Younger people are vulnerable to potential effects derived from lack of education, poor health care and unstable social structures. In addition, young people growing up in female headed households are also more vulnerable to potential risks of child labour, education deprivation and juvenile delinquency as a result of poor living standards and minimal income generation. The establishment of GMI is seen largely as an opportunity of generating a consistent income to improve living conditions. In addition, young women in Matthew's Ridge are also consider vulnerable to sexual harassment and assault (Minutes of Public Scoping Meeting in Matthew's Ridge). There are no persons with disabilities living in the community currently.

Local Economy

The main economic activity in the community of Matthew's Ridge is gold mining both small-scale mining, including pork-knocking or freelance prospecting, and medium-scale mining. A significant portion of Matthew's Ridge residents work either for small and medium scale miners in Arakaka or similar operations at Chinese Landing and Baramita among other locations. Those residents are away from the community for extended periods of time. Matthew's Ridge is also a primary stopping point for gold miners to access mining areas in the district. Overall, 42 percent of the local population are employed in the mining sector.

Agriculture and forestry related activities account for 16 percent of the population's main economic activity. In addition,10 percent are small business owners (shops that sell groceries and household items and provide entertainment). Entertainment in the form of bars and night activities and accommodation is also developing as a vibrant component of the local economy and employ women as servers and in housekeeping. However, it is unknown how many people are directly employed by this industry and their significance to the local economy. Eight percent of the population are transportation providers and 21 percent of the population are involved in other forms of employment including public servants, construction workers and repairs. Approximately 3 percent of the population are unemployed. A total of 6 percent of the population receives remittances from abroad.

Land Use

The total area of Matthew's Ridge is 700 hectares. This encompasses several brownfield mine sites and project infrastructure from the mining operations in the 1960s and 1970s. Since mining ceased at Matthew's Ridge, many of the previously used mining and plant sites were overgrown with secondary vegetation. Following the closure of the company, employees were encouraged to settle in the community and Government encouraged the development of agriculture in the community. However, this endeavor was not considered successful and by the 1990s, the community became dependent on mining contributing to the degradation of the area. However, agriculture remains a major land use in Matthew's Ridge. According to occupational surveys conducted by the GL&SC, there were 79 agricultural leases within Matthew's Ridge. According to information provided by GFC, GLSC also had plans to issue an additional 41 agricultural leases.

The residential areas of the community were developed both as housing quarters for employees of the Africa Manganese Company Ltd. and subsequently, development of settlements of former employees. Currently, there are eight residential areas in the community namely: Rail-End, Garrison Hill, Hell Hill, Heaven Hill, Hole, Flats, Pakera and Minab. Existing data suggest that 72 percent of households are believed to own land in the community, three percent of households had land leases and four percent is currently renting land. The remaining 14 are considered squatters and the land status of the remaining 7 percent is unknown. According to property laws, squatters living and

occupying a property for more than 13 years without disruption may apply for said land and claim land as their own. According to the GL&SC occupational survey, which was done for the purpose of issuing individual leases and titles to residents of Matthew's Ridge, land tenure remains important to the population especially persons of indigenous descent. In 2019, GFC issued two concessions within a five-kilometer radius of Matthews Ridge, however; the specific concession boundaries are yet to be set.

The footprint of GMI's project infrastructure will extend beyond those used by the manganese mining operations in the 1960s. In particular, the processing plant and ancillary facilities are located on a hillside west of where they were situated in the 1960s. Due to the proximity of the new processing facilities to the public road, GMI co-opted the existing public road into its processing facilities and constructed an alternative public road to connect Matthew's Ridge to the airstrip and Baramita. GMI also resettled residents who had settled within and proximate to the old tailings pond which would be rehabilitated and expanded for use by the project.

Social Infrastructure and Services

The community has the basic infrastructural needs required for habitation water, electricity, housing, health care, education, security as well as transport. Both privately and publicly ran facilities including social infrastructures such as places of worship, a police station and recreation facility. While landline services are not available to residents, the community is now serviced by the Digicel Group, who began cellular service provision in March 2011. To date there is one Digicel office responsible for distribution and maintenance of the service within the area.

Over the years, several investments have been made to develop the social infrastructure in Matthew's Ridge. The key social infrastructure in Matthew's Ridge includes:

- Nursery School and Primary School (Figure 19-8) with a Secondary Department (which ends at Level 9 suggesting that at completion students should have attained equivalent to a third form secondary level education). This system was developed to foster learning for students whose parents cannot afford to send them to attend secondary school in Port Kaituma. The age of the school population ranges from 5 years to 16 years. Upon completion of primary school, there is no other academic institution within the community, nor youth or community groups, recreational associations, etc. where the students can continue academic or vocational training although a Skills Training Center was previously functional. The school has been included in the government school feeding program in recent years which helped to significantly boost the rate of school attendance. The school is currently under the jurisdiction of the RDC and Ministry of Education. In recent years GMI has contributed to the social and infrastructural maintenance of both the nursery and primary schools.
- Road transportation network connecting Matthew's Ridge to Port Kaituma, Arakaka and Baramita. Neighbouring communities and mining areas are accessed by buses, pickup trucks or ATVs along the laterite road. For example, the community of Arakaka is located 23 killometers east of Matthews Ridge and travel time varies from 45 minutes to 1 hour depending on the weather and condition of the road. While some residents own private vehicle for transportation, 78 percent of the residents rely on publicly available transportation. In recent years, GMI has undertaken periodic repairs of the road to Port Kaituma and Arakaka. The company also made commitments in a MoU with the NDC to support with the repairs and maintenance of internal roads in the Matthew's Ridge community. However, according to the RDC and the NDC these obligations are not being totally fulfilled (EMC Personal Communication 02, 15, 17 and 18).
- Airstrip for both inbound and outbound flights. Local air service operators provide daily return flights from the Eugene F. Correia International Airport.
- Landline telephone services were once provided but no longer exist due to maintenance failures. However, the community is now serviced by the Digicel Group, who began cellular and data

service provision in March 2011. To date there is one Digicel office responsible for distribution and maintenance of the service. Communication can also be made by radio sets, or calls placed over the Internet.

- In addition, officers of several government and local organisations are also present in Matthew's Ridge and provide services to other communities. These include, the Matthew's Ridge Police Station (operated by the Guyana Police Force), the Guyana Post Office Corporation and GWI. These structures typically operate with constrained budgets and therefore, have challenges of efficiency in the provision of their services. According to the Demographic Survey completed by Reunion Manganese Incorporated in 2012[169], most of these institutions lack the resources to function effectively within the communities. Failing to garner support sponsorships the institutions are poorly motivated and have provided limited incentives for staff which has affected their overall performance and quality of service provided to the community.
- There are several places of worship in the community.
- The Pakera District Hospital (discussed further in the Health section below).

Figure 19-8: School at Matthew's Ridge

Health

Matthews Ridge and neighbouring communities are serviced by the Pakera District Hospital (Figure 19-9). The hospital has a 12-bed capacity and serves as the main source of medical treatment within the district and was the institution of first response during the histoplasmosis outbreak in 2019. The services offered range from pre and postnatal care, basic emergency facilities, dental care and laboratory services (mainly malaria testing). The hospital also has a mortuary. The medical institution currently has two doctors as well as a trained medic and approximately seven trained nurses. According to the MoH, the capacity of the hospital is limited and below the capacities required to serve Matthew's Ridge and the surrounding areas. Moreover, the Hospital was not equipped to manage the 2019 histoplasmosis outbreak and will not have the capacity to manage any similar health care crisis in the near future. It was indicated that the existing capacity of the hospital would have to be doubled to cater adequately for the estimated 400 workers to be based in Matthew's Ridge during the construction and operational phases of the project (EMC Personal Communication 11).

The most common diseases and health concerns in Matthew's Ridge are malaria, dengue fever, diabetes, hypertension, mining related injuries, and typhoid. Matthew's Ridge also has a history of other vector borne diseases such as sand flies causing leishmaniasis. Most households use mosquito

[169] Reunion Manganese Incorporated, 2012. Demographic Survey. Page 36, Paragraph 1

nets among other measures to prevent the incidence of vector borne illnesses. No data is available on the rate of infection of sexually transmitted diseases (STDs). Extreme medical cases and cases of surgery are referred to GPHC. Emergency evacuation to Georgetown by aircraft is arranged by the local authorities. It is important to note that in the 2019 the histoplasmosis outbreak at the current mine site the hospital was ill equipped to manage the outbreak and patients were transferred to GPHC for isolation and treatment. Following the outbreak, the Ministry of Health, under a medical support programme between the Governments of Guyana and China, made several requests to improve the capacity of the Pakera District Hospital. These included requests made for four (4) Chinese doctors to be stationed at Matthew's Ridge, including a General Practitioner, an Infectious Disease Specialist, and an Internal Medicine Specialist, as well as laboratory supplies and equipment. However, these requests are still to be addressed (EMC Personal Communication 11). However, GMI also supported the response to the COVID-19 pandemic by donating masks, hand sanitizer and disinfectant to the RDC and NDC as well as donated rapid test kits for COVID-19 to the hospital.

Figure 19-9: Pakera District Hospital

Electricity

Matthew's Ridge is connected to the national electric grid. However, electricity is supplied to approximately 19 percent of the population and is not provided on a 24-hour basis. Moreover, in March 2020 the generator that provides power to Matthew's Ridge was damaged and was not repaired until August 2020. No electricity was supplied from the grid during that 24-hour period. As a result, each household has its own means of electricity. Approximately 32 percent of the population depend on private generators for their supply of electricity, 26 percent depend on solar energy the remaining 23 percent of the population depend on gas or kerosene lanterns.

Drinking Water

Water is supplied mainly by GWI. GWI installed and commissioned the existing water supply system in 2001. It consists of springs which gravity feeds water through 100-millimeter PVC pipes to three storage units with an overall capacity of 197.97 cubic meters. The water is then gravity fed through 100-millimeter PVC SDR-26 pipes into two separate distribution networks referred to as low-line and high-line at different intervals. One of the systems is a concrete catchment/reservoir called "Industrial Yard" which collects water from three springs. The second is called Jacks and collects water from an additional three springs into above ground tanks. The production of water from the springs is seasonal and varies at different periods of the year depending on the bimodal seasonality of the area (wet and dry seasons). Although 68 percent of the population depend on GWI as their main source of water,

approximately 15 percent still depend on natural rainfall for their water supply and 8 percent still use streams and creeks.

According to the Demographic Survey completed by Reunion Manganese Incorporated in 2012[170], residents are of the view that the company has the potential to severely affect the community's water supply. At the Public Scoping Meeting, concerns were also raised about potential adverse impacts to the community's water supply including contamination and creation of an unsustainable demand. During the field visits to conduct baseline biological surveys, the EIA team also observed the indigenous practice of fish stunning in sections of the Pakera Lake which may also result in surface water contamination.

Cooking Fuel

Compressed cooking gas is used by 54 percent of households in Matthew's Ridge and 31 percent rely on kerosene. The remaining 15 percent utilise firewood. Compressed gas cylinders and kerosene are transported from Port Kaituma with estimated costs of GYD$ 5,500 per 20-pound cylinder and GYD$200 per pint respectively. Firewood is harvested from the nearby forest.

Food Resources

Small-scale crop cultivation is continuing to be developed as an important livelihood activity for residents of Matthew's Ridge. Crop cultivation is also an important element of subsistence food supply. A variety of food items are transported into Matthew's Ridge on a daily basis as cargo on aircraft. In addition, other food stuff such as canned foods, dry goods fish, meat and beverages, including alcoholic beverages, are purchased in Port Kaituma. Food is sold in stores, small shops and market. As an important transit point to various mining areas, many miners visit the Matthew's Ridge to procure fresh produce and other food items. During the construction phase of the project, GMI purchased food from Georgetown and commissioned a special weekly charter to deliver food into the region. Guyanese workers are required to provide their own meals and this has been a challenge (EMC Personal Communication 19).

Housing

The infrastructure of Matthew's Ridge is a snapshot of an era which has passed and reflect the design of homes which were designed to house employees in the 1960s. This includes double occupancy family houses and multiple occupant styles quarters. These quarters were sold to residents in the 1980s for as little as GUY$5,000. This, in part, accounts for the high percentage of land ownership in the community. Most of the houses are a single-storey family houses. Some houses function as shops or other businesses in front and family dwelling quarters at the back for the shop owner's family. The living quarters include bedrooms and kitchen. In many cases, bathroom and toilet facilities are outdoors and are, on occasion, shared with neighbors. In order to prevent placing strain on the housing resources in Matthew's Ridge, GMI will provide accommodation for approximately 200 local and expatriate employees. This accommodation will be based in at the headquarters of the GMI facility and can be dismantled following project closure, if needed. Accommodation was also provided at these facilities during the construction phase of the project.

Waste Disposal

A pit was recently created for community waste disposal in Matthew's Ridge and this location was identified based on engagement with the NDC (EMC Personal Communication 13). All types of waste, including scrap metal, are dumped into this pit. It is estimated that, prior to the creation of the pit, 94

[170] Reunion Manganese Incorporated, 2012. Demographic Survey. Page 36, Paragraph 1

percent of the population dispose waste by burning. Sewage is disposed of by both household septic tanks and pit latrines.

A Regional Environment Health Officer is stationed at the Pakera District Hospital and is responsible for the maintenance of a healthy environment in and around the community. The Officer is also tasked public education and awareness of proper methods of waste management, food preparation for public consumption, animal inspections before slaughter and storage and consumption of drinking water.

Residents of Matthew's Ridge are concerned about water contamination, waste disposal and soil erosion in the community.

Entertainment and Recreation

There are several forms of entertainment available in the community including a number of bars and dining areas. Other shops provide music and videos. The Matthew's Ridge sports club and community center is equipped with a sports ground and pavilion to provide for extracurricular activities for young people through the form of games, workshops and competitive sport activities.

Crime

According to the Matthew's Ridge Police Station, there has been a decrease in crime and criminal activities in the community of Matthew's Ridge. In particular, serious crimes such as rape, assault and murder declined. However, crime is more prevalent in neighbouring mining areas including the back dams of Eyelash and Five Star. The main forms of crime within the community of Matthew's Ridge include burglary and personal disputes. These crimes are typically committed by local and outside miners. The main areas of concern for the local police are shared with concerns for Region 1 and include domestic violence, drug trading and use, and illegal immigration. The main perpetrators of crime are young adults and teenagers. Alcohol and drug use were also identified as a concern in the community as approximately 33 percent of crime was attributed to alcohol use and 27 percent to drug (cannabis) use. According to the local police force, there is capacity to address the current crime situation, noting that the current population rely heavily on the police station for their safety and protection.

19.2.2.3 Arakaka

The community of Arakaka is located in the Matarkai sub-district of Region 1. Arakaka is administered by a CDC but it also falls within the NDC of the Matarkai sub-district. Its main neighbors are Matthew's Ridge, Eclipse Falls and Big Creek. The community of Arakaka expects economic gains and development in the area as a result of the GMI operations noting that it is the closest community to Matthew's Ridge. Gold mining activities in the community are declining and residents have expressed hope of being given priority to becoming employed with GMI (EMC Personal Communication 22).

Population and Demographics

According to the national census[171], in 2012, Arakaka had a population of 196 persons and the Arakaka-Matthew's Ridge Railway had a population of 423. This resulted in a total population of 619 of which 428 were male (69 percent) and 191 were female (31 percent). However, a 2016 estimate by the Amerindian People's Association indicate that the population was 700[172] people with a total of 140 households with an average of 3 to 5 persons occupying a household. Approximately, 25.5 percent of

[171] Guyana National Bureau of Statistics, 2012. Final Census Compendium 1.
[172] Paragraph 47, page 14 Our People Our Life 2017. Report for Region 1 and 2, Amerindian Peoples Association and Forest People Program

the population is between 0 and 19 years of age, 68 percent between 20 and 54 years of age, and approximately 6.5 percent between 55 to 79 years of age.

Based on the 2012 census data, 50 percent of the population have attained secondary education and 43 percent have acquired primary education. The Arakaka population comprises of several ethnic groups of which 26 percent are indigenous peoples, 5 percent Indo-Guyanese and 20 percent Afro-Guyanese. The largest proportion of the population, 49 percent are of mixed descent.

Religion

The Arakaka population follow several organized religions. However; Christianity remains the most dominant. The table below provides a breakdown of the religions practiced by the population.

Table 19-4: Religions in the Arakaka Population

Religion	Practicing Population
Christianity	585
Hinduism	10
Rastafarian	4
Muslims	2
Other	3
No religion	15

Vulnerable people

As previously noted, 26 percent of the population are people of indigenous peoples, who are classified as a highly vulnerable group and constitutes a large part of the rural poor population in Guyana. The rural poor typically live under conditions characterized by food insecurity, environmental stress, seasonal employment, dangerous employment and lack of access to services or markets all of which contribute to vulnerability. In addition, 14 percent of the population fall within the ages of 0 to 14 years thereby rendering them vulnerable to societal ills. They potential victims of crime and violence in the community around them and are also vulnerable to potential effects derived from lack of education and poor health care. The young members of female headed households are also extremely vulnerable to child labour, education deprivation and juvenile delinquency as a result of poor living standards and minimal income generation and limited room for improved alternative livelihood due to the effects of mining, pollution and accessibility. There are no persons with disabilities living in the community currently.

The Local Economy

The main economic activity in the community is gold mining which employs approximately 64 percent of the Arakaka population. Most of these persons are employed by small and medium scale miners in Arakaka. This may also be responsible for the large percentage of male residents of the community. However, since the onset of the COVID-19 pandemic, mining in the community has declined resulting in many mines being closed and residents seeking employment elsewhere, including with GMI. Two percent of the population are small business owners (shops that sell groceries and household items and provide entertainment and temporary accommodations for river travelers and miners). Given that Arakaka is a major mining area for small scale mining, entertainment in the form or bars and night life is an emerging sector which employs women as servers and attendants. Some of these shops also provide employment to Venezuelan migrants.

It is not known how many women are directly employed by this industry and their significance to the community economy. Four percent of the population provide mechnical repair services and 25 percent

of the population are involved in other forms of employment subsistence including farming. Only one percent of the population are involved in logging and forestry related activities. Less than 2 percent of the population receives remittances from abroad. Four percent of the population are believed to be unemployed.

Land Use

The total area of Arakaka is unknown but the community spreads out into several settlements such as central Arakaka and 14-mile Arakaka. There is no communal title for the community although attempts to obtain a title have been made since the 1980. The GL&SC has carried out occupational surveys of the area for the purpose of issuing individual leases. Only 18 percent of households are believed to own land in the community, five percent of households have land leases and four percent are renting land. Squatters are estimated to account for 58 percent of all households. The land status of the remaining 15 percent of households is unknown. Small and medium scale mining properties is also one of the primary economic uses of the land. However, this has been associated with land use conflicts as residents were forced out of traditional farming lands. Most residents practice subsistence farming in their backyards.

Social Infrastructure and Services

Unlike Port Kaituma and Matthew's Ridge, there are few social structures in Arakaka. These existing social infrastructure and services include:

- A primary school with three teachers. There are no secondary, tertiary or vocational institutions in the village. Students typically attend secondary school in Port Kaituma and stay with relatives or in the dorms. This arrangement may be burdensome to some families and this may account for the relatively low levels of primary and secondary education in the community.
- Road network connecting to Port Kaituma and Matthew's Ridge. People typically travel by buses, pickup trucks and ATVs. Arakaka also has a community bus. Only a few residents own private transportation and majority rely on publicly available transportation using either the community bus or taxi for travel within the community or to neighbouring areas. The cost of transportation internally in Arakaka is GYD$ 1,000 per drop and GYD$ 3,000 per passenger using the community bus to Matthews Ridge.
- The Barima River passes through Arakaka (Figure 19-10) and river transportation via the Barima River to Eclipse Falls and Port Kaituma as well as to other neighbouring communities and mining areas is done using boat equipped with outboard engines that are 75 horsepower or higher. Boats are made out of either wood or metal.
- The only government institution with an outpost in the community is the Guyana Police Force. All other government services have to be accessed in Matthew's Ridge or Port Kaituma. However, government officials from the GGMC also visit periodically.
- There is no landline service. However, Digicel cellular phone and internet service available in the community. Communication can also be made by radio sets, or calls placed over the internet. Residents who have access to these services charge other residents for usage when necessary.
- A Health Outpost staffed by a Medex. Doctors from the public health care system visit periodically. This is discussed further in the Health section below.
- There is a church and a recreation center which is currently in disrepair.

Figure 19-10: Arakaka Landing

Health

There is a health outpost and a resident medic currently in Arakaka. The most common diseases and health concerns in Arakaka are malaria, dengue fever, typhoid fever, minor injuries and diarrhea. While most households use mosquito nets, others take no preventive measures. It is important to note that these illnesses are influenced by the wet and dry season resulting in increased cases during specific times of the year. No data is available on STDs rate of infection. Serious cases, or other maladies which cannot be addressed by the health outpost are referred to the Pakera District Hospital where emergency medivac to the GPHC can be facilitated, if necessary.

Electricity

Arakaka is not connected to the national electric grid. Each household has its own means of electricity including generators to provide electricity for lighting, refrigeration, music, and other purposes. Other residents depend on gas or kerosene lanterns and solar power. Generators are used mainly during daylight and early evening hours. During the night, residents use charged battery lamps in order to save on fuel costs.

Drinking Water

Rainwater is main source of drinking water and is used by 81 percent of households. Some households have also established private water catchments and reservoirs. Residents once relied heavily on rivers and creeks for water supply for cooking, washing, and other day to day activities. However, surface water became contaminated and unsuitable for domestic purposes as gold mining increased in Arakaka. Under circumstances of rainwater scarcity during prolonged dry seasons residents have had to travel to springs or far-flung creeks to collect water.

Cooking Fuel

Compressed cooking gas is used by 52 percent of households, 24 percent use kerosene and 24 percent depend on firewood for cooking. Compressed gas cylinders and kerosene are transported from Port Kaituma. However, firewood is obtained from the nearby vegetated area.

Food Resources

Canned foods, some dry goods, fresh foods (including fruits and vegetables), and beverages including alcoholic beverages are available in the community and are generally imported from Port Kaituma. Fish and wild game meat are primarily purchased from the residents within the community. However, residents do not actively hunt wild game every day. Some residents may have small farming plots and raise small quantities of vegetables for their own consumption. There is limited commercial crop cultivation in Arakaka and none of this produce is sold locally. According to the residents, food prices fluctuates based on success of gold mining activities and the cost of gold. Food is sold in shops in the community.

Housing

Most structures in the community are single story flat family houses or houses on stilts. Most structures are made of wood or concrete with zinc roofing. Other houses function as shops or other businesses in front and family dwelling quarters at the back for the shop owner's family. The living quarters include bed rooms and kitchen. Many homes have bathroom and toilet facilities outdoor.

Pollution and Waste Disposal

Residents of Arakaka are concerned about environmental pollution caused by poor mining practices in the community. This has resulted in severe contamination of rivers and creeks which residents once relied on heavily for fishing. In response, residents are forced to increasing their travel time to fish grounds outside of the community. As previously noted, water pollution is also affecting the availability of water for bathing and other daily activities.

Most organic and inorganic solid waste are disposed of by burning, but some of the waste is thrown on the open land. Outdoor toilet facilities or pit latrines are used to dispose of sewage waste.

Entertainment and Recreation

Limited entertainment is available in the community. A well-established bar and night club exist within the community with satellite television stations and also show videos. Other shops also provide music and have DVD players. At present the community does not have a functional community center as it is in a state of disrepair.

Crime

Crime in the community ranges from simple larceny, burglary and personal disputes. At present, the community does not feel threatened by the current crime situation. It was noted that most theft and burglary within the community are committed by outsiders either visiting the area or entering the community to mine or seek other jobs. Residents rely heavily on the police presence in the community for protection and conflict resolution.

19.2.2.4 Eclipse Falls

The community of Eclipse Falls, also commonly referred to as Falls Top, is located in the Matarkai sub-district, Region 1 along the Port Kaituma to Matthew's Ridge roadway. Its closest neighbors are Arakaka and Big Creek. Eclipse Falls is not yet a titled indigenous village although it was approved for land title in 2015. The community is administered by a CDC consisting of a Chairman and several councillors. However, it is also within the boundaries of the NDC. Like many other communities in the Matarkai sub-district, residents of Eclipse Falls hope that GMI will provide employment opportunities

to its residents and also support the development of the community including through the provision of support for transportation and other materials.

Population and Demographics

According to the CDC Chairman, Eclipse Falls has a population of 120 persons of which 70 percent are males and 30 percent are females. There are approximately 40 households with an average of 1 to 3 persons occupying a household. The population of the community has constantly declined, reducing by more than 50% in recent years due to poor economic growth and employment opportunities. As a result, many residents have migrated to Port Kaituma, Arakaka and Matthew's Ridge to seek employment.

Eclipse Falls is comprised primarily of an indigenous population of Carib descent. Approximately 90% of the community population can still communicate in the native Cariban language. The population confirms to Christianity and approximately 30 percent of the residents are active church members.

Vulnerable people

The community comprises primarily of indigenous peoples who are classified as a vulnerable group and constitute a large proportion of the rural poor in Guyana. In addition, approximately 35 percent of the population fall below the ages of 0 to14 years who are vulnerable to the ills of the society in which they live. They may be considered as potential victims of the illicit activities in the community around them including crime. They are also vulnerable to potential life-long effects derived from lack of education, poor health care and inadequate social structures including social safety nets. The young members of female headed households are also extremely vulnerable to potential risks such as child labour, education deprivation and juvenile delinquency which may be brought about as a result of poor living conditions and minimal income generation. The community has recently provided refuge to emigrated relatives of community members who once settled in Venezuela. However, this was not considered as a burden to the community. There are no known persons with disabilities living in the community currently.

The Local Economy

Approximately 50 percent of the population are employed in either small or medium scale gold miners outside of the community resulting in a portion of the population being out of the village at varying intervals. Another 25 percent of the population practice freelance prospecting and mining (pork-knocking) both within and outside of the boundaries of the village. In total, approximately 50 percent of the population find livelihoods in the local economy. Approximately 25 percent of the population is engaged in subsistence crop cultivation of cassava, plantains and bananas. Any surplus produce is sold within the community. However, most residents are also involved in fishing and hunting for subsistence purposes. There are also small businesses in the community that sell groceries and household items as well as provide entertainment and meals.

Figure 19-11: Roadside Shops at Eclipse Falls

Land Use

A communal title was approved through the Amerindian Land Titling Project. However, this has not been granted to the Eclipse Falls community pending the boundary verification. This means that residents are allowed to settle within the community based on cultural customary rules but land cannot be independently owned by individuals although attempts have been made. There are no mining properties within the community but pork knocking is done within the existing community boundaries. A considerable portion of land is used for subsistence farming and hunting and livestock rearing within the community.

Social Infrastructure and Services

In general, there has been minimal infrastructural development in Eclipse Falls. However, the following infrastructure and services are in place:

- A Nursery and Primary School. Students travel to Port Kaituma for secondary school or other vocational training. While 70 percent of the community has acquired primary education, less than 20 percent of the population has attained secondary education. The relatively low level of secondary education may be related to the costs of daily travel to Port Kaituma or the challenges of securing accommodation for students in dorms or with relatives. At present there are only 4 students attending secondary school in Port Kaituma.
- The public road and Eclipse Falls Bridge connecting to Matthew's Ridge, Arakaka and Port Kaituma pass through the community. Maintenance of this infrastructure is the responsibility of the NDC. Residents located in proximity to the road are frequently challenged by significant dust emissions from which vehicles traverse the road particularly in the dry seasons. There are also concerns that increased traffic and heavy vehicles using the roads will impact the safety of road users, in particular children walking over the bridge. While some residents own private transportation majority of the residents rely on publicly available transportation mainly in the form of buses. Bus fares for adults from Eclipse Falls to the waterfront of Port Kaituma are GYD$3,000 and to Matthews Ridge GYD$5,000 per person. One-way hires to Port Kaituma are also expensive: cars charge GYD$15,000 and buses GYD$30,000. A return trip on a hired bus costs GYD$40,000. The community does not own a communal vehicle.
- River transportation connects to Arakaka via the Barima River.
- There is no landline service. However, Digicel cellular services provider has made cellular phone and internet service available in the community. Communication can also be made by

calls placed over the internet. Residents who have access to these services charge other residents for usage.
- There is an outpost of the Guyana Geology and Mines Commission in the community. Services of the Guyana Police Force have to be accessed from the Port Kaituma Police Station. In addition, all other government services are accessed in Port Kaituma.
- There are several churches in the village as well as a community owned resort.
- A Health Outpost (discussed further below).

Health

Currently, there is a Health Outpost staffed by a Medex in Eclipse Falls. This facility is usually opened daily to residents, however, due to the COVID-19 pandemic, this facility is only functional twice weekly. The most common diseases and health concerns at Eclipse Falls are malaria, minor injuries, dengue fever, typhoid as well as allergies and flu like illnesses believed to be caused by dust from the roadway during the dry seasons. While most households use mosquito nets, others take no preventive measures. No data is available on the rate of infection for STDs. Serious cases, or other maladies which cannot be addressed by the health outpost are referred to the Port Kaituma District Hospital where emergency medivac to the GPHC can be facilitated, if necessary.

Electricity

Eclipse Falls is not connected to the national electric grid. Each household has its own means of electricity ranging and a few have generators to provide electricity for lighting, refrigeration, music, and other purposes. Others depend on gas lanterns and solar power.

Drinking Water

The primary source of freshwater for domestic use is from rainfall. The collection of rainwater for domestic purposes is hindered by dust which accumulates on the rooftops of houses as a result of vehicles traversing the public road. Residents must wait for the dust to wash off of the roof before rainwater collection can begin. Residents also collect water from the Barima River for domestic purposes including bathing and washing. Previous contamination of the Barima River from gold mining activities had temporarily stopped the use of this water for domestic purposes. However, the causes of this contamination have been addressed. In addition, GWI has a solar pump in village which supplies water to Government buildings. During the interview with the Chairman of the CDC, concerns were raised about potential contamination of the Arakaparu Creek, the head of which is in Matthew's Ridge and ultimately connects to the Barima River which supplies freshwater to Eclipse Falls and Arakaka.

Cooking Fuel

Compressed cooking gas is used by 5 percent of households in Eclipse Falls, while 10 percent of the population rely on kerosene as fuel for cooking. The remaining 85 percent of the population utilise firewood for cooking. Compressed gas cylinders and kerosene are transported from Port Kaituma and sold to residents at a cost of GYD$ 5,500 per cylinder or GYD$ 200 per pint of kerosene on average. However, these prices fluctuate depending on availability. Wood for cooking is obtained from the nearby vegetation.

Food Resources

Canned foods, some dry goods, fresh foods (including fruits and vegetables), fish, meat and wild game and beverages, including alcoholic beverages are purchased in Port Kaituma and sold by shops in the

community. Fish and wild game meat are primarily hunted by residents and in some cases purchased from other residents. Most residents cultivate provisions and vegetables for their own consumption.

Housing

Structures within the community are either single story family houses or houses on stilts (high). The community does not experience flooding and there is no need for the flat houses to be elevated off the ground. While other houses function as shops or other businesses in front and family dwelling quarters at the back for the shop owner's family. The living quarters include bedrooms and kitchens. Most bath rooms and toilet facilities are outdoors. Most structures are made of wood with zinc and or thatched roofing.

Pollution and Waste Disposal

Residents of Eclipse Falls are concerned about environmental pollution particularly water contamination based on previous experience of contamination of the Barima River. Dust pollution caused by vehicular traffic, including heavy vehicles, on the road ways are affecting the health and wellbeing of the community population as well as rainwater collection efforts. The adverse impacts of dust pollution are amplified during the dry seasons. Organic and inorganic waste are mostly disposed of by burning or burying in small holes established by residents. Sewage waste is disposed of primarily via latrines.

Entertainment and Recreation

Limited entertainment is available in the community. Shops provide music and alcohol sale to residents of the community. While no central playground exist the community owned tourist resort provides a safe recreation facility for residents and facilitate fishing and games.

Crime

The community does not have the presence of the Guyana Police Force or a community policing group. However, ranks from the Port Kaituma Police Station visit the community from time to time. There are several challenges in emergency response since police have to be summoned from Port Kaituma and cell phone connectivity can sometimes be intermittent. Response times are also lengthy. It was indicated that crime is on the decrease in the community. However, alcohol use influences petty crime such as disputes and conflict. Alcohol within the community is consumed by both males and females, primarily between the ages of 18 and 40 years. The residents have little means of protecting themselves from crime.

19.2.2.5 Four Miles

Four Miles is located on the right bank of the Kaituma River, Region 1. Its main neighbours are the Citrus Grove, Oronoque and Canal Bank settlements in Port Kaituma. Four Miles is a titled indigenous village having received its title in 2015. The village is governed by the Village Council consisting of a Toshao and several councillors. According to the Toshao, community members are already hired by GMI and are based in Matthew's Ridge. The Toshao shared hopes that more community members will be hired by the company when it becomes fully operational. In particular, GMI has also created hopes of employment for young people in the community and many youths and young adults expecting employment from the company.

Population and Demographics

Four Miles has a population of 1,200 persons of which 60 percent are males and 41 percent are females. There are approximately 140 households with an average of 2 to 5 persons occupying a household. The population comprises of a mixed indigenous descent mainly Warrau, Lokono and Caribs. Approximately 35 percent of the community population can still communicate in the native languages. Approximately 50 percent conforms to Christianity, of two main dominations; Seven Days Adventist and Pentecostal. The remaining 50 percent of the population are non-Christians.

Vulnerable people

The community comprises of indigenous peoples who are classified as a vulnerable group and constitutes a large part of the rural poor population in Guyana. The population between the ages of 0 to 14 years are also considered vulnerable to the ills of the society in which they live. They potential victims of crime and violence in the community around them, they are also vulnerable to potential effects derived from lack of education, poor health care. The community has recently given refuge to several emigrated relatives of community members who once settled in Venezuela. However, this has not been a burden for the community. Generally, the young members of female headed households are also extremely vulnerable to potential risks such as child labour, education deprivation and juvenile delinquency. There are no known persons with disabilities living in the community currently.

The Local Economy

The main economic livelihoods are from mining, pork-knocking or prospecting and crop cultivation. Crops cultivated include cassava, plantains and bananas among others. Irrigation is reported as one of the main challenges of crop cultivation because the main source of water is freshwater from rainfall. Produce is transported by road to Port Kaituma for sale. Most households also cultivate crops for subsistence purposes. Residents are also involved in fishing and hunting for subsistence purposes. Many community members are also involved in gold mining and are either employed by small or medium scale miners in Region 1, or are engaged in freelance prospecting (pork-knocking) within and outside of the boundaries of the Village. Only a few residents are small business owners of shops that sell groceries and household items and provide entertainment.

Land Use

Four Miles was granted a communal title through the Amerindian Land Titling Project in 2015. This means that residents are allowed to settle within the community based on cultural customary rules. However, parcels of land cannot be independently owned by individuals although attempts have been made. There are no mining properties within the community but pork-knocking is done in some areas within the community. The primary economic use of community lands are for crop cultivation.

Social Infrastructure and Services

In general, there has been minimal infrastructural development at Four Miles. However, the following infrastructure and services are in place:

- A Nursery School. Students travel to Port Kaituma for primary and secondary school or other vocational training. Approximately, 50 percent of the population has a primary education and 30 percent has a secondary education. This may be due in part to students having to leave the village to access education and the challenges of transportation costs as well as reliable transportation.
- Road network is the main mode of transportation and the public road connecting Port Kaituma to Matthew's Ridge passes through the Village (Figure 19-12). Residents located in proximity to

the road are frequently challenged by significant dust emissions generated by vehicles traversing the road, particularly in the dry seasons. There are also concerns that increased traffic and heavy vehicles using the roads will impact the safety of road users. Some residents own private transportation but majority rely on publicly transportation mainly in the form of buses. However, fewer buses operate when the roads are in poor condition during the rainy season. Bus fares for adults are GYD$500 from Four Miles to Port Kaituma while children pay a fare of GYD$100. Privately owned vehicles include pickup trucks and ATVs. The Village Council does not own a community vehicle.

- There is no landline service in the Village. However, Digicel has made cellular phone and internet service available in the community. Communication can also be made calls placed over the internet. Residents who have access to these services charge other residents for usage.
- There is a Village Office and a Multi-Purpose Building. The Village Council also runs a shop.
- There is a Health Outpost which is staffed by a Medex, which is discussed further below. However, all other Government related services are accessed in Port Kaituma.

Figure 19-12: Truck Transporting Lumber traversing the Port Kaituma to Matthew's Ridge Road passing through Four Miles

Health

There is a Health Outpost in the village which is staffed by a Medex. This facility usually opened daily to residents. However, due to the COVID-19 pandemic this facility only functional twice weekly. The most common diseases and health concerns in Four Miles are malaria, cold and flu, and diarrhea. No data is available the STDs rate of infection. Serious cases, or other maladies which cannot be addressed by the Health Outpost are referred to the Port Kaituma District Hospital where emergency medivac to the GPHC can be facilitated, if necessary.

Electricity

Four Miles is not connected to the national electric grid. Each household has its own means of electricity. Most residents depend on gas or kerosene lanterns and flambeaus. Only a few residents own generators.

Drinking Water

The main sources of drinking water is rainwater which is collected by most households during the rainy seasons. Generally, rainwater supplies can become scarce during prolonged dry seasons. Previously residents relied heavily on creeks for water supply for cooking, washing and other day to day activities, mining and cattle pastures upstream of the Village contaminated the water supply making it unsafe for use by villagers.

Cooking Fuel

Compressed cooking gas is used by 50% of households, while 50% rely on firewood. Compressed gas cylinders are transported from Port Kaituma at a cost of GYD$5,500 per cylinder of gas. However, firewood for cooking is obtained from the surrounding vegetation.

Food Resources

Most residents may have farming plots and cultivate provisions and vegetables for their own consumption. While flooding does not affect houses within the community, it contributes to cassava rot and thereby negatively affects crop yields. Fish and wild game are primarily hunted by residents and in some cases purchased from other residents within the community. However, residents do not actively hunt wild game every day. Canned foods, some dry goods, fresh foods (including fruits and vegetables), meat and beverages including alcoholic beverages are also purchased in Port Kaituma.

Housing

Structures within the community are either single storey family houses or houses on stilts. Most structures are made of wood or concrete with zinc roofing. Fewer than five percent of houses have thatched roofs. The living quarters include bedrooms and kitchen. Bathroom and toilet facilities are typically located outdoors.

Pollution and Waste Disposal

Residents of 4 miles are concerned about environmental pollution particularly water contamination caused by mining discharges which has impacted creeks and livelihoods in the community. Water pollution is also affecting the availability of water for bathing and other daily activities. The community has also indicated that seasonal dust pollution caused by increased heavy traffic of trucks on the roadways are affecting the health and wellbeing of the community population, hence the need for dust management on the roadways.

The NDC operated dumpsite is located in close proximity to the village. The Toshao indicated that this dumpsite is a nuisance to the Village as it attracts pests, like flies and vermin, and poses health threats Villagers also believe that this dumpsite contributes to some of the illnesses commonly experienced including diarrhea. Although waste at the dumpsite is intended to be burnt, often times waste dumped is not consolidated and garbage is not completely burnt. Sewage is disposed of primarily in latrines.

Entertainment and Recreation

There are five churches in the village for different denominations of Christians. There is also a burial ground in the village. The monument erected in memory of the mass murder/suicide in ‘Jonestown’ in 1978 is also located in the Four Miles village. There is a playground, including a pavilion, where sports such as cricket, football and volleyball are played.

Crime

The village has a community police group comprising of five persons. However, serious crimes are also reported to the Port Kaituma Police Station. In general, conflicts in which no weapons were used are settled at a village level. However, when weapons are used the cases are elevated to the police. Over the last 2 years there were two murders as well as a few conflicts induced by alcohol.

19.3 Impact Assessment – Socio-Economic Environment

This section analyses the potential socio-economic impacts which may arise from planned project activities on the social and economic environments of the five communities discussed above which are all within the Matarkai sub-district and are considered to be within the primary, secondary and tertiary AoI. The definition of the types of impacts are consistent with the impact definitions and ratings in Chapter 7.

19.3.1 Potential Impacts of Employment

Throughout the lifetime of the project, but particularly during the construction and operational phases, local populations will be directly employed by GMI. At all three of the public scoping meetings held, GMI reiterated their commitment to hiring local populations for both skilled and unskilled jobs with the company in both the construction and operational phases of the project. During the construction phase of the project, a higher number of Chinese expatriates are employed. The maximum numbers of Chinese expatriates and local workers during the construction and operational phases of the project are presented in Table 19-5 below. However, during the operational phase greater number of Guyanese will be employed by the project. GMI will also develop a vocational training programme under which Chinese experts will train local workers in a range of skilled jobs. This will allow local workers to develop transferrable skills and also reduce the number of expatriates working on site. Several skilled and unskilled jobs have been earmarked for local populations including, but not limited to, security, warehouse clerks, finance clerks, handymen, cleaners, kitchen staff and chef, electricians, mechanics, carpenters, drivers, heavy machine operators and jobs in the engineering department.

Table 19-5: Chinese Expatriate and Local Workers

	Construction Phase	Operational Phase
Chinese Expatriates	Maximum of 260	100
Local Workers	Maximum of 134	300
Total	**394**	**400**

GMI has also indicated that employment will be prioritised for job applicants from Matthew's Ridge. If there are no suitable qualified employees in Matthew's Ridge, applicants from the other communities in the Matarkai sub-district will be prioritised before selecting job applicants from other communities in Region 1 or other parts of Guyana. GMI will also consider suitably qualified Venezuela migrants, expatriates or re-migrants, if they have valid work permits and the required skills cannot be sourced from local communities. At the time of preparation of this EIA, GMI had hired workers from five of Guyana's administrative regions although most were from Region 1 as seen in Table 19-6. The company has shared their commitment to gender responsiveness in its recruitment strategy but it is recognised that the labour force will be predominantly male given the nature of the jobs available and the gender roles traditional in the community. As of May 2020, only 13 percent of the workforce during the construction phase of the project were female. The company has also committed to providing employment for vulnerable groups such as indigenous people. At the time of EIA preparation, indigenous people represented approximately 22 percent of the local labour force. More than 90 percent of these employees were from the Matarkai sub-region. When the project is operational, most of the labour force will be based in Matthew's Ridge.

Table 19-6: Origins of Local Labour Force

Administrative Region	Labour Force (%)
Region 1	80
Region 3	3.1
Region 4	5.4
Region 5	2.3
Region 10	9.2

Training and skills development will be a key focus of the mine and will continue to be a priority throughout the operational phase. GMI plans to embark on training all of all newly recruited staff in the varying departments they are attached to ensure efficiency and boost the skills development of local employees. GMI has established a Human Resources (HR) Department who is responsible for recruitment, dismissal and building employee awareness of GMI's procedures. The HR Department has also documented procedures for recruitment, disciplinary action, dismissal and occupational safety and health. GMI is committed to following the labour laws of Guyana and offers suitable benefits to its local employees including meals allowances, accommodation for some employees, transportation, annual leave and day-off sick. Employees will be provided with all PPEs required to do their jobs.

Given the challenges of employment and poverty in the AoI and the Region, the project is expected to be of a considerable boost to the local economy and social wellbeing of the current population resulting in significant **positive, direct** and **regional impacts**. The potential impacts of employment are **long-term** as they are likely to last for the construction and operation phases of project and end after the project is decommissioned. The benefits of vocational training are also **long-term** and transferrable making employees more attractive for recruitment elsewhere when the project ends. This underscores the importance GMI maximising employee training during the construction and operational phase. These impacts are of **moderate significance** and are **certain** to occur during the project lifetime.

19.3.2 Potential Impacts from Planned and Unplanned Migration for Employment

Although GMI will give preference to employees from Matthew's Ridge and Port Kaituma, it is inevitable that that workers will be recruited from other areas of Region 1, other administrative regions in Guyana and Chinese expatriates. Indeed, GMI's labour force during the construction phase of the project was already reflective of such a labour force composition. Moreover, as typical of large projects, operationalisation of the project may be accompanied by local vendors and service providers, including sex workers, may be attracted to the area. Moreover, matriculation of locals and immigrants, including possibly Venezuelan immigrants, seeking employment typically occurs particularly during the formative years of the project. This effect may be amplified in Matthew's Ridge where operations will be more intensive and more employees will be based.

Migration into the community for employment, in particular unplanned migration, is likely to result in the following potential impacts:

- Pressure on resources such as land, water for domestic use, food harvested from the environment (crop cultivation, fishing, hunting), etc. This effect may be exacerbated where resources are scarce or are used by the existing local populations, including the rural poor, for subsistence or livelihoods.
- Fence line development that attracts persons to settle, vend or pursue other economic activities around the perimeters of the project area posing the emergence of several social issues for employees and communities. This can also severely impact on the landscape, land use and resource use among native populations, adding pressure on local cultures and the lives of women and children. This effect is already observed at Port Kaituma with crop

cultivation having commenced on the lands adjacent to the newly constructed access road to the Kaituma Marine Terminal.

- Pressure on community services and housing which are already overburdened. However, GMI will provide accommodation for 200 employees in Matthew's Ridge and 20 employees in Port Kaituma. In addition, GMI will self-generate electricity for these settlements and will augment GWI's water supply for drinking and domestic purposes.
- Increased populations may also increase pollution in particular pollution from improper disposal of solid waste and sewage. However, GMI will implement a Waste Management Plan for waste generated by its operation and will not increase pressure on community dumpsites.
- Health risks to local populations due to the transmission of contagious and other diseases placing additional pressure to an already pressured health care system. Potential increases in sex work is also connected to higher incidences of STDs, including HIV. This would ultimately pose security risks including issues of safety within the project area and other neighbouring indigenous communities.
- Security risks from increased crime and criminal activities which may be a consequence of migration for work. This may be amplified by increased population and higher unemployment which may be associated with fence line development and matriculation into the project locations. This would place additional pressure on the police departments which currently operate under resource constraints. During the Public Scoping Meeting in Matthew's Ridge, concerns were also shared regarding external workers sexually harassing or assaulting young women in the village and increasing trade or use of illicit drugs.
- Socio-cultural changes in the local communities contributing to loss of indigenous culture and practices including loss of local languages. This may also impact villages from which external workers originate if, as elders of the home, their absence for prolonged periods hinders passing on of traditional knowledge and activities with the family.
- Increased pressure on the local school system if workers or people looking for work move with their families to the project locations.

The potential impacts associated with migration for employment are expected to be **negative, direct** but **short-term** and **local**. These potential impacts are of **major significance** and are **likely** to occur, particularly during the operational phase of the project. As a result, the potential impacts associated with migration from employment are of **High Risks** of the project.

19.3.3 Potential Impacts of Community Engagement and Expectations

Manganese mining in Matthew's Ridge has left a legacy of success stories related to employment, economic growth and development for the Matakrai sub-district. The reopening of the mine several decades later has awakened expectations of employment and economic prosperity for the residents of communities within the Matakari sub-district and the wider Region 1. Beyond employment, residents also expect GMI to contribute to the social and economic development of the communities including enhancement of community infrastructure including rehabilitating roads and bridges and supporting the provision of social services foremost of which interventions are expected in education and water. Since 2017, GMI has made a range of social non-profit interventions in Matthew's Ridge, Port Kaituma and Mabaruma. In this regard, GMI has provided support to several local organisations including the Pakera Nursery School, Matthew's Ridge Primary School and Secondary Department, Pakera District Hospital, the NDC of Port Kaituma, Matthew's Ridge and Arakaka, GWI, the Matthew's Ridge Youth, Sports and Culture Club, and Matthew's Ridge Power and Light Company. GMI has also contributed safety equipment and sanitisation supplies to support the Regional and to the NDC's response to the COVID-19 pandemic. A complete list of GMI's interventions in the Region is presented in Appendix I.

However, expectations are starting to diminish. The company and the NDC have entered into a formal MoU under which the NDC has waived tolls for GMI's vehicles entering Port Kaituma while GMI has committed to repairing and maintain the internal roads and bridges in Matthew's Ridge. However, the

NDC has shared its dissatisfaction with GMI in fulfilling its obligations under the MoU and is actively considering withdrawing from the MoU (EMC Personal Communication 17). The NDC's consideration and decision to withdraw from the MoU are also supported by the Regional Administration of Region 1 (EMC Personal Communication 18). The NDC has also indicated that BCL when it was operational and other companies currently operational within the Matarkai sub-district more actively fulfil the commitments undertaken and are willing to contribute to community development (EMC Personal Communication 15). The RDC has also shared dissatisfaction that GMI is yet to engage local communities about the project in particular communities located along the river transport route (EMC Personal Communication 18).

Community expectations of the project are also changing. According to the Chair of the NDC, local communities had expected greater employment and regional benefits from GMI since the company's entry to the region in 2016. However, these are tempered by further expectations that these benefits will be forthcoming when the company is operational. Moreover, during the construction phase, stakeholders reported negative experiences associated with project activities in particular unsafe storage of road construction materials, inadequate traffic management measures (EMC Personal Communication 13), unsafe driving practices and increased dust emissions from company vehicles traversing the laterite roads (EMC Personal Communication 19 and 20). Communities have also shared fears of water contamination with local authorities and GMI, including potential for contamination of the Barima River If these concerns are not addressed, it could result in loss of welcome and acceptance within the community and the wider Region 1, by extension. Management of community expectation is important in communities believing GMI has the 'social licence' to exploit resources and operate in the communities. The positive impacts expected from employment and community development cannot be realized without careful management of community expectations.

Project activities have also required resettlement of residences and small-scale farms in both project locations of Port Kaituma and Matthew's Ridge. However, representatives of the RDC and NDC are involved in the negotiation process, so as to ensure these settlements are fair and that concerns of the relocated residences are adequately addressed.

Planned project activities have shifted the socio-cultural practices in Matthew's Ridge. Under an agreement with the NDC, GMI fenced and restricted access to the Pakera Lake which is the source of water for the 'water pool' which will supply the processing plant during the dry seasons. Although fencing of the Pakera Lake was for public safety, the Lake was an important part of community recreation as residents visited to swim, picnic and recreationally fish particularly during the dry seasons. Local indigenous populations also conducted the indigenous fishing practice of fish stunning in a section of the Pakera Lake. Although the NDC expected GMI to provide an alternative site or facility for community recreation, residents and community members may experience feelings of acrimony and contribute to negative perceptions of the company and project.

These potential impacts are considered to be **negative** and **direct.** If no mitigation or management measures are employed, they may possibly be **local** and **long-term**. These impacts are expected to be of **moderate significance** and are **likely to occur** throughout the lifetime of project. Impacts associated unachievably high or negative community expectations pose **Medium Risks** to the project but can be managed with the implementation of effective mitigation measures.

19.3.4 Potential Impacts to Indigenous Peoples

Indigenous peoples are one of Guyana's most vulnerable social groups due to relatively poor socioeconomic conditions, low levels of formal employment, the remote locations of some communities where the capacity to respond to emergencies is inadequate or non-existent, insecurity of land tenure and poor access to vital services, foremost of which are health-care, water and education. As discussed in the Baseline Conditions, indigenous peoples living in communities that are

part of both the primary and secondary AoI of the project already share all of the vulnerabilities listed above. Planned project activities may further amplify these vulnerabilities. Potential impacts to indigenous populations from planned project activities are economic and socio-cultural and include:

- Project vehicles traversing through Eclipse Falls and Four Miles will likely amplify dust pollution which is commonly believed to be linked to high incidences of illness. However, GMI has made provisions for dust suppression in Port Kaituma during the dry seasons and this includes sections of the public road passing through the Four Miles Village.
- Indigenous populations where primary or secondary education levels, due mainly to limited access to formal schooling, will be challenged to obtain skilled positions with the company and may even be considered ineligible for vocational training. This may result in exclusion from the formal economy or indigenous peoples constituting the majority of the lower organisational hierarchy. However, 20 indigenous persons are already employed by the project and GMI has committed to hiring more indigenous persons in the future. In addition, educational levels or other formal qualifications are only one factor considered during recruitment.
- Indigenous communities located along the road transportation route may face increased risks associated with vehicular accidents.
- Increased incidences of sexual exploitation of indigenous women and young girls including Venezuelan migrants of Warrau descent by people who have come into the communities to work for GMI or in search of employment.
- Dredging of the new turning basin in the Kaituma Canal may contaminate surface water used by residents downstream for domestic purposes including drinking.
- Limited negotiation skills to represent community interests in discussions with GMI resulting in the community accepting lower benefits than they may otherwise obtain.
- Some members of local indigenous populations use indigenous languages and practice traditional customs. Indigenous peoples working on the project and speaking English may lose the ability to communicate in indigenous languages. On the other hand, elders who work for long periods away from the home may not be around to pass on the languages and customs. However, this potential impact may be partly mitigated by the workers turnaround schedule.

These potential impacts are **indirect, negative, localised** and **long-term**. However, addressing the fundamental vulnerabilities faced by indigenous peoples is beyond the scope of this project. Nonetheless, the project and GMI should strive not exacerbate these vulnerabilities and instead, could contribute to managing their impacts by promoting social and economic inclusion in the project, meaningfully engaging indigenous populations, promoting safety and well-being of indigenous peoples and contributing to lifelong learning both academically as well as vocationally. As such, these potential impacts are of **moderate significance** and are **likely** to during the project lifetime. As such, depending on the mitigation and measures put in place, the project will potentially have **Medium Risks** to the local indigenous populations.

19.3.5 Potential Impacts to Other Vulnerable Groups and Gender Impacts

Generally, minority groups are at risk of greater poverty and are highly vulnerable. Although gold mining is prevalent in Region 1, most of rural poor employed in this industry are waged employees of small- and medium-scale miners. As previously discussed, Venezuelan migrant populations and small segments of the local creole population including women and children are also considered vulnerable populations. While these groups are socially integrated into the wider population, they must be specially considered given unique challenges related to lack of resources, limited education, language barriers, limited power to effect change and poor employment. Children from poorer homes are also most likely to drop out of school to seek employment with any of the service providers who may develop around the project. However, GMI has a strict policy against hiring employees younger than 18.

Mining, like any other industries, also have significant impacts on these groups which can translate into deprived access to land ownership. Women and teens are sometimes vulnerable to teen pregnancy, delinquency, school dropouts, sexual harassment and early marriage especially if employment opportunities are limited. These situations are likely to have negative impact on the productivity of vulnerable groups especially with the absence of technical training centers, youth development programs and a secondary school in Matthew's Ridge. If special efforts are not implemented to ensure that vulnerable groups benefit from the project, GMI's operations may exacerbate these impacts which already exists in the Region. GMI has indicated that efforts will be made to develop apprenticeship training programmes during project implementation.

These potential impacts are considered to be **negative**, **indirect, localised** and **long-term** of **moderate significance** and are **unlikely** to particularly during the operational phases of the project. This poses **Low Risks** to the project but is reversible with the implementation of effective mitigation measures.

19.3.6 Potential Impacts of Resource Use Conflicts

Project infrastructure and planned project activities will intersect with several existing uses of resources and lands. GMI will share use of the road transportation infrastructure with local communities, in particular the communities located in the Matarkai sub-district. Although GMI's vehicles will increase road traffic, it is unlikely to result in traffic jams or create significant delays in commute times. However, there are potential adverse impacts associated with increase, given reports of GMI's vehicles traversing the roads through Four Miles and Eclipse Falls at relatively high speeds. However, GMI conducts safety training regularly and employees who breach the safety policy face disciplinary actions. In addition, the Toshao of the Four Miles Village indicate that speed and unsafe driving practices caused two separate accidents of GMI's vehicles overturning on the public road which passes through the Village. The Chair of the Eclipse Falls CDC shared concerns about heavy vehicles frequently using the roads and bridge in the community which are also used by pedestrians and school children. Further, increased use of the roads during the dry season will amplify the challenges of dust pollution which is already being experienced by these communities. The potential impacts of shared use of the road transportation network are **negative, direct, short-term** and **localised** of **moderate significance** but are **certain** to occur during the project lifetime. This results in **High Risks** from the project activities. However, GMI will conduct upgrades to the road, including resurfacing and widening, and will maintain the road throughout the duration of the project. Rehabilitation and other improvements will also be done to the bridge at Eclipse Falls. These initiatives will contribute positively to the Region and the communities since the improved roadway will be utiliseutilised by all, which will improve travel time and safety, and reduce maintenance cost for vehicles. This will contribute to improving the economic wellbeing of residents and other personnel. Further, it will allow for Regional and Government authorities to divert and utilise funds which would have been used for the road maintenance for other areas of development for the Region. Improved roadway also has the potential of boosting development of other industries including tourism, education, transportation and agriculture.

Ore shipment will share the use of river transportation route with people residing on the banks of the Kaituma Canal, Kaituma River and Barima River. This includes settlements at Canal Bank, Lower Kaituma, St. Anselm, Smith's Creek, Morahwanna and the township of Mabaruma (inclusive of Aruka Mouth). Residents from these communities use these waterways on a daily basis, typically using canoes or other small vessels fitted with outboard engines, for transportation of people from their homes to other villages or economic hubs in Port Kaituma and Mabaruma. Children from these communities also travel on a daily basis to attend school in Mabaruma and Port Kaituma. Small individual or communal vessels are also used to transport produce from small-scale farmers to markets in Port Kaituma and Mabaruma, and harvested manicole to AMCAR. Most residents also frequently fish in the rivers for subsistence purposes and artisanal fisherfolks catch fish for sale in markets. As

previously mentioned, these markets are accessible only by river. In addition, several large vessels use these waterways, including ferries plying the Georgetown to Mabaruma and Georgetown to Port Kaituma routes, as well as fuel and cargo boats which also transport food supplies into the region. GMI will construct a new turning basin in the Kaituma Canal adjacent to the location of the Kaituma Marine Terminal. To avoid crowding of the canal and increasing the likelihood of accidents occurring GMI's barges will be fully contained within the new turning basin. However, risks of accidents involving for smaller vessels are likely to arise if the barge encounters another large vessel en route. To avert risks, small vessels may have to wait to pass thereby increasing commute times. As such, these potential impacts are **negative, direct, short-term** and **localised** of **moderate significance**. However, if GMI develops appropriate safety measures and engage with local communities on the barging schedule these potential impacts are **unlikely** to occur during the project lifetime. In addition, there will be only three such shipments per week from the Kaituma Marine Terminal. Further, GMI will create a mooring facility outside of the direct channel of the Kaituma Canal (see design of Kaituma Marine Terminal in Figure 4-10). This results in **Medium Risks** from the project activities.

Planned project activities and infrastructure has displaced existing resource use in Port Kaituma and Matthew's Ridge including residences and small-scale farming in both project locations. GMI directly engaged with the affected parties to negotiate resettlement agreements. As previously discussed, the project also restricted public access to the Pakera Lake. In addition, potential for future land use conflicts exists given that the GL&SC intends to issue additional agricultural leases in Matthew's Ridge. Although the land issued for agricultural leases may not overlap with the GMI's project areas, they may potentially be within range of high-risk project activities such as blasting. During the Public Scoping Meeting in Matthew's Ridge, participants also recommended that GMI should establish a property boundary/fence so as to prevent residents from setting-up small scale farms or conducting freelance gold prospecting on lands earmarked for use by the project. Potential impacts associated with conflicting land uses are expected to be **negative, direct, short-term** and **localised** of **moderate significance** but are **likely** to occur during the project lifetime. This results in **Medium Risks** from the project activities.

19.3.7 Potential Impacts of Economic Development and Community Well-Being

Matthew's Ridge was founded by the previous manganese mining operation which operated between 1959 and 1969, employing approximately 600 persons. When this operation ceased the area subsequently progressed into a depressed state, since there were no major economic and employment opportunities to sustain the livelihood of the population. The resuscitation of manganese mining in Matthew's Ridge will create a number of new direct and indirect economic opportunities. In particular, economic development within the AoI (and the Region as a whole) may be stimulated by increased disposable income by GMI employees and economic development created resulting in increased sale of good and services for the project. Increased disposable income may also be used for home repairs and positively contribute to the aesthetics of houses in the community, as well as other forms of livelihood improvements. At a national level, the project will contribute to foreign exchange earnings from the export of manganese and therefore is expected to contribute to an increased Gross Domestic Product and possibly also to the Natural Resources Fund. In addition, local workers who succeed in vocational training and hold skilled jobs with the company are expected to serve as positive role models for young people. Further, improved infrastructure also has the potential of boosting development of other industries including tourism, education, transportation and agriculture.

GMI is in a unique position to encourage growth of the community economy and promote well-being. In particular, the company may explore:

- Boosting local procurement of goods and services. Specifically, GMI may encourage local crop cultivation by purchasing produce and other food items from the community that satisfies its

demand. This may be beneficial throughout the life of the project and even beyond the decommissioning of the project as local farmers will have markets in other communities within the AoI.
- Opportunities for creating a new recreational facility based on feedback from the local community.
- Opportunities to proactively design a CSR programme to contribute to community development in consultation with the community.

However, adverse impacts are also likely including diminished value of residential properties which can potentially be affected by noise and dust pollution from planned project activities such as blasting. Nonetheless, the overall potential impacts on economic development and well-being is considered **positive, direct**, **regional** and **long-term.** The impacts are expected to be of **moderate significance** and is **certain to occur**.

19.3.8 Cumulative Impact Assessment

Manganese mining and processing is expected to contribute to the development of communities within the project footprint, the Matarkai sub-district and the Region as a whole. These positive impacts were discussed above and relate to increased employment in the Region particularly within the Matarkai sub-district. Moreover, the project is expected to contribute to overall economic development and community well-being by increasing local procurement of goods and services and by developing a programme of CSR interventions. The positive benefits of the project, in combination with existing livelihood activities in the Matarkai sub-district such as small- and medium-scale mining are expected to result in development impacts that are **positive, direct**, **cumulative, regional** and **long-term** of **moderate significance** and **certain** to occur.

The Matarkai sub-district provides access to the principal mining districts in Region 1 and a significant percentage of the population of these areas are employed in the gold mining sector by freelancing (pork-knocking) or engaged in small- or medium-scaled enterprises. As a consequence, communities within the district are already vulnerable to socio-cultural impacts associated with the mining sector, such as loss of culture, including indigenous culture, when elders work for extended periods away from the home environments. This impact may be amplified if previously unemployed people from communities within the secondary and tertiary AoI leave their homes to work with GMI in Matthew's Ridge or Port Kaituma. These potential socio-cultural impacts are **negative, indirect, cumulative, local** and **long-term** of **moderate significance** and **likely** to occur. As such, these are **Medium Risks** of the project.

As discussed previously in this Chapter, GMI has implemented mitigation measures to prevent adverse impacts to community services which are already strained. These measures include establishment of a spring at Matthew's Ridge from where most of the water required for domestic purposes will be sourced, self-generation of electricity at Matthew's Ridge and Port Kaituma, provision of accommodation for most employees and the establishment of waste disposal facilities at both project locations. However, the existing public services for the provision of health-care, education and public security (through the Guyana Police Force) are also under strain to manage existing demand from the local communities. These challenges are particularly amplified for the public health and education systems in Matthew's Ridge. It is expected that planned project activities will also contribute to increased demand on these services. If extant capacities are not increased, local communities may also experience diminished access to these essential services. These potential socio-cultural impacts are **negative, direct, cumulative, localised** and **short-term** of **moderate significance** and **almost certain** to occur. As such, these are **High Risks** of the project.

19.4 Mitigation and Monitoring Measures – Socio-Economic Environment

As previously discussed, GMI has already instituted several measures to reduce the potential impacts of their operations on existing social systems and services. These measures include:

- Providing accommodation for 200 employees at Matthew's Ridge and 20 employees at Port Kaituma.
- Sourcing most water for domestic purposes for employees at Matthew's Ridge from a spring which is not used by GWI.
- Self-generating of electricity for operations at both Matthew's Ridge and Port Kaituma.
- Managing of all waste generated during the operational phase of the project independently from the community waste management system.
- Ensuring that all expatriate employees are permitted to work in Guyana and comply with the laws of Guyana.
- Allowing for shared use of project roads, in particular the bypass roads in Matthew's Ridge and Port Kaituma, to local producers such as farmers, small-scale miners (including pork-knockers) and loggers.
- Conducting safety training with employees including driving safety courses for drivers.
- Making provisions for dust suppressing by road wetting in Matthew's Ridge and Port Kaituma during the dry seasons.
- Purchasing some foods items, such as eggs, from a local producer in Matthew's Ridge.
- Informing residents and local authorities of vacancies and application procedures whenever jobs are available.

In addition to these measures, GMI should also implement the following actions to manage the risks discussed above:

- Recommit to the MoU with the NDC and fulfilling all obligations undertaken for community development including maintenance of roads in Matthew's Ridge and creating an alternative recreational facility, in consultation with residents.
- Develop of a Stakeholder Engagement Plan which will be iterative and updated periodically. The Plan should make provisions for:
    - Continuous engagements with local authorities and residents to share updates on the project and receive feedback. This will also aid in managing expectations regarding the employment and economic benefits which may accrue from the project.
    - Informing local communities, including communities along the river transportation route, of the planned project activities which may negatively impact them including mine blasting and barging of ore, among others.
    - Periodically scheduled meetings, quarterly or biannually, with representatives of the NDC and residents of Matthew's Ridge to discuss needs and opportunities for CSR interventions. This should also consider support to local communities to enable local producers to purchase equipment, tools or other supplies required to get their business ventures off the ground (such as micro-credit schemes and grants to encourage agricultural development, etc).
    - Periodically schedule meetings with the CDCs or Village Councils of other communities to receive feedback on impacts they may be experiencing and get feedback.
    - Inform community members of the types of goods, including fresh produce and food, which could be procured locally. This can motivate and empower vulnerable groups including indigenous people and women allowing them to engage in commercial farming while earning to provide for their families.
    - Gender responsiveness of any all engagements with the community.
    - Vulnerable groups like women and youth should be encouraged to play an active role in contributing to decision making in the community.

- Actively engage with the RDC and other local authorities to provide updates on the implementation of project activities and receive feedback and recommendations. GMI should also consider directly engaging with the RDC to determine whether the company could support the work of the Regional Disaster Risk Committee and further develop the systems for emergency response for potential incidents in which GMI may be involved.
- Development of an Indigenous Peoples Plan (IPP), in consultation with indigenous peoples, outlining the measures GMI will undertake to ensure the indigenous people from Matthew's Ridge, Port Kaituma, the Matarkai sub-district and the wider Region 1 have opportunities to equitably benefit from the project and avoid exploitation. The IPP should be prepared following the principle of Free, Prior and Informed Consent and use culturally appropriate language and non-ambiguous terminology.
- Designate personnel, preferably locals, who will conduct all company-led stakeholder engagements with local communities.
- Development of a Grievance Resolution System accessible to community and provides for timely and meaningful action to be taken by the company.
- Development of procedures for safe use of local transportation networks which all drivers and barge operators must follow.
- Enhancing vocational training for residents of Matthew's Ridge and Port Kaituma so that required skills do not have to be imported from other parts of the country.
- Training for all employees of GMI's internal procedures for accessing training, disciplinary measures and dismissal.
- Develop an awareness programme for employees, in consultation with community members, of cultural practices in the local communities and how these should be respected. In this regard a Code of Conduct for workers may be developed.

Table 19-7: Summary of Impacts and Mitigation Measures

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Significance	Likelihood			
Project Construction and Operation	Compliance with Laws of Guyana and International Conventions	Employment	Positive, Direct, Regional, Short to Long-term	Moderate	Certain	N/A	N/A	N/A
Planned and Unplanned Migration for Employment	Compliance with Laws of Guyana	Pressure on natural resources and social services, increased populations, increased crime, new transmittable diseases loss of culture	Negative, Direct, Local, Short-term	Major	Likely	High	Continuous stakeholder engagements to manage expectations for employment Community consultations to develop CSR programme Development of Grievance Resolution System	
Project Construction and Operation	Compliance with Laws of Guyana	Unrealistic expectations for employment, negative perceptions of project and company	Negative, Direct, Regional, Long-term	Moderate	Likely	Medium)	Fulfilling all obligations made to local authorities Consulting residents of Matthew's Ridge on the new recreation facility	Periodic meetings with residents and local authorities to receive feedback and recommendations

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Significance	Likelihood			
							Expanding local procurement of goods and services Informing local communities well in advance of planned project activities such as blasting, ore shipment schedule Development of Grievance Resolution System	
Project Construction and Operations	Compliance with Laws of Guyana	Impacts on indigenous peoples including pollution, economic exclusion, inadequate emergency response, labour exploitation, sexual exploitation,	Negative, Direct, Localised, Long-term	Moderate	Unlikely to Likely	Low to Medium	Development and implementation of IPP Development of Grievance Resolution System	Periodic meetings with indigenous communities to receive feedback and recommendations

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Significance	Likelihood			
		loss of culture						
Vulnerable Groups	Compliance with Laws of Guyana	Vulnerable groups do not equitably benefit, increased sexual harassment and sex work	Negative, Direct, Localised, Long-term	Moderate	Unlikely	Low	Development and implementation of IPP Stakeholder Engagement Plan and stakeholder consultations are gender responsive Development of Grievance Resolution System	Periodic meetings with residents and local authorities to receive feedback and recommendations
Overland Transportation of Ore	Compliance with Laws of Guyana	Road accidents and dust pollution	Negative, Direct, Localised, Short-term	Moderate	Certain	High	Implement road safety procedures all company drivers must follow	Periodic meetings with residents and local authorities to receive feedback and recommendations
Riverine Transportation of Ore	Compliance with Laws of Guyana	River accidents	Negative, Direct, Localised, Short-term	Minor	Unlikely	Low	Implement river safety procedures all company barge operator must follow	
Project Operation and Mine Expansion	Compliance with Laws of Guyana	Land Use Conflicts	Negative, Direct, Localised, Short-term	Moderate	Likely	Medium	Establishing boundary of lands leased and licensed by GMI	

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Significance	Likelihood			
							Development of Grievance Resolution System	
Project Operations	Compliance with Laws of Guyana	Economic development and improved community well being	Positive, Direct, Regional, Long-term	Moderate	Certain	N/A	N/A	N/A
Cumulative Impacts								
Project Operations	Compliance with Laws of Guyana	Economic development from implementation of project and non-project livelihood enterprises	Positive, Direct, Regional, Long-term, Cumulative	Moderate	Certain	N/A	N/A	N/A
Project Operations	Compliance with Laws of Guyana	Amplification of socio-cultural impacts from project activities and small- and medium-scale gold mining	Negative, Indirect, Local, Long-Term, Cumulative	Moderate	Likely	Medium	N/A	N/A
Project Construction	Compliance with Laws of Guyana	Increased pressure on social	Negative, Direct, Localised,	Moderate	Almost Certain	High	Periodic meetings with residents and local	

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Significance	Likelihood			
and Operations		services including health care and security from project and non-project activities	Long-Term, Cumulative				authorities to receive feedback and recommendations	

Chapter 20 – Health

There can be significant health risks associated with mining and human life in mining communities. This chapter assesses the baseline conditions which may impact the health and safety of project staff and local communities. It then conducts a health risk assessment of project activities taking account of the existing health conditions in the project locations and the wider region. Finally, it proposes mitigation measures which should be followed to ensure that these risks are mitigated and managed effectively so that adverse health outcomes may be avoided.

20.1 Administrative Framework – Health

Table 20-1 summarises the legislation, policies, strategies, and international treaties that are relevant to the planned project activities.

Table 20-1: Legislation, Policies, Strategies and International Treaties

Title	Description	Applicability to the Project
Legislation		
Public Health Ordinance (1934)	Makes provisions for regulating 'offensive trades', that is, a trade that damages the health of the persons engaged in the trade. The Ministry of Health has convened a Committee for the management of offensive trades and this Committee is chaired by the Chief Medical Officer.	Regulates activities that can damage the health of employees during their routine duties. The Government's COVID-19 measures with which the project must comply were made under this Ordinance.
Ministry of Health Act (2005)	Outlines the responsibility of the Ministry for the provision of health care in Guyana and the management of its facilities at the national, regional and community levels.	GMI is obligated to obey the health laws and thereby reduce the health risks associated with its operations for its employees and community members. GMI must ensure that appropriate clothing and safety gears are provided for its employees.
National Insurance and Social Security Act (1969, 1997)	Establishes a system of national insurance and social security providing pecuniary payments by way of old age benefit, invalidity benefit, survivor's benefit, sickness benefit, maternity benefit and funeral benefits. The Act also provides for compensation as a system of insurance against injury or death caused by accident arising out of and in the course of employment or resulting from disease due to the nature of employment.	GMI is required to provide its share of the contributions to NIS so that payments and benefits in keeping with this Act can be available including compensation for workers during their employment. The National Insurance Scheme is responsible for post-employment pensions payable to employees based on the contributions to the scheme.
Occupational Health and Safety Act (1997, 2009)	Provides the framework for the registration and regulation of industrial establishments, for occupational health	The operations of GMI will have to meet national Health and Safety standards as described in this and other related legal documents.

Title	Description	Applicability to the Project
	and safety at work and related matters including transport safety.	
Environmental Protection Regulations (2000)	Establishes Regulations for the issuance of Environmental Authorisations, Hazardous Waste Management, Water Quality, Air Quality and Noise Management.	GMI will be required to operate within the established conditions of its permit issued by the EPA which includes the establishment of baseline conditions and continuous monitoring of its discharges.
International Treaties and Protocols		
International Health Regulations (2005)	Under the International Health Regulations (IHR 2005) all States Parties are required to have or to develop minimum public health capacities to implement the IHR (2005) effectively.	Health Emergencies of certain nature and classifications will have to be reported to the WHO. Local Representatives of the WHO will form part of the response team to tackle the medical emergency.
International Labour Organisation, Chemicals Convention, 1990 (No. 170)	Provides protection of workers from the harmful effects of chemicals and also enhances the protection of the general public and the environment, recognises that workers have a need for, and right to, information about the chemicals they use at work.	Protection of workers required to handle dangerous chemicals and explosives. Specifies the requirements for labelling, warning signs, secure storage, training, etc. for the handling of chemicals/explosives.
International Labour Organisation Safety and Health in Mines Convention, 1995 (No. 176)	Establishes a working environment to prevent any fatalities, injuries or ill health affecting workers or members of the public, or damage to the environment arising from mining operations.	GMI will be required to provide a safe environment for its workers as guided by local and international requirements and best practices.

20.2 Baseline Conditions – Health

Region 1 is possibly one of the most remote administrative region of Guyana. It is bordered by the Atlantic Ocean to the north, Venezuela to the west and Regions 2 and 7 to the east and south respectively. Due to its remoteness, there are no road networks connecting Region 1 to its neighbouring administrative regions or to the capital of Georgetown. There are two primary modes of access to the region. Firstly, access by air is facilitated by numerous airstrips with the main ones located in Bemichi, Mabaruma, Port Kaituma, and Matthew's Ridge. The latter two airstrips are located in communities which are part of the primary AoI of the project and several private air service operators provide daily return flights from the Eugene F. Correia International Airport to these airstrips. The second mode is access is by river with a Government-operated fortnightly ferry service into Mabaruma and Port Kaituma. In addition, small passenger boats, speedboats, connect various landing points across Region 1 and into Region 2. In particular, speedboats travel into Port Kaituma from Charity (Region 2), Mabaruma, Moruca and Arakaka, all of which are in Region 1. The remoteness of the region and its far-flung communities provides an additional challenge in the provision of health care and emergency services, including emergency medical evacuation.

20.2.1 Health Administration in Region 1

Region 1 has three sub-districts each of which have local authorities, namely the Matarkai sub-district which is managed by a NDC, the Mabaruma District and Town Council, and the Santa Rosa Village

Council. The RDC which is responsible for administration of the region as a whole is located in Mabaruma and each local authority reports to the RDC. The RDC is governed by a Regional Chairman who is an elected official and a Regional Executive Officer (REO) who is appointed by and reports to the Ministry of Local Government and Regional Development. Region 1 also has a Regional Health Officer (RHO) who reports directly to the REO. The RHO also works directly with the Regional Health Superintendent who ultimately reports to the Minister of Health. The RHO is tasked with ensuring that the health workers and personnel attached to the health system are trained, provided with adequate information in preparation of the Region's health response and support the implementation of systems to respond to emergencies or disasters. The RHO must also conduct frequent maintenance checks on serviceability of all health-related equipment and machinery by spending time in the districts.

In the event of any health emergency, the REO or the RHO can contact the Ministry of Health (MoH) to request support be sent into the Region. Subsequently, an assessment of the situation on the ground will be led by the Chief Medical Officer (CMO), or an appointed representative, so as to determine the initial response to the health emergency. The MOH will notify the Civil Defence Commission and the Minister of Health will determine if the Health Emergency Operation Center (HEOC) will be activated. The CDC, and its subject minister, will also analyse the situation and determine whether the National Emergency Operations Centre (NEOC) will be activated for the health emergency.

20.2.2 Health Care in Region 1

According to the national census, in 2012, the population of Guyana was counted as 744,955 and the population of Region 1 at 27,042 accounting 3.63 percent of the total[173]. In 2018, the number of deaths in Guyana was 4,909 of which 79 were from Region 1 disaggregated by gender with 51 males and 28 females[174]. Region 1 has been linked to several types of health hazards that were vector borne, bacterial and of viral causes[175]. Malaria was identified as the main pathogen and exposure to water borne illness was also highly rated. There is also a history of outbreaks such as acute gastroenteritis, typhoid and cholera while four cases of Zika virus were recorded in the Region in 2016[176].

The MoH has a country-wide vaccination programme that aims for 100 percent immunisation of children against the following diseases Measles, Mumps and Rubella (MMR), Diphtheria, Whooping Cough and Tetanus (DPT), and Oral Polio Vaccine (OPV). Based on data collected in 2008, Region 1 had the lowest percentage of immunisation for three vaccines as compared with the other administrative regions of Guyana (Table 20-2). The average across the vaccine lines is over 85 percent but still far below the accepted rate of 100 percent. The challenge with vaccination reflects the greater challenge with providing health care to remote communities in this region separated by numerous waterways and mountains.

Table 20-2: Immunisation of children by region for Guyana in 2008

Immunisation of Children by Region	Percent Immunisation			
Region	**DPT**	**OPV**	**BCG**	**MMR**
Region 1 (Barima - Waini)	79.5	79.7	85.6	96.2
Region 2 (Pomeroon - Supenaam)	94.7	94.7	93.5	97.9
Region 3 (West Demerara - Essequibo Islands)	100.0	99.8	98.9	99.9
Region 4 (Demerara - Mahaica)	91.1	91.1	89.4	92.2

[173] Guyana National Bureau of Statistics. 2016. 2012 Population and Household Census, Final Results. Page 2, Table 1
[174] Guyana National Bureau of Statistics. 2018. Yearly and Quarterly Deaths by Region and Sex for 2009 to 2018. Table 1, Sheet 1.
[175] Oronde Drakes & Dina Benn. Hazard and Vulnerability Assessment of Barima-Waini Region One. Civil Defence Commission, 2016. Page 1, Paragraph 3
[176] Ibid, Page 18

Immunisation of Children by Region	Percent Immunisation			
Region	**DPT**	**OPV**	**BCG**	**MMR**
Region 5 (Mahaica - Berbice)	91.6	91.6	91.9	94.2
Region 6 (East Berbice - Corentyne)	95.0	95.0	99.7	97.4
Region 7 (Cuyuni - Mazaruni)	96.1	96.1	88.8	84.4
Region 8 (Potaro - Siparuni)	92.7	93.0	89.9	97.6
Region 9 (Upper Takatu - Upper Essequibo)	84.7	84.7	91.3	96.2
Region 10 (Upper Demerara - Upper Berbice)	92.9	94.7	95.5	100.0
All Regions	**92.8**	**93.0**	**96.1**	**95.4**

Source: Bureau of Statistics, Immunisation by Region, 2008

There are four district hospitals in Region 1 of which two are in communities within the primary AoI of the project. These are the Pakera District Hospital in Matthew's Ridge and the Port Kaituma District Hospital. The other two District Hospitals are located at Mabaruma and Santa Rosa. The Mabaruma Regional Hospital performs the function of the leading health care institution in the Region. However, there are several smaller health care facilities in the Region which have limited capacities of provision of health care. In general, small health care facilities like Health Outposts have limited treatment capacities and diagnostic capacities. The health care system in Region 1 faces several challenges. According to the Regional Chairman, the system is overburdened and most particularly by limited human resource personnel. It was estimated that additional human resources for health care in the Region are direly needed and across the Region health care facilities are run with less than 50 percent of the required human resource complement (EMC Personal Communication 18).

Table 20-3: Health Care Facilities Institutions in the Region

No.	Items	Region 1
1	District Hospitals	4
2	Health Outposts	43
3	Health Center	3
4	Hospital Beds	61

Source: Bureau of Statistics, Health Institutions by Region, 2009

The health care facilities typically provide free medical care for the local population and also provides medication free of cost. However, there are privately owned pharmacies across the Region which sell prescription medications and over the counter medicines as well as numerous privately owned small stores also selling over the counter drugs. In addition, herbal medicines and other locally created cures are widely used, particularly in the indigenous communities who prefer to treat illnesses with cultural cures.

According to the Hazard and Vulnerability Risk Assessment of Region 1, vector borne diseases are widespread. The particular prevalence of mosquito borne illnesses are linked to improper garbage disposal, proximity of dwellings to surrounding forests and due to a significant proportion of employment taking place within forested areas including mining and logging, as well as traditional practices such as slash and burn agriculture. Littering with empty containers and other types of garbage clog the drainage systems, trap and slow water flow while standing water in dark warm areas allow the insects to proliferate. These high populations of mosquitoes will attack with greater frequency having an increased likelihood of transmitting any pathogens to those they bite[177].

[177] Ibid, Page 34

Diarrhoea and vomiting were also among the most common maladies discovered in the health risk assessment[178]. However, the lack of access to medical facilities, resultant from the limited transportation options in the Region, means that these common ailments can be life threatening to significant numbers of the population should they remain untreated.

20.2.2.1 Existing Health Care Provisions and Conditions in the Project AoI

The Pakera District Hospital located in Matthew's Ridge is the primary provider of health care services for Matthew's Ridge and surrounding communities including Arakaka and Baramita. Specific services offered includes maternal and child health services, chronic disease, malaria diagnosis and treatment and dental care. In addition, the hospital has the capacity to extract samples to be sent to the National Public Health Reference Laboratory to be tested for COVID-19 as well as to quarantine and treatment patients who are positive for COVID-19. The Hospital also has a mortuary, a lab, and an ambulance.

At Pakera District Hospital the most common health issue is that of malaria infection which is treatable and presents few complications when after being treated fully. Patients can be tested and treated for both types of malaria as the hospital provides laboratory services to identify the malaria parasites, and after which appropriate treatment is administered. People are frequently repeatedly infected while working in the mining areas. Deaths resulting from malaria are rare due to the health care available for the community. According to the Chief Medical Officer (CMO), Matthew's Ridge has a history of vector-borne diseases. In particular, mosquitoes that cause malaria, and the sand flies that cause leishmaniasis breed in Matthew's Ridge resulting in high incidences of both diseases (EMC Personal Communication 11). Other frequently occurring diseases include diabetes and hypertension, both of which the hospital also has the capacity to diagnose and treat.

Figure 20-1: Ambulance at the Pakera District Hospital

At present, the hospital is staffed by two doctors, one medex, and eight nurses with a total of twenty staff of all categories. The hospital has a 12-bed capacity and serves as the main source of medical treatment within the district, and was the institution of first response during the histoplasmosis outbreak in 2019. According to the CMO, the capacity of the hospital is limited and below the capacities required to serve Matthew's Ridge and the surrounding areas. Moreover, the Hospital was not equipped to manage the 2019 histoplasmosis outbreak which afflicted contractors working for GMI and does not have the capacity to manage any similar health care crisis in the near future. It was indicated that the existing capacity of the hospital would have to be doubled to cater adequately for the estimated 400 workers to be based in Matthew's Ridge during the construction and operation phases of the project

[178] Ibid Page 34

(EMC Personal Communication 11). Other challenges faced by the hospital include severe erosion of the Pakera Hill (on which the hospital is situated) and unreliable supply of electricity.

The other major hospital in the AoI is the Port Kaituma District Hospital which provides health care services to all communities in Port Kaituma as well as other communities in the secondary AoI such as Four Miles Village and Eclipse Falls. In 2020, the Government of Guyana commissioned a new District Hospital in Port Kaituma valued at GYD$ 959 million. The new facility has 50 beds and specialised medical practitioners including resident internal medicine specialist and a paediatrician. The hospital is fitted with water filtration systems and as of 2019, had a functioning modern ambulance service. Prior to the commissioning of the new district hospital, there was a smaller District Hospital which had 20 beds and which was refurbished in the early 2000s with support from Barama Company Limited. This smaller hospital will also remain open in Port Kaituma (EMC Personal Communication 11). The most common illnesses treated by this hospital are malaria, typhoid fever, rashes and fever and mining related injuries. Most households use mosquito nets to prevent mosquito borne diseases and other preventive measures are in place by the community including fogging and education awareness.

For health care emergencies that cannot be handled by either the Pakera District Hospital or the Port Kaituma District Hospital, patients are referred to either the Mabaruma Regional Hospital or the Georgetown Public Hospital Corporation (GPHC). Travel to Georgetown for medical treatment is generally facilitated by air with emergency medical evacuations from the airstrips in Matthew's Ridge or Port Kaituma. These medical evacuations are facilitated with support from the NDC of the Materkai sub-district and occasionally with support from the RDC.

It should also be noted that there are Health Outposts in the secondary and tertiary AoI. For example, within the secondary AoI of the project there are Health Outposts in Arakaka, Eclipse Falls and Four Miles, each of which is staffed either by a Medex or a Community Health Worker. Further, within the tertiary AoI there is a Health Outpost in the St. Anselm community but this facility is not staffed. As such, patients with serious illnesses are referred to the hospitals in Matthew's Ridge, Port Kaituma and Mabaruma for treatment.

20.2.2.2 The COVID-19 Pandemic

In 2020, the Santa Rosa Village in Region 1 became one of Guyana's hotspot areas for the COVID-19 infections. Over the June to July 2020 period, Region 1 was the second most infected administrative area, with more than 75 percent of new positive COVID-19 persons being from the Region during that period. Although known infections in Matthew's Ridge, Port Kaituma and their surrounding communities are low (at the time of writing), the risks of transmission of the coronavirus in the project locations are high. As part of creating regional preparedness to manage the disease, the RHO was tasked to make the necessary preparations for COVID-19 by the Health Emergency Operations Center of the MOH. Accordingly, the RHO prepared isolation facilities at each District Hospital and selected personnel were trained to take nasal samples from suspected patients. The RHO was also required to ensure the implementation of systems at all hospitals and health centres within the Region for surveillance and monitoring for significant increases and/or outbreaks in illnesses within the region.

Each of the four District Hospitals were provided with PPEs should they have to quarantine persons of interest or isolate COVID-19 positive cases. Health facilities were also prepared to educate community members in order to encourage safe practices such as hand washing/sanitising, proper use of face masks and social distancing. Staff are trained to screen patients with laser thermometers where available or to take a reading with the regular thermometer.

At the level of the NDC for the Matarkai sub-district, several measures were also implemented to prevent the spread of COVID-19 and a Sub-Regional Task Force was created to coordinate the implementation of these measures in the Matarkai sub-district. These included:

- Entry of passenger boats from Charity, Mabaruma and Moruca into Port Kaituma were suspended due to COVID-19.
- Establishment and manning of 24-hour screening sites and checkpoints at Matthew's Ridge Airstrip, Four Miles Barrier along the Port Kaituma - Matthew's Ridge Road, Baramita exit and entry road, at the Kaituma Boat Landing, and along the Kaituma River.
- Installation of hand washing stations at public spaces with businesses having either hand washing station or sanitisation sprays for customers along with the distribution of face masks to the public.
- Sanitisation of the Port Kaituma market area on Sundays.
- Public awareness and education to inform residents that COVID-19 is real and that measures such as wearing of masks and social distancing are required to control the spread of the disease.

GMI donated masks, hand sanitisers and disinfectants to both the RDC and NDC to support their response to the coronavirus pandemic. In addition, GMI also donated coronavirus rapid test kits to the Pakera District Hospital.

20.2.3 Air Quality and Health

Vehicles operating in the area are emitting carbon monoxide, carbon dioxide, nitrogen dioxide and volatile organic compounds (VOCs) in various volumes depending on the fuel type and vehicle category. It is expected that most of the gases quickly dispersed into the open air around vehicles and therefore are not allowed to build to dangerous concentrations. This was evident in the air quality baseline data collected by the EIA team which measured the levels of gases at various locations in Matthew's Ridge, Port Kaituma and along the roadway. These results indicated that nitrogen dioxide, sulphur dioxide and carbon monoxide were within acceptable limits although the levels of VOCs were high at some high-traffic locations. Particulate matter was also generally within acceptable levels. However, the levels of particulate matter were high in some areas in Matthew's Ridge and Four Miles and this was attributed to road traffic and foggy conditions are the time of sampling. The findings of the baseline assessment are presented in detail in Chapter 11.

A significant air pollutant is dust/particulate matter disturbed from the laterite roads when vehicles traverse, especially during the dry periods and this may cause an inflammatory response in the lung leading to respiratory effects. Currently, during the dry seasons, significant quantities of dust are produced when vehicles traverse the project roads and the public roadway connecting Matthew's Ridge to Port Kaituma. According to feedback provided by representatives of the Guyana Geology and Mines Commission (GGMC), during the dry seasons, dust emissions from the Matthew's Ridge to Port Kaituma public road result in considerable changes in daily life of the residents of Eclipse Falls who were reported to having to wait until evening and nights, when traffic is lower, to hang out their laundry (EMC Personal Communication 10). This was supported by feedback from local stakeholders. According to the Chair of the CDC, in Eclipse Falls, dust covers the roofs of houses and hinders rainwater collection because the dust has to be washed off of the roof surface before rainwater collection can begin. Residents at Eclipse Falls also believe that dust emissions may lead to illnesses like cold and flu, especially among children (EMC Personal Communication 20). Moreover, dust emissions were reported to cover internal surfaces of homes in Four Miles Village (EMC Personal Communication 19).

According to data collected by the NDC operated toll booth at the Port Kaituma road boundary, in 2019, the highest number of trucks entering Port Kaituma on a daily basis was 7. In addition, there

were entries of approximately 32 other light vehicles such as ATVs, cars, land cruisers and canters. These numbers provide a reliable baseline estimate of heavy vehicles and other lighter vehicles that traverse the entirety or sections of the public road connecting Matthew's Ridge to Port Kaituma on a daily basis.

20.2.3.1 Air Manganese Exposure

Inhalation of dust/particulate matter from inorganic manganese compounds or manganese fumes has been linked to adverse health outcomes for populations that are environmentally exposed. These include[179]:

- Inflammatory response of the lungs resulting in respiratory effects due to exposure to manganese dust. However, this is linked to irritation from the particulate/dust and is not due to manganese exposure per se.
- Low levels of iron serum in women as compared to men who were environmentally exposed to manganese in the air.
- Men who are older than 50 years of age have experienced neurobehavioural and neuropsychiatric effects including significant disturbances in several mood symptoms with significantly increased values for anxiety, nervousness, and irritability; emotional disturbance; and aggression and hostility. Poor performance in upper limb and hand-eye coordination was also observed.
- Cognitive impairment measured against 10 measures of both men and women when exposed to high levels of air manganese exposure. However, there was no risk of poor performance was found with a 0.05 micrograms per cubic meter cut-off point. When using a 0.1 micrograms per cubic meter cut-off point, only 1 of 10 cognitive measures had a significantly increased risk of poor performance.
- Increased risk of Parkinson disease from prolonged exposure, a decade of longer, to respirable manganese concentrates.
- Increased risk of poor intellectual function to young school children exposed to airborne manganese.

Manganese mining was actively conducted in Matthew's Ridge for approximately 8 years during the period 1960 to 1968. However, data collected from the Pakera District Hospital do not indicate that any of these adverse health outcomes have been recorded in Matthew's Ridge and there have been no epidemiological studies to determine whether environmental exposure to manganese in the air resulted in any adverse health outcomes for this population.

20.2.4 Water Quality and Health

The quality of water which people have access for domestic purposes like washing, cooking and drinking is a significant determinant of their health. Several communities in the primary and secondary AoI of the project depend on surface water sources for water for domestic purposes. These include:

- Residents of Matthew's Ridge who depend on water supplied by GWI which is sourced largely from surface water sources.
- Approximately 700 residents of Port Kaituma who depend on water supplied by GWI which is sourced from surface waters in particular from tributaries of the Kaituma River.
- Residents of Canal Bank who depend on water from the Kaituma Canal for domestic purposes.
- Residents of Eclipse Falls and Arakaka who depend on water from the Barima River for domestic purposes.

[179] Williams M, Todd GD, Roney N, et al, 2012. Toxicological Profile for Manganese.

The quality of water from these sources can be affected by a variety of existing factors. Firstly, passenger and cargo vessels use the Kaituma Canal and Barima River increasing risks of turbidity and contamination from hazardous (fuel, oil, etc) and non-hazardous waste. There are well established practices of solid waste disposal at several locations around the old turning basin in the Port Kaituma commercial district. In addition, all surface waters are at risk of contamination from coliforms due to both exposure to human sewage as well animal faecal matter. Based on the baseline assessment of water quality conducted by the EIA team in 2020, surface waters were within permissible limits for physio-chemical parameters including pH, temperature, turbidity, total dissolved solids, total suspended solids and conductivity. However, based on data shared by GWI, coliforms and E. Coli were frequently in exceedance of permissible levels in the water supply for both Matthew's Ridge and Port Kaituma.

Given the prevalence of small- and medium-scale gold mining in the Matarkai sub-district, mercury contamination of surface waters has previously occurred in both the Barima River and Kaituma Canal (EMC Personal Communication 07 and 20). This resulted in residents having to temporarily cease use of water from these sources until the water levels were once again safe for use and this resulted in considerable hardships for these communities.

20.2.4.1 Water Manganese Exposure

Residents may also be environmentally exposed to inorganic manganese via the water supply and this has also been linked to adverse health outcomes. These are similar to the adverse health outcomes associated with air manganese exposure which were discussed above. However, unlike the air manganese exposure which is associated with increased risks of intellectual impairment for young children, epidemiological studies have found a strong causal relationship between exposures to manganese in drinking water and diminished intellectual performance of children including diminished IQs. Children exposed to manganese also exhibited increased hyperactive and oppositional behaviours.[180]

As such, the World Health Organisation recommends that levels of manganese compounds in drinking water should not exceed 50 micrograms per liter or 0.05 milligrams per liter. During the baseline water quality assessment conducted by the EIA team in 2020, high levels of manganese were detected in all surface waters assessed in Matthew's Ridge but these are not typically sources of drinking water for residents. However, manganese levels were also high, with a recorded level of 3.91 milligrams per liter, in the Hill 3 aquifer which is one of the sources of potable water in the community.

20.2.5 Exposure to Dangerous Chemicals

Small- and medium-scale mining relies on the use of mercury in its gold processing operations. Exposure to mercury has long term health complications, including neurological conditions, and can be fatal if ingested. It is expected that the local miners will have trace amounts of mercury in their tissues. The water will have trace amounts of mercury and other chemicals with low decay rates that were used by persons in the area. Approximately 33 percent of the Matthew's Ridge residents are employed in the mining sector and will have some level of exposure to mercury.

20.2.6 Occupational Health and Safety Risks

Given that construction activities have already commenced, the GMI workforce has been exposed to several occupational health and safety risks.

[180] Bouchard M.F, Sauve S, Barbeau B, et al, 2010. Intellectual Impairment in School-Age Children Exposed to Manganese from Drinking Water

20.2.6.1 Histoplasmosis Outbreak of 2019

In 2019, there was an outbreak of histoplasmosis of GMI workers in Matthew's Ridge which resulted in two fatalities. According to the report prepared by the CMO on the outbreak, on March 28, 2019, the MoH was notified by the District Medical Officer of the Pakera District Hospital of an unusual illness among the workers of GMI[181]. The workers were clearing the old mining tunnels that were filled with decades of bat droppings and other debris. GMI indicated that 23 of the Chinese contractors were involved in the clearing of the abandoned mine shafts and tunnels. No Guyanese was involved in the tunnel clearing but were in contact with infected persons.

In response to the report, the MOH activated its emergency response system in coordination with the GPHC, Pan American Health Organization/World Health Organization (PAHO/WHO) and other main stakeholders. The National Emergency Operating Center was partially activated and a committee to monitor the response and containment measures established. A case definition was established by MOH formally informing the International Health Regulations Global Alert Monitoring focal point at PAHO of the situation. One Chinese national succumbed to the condition while receiving treatment at the Pakera District Hospital and another died while on the ventilator support at the GPHC. During the second week of case management four critical cases and six others hospitalized were transferred to China via a medical evacuation air lift coordinated by the Center for Disease Control of China and the Chinese Red Cross.

Figure 20-2: Tunnels from which Bat Droppings and Debris were Cleared

Following an investigation of the incident, the MoH concluded that the contractors were not equipped with the appropriate PPE and only one of the 23 workers interviewed indicated that a face mask was used during the cleaning operations. It was determined that although the safety equipment were procured by GMI that they were not yet released by the Guyana Revenue Authority (GRA) when work commenced.

Following the incident, GMI buried all of the materials removed from the tunnels which are expected to have been contaminated by the spores which caused histoplasmosis. Two burial sites were utiliseutilised, both in proximity to each other, and are located in the storage yard for raw ore and is shown in Figure 20-4. One of the burial area is shown in Figure 20-3.

[181] Dr Shamdeo Persaud, Chief Medical Officer, April 2019. Final Report: Outbreak of Febrile Illness at Guyana Manganese Incorporate, Matthews Ridge, Region 1 Guyana. Page 1, Paragraph 1.

Figure 20-3: Burial Site for Materials removed from the Tunnels

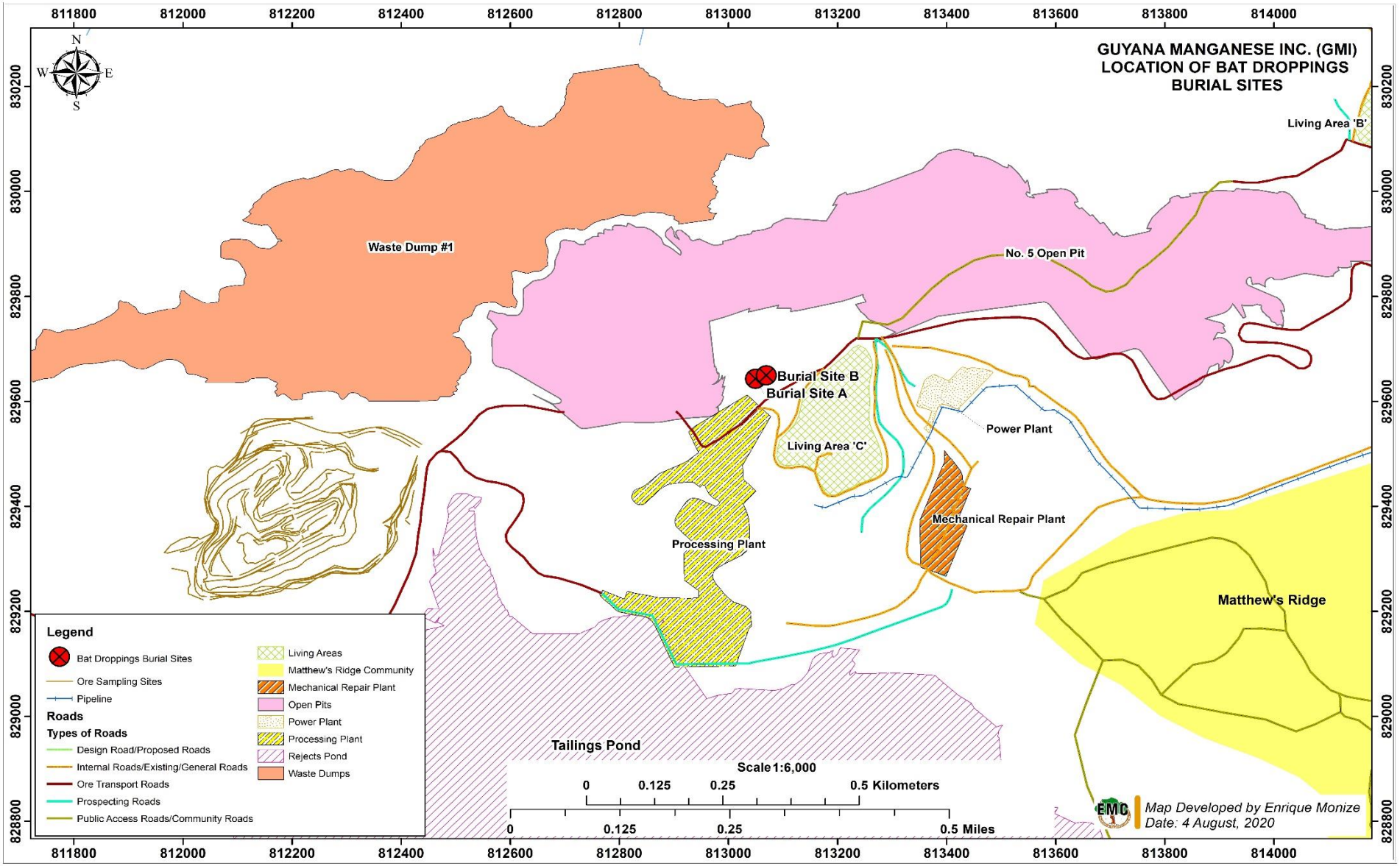


Figure 20-4: Burial Sites for Bat Droppings and Other Debris Removed from the Tunnels

Following the outbreak, the Ministry of Health, under a medical support programme between the Governments of Guyana and China, made several requests to improve the capacity of the Pakera District Hospital. These included requests made for four (4) Chinese doctors to be stationed at Matthew's Ridge, including a General Practitioner, an Infectious Disease Specialist, and an Internal Medicine Specialist, as well as laboratory supplies and equipment. However, these requests are still to be addressed (EMC Personal Communication 11).

20.2.6.2 Occupational Exposure to Manganese

There is conclusive evidence from studies in humans that inhalation from occupational exposure to high levels of inorganic manganese compounds (usually manganese dioxide, but also compounds with Mn(II) and Mn(III)) can lead to a disabling syndrome of neurological effects referred to as 'manganism'. Manganism is a progressive condition that usually begins with relatively mild symptoms, but evolves to include dull affect, altered gait, fine tremor, and sometimes psychiatric disturbances. Some of these symptoms also occur with Parkinson's disease, which has resulted in the use of terms such as "Parkinsonism-like disease" and "manganese-induced Parkinsonism" to describe those symptoms observed with manganese poisoning[182].

However, neurological assessments of workers exposed to low levels of inorganic manganese detected preclinical neurological effects (alterations in simple reaction time, audio-verbal short-term memory capacity, and hand tremor) in workers exposed to 0.97 milligrams per cubic meter of manganese (median concentration in total dust) as manganese dioxide, manganese tetroxide, manganese sulfate, manganese carbonate, and manganese nitrite for a group average of 7.1 years[183].

The United States OSHA has developed regulatory standards for exposure to inhaled manganese shown in Table 20-4 below.

Table 20-4: US OSHA Regulatory Limits for Occupational Manganese Exposure[184]

Substance	OSHA Regulatory Limits (milligrams per cubic meter)	
	Maximum	8-hour Time Weighted Average
Manganese Compounds (as Mn)	5	0.2
Manganese Fume (as Mn)	5	0.2

20.2.6.3 COVID-19

Based on COVID-19 pathology as a rapidly spreading communicable disease, GMI workers are vulnerable to becoming infected. To safeguard staff against this pandemic, GMI has instituted several measures to control the spread of the disease. These include the installation of wash stations at the entrance to their compound. In addition, temperature screening is done for all workers and visitors at the entry point to the facility. GMI has also adopted a mandatory policy that all workers are required to wear masks.

20.2.6.4 Living Conditions

According to the MOH and Ministry of Social Protection, Guyanese workers were living in unhygienic and unsanitary living conditions when the team visited to assess the histoplasmosis outbreak (EMC

[182] Williams M, Todd GD, Roney N, et al, 2012. Toxicological Profile for Manganese.
[183] Ibid
[184] Occupational Safety and Health Administration, 2017 and 2019. OSHA Annotated Table Z-1.

Personal Communication 08 and 11). However, GMI has since upgraded accommodation provided for employees and prefabricated house were constructed at both Matthew's Ridge and Port Kaituma (Figure 20-5). Prefabricated buildings were also used to construct new toilet and bathroom facilities, as well as office and kitchen areas.

Figure 20-5: Workers Accommodation in Matthew's Ridge

20.2.7 Social and Cultural Practices

The economies of Matthew's Ridge and Port Kaituma are strongly tied to mining activities. Mining and its supporting services attract many people into these areas including sex workers who work for short terms before moving onto the next landing or town. There are sex workers operating in the area mainly from Venezuela and Brazil with a few Guyanese. There are shops that sell alcohol that are also frequented by sex workers of Venezuelan origin. Community members, mainly males, visits these shops to drink alcohol and engage in other forms of entertainment including sex.

Locals also participate in the use of drugs and alcohol associated with the mining culture and some local communities. In the Region alcohol remains the substance most likely to be abused perhaps due to its availability but illicit drugs are increasingly being used by the young adult population[185].

20.3 Impact Assessment – Health Risk Assessment

This section presents a health risk assessment aimed at determining the potential for changed health risks to occur in the project locations that may be associated with the project. The health impacts and health related hazards considered in the assessment are outlined in Table 20-5.

[185] Oronde Drakes & Dina Benn. Hazard and Vulnerability Assessment of Barima-Waini Region One. Civil Defence Commission, 2016. Page 34, Paragraph 4

Table 20-5: Health Impacts and Health Related Hazards Considered in the Assessment

Observed and Potential Health Impacts	Health-Related Hazards	Populations at Risk
Vector and water borne diseases	Malaria, Dengue, Zika	GMI staff and local communities
	Typhoid, Diarrhoea, Gastroenteritis	
Histoplasmosis Outbreak	Spores found in bat infested tunnels	GMI staff
COVID-19 Outbreak	Transmission from infected people	GMI staff and local communities, Region 1 and Guyana
Air pollution resulting in adverse health outcomes	Inflammatory responses in lungs with adverse respiratory effects	GMI Staff, Local communities
Water pollution resulting in adverse health outcomes	Increased incidence of water borne diseases	GMI Staff, Local communities
Occupation Health and Safety Risks	Exposure to hazardous materials and waste	GMI Staff
	Noise and fly rock from blasting	
	Construction related injury or fatalities	
	Spread of contagious diseases among workers	
	Occupational Exposure to Manganese	
Community Health and Safety	Road and river transportation incidents and accidents and noise and flyrock from blasting	Matthew's Ridge community
Social & Cultural Practices	Sexual Transmitted Illnesses	Project Staff, Local Communities and Migrant Communities
	Drug and Alcohol abuse	

20.3.1 Vector Borne Diseases

As previously discussed, Region 1 has a high incidence of vector borne diseases and the regional assessment identified malaria was the chief human pathogen. Moreover, malaria was also the disease with the highest incidence in Matthew's Ridge and Port Kaituma. In particular, the mosquitoes that cause malaria as well as sand flies that cause leishmaniasis breed in Matthew's Ridge. Malaria can be diagnosed by both the Pakera District Hospital and the Port Kaituma District Hospital and can be treated effectively. The water retention and tailings ponds, and well as the environment around the pond, as well as pits to be established for disposal of project waste may provide breeding grounds for the vectors that cause these diseases. However, given the high incidence of these diseases in the area, and the ongoing gold mining activities which also contribute to vector breeding, project activities are expected to increase vector breeding marginally. As a result, potential impacts of increased vector borne diseases as a result of the project activities are expected to be **negative, direct, long-term** and **localised** of **negligible significance** but **likely** to occur during the lifetime of the project. Potential increases in vector borne diseases are a **Low Risk** of the project. The Ministry of Health has indicated that the construction of concrete drains by GMI allows for improved drainage of the area and will play an important role in vector control (EMC Personal Communication 11). These drains serve as intercepting drains surrounding the processing plant, the power plant and other areas in the GMI's

Matthew's Ridge compound. The drains are six hundred millimetres in width and height and discharge is controlled.

20.3.2 Air Pollution

The operations will generate emissions of gases from fuel combustion. These emissions will be associated with a variety of sources including project machinery and vehicles as well as the generators used in the power plant at Matthew's Ridge. However, as discussed in detail in Chapter 11 – Air Quality, emissions from mobile sources are transient and disperse rapidly as the source moves further away. Emissions from stationary sources similarly disperse over distance and community exposure to these gases will be within safe concentrations. As a result, potential environmental exposure to gases from fuel combustion are **negative**, **direct**, **localised** and **short-term.** Their significance due to low concentration levels are **negligible** but **unlikely** during the project lifetime. As a result, the risks associated with are **Low**.

The use of the roads by project vehicles will also generate dust/particulate matter in the air that will settle on the plants, houses and inhaled by road users. GMI will have a fleet of 30 hauling trucks and several other vehicles for mining and administrative purposes. Haul trucks are expected to make two return trips for ore transportation between Matthew's Ridge and Port Kaituma during the dry season and one trip during the wet season. There will be additional project related traffic in the form of fuel trucks, trucks transporting supplies to the site, and light vehicles (pick-up trucks). This represents a significant increase in heavy vehicles traversing the entirety or sections of the public road connecting Matthew's Ridge to Port Kaituma and therefore contribute to increased dust levels. GMI has made provisions for dust suppression by wetting roads in Matthew's Ridge and Port Kaituma. However, there are no provisions for dust suppression on other sections of the road and the residents of Eclipse Falls will be exposed to higher levels of road dust. Existing negative health effects associated with road dust may be amplified as a result of project activities. These adverse impacts will be **negative, direct**, **short-term** and **localised** of **moderate significance** and **certain to occur** thereby resulting in **High Risks** to the residents of Eclipse Falls. However, it should be recognised that GMI's activities may also have positive health outcomes for the residents of Matthew's Ridge and Port Kaituma who would benefit from lower dust levels as a result of road wetting activities.

Project activities may create circumstances that result in the environmental exposure to manganese dust/particulate matter for the local community. Manganese particulates may become airborne as a result of blasting, extraction and processing. As seen in Chapter 11, modelling of suspended particulate matter of manganese will disperse and decline as distance from the source increases. However, levels may exceed safe levels of exposure determined by the US OSHA but were not prolonged exposure for proximate community receptors. Other populations in the project AoI may also experience transient, low-level expsoure to manganese dust and fumes including residents living along the transport routes and downwind of the stockpile storage area in Port Kaituma. Particulates of manganese will be suppressed by wetting the blasting and mining sites, and also the storage area. In addition, the manganese products will be covered during transportation from Matthews Ridge to the Kaituma Marine Terminal. As such, it is expected that the potential health outcomes of airborne manganese exposure will be **direct, negative short-term** and **localised** of **moderate significance** but **likely** to occur. This results in **Medium Risks** associated with the project activities.

20.3.3 Water Pollution

Surface waters in Matthew's Ridge and Port Kaituma may be polluted by the project activities making them unsafe for use for domestic purposes. High levels of coliforms and *E. Coli* were measured in surface waters at both Matthew's Ridge and Port Kaituma. Sewage generated at the project locations may seep into proximate waterways in particular the Kaituma Canal, if septic systems are not properly designed and maintained. Similarly, discharges of other sanitary wastewater from washing and

bathing may escape into these surface water flows, including the Kaituma Canal. Accidental discharges of sewage from project barges on return trips to transport ore could also negatively impact residents in settlements along the secondary and tertiary AoI who depend on water from the Kaituma Canal and the Barima and Kaituma Rivers. The disposal of general solid waste during the construction phase, both organic and inorganic forms, also can contribute to contamination of the Kaituma Canal. Of particular importance at Matthew's Ridge is the spring aback Guyana House from where GMI sources water to be used for most domestic purposes for its Matthew's Ridge operations and the spring proximate to Hill 5 which is used by GWI to supply water to the community. Contamination of surface flows could increase coliform loads in water and increase the incidence of water borne diseases acute gastroenteritis, diarrhoea, typhoid and cholera. However, it is recognised that Region 1 has a history of these diseases occurring and the contribution of project activities will be marginal. As a result, potential impacts of increased water borne diseases as a result of the project activities are expected to be **negative, direct, long-term** and **local** of **negligible significance** but **unlikely** to occur during the lifetime of the project. Potential increases in water borne diseases are a **Low Risk** of the project.

The project will transport fuel into Port Kaituma via the Mora Passage, Barima River, Kaituma River and the Kaituma Canal. Fuel will be discharged at the Kaituma Marine Terminal and then transported overland to Matthew's Ridge. Several waterways interact with the road transport route including the Barima River which provides water to residents of Eclipse Falls and Arakaka. There are risks of significant fuel spills occurring during the transportation and offloading processes resulting in contamination of these surface flows. Low levels of oil and grease were detected in surface flows in Matthew's Ridge, Port Kaituma and along the connecting public roadway. Increasing in the oil and grease content in surface flows may result in several negative health outcomes including dermal irritation from bathing. This would also render these waters unsafe for consumption. However, these potential impacts are entirely mitigable if proper fuel handling and management practices are followed. Some communities have also expressed concerns about spills of hazardous water from the water retention and tailings dam. However, the dam was designed with a freeboard to accommodate a 24-hour precipitation maximum of 955 millimeters. The dam design and construction included overflow structures to be incorporated to enable gravity release of water into a spillway. During operational stages, a 24-hour monitoring station will be installed at the dam to monitor piezometric pressures, water levels, signs of displacement and to release water via the spillway as necessary. As a result, potential impacts of increased water borne diseases as a result of accidental spills of hazardous materials and process effluent are expected to be **negative, direct, long-term** and **local** of **major significance** but will occur **rarely** during the lifetime of the project. Potential increases in surface water contamination from fuel spills are a **Low Risk** of the project.

As discussed in Chapter 8 – Water Resources, the geology of the soil (impermeable saprolite) will result in almost zero seepage of contaminants into the groundwater supplies in Matthew's Ridge. Spills of untreated wastewater, fuel or other hazardous materials are expected to have impacts that are **negative, direct, long-term** and **localised**. However, they will be of **moderate significance** to groundwater resources and are **unlikely** to occur during the project. Potential contamination of groundwater is a **Low Risk** of the project.

Given the geology of Matthew's Ridge, manganese occurs in naturally high levels in the water supply. However, exceeding safe water concentrations of manganese in the water supply are likely to result in several adverse health outcomes foremost of which are impaired intellectual capacities of young children. As previously discussed, the levels of manganese in all surface waters tested and the Hill 3 aquifer analysed during the baseline water quality assessment exceeded the safe levels established by the WHO of 50 micrograms per liter or 0.05 milligrams per liter. These situations existed prior to GMI's operation and the recommencement of mining. Project activities that expose the manganese ore may also increase the concentration of manganese in surface water flows in Matthew's Ridge some of which are used by GWI for community water supply. Dams or drainage systems will be

installed to prevent the water from the mining pits, stockpile areas, dumps and the processing site from contaminating the surface water which is used by community. The accumulated will be directed to the tailings pond or a designated water pond. High levels of manganese in drinking water will have potential impacts that are **negative, direct, long-term** and **localised.** Given the serious toxicology impacts of prolonged exposure, these potential impacts will be of **major significance** and are **likely** to continue during the project lifetime. Potential for adverse health impacts of prolonged environmental exposure from high levels of manganese in the water supply are **High Risk** with or without planned project activities.

20.3.4 Occupational Health and Safety

The health risks to the employees under this category can be far reaching if not managed. If these risks are not properly managed can lead to occupational injuries or death, work stoppages and production losses for GMI.

20.3.4.1 Exposure to Hazardous Materials

GMI will be using materials classified as hazardous in its operations (Table 20-6). Exposure to these chemicals is possible in transportation, storage and handling. GMI is required by international and local laws to ensure that the chemicals are properly labelled, stored and that employees trained to handle them in their work routines. GMI is expected to adequately inform its employees of the chemicals they are being exposed to and the risks associated with each chemical. Adverse health outcomes associated with exposure to hazardous materials if proper health and safety procedures are not followed can occur. As a result, potential impacts of dangerous exposure to hazardous materials are expected to be **negative, direct, long-term** and **localised** of **moderate significance** but will occur **rarely** during the lifetime of the project. Potential increases in surface water contamination from fuel exposure to types of hazardous materials to be utilised are a **Low Risk** of the project.

Table 20-6: Hazardous Materials Used by Project Operations per Year

Material	Container	Quantity	Volume (kilograms)
Dieselene	Tank	4	9,497,261
Gasoline	Drum	2	19,800
Engine Oil	Drum	2	3,700
Transmission Oil	Drum	2	1,100
Hydraulic Oil	Drum	2	1,600
Coolant	Drum	1	750
Grease	Pails	3	1,900

20.3.4.2 Mining Pit Collapse

As part of the design of the mine areas, GMI has incorporated several features to reduce the likelihood of mine collapse based on the material type and safety limiting factors. As such, crest elevations will not exceed 84 meters. Benches to be used to access the mining pits will be approximately 30 meters wide and 6 to 12 meters high. In addition, drainage on benches will be assured by catchment berms, drains and culverts to minimise surface water descending into the pit. Pumps in sumps with connecting drains will be placed in pit bottoms to collect and evacuate underground water springs and seepage, and rainfall, as necessary. As discussed in Chapter 9 (Soils and Geology), land subsidence can occur as result of de-watering of the open pits. Nonetheless, the risks of pit cave-ins remain and damage can be significant. Mining equipment and machinery can be damaged beyond repair and in worst-case scenarios pit cave-ins can result in loss of lives. Potential impacts of pit cave-ins are **negative, direct, short-term** and **localised.** Given the potential for loss of life, impact is of **extreme significance** but

will occur **rarely** during the lifetime of the project. Potential impacts of mining pit cave in are **Medium Risk** of the project.

20.3.4.3 Explosives and Blasting

There are numerous health risks associated with the transportation and use of explosives in GMI's operations. By law, explosives and detonators have to be transported separately and stored separately under armed security. When required for blasting activities, they will be carefully transported to the mine site to be deployed only by trained personnel. During blasting activities, workers can be exposed to high levels of noise, vibrations or may be hit by fly rock. However, these potential impacts can be managed and mitigated if safety measures for maintaining a safe blast radius and using all required PPEs are followed. Potential injuries or fatalities from the transportation and storage of explosives and their use in blasting will be **negative, direct, short-term** and **localised.** Given the potential for injury or death, impact is of **extreme significance** but will occur **rarely** during the lifetime of the project. Potential impacts of using explosives are **Medium Risk** of the project.

20.3.4.4 Occupational Exposure to Manganese

Workers exposure to high concentrations of manganese in the air for a prolonged period are at risk of serious neurological illnesses. The primary sources of exposure will be at the mine and processing sites where manganese ore will be extracted and processed by jigging and crushing. As seen in the Chapter 11 – Air Quality, modelling of dispersion of total suspended manganese particulates are likely to exceed the OSHA permissible levels for manganese exposure within 500 meters of the source. However, occupation exposure to inhaled manganese dust or particles can be managed if appropriate PPEs are used by vulnerable workers. In addition, the crushers and the jigging machines are contained, so particulates of manganese would not be dispersed to surrounding areas during processing. Further, the particulates on the conveyor belt will be suppressed by spraying of water. The mining site will also be wetted frequently in the dry season. Adverse health outcomes associated occupational exposure to high levels of manganese dust or fumes are **negative, direct, long-term** and **localised.** If appropriate PPEs are utilised, this potential impact will be of **moderate significance** and **likely** to occur during the project lifetime. As a result, occupational exposure to manganese dust are **Medium Risks** of the project.

20.3.4.5 Construction Work

The project will have continuous construction of mining pits, roads and temporary housing during its lifetime. The employees will be at risk from a combination of factors in each situation. During construction of housing and other units the workers will be at risk from the electrical tools, projectiles, construction materials (lumber, steel), cement dust, paint and other toxic substances. Construction accidents which can result in injuries are very common in Guyana typically because health and safety procedures are not strictly implemented. GMI provides relevant PPEs to all workers and their use should be strictly enforced on the jobsite. Road construction and repairs will have to be properly managed by GMI. These adverse impacts will be **negative direct, short-term** and **localised.** These potential impacts are of **moderate significance** but are **unlikely** to occur if appropriate occupational safety and health measures are followed. As a result, injuries or fatalities associated with construction work are **Medium Risks** of the project.

20.3.4.6 Histoplasmosis Outbreak

Since 2019, GMI has sealed the tunnels from which bat droppings and debris infected with the spores which causes the histoplasmosis outbreak. GMI has ceased all operations to excavate tunnels which were not yet explored. Although the infected materials were buried, the spores may be released again if the area is disturbed in the future. Given that the infected materials were buried in areas to be used

by the project as a raw ore storage yard, project workers may accidentally disturb and risk infection if the spores remain active. However, this may be mitigated if GMI cordons off the area and prevents any soil disturbing activities thereon for the foreseeable future. As a result, potential impacts of another histoplasmosis outbreak are expected to be **negative, direct, short-term** and **localised** of **moderate significance** but will **rarely** occur during the lifetime of the project. Potential increases in vector borne diseases are a **Low Risk** of the project.

20.3.4.7 COVID-19 Outbreak

The possibility of a COVID-19 outbreak remains high and as of August 2020, the number of cases continued to increase nationally as well as in Region 1. In addition, Region 1 is one of three regions into which the Government has restricted incoming and outgoing travel. However, as at August 2020, there has been zero positive cases among the employees of GMI. The company should continue to implement and strictly enforce the measures which were instituted to control the spread in its workforce. Nonetheless, it is recognized that this situation can only be partially managed by GMI even if all measures are followed to prevent occupational spread given that employees may engage in risky behaviours when not on duty. As a result, the risk of transmission remains high particularly given the density of the workforce accommodation at both Matthew's Ridge and Port Kaituma. Adverse health outcomes associated with the spread of COVID-19 in the project location **negative, direct, long-term** and **regional.** These potential impacts are of **extreme significance** and are **likely** to occur resulting in **High Risks**.

20.3.5 Community Safety

The project will require river barges travelling between from Port Kaituma and Trinidad to deliver the manganese ore concentrates and return to the loading site. Residents from settlements along the river transportation route use these waterways on a daily basis, typically using canoes or other small vessels fitted with outboard engines, for transportation of people from their homes to other villages or economic hubs in Port Kaituma and Mabaruma. Children from these communities also travel on a daily basis to attend school in Mabaruma and Port Kaituma. Small individual or communal vessels are also used to transport produce from small-scale farmers to markets. In addition, several large vessels use these waterways, including ferries plying the Georgetown to Mabaruma and Georgetown to Port Kaituma routes, as well as fuel and cargo boats which also transport food supplies into the Region. There are risks of accidents causing injury or death involving, in particular, smaller vessels that may arise if the barge encounters another large vessel en route. These potential impacts are **negative, direct, short-term** and **localised** of **moderate significance**. If GMI develops appropriate safety measures and engage with local communities on the barging schedule these potential impacts are **unlikely** to occur during the project lifetime. As a result, these are associated with **Medium Risks**.

The probability of road accidents is also expected to increase with more frequent traffic along the overland transport route. Risks are greater for the local people who use smaller vehicles such as ATVs or are travelling on foot. According to the Toshao of Four Miles, speeding and unsafe driving practices caused two separate accidents in which GMI's vehicles overturned on the public road which passes through the Village. There were no injuries as a result of these accidents. The Chair of the Eclipse Falls CDC shared concerns about heavy vehicles frequently using the roads and bridge in the community which are also used by pedestrians and school children. Although GMI's vehicles will increase road traffic, it is unlikely to result in traffic jams or create significant delays in commute times. In addition, road construction and repairs, moving heavy duty equipment, stockpiling of construction materials, etc., will pose safety risks to other road users. These potential impacts are **negative, direct, short-term** and **localised** of **moderate significance**. These risks could be managed if GMI continues to provide training sessions on safe driving practices to workers frequently and consistently. Nonetheless, road accidents have already occurred and are **likely** to happen again during the project lifetime resulting in **Medium Risks** of injury to workers or community members.

Blasting can pose safety risks to the Matthew's Ridge community. During blasting activities, community members can be exposed to high levels of noise, vibrations or may be hit by fly rock. However, these potential impacts can be managed and mitigated if safety measures for maintaining a safe blast radius can be followed. Flyrock management and control has become an indispensable part of blast design for which GMI is expected to address. Also, with careful control and adherence to the regulation and best practices the blasts should be executed within safety parameters, including maintaining a safe blast radius, that the local community be given advance notice, and an alarm is sounded to warn of the blast. The majority of the open pits will be further away from the central Mathew's Ridge settlement and this will put the settlement outside the danger zone of the blasts. Potential injuries or fatalities from the transportation and storage of explosives and their use in blasting will be **negative, direct, short-term** and **localised.** Given the potential for injury or death, impact is of **extreme significance** but will occur **rarely** during the lifetime of the project. Potential impacts of blasting on the community are **Medium Risk** of the project.

20.3.6 Social and Cultural Practices

The economy of Matthew's Ridge and Port Kaituma will be significantly boosted by the additional incomes generated and services provided by locals. This will attract many persons to the area including sex workers. There are sex workers operating in the area currently are mainly from Venezuela. A vibrant economy can lead the sex workers to encourage additional friends/family to migrate to the area. Growth in the sex worker industry can increase the risk of local persons contracting Sexual Transmitted Infections and Sexual Transmitted Diseases (STDs) including HIV/AIDS from unprotected sex. It is critical to note that COVID-19 can be spread by sexual contact during sex work and by casual sex. It is expected that there will be an increase in the use of drugs and alcoholism associated with mining booms in the local communities. Visiting workers who are alcoholics or drug users can encourage the locals, including local youth, to abuse alcohol or participate in illegal drug use. These adverse impacts will be **indirect, negative, long-term** and **localised** of **moderate significance** and **likely** to occur during the project lifetime. These potential impacts present **Medium Risks** of negative health outcomes.

20.3.7 Cumulative Impact Assessment

The potential impacts of planned project activities, including ancillary project activities, are discussed above. Currently, there are no existing or planned project activities within or proximate to the AoI which are expected to amplify the known existing disease or illness profile of the project areas. As a consequence, no cumulative impacts are anticipated.

20.4 Mitigation and Monitoring Measures – Health

As previously discussed, GMI has already instituted several measures to reduce the potential health risks associated with the project. These measures include:

- Employing an Occupational Health and Safety Officer.
- Developing and implementing an Occupational Safety and Health Policy which outlines, among other things, the duties of the company's Health and Safety Officer.
- Providing employees with all relevant PPEs. Issuance and adherence to the use of personal equipment underscores GMI's safety program and practice. Safety gear, inclusive of helmets, industrial boots, dust masks, earmuffs/plugs to protect the ear from noise/vibration; gloves, safety vests and safety glasses will continue to be issued depending on the activity.
- Preparing and implementing an Emergency Response Plan (ERP) to respond to any injury or disease, including occupational injuries, of its workforce. Under the emergency response plan, when a situation occurs involving a casualty, the Pakera District Hospital and the Port Kaituma District Hospital, depending on where the incident occurred, will be informed immediately.

Upon arriving at the scene, the medical personnel will assess the patient and inform the senior GMI person onsite whether the Hospital can treat the patient of whether an Emergency Medical Evacuation will be required. If an emergency medical evacuation is required, GMI will put measures in place to facilitate emergency evacuation via air to the GHPC as detailed in the Emergency Response Section.

- Constructing and upgrading all septic systems in accordance with the GNBS Guidelines for the Construction of Septic Tanks and Associated Secondary Treatment and Disposal Systems.
- Sealing of the tunnels from which bat droppings and other debris containing histoplasmosis spores were excavated.
- Contributing to the local and regional response to the COVID-19 pandemic by donating masks, hand sanitisers, disinfectants and rapid test kits.
- Implementing measures to protect workers from the spread of COVID-19 including installing wash stations, temperature checks and mandatory masks for all workers.
- Designing the open pit mining systems to mitigate risks associated with pit cave in.
- Providing frequent training sessions to employees on occupational health and safety including safe driving.
- Making provisions for road wetting in Matthew's Ridge and Port Kaituma.
- Providing safe transport, handling, storage and use of explosives which will be supported with the use of a dedicated marine barge and a specialized explosive truck. Transport by armed escort explosive use will also be undertaken.
- Constructing concrete drains which allows for improved drainage of the area, thus playing an important role in vector control.
- Implementing measures to prevent dust and manganese emissions by regular wetting of roads, stockpiles areas, mine sites, conveyor system and by covering trucks transporting the product to Port Kaituma. In addition, the crushers and the jigging machines are contained, so particulates of manganese would not be dispersed to surrounding areas during processing.
- Installing dams or drainage systems to prevent the water from the mining pits, stockpile areas, dumps and the processing site from contaminating the surface water which is used by community. The accumulated will be directed to the tailings pond or a designated water pond.
- Identifying the health and safety risks and determining the suitable mitigation measures as is outlined in the table below.

In addition to these measures, GMI should also implement the following actions to manage the risks discussed above:

- Establish a Health and Safety Committee to oversee Health and Safety of the operation and the implementation of the Occupational Safety and Health measures required by the regulations. The committee should meet at least monthly.
- Strengthen the OSH Department by including additional personnel to implement and monitor the OHS requirements.
- Develop a water quality monitoring programme, in partnership with GWI, to regularly monitor manganese levels in the Matthew's Ridge community water supply. If manganese levels exceed safe consumption levels, GMI should work with GWI to make an alternative source of drinking water available for community members.
- Monitor water quality for physio-chemical and biological parameters and trace metals on a monthly basis.
- Develop an air quality monitoring programme to determine levels of manganese in the air at high-risk worksites (manganese extraction and processing) and sensitive receptors down-wind of these sites.
- Putting measures in place to manage levels of dust/particulate matter from the operations to:
    - Remove dust/mud accumulations as an ongoing feature of operations.
    - Wetting of spoil piles.

    - Screening of operational sites with vegetation to trap dust.
    - Re-vegetating of reclaimed areas.
- Cover manganese being transported by truck or barge.
- Provide N95 masks for all employees working in areas where risks of exposure from manganese dust are high in particular employees involved in manganese extraction and processing.
- Develop, in partnership with the MOH and the Pakera District Hospital, a surveillance programme to identify incidence of an adverse health outcomes associated with high levels of manganese exposure.
- Regularly fog its compounds and ensure that all employees are supplied with treated mosquito nets.
- Appropriate safety signage should be posted throughout each component of the operation to ensure workers are aware of the risks and hazards and the necessary OSH actions. Signage should also be erected along the roadways in hazardous areas.
- Develop a system to prepare Job Safety Assessments (JSA) for each job at GMI and ensure that there are daily toolbox talks and briefings of these JSAs before work begins.
- Periodic meetings with local communities to receive feedback on issues related to community health and safety associated with the project activities.
- Continue to support local and regional authorities to prevent the spread of COVID-19.
- Cordon off and mark the areas where the bat droppings and other debris contaminated with histoplasmosis spores were buried.
- Developing training modules on the handling of hazardous materials and waste.
- Training and reviews of blasters and their practice should be supported by the explosives supplier and the GGMC. The interface of the supplier and the institutional support and guidance of the GGMC will be both pivotal to the maintenance of a high standard of administrative and operational safety with respect to the safe handling, use and storage of explosives in GMI's mining activities.
- Field-testing the provisions of the emergency response plan to ensure that the employees of GMI can expect the best possible response to any incidents.
- Putting traffic management measures in place during road construction. The roads should be carefully marked cordoned/manned in busy intersections by flag persons. Construction vehicles should be marked with reflectors to provide visibility at nights. Parked vehicles should be required to mark their location with reflective cones or triangles to warn oncoming traffic. Road construction workers should be required to wear high visibility vests during work hours. Material stockpiles should not impair sight lines.
- Ensure all drivers are licensed and trained and implement speed limits for company vehicles. Drivers should be made aware that extreme caution should be taken when passing through populated areas such as Four Miles and Eclipse Falls and driving during wet weather conditions.
- Machines should be operated by competent and authorised personnel only and in a manner that does not endanger other employees or company property. Passengers should not be permitted on mobile equipment unless they are being trained to operate the machine or are required to ride on it as an unavoidable part of their duties provided it is safe to do so.
- Ensure all waste are properly collected, stored and disposed and monitor waste disposal pits so that it reduces conditions favourable to mosquito breeding.
- All septic tanks should be constructed in accordance with the GNBS Guidelines for the Construction of Septic Tanks and Associated Secondary Treatment and Disposal Systems.
- Develop a Blasting Plan which should address the safety of workers as well as the community.
- Training sessions with workers to educate them on the dangers of substance abuse, STDs, drunk driving among other issues.
- Administering random drug and alcohol testing to ensure that employees are adhering to GMI's OSH and drug and alcohol policy.

Table 20-7: Summary of Impacts and Mitigation Measures

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
Tailings pond, solid waste disposal pits	Best practices for Vector control, Waste management and flood awareness	Increased incidence of vector borne diseases	Negative Direct, Long Term, Localised	Negligible	Likely	Low	Adherence to waste management practices Frequent fogging of GMI's properties Sleeping in nets or in meshed rooms	Malaria infection rate amongst workers Staff awareness and education on best health practises for malaria and other vector illnesses
Fuel Combustion	Compliance with local laws and regulations	Respiratory effects	Negative Direct, Long Term, Localised	Negligible	Unlikely	Low	N/A	Implementation of an air quality monitoring programme
Road Transportation	Compliance with local laws and regulations	Respiratory effects	Negative Direct, Short Term, Localised	Moderate	Certain	High	Watering of Roads in dry season	Community engagement including with Eclipse Falls
Blasting, ore transportation	Best practices	Environmental exposure to airborne manganese	Negative Direct, Short Term, Localised	Moderate	Likely	Medium		Air quality monitoring programme to measure manganese levels
Project Construction and Operations	Compliance with local laws and regulations	Water pollution resulting in increased incidence of water borne diseases	Negative Direct, Short Term, Local	Negligible	Unlikely	Low	Proper disposal and management	Water quality monitoring programme for physio-chemical and

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
							of solid waste and sewage	biological parameters as well as trace metals
Project Construction and Operations	Compliance with local laws and regulations	Water pollution from accidental spills of fuel or other hazardous materials or waste	Negative Direct, Long Term, Local	Major	Rare	Low	Proper handling and management of fuel, hazardous materials and hazardous waste	
Project Construction and Operations	Compliance with local laws and regulations	Water pollution of groundwater resources	Negative Direct, Long Term, Localised	Moderate	Unlikely	Low	Proper disposal and management of solid waste and sewage Proper handling and management of fuel, hazardous materials and hazardous waste	
Project Construction and Operations	Compliance with local laws and regulations	Environmental exposure to manganese in drinking water	Negative Direct, Long Term, Localised	Major	Unlikely	Medium	Development of a water quality monitoring programme to measure manganese levels in community	

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
							drinking water supply	
Occupational Exposure to Hazardous Materials	Compliance with local laws and regulations	Negative health impacts	Negative Direct, Short Term, Localised	Moderate	Rare	Low		Training and awareness for employees on proper handling and management
Mining	Compliance with local laws and regulations	Injury or death from mining pit cave in	Negative Direct, Short Term, Localised	Extreme	Rare	Medium	Safe mine design parameters informed by local geological conditions	
Blasting and Explosives	Compliance with local laws and regulations	Injury or death from blasting activities or explosives transport and storage	Negative Direct, Short Term, Localised	Extreme	Rare	Medium	Separate transport and storage of explosives and detonators with armed guards Development of Blasting Plan	
Ore Mining and Processing	Compliance with local laws and regulations; Voluntary	Occupational exposure resulting in manganism	Negative Direct, Long Term, Localised	Moderate	Likely	Medium	Use of N95 masks for high-risk workers	Air quality monitoring programme to measure manganese levels

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
	compliance with OSHA levels							
Project Construction	Compliance with local laws and regulations	Injury or death from poor construction practices	Negative Direct, Short Term, Localised	Moderate	Unlikely	Medium		Enforcement of safety and health measures Training in appropriate health and safety measures
Project Operations	Compliance with local laws and regulations	Histoplasmosis Outbreak	Negative Direct, Short Term, Localised	Moderate	Rare	Low	Sealing of contaminated tunnels Cordoning off areas where contaminated droppings and debris were buried	
Project Operations	Gazetted Orders -COVID-19 Emergency Measures RDC/NDC Emergency Measures	COVID-19 Outbreak	Negative Direct, Long Term, Regional	Extreme	Likely	High	Adherence to COVID-19 guidelines Hand-washing stations Employee Temperature Testing	Enforcement of all COVID-19 mitigation measures

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management/ Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
							Mandatory masks	
Project Operations	Compliance with local laws and regulations; MARAD guidelines	Injury or death from riverine accidents and incidents	Negative Direct, Short Term, Localised	Moderate	Unlikely	Medium	Implement river safety procedures all company barge operator must follow	Periodic meetings with residents and local authorities to receive feedback and recommendations
Project Construction and Operations	Compliance with local laws and regulations	Injury or death from road accidents and incidents	Negative Direct, Short Term, Localised	Moderate	Likely	Medium	Implement road safety procedures all company drivers must follow	
Project Construction and Operations	Compliance with local laws and regulations	STDs, drug and alcohol abuse	Negative Indirect, Moderate Term, Localised	Moderate	Likely	Medium	Random drug and alcohol testing	Training and awareness about the dangers of STDs and drug and alcohol abuse, etc

Chapter 21 - Land Acquisition, Resettlement and Livelihoods

There are currently no permanent communities within the boundaries of project sites. However, communities exist within the project's environmental and social areas of influence. In the case of occupancy by persons within the project sites there are at least nine such occurrences within the tailings pond area at Matthew's Ridge and three waterfront structures located on the site for the Kaituma Marine Terminal. This chapter describes the current occupancy, efforts by GMI to relocate and compensate these persons, and any impacts the relocation may have.

21.1 Administrative Framework – Land Acquisition, Resettlement and Livelihoods

Table 21-1 summarises the legislation, policies, strategies, and international treaties that are relevant to the planned project activities.

Table 21-1: Legislation, Policies, Strategies and International Treaties

Title	Description	Applicability to the Project
Legislation		
Acquisition of Land for Public Purposes Act (2001)	This Act empowers the Government of Guyana, through the Minister of Public Works, to acquire any area for the proposed construction of a public work whether or not there is any public or private building or erection on said land. The Act also provides mechanisms for compensation to owners for the acquisition and damage done to such lands during public works.	Provides guidance for resettlement and land acquisition process.
Policies and Strategies		
National Land Use Plan (2013)	Provides a strategic framework to guide land development in Guyana. According to the NLUP the primary development options of the Northwestern District include: small to large scale mining; focusing mainly on gold, diamond and manganese extraction. Provides support to decision making through looking at development options and constraints throughout the country. .	Provides guidance in developmental decision making and identifies manganese mining as an optimal use of land in Matthew's Ridge.
GLSC Standard Operational Plan (2018)	The GLSC SOP is in keeping with the GLSC Act, under which the GLSC is allowed to issue land in accordance with any law regulating the administration and disposition of public lands with emphasis on waterfront lands and other state-owned land.	Provides procedures for land administration of waterfront lands/riparian areas.

21.2 Baseline Conditions – Land Acquisition, Resettlement and Livelihoods

GMI has jurisdiction over the project sites it intends to utilise. At Matthew's Ridge the project sites were under the control of the Manganese Mines Management Limited up to 1968. In 2011, RMI acquired four PLs. GMI subsequently acquired PLs from RMI and has since applied to GGMC for the conversion of two of the PLs (PLs 2 and 3) into Mining Licenses. This covers the mining areas as well as auxiliary areas, including sites for the tailings pond and the project infrastructure.

At Port Kaituma, GMI has applied to the GLSC to lease the site for the Marine Terminal. GLSC has completed surveying of the site and the lease is being processed. The residences which previously occupied the site had to be relocated. At Matthew's Ridge, persons occupying sections of the tailings pond are required to relocate as a result of a combination of health and safety considerations and GMI subsequently incorporating the areas into the project design. GMI, along with government agencies, initiated the negotiation and resettlement process with the occupants. To date, agreement was reached with 62 percent of the occupants within the tailings pond, and 100 percent of impacted residents within the Marine Terminal site.

21.2.1 Land Acquisition Port Kaituma

At the site for the Kaituma Marine Terminal, which is located on the right bank of the Kaituma Canal, existed three households and farmlands owned by a total of six individuals. Each of the households had dwelling and farmlands (Figure 21-2). The farmlands included some permanent crops such as citrus, as well as temporary crops such as vegetables and plantains (Figure 21-1). All of the dwellings and farmlands are located within the required by GMI for the development of the Kaituma Marine Terminal, and are within the area for which the lease for the land is being processed. It was determined that the residents had no legal rights to the land they occupied. The location of the properties and farmlands can be observed in Figure 21-3.

Figure 21-1: Farming Area within the Kaituma Terminal Site

Figure 21-2: One of the Dwellings at the Site

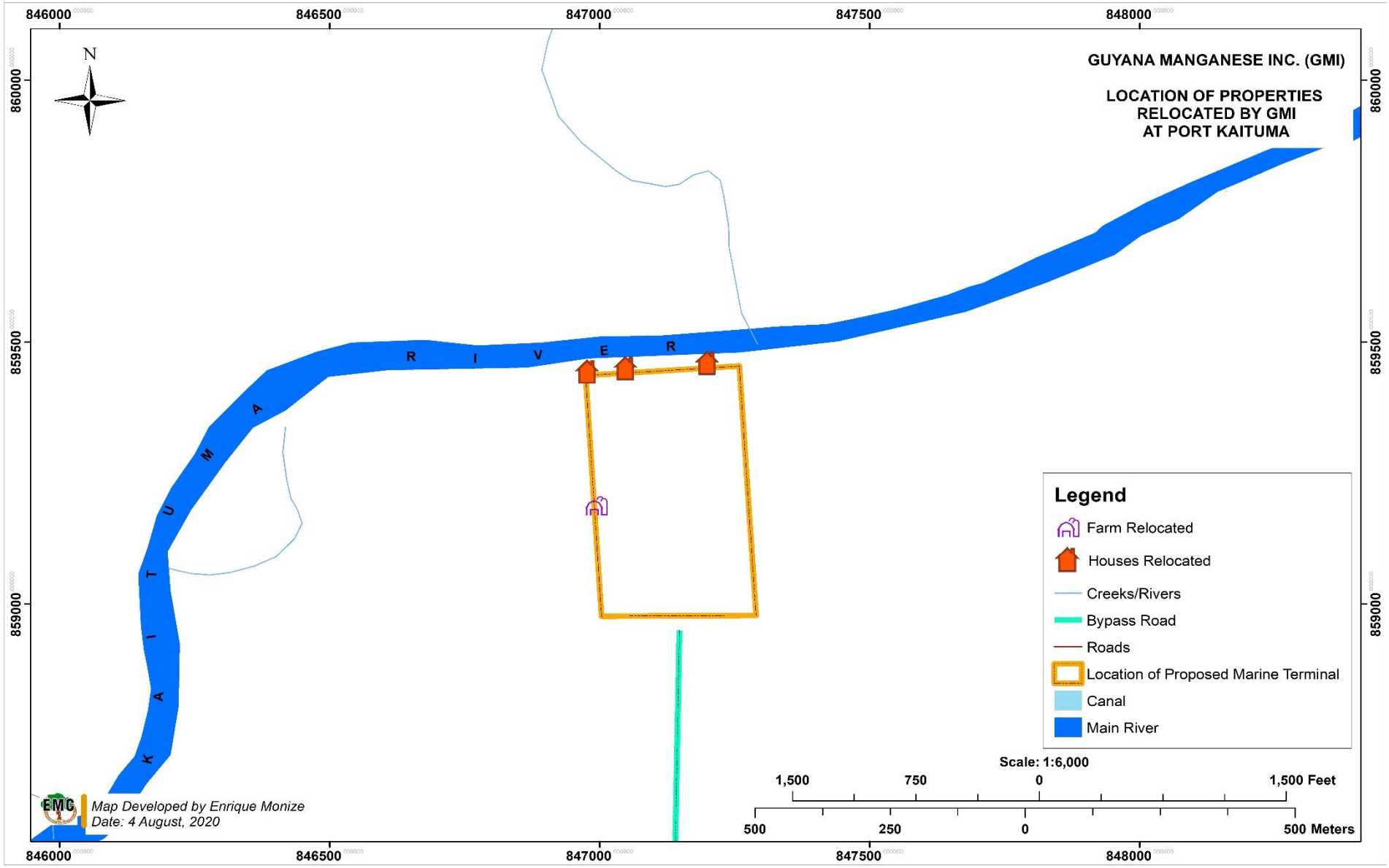


Figure 21-3: Properties and Farmlands Relocated by GMI at the Port Kaituma Marine Terminal Site

GMI entered into independent agreement with the property owners for the purpose of resettlement since consideration was made with respect to compensation benefits for these individuals. Given that the occupants had no legal rights to the land, GMI had the right to resort to the government authority to gain compulsory access to the land or abide by the GLSC Standard Operating Procedure for the acquisition of land. However, neither channels were pursued by GMI. Instead, in the nature of goodwill, GMI moved towards engaging the residents directly to acquire the land use rights through direct negotiations with the residents. The NDC had prior knowledge of the negotiations and were involved in the discussions. In this case, GMI offered residents the full replacement cost (market value), which is the cost of purchasing or rebuilding a property within an area and of a quality similar to that being acquired by GMI. Two of the agreements were made on December 02, 2018 and the other on March 18, 2020 for a full financial compensation to be paid to each resident by GMI at an accepted rate to each resident, amounting to a total of GYD$11,800,000. It was agreed that 50 percent will be paid in advance of the move and the remaining 50 percent will be paid to the residents once the land was fully vacated. GMI has already disbursed 100 percent of the compensation package following full compliance with residents who have vacated the site. A copy of the Compensation Agreement is included in Appendix J. A synopsis of the agreements is presented in Table 21-2. During the negotiation process the NDC was engaged for the purpose of identifying suitable state lands for the purpose of resettling the displaced residents.

Table 21-2: Synopsis of Relocation/Compensation Agreements – Port Kaituma

Household	Property	Compensation (GYD$)
Household 1	One wooden dwelling along with cultivated trees and crops	2,800,000
Household 2	Two wooden dwellings and one storage shed, along with cultivated trees and crops	1,500,000
Household 3	One concrete house and one wooden shed, along with cultivated trees and crops	7,500,000

21.2.2 Land Acquisition in Matthew's Ridge

At Matthew's Ridge the some of the project areas from the previous manganese mining operations were encroached, occupied and utilized by residents from the community over the years. However, occupancy and utilization of areas which GMI needs for its project is limited to the tailings pond and the Pakera Lake.

For the tailings pond there are three clusters of occupancy which will require relocation. These clusters are described below:

1. There are three houses and three camps along with farmlands near the road to the airport in the vicinity of the wash plant. These houses and farmlands will have to be relocated since they fall within the footprint of the tailings pond and will be affected by the operation.

2. There are four farms along with a camp located further within the tailings pond. These will also have to be relocated since they fall within the footprint of the tailings pond and will be affected.

3. There are three camps along with farms located in close proximity to the road heading to the airstrip on the periphery of the tailings pond. These houses and farms would not be directly affected by the tailings pond, but it was decided to relocate them as a precaution over safety concerns as the tailings pond increase in size over time.

Some of the houses and farmlands can be observed in Figures 21-4 and 21-5, while their locations are shown in Figure 21-6. A total of eight individuals will be affected by this relocation since individuals own multiple farms and camps. The lands occupied were targeted due to its availability after the closure of the manganese mine several decades ago. Mainly cash crops (cassava, plantains, pineapple, corn and banana) are being cultivated. The current farm plots under cultivation vary in size ranging from 0.4 hectares to 2 hectares. The displaced individuals there are 80 percent females while 20 percent are males. At present, most of the property owners reside within the residential community of Matthew's Ridge. The main source of economic income of residents currently occupying this area is farming.

Figure 21-4: Residences and Farmlands within the Tailings Pond

Figure 21-5: Farmlands within the Tailings Pond

At Matthew's Ridge the persons and activities to be displaced are mainly those presently occupying the areas to be utilized as the tailings pond. For those occupying areas of the tailings pond for farming or settlement it was determined that they have no legal rights to the land being occupied. In this regard, GMI has the right to resort to the Government authority to gain compulsory access to the land or abide by the GLSC Standard Operating Procedure for the acquisition of land. However, in the nature of goodwill, GMI has also initiated direct engagements with these persons to acquire the land use rights through direct negotiations.

The NDC and RDC are involved in these negotiations and has supported and facilitated the identification of state lands for relocation of farms and residents during this process. The Ministry of Agriculture, through the RDC, has also provided crop appraisal assessments for impacted farms for the purpose of compensation. Below is the status of the relocation efforts:

1. For the three houses and three camps along with farmlands near the road to the airport in the vicinity of the wash plant the crops on the farmlands were already assessed by the Ministry of Agriculture through the RDC and a conclusion of the agreement between GMI and the residents is expected shortly.

2. For the four farms with a camp located further within the tailings pond, these were also already assessed by the Ministry of Agriculture through the RDC and a conclusion of the agreements between GMI and the residents of three of the farmlands were reached. The agreement for the other farmland is expected shortly since negotiation is still ongoing.

3. For the three camps along with farms located in close proximity to the road heading to the airstrip, GMI has now decided to relocate these persons and the process to reach an agreement is expected to commence in future.

GMI offered affected farmers were the full replacement cost (market value), which is the cost of current crops and trees after evaluation by the Ministry of Agriculture. In the case of the residences, GMI has offered the full replacement cost (market value), which is the cost of purchasing or rebuilding a property within a similar area and quality to that being acquired by GMI. To date the company has entered into separate agreements with three of the affected five individuals already assessed. Negotiations are ongoing with the other two occupants of the area. These agreements were entered into on July 29, 2020 for a full financial compensation to be paid to each individual by GMI at an accepted rate, amounting to a total of GYD$4,496,200. It was agreed that 50 percent will be paid in advance of the move and the remaining 50 percent will be paid to the residents once the land was fully vacated. To date GMI has disbursed the 50 percent pending full vacation of the land. The agreements which were already signed off between the Company and the individuals are included in Appendix J. GMI has committed to offering land preparation assistance to farmers once suitable farming plots are identified between the NDC and the farmer for relocation. This will greatly assist the individuals to return to their economic and livelihood activity.

For those individuals now being engaged it is recommended that a similar approach be utilized to bring an amicable agreement between GMI and the individuals, with the NDC, RDC and Ministry of Agriculture being involved in the process, and adequate compensation and other assistance provided.

Table 21-3: Synopsis of Relocation/Compensation Agreements to date – Matthew's Ridge

Resident	Property	Compensation (GYD$)
Resident 1	Farm: compensation for cash crop and permanent crop	655,700
Resident 2	Farm: compensation for cash crop and permanent crop	1,254,000
Resident 3	Farm: compensation for cash crop and permanent crop	2,586,500

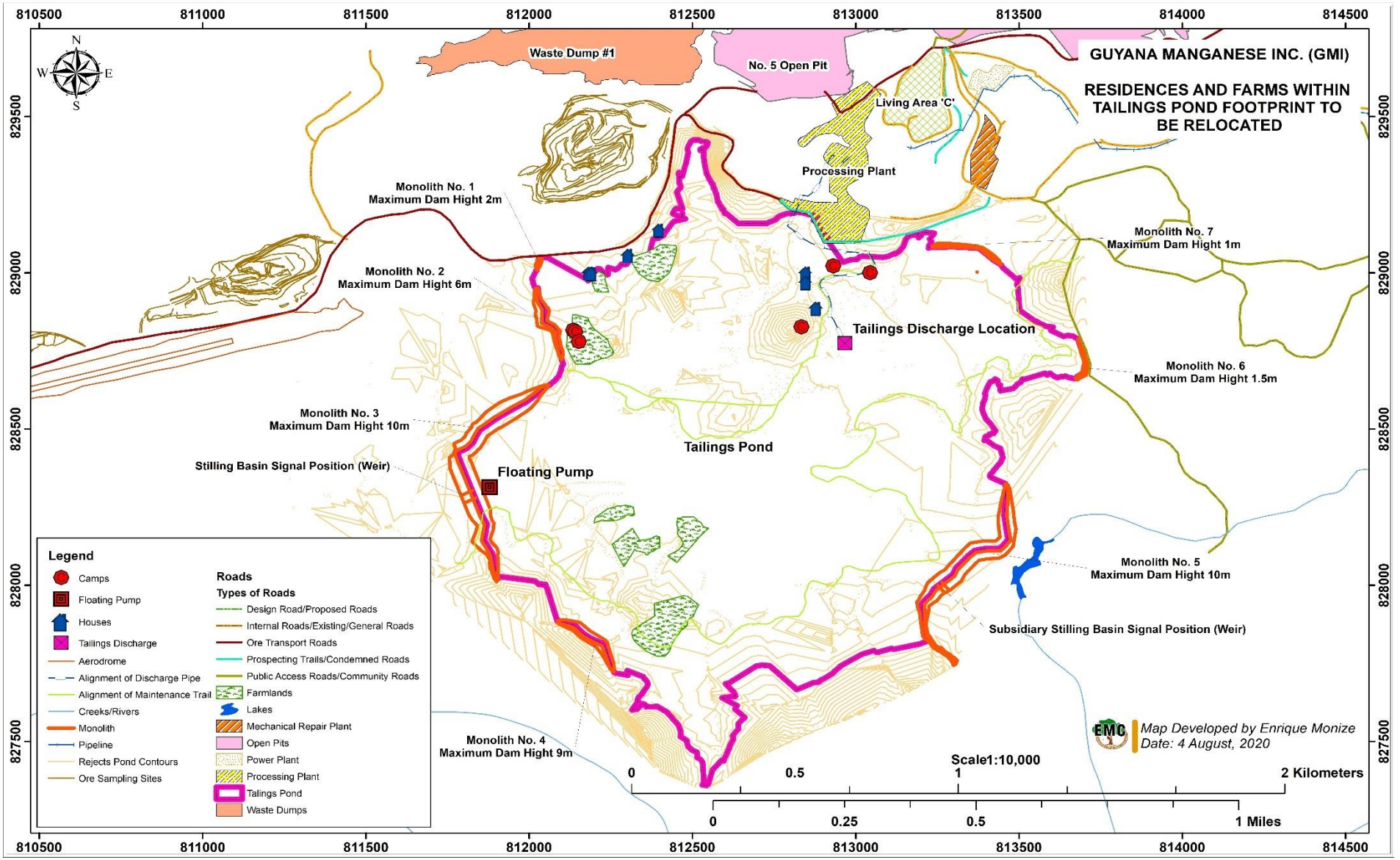


Figure 21-6: Residences and Farmlands within the Tailings Pond

In addition to the tailings pond residents utilized the Pakera Lake, which they referred to as the 'water pool'. The Pakera Lake was created during the previous manganese mining operation by damming of the Pakera Creek to supply water for the wash plant. Residents utilise the lake for recreation purposes, especially during the dry season. Residents generally utilise the area for picnicking, sports, swimming and even recreational swimming. GMI will utilise the lake for water supply and has rehabilitated the infrastructure, including the dam and the water control structure and the lake is now filled. As such, the Company, as a safety precaution, has restricted access to the lake. The Pakera Lake can be observed in Figure 21-7. The figure on the left shows the lake during the dry season (January 2020) prior to the rehabilitation of the control structure and dam. The figure on the right shows the flooded lake in July 2020 after rehabilitation of the dam and control structures. It is because of these naturally occurring flood conditions, prevalent during the wet seasons, which GMI is required to restrict access to residents for public safety. To offset for the displacement of recreational activities at the Pakera Lake conducted by residences the Company has agreed with the NDC to assist in providing an alternative source of recreation for residents of Matthew's Ridge, such as a playground.

Figure 21-7: Pakera Lake which is Utilised by Residents for Recreational Purposes (Lake during dry season [left] and flooded due to rehabilitation of infrastructure [right])

21.2.3 Other Communities

The project will in no anyway infringe on livelihood activities and or result in further resettlement within the scope of the project's indirect areas of influence, specifically in the communities of Arakaka, Eclipse Falls and Four Miles. However, based on negotiations with the RDC, the project is required to upgrade and widen the existing Matthew's Ridge to Port Kaituma public road infrastructure and rehabilitate of the existing Eclipse Falls Bridge across the Barima River. In addition to the upgrading of existing transportation route, GMI has constructed an additional 9-kilometer of road to access the Kaituma Marine Terminal. None of these activities will result in displacement. The rehabilitation of the existing and construction of the new roadway on already degraded state lands will only add to the aesthetic of the area, while improving transport and livelihoods of residents and businesses of the region. The 9-kilometer roadway constructed at Port Kaituma is already being used by freelance miners (pork knockers) and farmers to gain access to isolated areas.

21.3 Impact Assessment – Land Acquisition, Resettlement and Livelihoods

This section assesses the potential impacts of land acquisition, resettlement and livelihood, and the risk associated with these impacts on planned project activities during the construction and operational phases. It includes an assessment of risk associated with land acquisition, resettlement and livelihoods. Relocation and compensation were highlighted as a major concern for stakeholders occupying the area, and was raised at the Scoping Meetings conducted as part of the EIA process.

As noted in section 21.2.1 there were three water front households and farms at the site for the Kaituma Marine Terminal which were acquired by GMI, and which were relocated. At Matthew's Ridge there is a total of eight occupants within the tailings pond area. Two of the occupants were already relocated, while the others will eventually have to be relocated as negotiations are completed. Further, access to the Pakera Lake, which was utilised for recreational purposes by residents, is now restricted.

21.3.1 Physical Displacement and Resettlement Impacts

For the construction of the Kaituma Marine Terminal structures, small farms and permanent crops belonging to six individuals were acquired. For this site physical displacement of structures of the three waterfront properties occurred as a result of the project, which would be permanent. While resettlement has not yet completed in the Matthew's Ridge, there are dwellings and farmlands within the tailings pond footprint who will be physically displaced. None of the occupiers at Port Kaituma and Matthew's Ridge have legal rights to the land. However, these are largely vulnerable groups of persons occupying state lands. Nevertheless, there are alternative areas available to which these persons can relocate. These displacements are considered to be **direct** and **localised,** of **moderate significance** and are **certain** to occur during the construction and operational phase of the project. Physical displacement and resettlement are of **Medium Risk** to the project. Physical displacement impacts were significantly reduced based on the measures implemented by GMI, as is outlined in Section 21.4.1. At Port Kaituma the rights to occupy the site will be granted to GMI through a lease which is being process by the GLSC, while at Matthew's Ridge the project areas will be included in the Mining Permit to be issued by the GGMC.

21.3.2 Livelihood and Economic Displacement Impacts

Along with experiencing of physical displacement, the five parties affected by the three resettlements at Port Kaituma experienced some form of economic displacement as the properties included small farm plots with agricultural crops and fruit trees. In the case of the Matthew's Ridge, all of the individuals to be relocated were involved in farming activities within the tailings pond area. There are no other economic activities identified in Matthew's Ridge which will be affected as a result of implementation of the project. It should be noted that at Matthew's Ridge there were limited options for employment and economic activity. However, with the presence of GMI, this situation is gradually changing. At Port Kaituma, there are more options available for economic activities and employment. Nevertheless, efforts are being made to ensure the affected persons are able to re-establish their farming activities at their new locations. The livelihood and economic impacts that could result from the project implementation are considered to be **direct and localised** of **minor significance** and are **likely** to occur, and present **Medium Risk** to the Project. However, livelihood and economic displacement impacts will significantly be reduced based on the measures implemented by GMI, as is outlined in Section 21.4.1.

21.3.3 Socio-cultural Displacement Impacts

Access to the Pakera Lake, which the community had utilised for recreation and other purposes, is now restricted by GMI. GMI has fenced the access to the lake and has a security presence at the site. This is to ensure the safety of residences since the lake is now flooded due to GMI rehabilitating the dam and water control structure. Within Matthew's Ridge there is limited recreational facilities and the use of the lake, especially during the dry season when the water level within the lake is lower, is an important source of recreational activity for residents, especially given its close proximity to the community. This issue was discussed between GMI and the NDC and the NDC agreed that GMI can implement the measures to restrict access to ensure public safety, but would need to offset the impacts by assisting in providing additional sources of recreation. The impact relating to this loss of recreation

activity can be considered to be **direct**, **localised** of **minor significance,** and is **certain** to occur. Socio-cultural displaced are of **Low Risk** to the project.

21.3.4 Cumulative Impact Assessment

As discussed above, GMI directly engaged in negotiations with residents to acquire lands within the project footprint at Matthew's Ridge and Port Kaituma which were used as residences and farmlands. Moreover, the NDC was directly involved in the negotiations with these residents. Currently, there are no other existing or known planned projects within or proximate to the AoI which will require the resettlement of residents or lands used for livelihoods purposes. As a consequence, no cumulative impacts are anticipated from these activities.

21.4 Mitigation and Monitoring Measures – Land Acquisition, Resettlement and Livelihoods

There are unavoidable physical displacement resulting from the implementation of the project. However, only limited economic displacement will occur in the acquisition of project lands. Most of the impacts relate to physical displacements. To avoid social disputes, the relocation of locals should only be considered as a last resort. This was considered by GMI, hence the limited relocation required. In the future, although unlikely, relocation may be necessary due to air quality and/or noise effects, or other health and safety issues linked to manganese mining or processing as the project progresses.

The mitigation measures are intended to anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by providing compensation for loss of assets at replacement cost and ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected. Below are the measures being employed by GMI to mitigate impacts associated with the current relocation and resettlement of persons and farming activities which are required as part of the project implementation:

- Engaging with the local authorities before commencing discussions with land occupants on resettlement.
- Ensuring that there was independent third-party valuation of commercial resources on the properties to be acquired.
- Engaging with occupants in a spirit of goodwill to reach mutually agreeable compensation and resettlement packages.

GMI should also implement the following measures:

- Engage with the NDC and residents to determine the most suitable recreational facility for the community.
- Develop a Stakeholder Engagement Plan outlining the measures to be taken to continuously engage with stakeholders and the community. As was previously discussed, the project will cause physical, economic and recreational displacement and as a consequence community and stakeholder engagement specifically focused on these aspects will be necessary throughout the construction and operation phases of the project, until all displacement and resettlement negotiations are resolved. A Stakeholder Engagement Plan for the project is included in the ESMP (Section 22.67).
- Preparation of a Grievance Mechanism to allow for individuals, residences and transient groups, if they believe that they are being unfairly denied access to traditional land engagement and livelihood activities, to have an avenue to engage with the company. This is. As such, a grievance redress mechanism is included in the ESMP (Section 22.7).
- Prepare a Relocation and Resettlement Plan if further relocation is required in the future. The findings of the EIA should be taken into consideration when planning such initiatives, including

the involvement of local government officials and stakeholders. The objective is to treat customary and formal rights as equally as possible in devising compensation rules and procedures. The plan should address the issues raised by the different tenure systems found in a project area, including the compensation eligibility so as to improve or restore, the livelihoods and standards of living of displaced persons, and to improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.

- Engage with the Guyana Lands and Surveys Commission in advance of any future resettlement activities.

Table 21-4: Summary of Impacts and Mitigation Measures

Impact Producing Activity	Operational Controls and Regulatory Compliance	Potential Impact	Impact Assessment			Impact Risk	Management / Mitigation	Monitoring
			Type	Signifi-cance	Likelihood			
Land Acquisition, Livelihood and Resettlement								
Land acquisition and resettlement at Port Kaituma and Matthew's Ridge	In compliance with the Laws of Guyana, Lease and Mining Permit requirements, and involvement of Government institutions.	Physical displacement and resettlement impacts	Negative, Direct, Localised	Moderate	Certain	High	Providing compensation and assisting in relocation.	Regular engagement, implementation and Grievance Mechanism in place.
Land acquisition and resettlement at Port Kaituma and Matthew's Ridge		Livelihood and economic displacement impacts	Negative, Direct, Short Term, Localised	Minor	Likely	Medium	Providing compensation and assisting in relocation.	
Restriction of access to Pakera Lake	In compliance with the Laws of Guyana, Mining Permit requirements, and agreement with the NDC.	Recreational displacement	Negative, Direct, Localised, Long Term	Minor	Certain	Medium	Assist in providing alternative facility.	

Chapter 22 - Environmental and Social Management Plan

22.1 Introduction

This Environmental and Social Management Plan (ESMP) Chapter brings together, in summary, the measures captured in the individual resource chapters to be implemented by GMI to avoid, minimise, mitigate and/or manage impacts of the project. The Terms and Scope for the EIA provided guidance towards framing the ESMP.

The scope of this ESMP covers the environmental and social attributes of GMI's operation for mining and processing of manganese at Matthew's Ridge, road transportation to Port Kaituma, and storage and transshipment for the Kaituma Marine Terminal. The operations include the rehabilitation and, in some cases, replacement of plants and buildings; rehabilitation and upgrade of several mine sites; installation of processing plant and upgrade and constructions of roads and construction of the wharf. Detailed information on the scope of the project is elaborated in Chapter 4 of this report. This Chapter covers the environmental plan and social plan separately and highlight, by affected resource, the source of impact and the specific management actions/measures to address the impact. It also includes the legislative requirements for the operation and implementation of the project, impacts and project specific measures, occupational health and safety, monitoring, emergency response and rehabilitation and closure of project activities as highlighted in the EIA. This ESMP provides the basis for GMI Environmental Management and Monitoring Program. The specific objectives of the ESMP are to:

- Demonstrate compliance with the various agreements/permits/licences issued by the EPA and other regulatory agencies for the project;
- Demonstrate commitment to adhere to national legislation, standards and guidelines; and
- Establish clear roles and responsibilities and forms of communication among regulatory parties and GMI.

22.2 Key Relevant Policy and Legislation

The relevant policies, legislation, standards and guidelines applicable to the implementation of the GMI manganese mine operations are elaborated in Chapter 3 of this report. For the purpose of this ESMP, a summary of the main environmental and social policies and resource specific legislation are highlighted which directly and indirectly apply to addressing the potential impacts during project implementation. These policies/strategies in particular are:

- **Green State Development Strategy (GSDS): Vision 2040**: The GSDS provides a 20-year outlook on development around a green agenda. Its vision is defined as sustainable, low-carbon and resilient development through efficient use of resources across multiple generations. A critical objective of the GSDS is development that improves the quality of life for all Guyanese utilizing the country's natural resources of land, water, forests, minerals and aggregates, and biodiversity.
- **Low Carbon Development Strategy (LCDS):** The LCDS outlines Guyana's approach to low-carbon and climate resilient development including but not limited to the use of renewable energy, sustainable forest management, and climate change adaptation.
- **National Development Strategy (NDS)**: The NDS serves as a development policy framework for Guyana by outlining the framework for national planning. It incorporates several cross-sectoral issues inclusive of the environment, forestry, agriculture, mining, tourism and

fisheries. The strategy proposes a programme of diversification focusing on the production of non-traditional commodities, for both the domestic and exports markets. This perspective allows for an expansion of the economy while at the same time consolidating and expanding the performance of traditional sectors such as mining.

- **National Biodiversity Strategy and Action Plan**: Aims to promote conservation of biodiversity in Guyana, including sustainable use of its components. It also allows for equitable benefit sharing and includes biodiversity related to forest, agriculture, and freshwater.

- **National Action Plan (NAP) to Combat Land Degradation**: The NAP provides a guiding framework for the implementation of actions to address desertification and promote sustainable land management. It allows for lands under productive use such as agriculture, forestry, and mining to be sustainably managed to ensure the maintenance of ecosystem productivity and ecological functions, while addressing environmental protection, economic growth and livelihoods.

The legal framework that governs the implementation of the project, including the specific obligations to acquire an environmental authorisation from the EPA, and mandating GMI to address the environmental and social consequences of its operations is highlighted here. In particular, the most fundamental statute is the *Constitution of Guyana*. The Constitution is the highest governing document in Guyana and outlines the fundamental rights of Guyanese. Specifically, Chapter II of the Constitution defines the principles for the political economic and social systems, including the right of citizens to participate in activities to improve the environment and protect human health. The realization of the principles of the Constitution is through national legislation.

The most important pieces of legislation governing the protection and management of the environment is the *Environmental Protection Act* and its six supporting regulations. These obligate GMI to apply to the EPA for environmental authorisations to operate and specifically governs the EIA process. Within the framework, the Act and regulations provisions are made to prevent and/or control pollution, protection of the environment and human health and consequences for non-compliance of any statutory provisions.

The primary resource specific legislation is the *Mining Act* and its mining regulations. The Act provides the mandate to GGMC to establish the legal framework for the utilisation of Guyana's mineral resources and licencing processes. A mining licence is required in order to mine any mineral. The Act also safeguards the rights of persons in possession of lands grants as well as the privileges of Amerindians in relation to prospecting and mining. Further the regulatory framework under the Act makes provisions for the disposal of sanitary waste and the storage.

The *Occupational Safety and Health Act* and the *Amerindian Act* are two pieces of legislation to address social issues and protect the rights of workers and indigenous communities respectively. The former establishes the procedures and outlines the requirements related to health and safety and obligates GMI to ensure its operations adhere to the requirements. The *Amerindian Act* allows for the collective rights of indigenous peoples, their villages and communities. The Act elaborates specific rights for indigenous peoples especially in relation to their governance and use of land. Other applicable pieces of legislation are the:

- Explosives Act
- Blasting Operations Act
- River Navigation Act
- Sea Defence Act
- Protected Areas Act
- National Trust Act

- Natural Resources Fund Act

22.3 Impact Prediction, Assessment and Mitigation

The potential environmental and social impacts of project activities were assessed across the various phases - construction, operational and closure – using the baseline conditions of the areas of influence. This was done by establishing the potential interactions between the activities and the characteristics of the existing physical, biological and socio-economic environment. The methodology employed for the impact prediction and assessment is elaborated in Chapter 7 using a three-step process (impact identification, impact assessment and mitigation and management). Impacts were considered positive or negative; direct or indirect; short-term or long-term; localized, local or regional and cumulative. Risk ratings were assigned using a Risk Assessment Matrix based on the significance and likelihood of potential impacts occurring.

GMI will implement actions to avoid (remove or minimize the source of the impact by modifying project operations) or reduce (lessen the chances of adverse interaction between the project activities and receptions) the potential risks identified during the Impact Assessment of each individual resource. The mitigation and management measures are summarised in the sections below, including procedures to be executed in the event of an emergency.

22.4 Environmental Management Plan

This section summarizes the potential environmental impacts of the project and the specific management measures GMI is expected to implement to avoid, minimize, mitigate and/or manage impacts of the project. This information is obtained from the detail resource chapters in this report and include baseline, potential direct and indirect impacts and their severity (prediction and assessment) along with mitigation/management actions. This summary highlights the sources of impact by phase of the project and the measures to be implemented by GMI. It is expected that this ESMP will be periodically updated by GMI to reflect changes which may have occurred operationally, or adjustments to the mitigation and monitoring measures implemented.

22.4.1 Water Resources

The surface and ground water hydrology and surrounding water quality were assessed for specific project locations in Matthew's Ridge and Port Kaituma considering planned and accidental discharges as a result of project implementation. The water quality assessment built on an earlier analysis executed in 2012 covering physical and chemical parameters such as turbidity, suspended solids, and heavy metals. The results were assessed within the IFC/World Bank Group Effluent Discharge Guidelines and the Guyana National Bureau of Standards (GNBS) Interim Effluent Guidelines. Chapter 8 provides detail baseline information on surface and ground water and the impact assessment, including sources of impact and impacted sources associated with the project.

The measures detailed below have been implemented by GMI during the construction phase of the project and will be continue to be implemented during project implementation to reduce the risk of pollution from project activities on the surrounding watershed and river system, as well as on stakeholders including the communities:

- Developing storm water drains around key project components including stockpiled areas, the processing plant and power plant.
- Maintaining existing drainage structures and constructing new drainage features, where necessary on all project roads.
- Constructing and rehabilitating septic systems in compliance with GNBS guidelines.

- Creating secondary containment structures or bunds for fuel storage tanks/bowers affixed with oil/water separators for drainage of these containment areas.
- Collecting runoff in settling ponds, including at the processing plant, mine sites and the Kaituma Marine Terminal.
- Designing the processing plant as a closed loop system of water to treat and reuse as much process water as possible thereby reducing the water demanded for processing as well as the effluent generated.
- Designing foundation for the processing plant and other critical project components to minimise erosion.
- Installing concrete drains to channel storm water runoff from the processing plant and other operational areas into the tailings pond to reduce sedimentation and erosion. This also prevents soil from becoming a contaminant of runoff.
- Installing concrete-lined storm water trenches and slope stabilization.
- Managing drainage and discharge of storm water runoff on haul roads to minimize sedimentation.
- Creating a 24-hour monitoring station at the tailings pond to monitor piezometric pressures, water levels, signs of displacement and to carry out water releases via the spillway as necessary.
- Maintaining topsoil/organic matter stockpiles; and grading, scarifying, and re-vegetation of road ROWs, exploratory roads, and other temporarily cleared areas.
- Ensuring compliance with safe operational practices of all project vehicles.

In addition to the above listed mitigation and management measures, GMI could consider implementing the following additional measures informed by the IFC's "Environmental, Health, and Safety General Guidelines", and the IFC's "Environmental, Health, and Safety Guidelines for Mining":

- Develop a water quality monitoring programme, in partnership with GWI, to regularly monitor manganese levels in the Matthew's Ridge community water supply. If manganese levels exceed safe consumption levels, GMI should work with GWI to make an alternative source of drinking water available for community members.
- Monitor water quality for physio-chemical and biological parameters and trace metals on a monthly basis. This should include frequently monitoring of water sources at high risk of contamination including the Hill 5 spring, GMI's spring and upstream and downstream of operations at the Canal Bank, among others.
- Prepare and implement monitoring programmes for ore and waste geochemical characterization methods for proper routing of Potentially Acid Generating (PAG) materials and Acid Reduction Detection (ARD).
- Prepare and implement an Erosion and Sediment Control Plan.
- Prepare and implement a Water Management Plan.
- Engage with GWI before conducting any future dredging activities in the Kaituma Canal.
- Install and maintain oil and grease traps/separators or sumps at refueling facilities, workshops, fuel storage depots, and containment areas, and spill kits.
- Establish bunded secondary containment areas for the storage of all hazardous materials and hazardous waste.
- Provide training for employees on proper collection, handling and management measures for hazardous waste.
- Field-test the procedures of the emergency response plan for clean-up of any accidental discharges from the operations.
- Develop an emergency response plan for clean-up of any accidental discharges from the operations.
- Monitor water consumption of project activities.

- Engage with communities and local authorities to determine whether there are any adverse impacts from the company operations to water resources in the project footprint at Matthew's Ridge and Port Kaituma.
- Implement a Grievance Mechanism to receive any complaint regarding impacts to water resources.
- Consider options for improved tailings management throughout the lifetime of the project. If warranted, as a result of monitoring, the following modifications to operating procedures could be considered:
    - Increase in slurry discharge density from 40 percent solids (higher densities lessen fine-coarse particle segregation and the generation of slime ponds) by changing the thickening methods in the plant.
    - Frequent relocation of tailings discharge points within the facility.
    - Discharge of tailings from embankments – this could increase embankment stability by removing pond water from the edge of the embankment.
    - Deposit a fraction of tailings in one or more mined-out pits. The use of a mined-out pit for tailings disposal. This is an acceptable strategy and was practiced by Omai, Guyana in 2004. However, it may be limited at Matthew's Ridge by the potential to sterilize mineral resources and the expected need to construct and operate a water treatment plant.

Based on the assessment, the potential impacts to water resources as well as the mitigation and management measures listed below and summarized in Table 22-2.

22.4.2 Soils and Geology

Soils and geological conditions were assessed for the project footprints in Matthew's Ridge and Port Kaituma. The assessment was based on detailed geotechnical assessments conducted for the Matthew's Ridge footprint in 2012 as well as various other secondary sources. Soil classification was based on international classification systems utilised by the Guyana Lands and Surveys Commission, Detailed information on the baseline for soils and geology in the primary AoI as well as potential impacts posed by the project are presented in Chapter 9. The overriding strategy for the project is to prevent or minimise impacts on the soils and geological conditions as well as on stakeholders including the communities. As a result, GMI has put the following measures in place to mitigate impacts and risks posed to soils and geology:

- Stockpiling of topsoil at various locations across the nine waste dumps areas. In addition, these stockpile areas will be monitored monthly to check for changes in conditions.
- Putting measures in place to manage risks associated with AMD including:
    - Controlling runoff from exposed ground with the careful placement of flow retarding barriers.
    - Putting measures in place to channel water generated from mine dewatering into the Tailings Pond to be used in the process.
    - Using a flocculant to treat water to be discharged from the processing plant into the Tailings Pond which will have a buffering or neutralizing effect on the discharge.
    - Containing process water in the Tailings Pond with minimal discharges into the environment, only as needed, via a spillway.
- Adhering to the relevant mine design parameters, such as the layout of mine workings and the geometry and strengths of slopes and pit characteristics so as to mitigate risks of subsidence and landslides.
- Using techniques to stabilize or retain slopes including mechanical means via use of cement, limestone or other chemical agents; diverting and controlling surface runoff; and designing mines with a safety factor of 1.1 to 1.3; and using terracing methods.

- Conducting periodic inspections to ensure that drainage systems and pumps are fully functional.
- Monitoring the water levels in the Tailings Pond on a 24-hour basis and creating a spillway to allow for emergency drainage.
- Putting measures in place to prevent soil contamination by hazardous waste including:
    - Ensuring that all hazardous materials and waste are stored on impervious surfaces within secondary containment.
    - Ensuring that there are suitable drips trays for refueling and oil changes.
    - Using appropriate vehicles for river and road transportation of fuel.
    - Refueling and oil change should take place in designated workshop areas. If maintenance at field locations are unavoidable, appropriate drip containers will be used the site will be cleaned up appropriately.
    - Training workers in proper fuel handling and management measures.

In addition, GMI should implement the following measures to mitigate and monitor the risks during the operational phase of the project:

- Manage and reduce risks of topsoil loss by implementation of the following measures:
    - Strip topsoil to a maximum depth of 200 millimeters.
    - Ensure that topsoil stockpiles are kept as small as possible in order to prevent compaction and the formation of anaerobic conditions, typically around 1 meter thick or less.
    - Store topsoil stockpiles for the shortest possible timeframes.
    - Restrict handing of topsoil when moisture content exceeds 12 percent.
    - Ensure that topsoil stockpiles are kept separate from subsoils.
    - Store topsoil and other soil materials in bermed area on the higher lying areas of the footprint area. Topsoil should not be stored in any storm water run-off channels or any other areas where it is likely to cause erosion, or where water would naturally accumulate.
    - Optimize the mine plan to have stripping, extraction of ore and backfilling done in such a way as to minimize the exposure of material to erosion
    - Use topsoil to progressively backfill mined out areas thereby allowing for the re-growth of the seed bank contained within the topsoil.
    - Use natural or manufactured fertilizers to invigorate the topsoil when redistributed.
    - Put measures in place to prevent wind erosion of the stockpiles.
    - Stockpiles susceptible to wind erosion are to be covered during windy periods.
- Manage and reduce risks of AMD by implementation of the following measures:
    - Test soil and rock on an annual basis for AMD and NP as the mine progresses and material from depth becomes accessible.
    - Audit mine residue deposits, including water return dams, waste rock dumps, tailings storage facilities annually to ensure that best practices are being followed throughout the mining operation.
    - Limit ground exposure, surface area and duration, wherever possible.
    - Ensure that ore stockpiles at the Kaituma Marine Terminal are contained to prevent runoff from entering the Kaituma Canal.
- Manage and reduce risks of subsidence associated with project activities by implementation of the following measures:
    - Conduct monthly visual inspections to detect significant instances of subsidence.
    - Control of the rate of dewatering of the mine and the area affecting the strata surrounding the mine workings.
    - Design consideration of the structural, lithological and geotechnical characteristics of the overburden and inter-burden

    - Minimize any conditions that may cause increased loading or changes to the stress environment surrounding the mine workings.
- Manage and reduce the risks of landslides by continuous visual and instrumental monitoring of all slopes for erosion and landslide indications. At critical points devices must be installed to detect seismic movements and vibrations.
- Dewatering of material to reduce plasticity and hydrostatic pressures along slopes.
- Consider the use of vegetation for slope stabilization, prevention of erosion.
- Prepare a Blasting Plan before blasting operations.
- Ensure that spill kits are available to clean up accidental spills from earthmoving machinery or other project vehicles. These kits should be well-marked and workers should be trained in their use.
- Employ soil wetting techniques to prevent it from becoming dry and being lost to the wind.
- Limit traffic on disturbed, storage and reclaimed areas.
- Limit the double handling of material.
- Ensure that there is progressive reclamation throughout the life of the mine with annual monitoring to check on the status continuous mine rehabilitation.
- Undertake measures to be taken to mitigate the risks of non-rehabilitation of the mine including the development of the mine Closure and Decommissioning Plan in keeping with the national regulations to demonstrate that closed out Matthew's Ridge and Port Kaituma facilities will represent minimal long-term deleterious legacies. The Plan should be updated as the operations progress.

Based on the assessment, the potential impacts to soils and geology as well as the mitigation and management measures are summarized in Table 22-2.

22.4.3 Air Quality

The baseline ambient air quality was assessed for specific project components and receptors in Matthew's Ridge and Port Kaituma within the area of influence. The main potential pollutants determined from the assessment are particulate matter and fugitive dust, manganese dust and fumes, sulfur oxides (SO_x), nitrous oxides NO_x), methane (CH_4), carbon oxide and VOCs mainly from the extraction, processing, transportation of ore, and activities requiring fuel combustion. Chapter 10 provides detailed baseline information including the impact assessment – emissions, sources and receptors. GMI has already instituted several measures to reduce the potential health risks associated with the project. These measures include:

- Putting measures in place for road wetting in Matthew's Ridge and Port Kaituma by acquiring three water trucks.
- Developing methods to cover manganese ore which will be transported by haul trucks and barges.
- Wetting of ore stockpiles and spoil piles.
- Enclosing the crushers and jigging machines.
- Suppressing particulates on the conveyor belt by spraying of water.
- Procuring low emissions fuel by specification.
- Commencing monitoring of $PM_{2.5}$, PM_{10} at Matthew's Ridge.

However, the following mitigation and monitoring measures should also be implemented to minimise dust emissions associated with the project:

- Develop an air quality monitoring programme to determine levels of manganese in the air at high-risk worksites (manganese extraction and processing) and sensitive receptors down-wind of these sites. The air quality monitoring programme should also measure the concentrations

of other air pollutants including dust generated along the Matthew's Ridge to Port Kaituma Road in the vicinity of Eclipse Falls.
- Explore options for dust suppression on the Matthew's Ridge to Port Kaituma public roadway.
- Test emissions from the generator house stack annually for NOx and PM to ensure emissions guidelines are met. In addition, specification of fuel is being provided by Sol for each shipment.
- Provide N95 masks for all employees working in areas where risks of exposure from manganese dust are high in particular employees involved in manganese extraction and processing.
- Re-vegetate or cover exposed soils and other erodible materials promptly and as part of mine reclamation.
- Enclose dusty materials storage areas by installing efficient dust suppression methods in these areas.
- Ensure that the loading, transferring, and discharging of materials will take place with a minimum height of fall, and will be shielded against the wind.
- Cover and equip conveyor systems for dusty materials with measures for cleaning return belts.
- Maintain a vegetated buffer zone on the project boundary.
- Establish an automated meteorological station to measure rainfall, temperature (maximum and minimum), humidity, evaporation, wind speed and direction, and hours of sunshine.
- Liaise regularly with nearby receptors to determine if persons are being affected by dust and other emissions.

Based on the assessment, the potential impacts to air quality as well as the mitigation and management measures are summarized in Table 22-2.

22.4.4 Climate and Climate Change

The potential impacts on climatic change due to emissions of greenhouse gases were assessed. The details are elaborated in Chapter 11. The assessment include key-climate related hazards to which project activities and components are vulnerable due to risks of increased greenhouse gas emissions with a focus of adaptation to climate hazards. Relatively low emissions of greenhouse gases are estimated to be released and therefore the main focus is on energy conservation measures to reduce emissions. Several Energy Conservation Measures were already built into the project design and these include:

- Using high-efficiency heavy digging and transportation machines to achieve high equipment effectiveness.
- Targeting deposits with rich ore quality to enable fast turnarounds and lower energy consumption.
- Taking advantage of the natural landforms when constructing project facilities so as to reasonable shorten transit distances.
- Recirculating water in the processing plant.
- Using energy efficient transformer for the electricity generation plant.
- Using energy efficient equipment and appliances.
- Installation of solar powered lighting fixtures.
- Using solar powered water heaters at camp.
- Using electric tricycles to transfer light-weight items around the compound at Matthew's Ridge.
- Strengthening energy management, including by having relevant workers supervising energy management, keeping records of energy consumption and evaluating potential energy-saving measures to implement continuous monitor energy consumption by the project.

In addition, GMI should consider the following monitoring measures, in keeping with IFC Guidelines for Energy Conservation, to ensure that all fuel use is done in an efficient manner:

- Schedule maintenance of all engines to maximize fuel efficiency periodically.
- Monitor the energy distribution at the Matthew's Ridge facilities in order to reduce losses during energy distribution.
- Develop a staff awareness and education programme on the importance of energy conservation and measures which can be taken to conserve energy.
- Monitor and record, on a continuous basis, the volume of fuel used by all combustion sources.
- Include information on the volumes of fuel used by combustion sources in annual reports submitted to the EPA.

GMI should also consider the measures outlined below to adapt to climate change and build resilience of its operations to adverse impacts of climate change:

- Establishing a system for drainage of the roadway including:
  - Roadside drainage for surface runoff including turnout drains, ditches at frequent intervals,
  - Installing structures for cross drainage of the road and ensure that these structures are sufficiently elevated.
  - Monitor road conditions bi-weekly, or more frequently, during the rainy seasons to rapidly identify areas in need of repair and maintenance.
- Developing an occupational safety and health protocol for the work force to follow during periods of high temperatures including access to emergency health care should a heat stroke occur.
- Building awareness of the work force to signs and symptoms of heat stresses and measures to bring relief.
- Instituting dust reduction methods in the absence of road wetting through the village. These methods may include reduce speed limits of project vehicles passing through the village to reduce dust levels generated.
- Continuing to explore options for maximizing operational efficiency. Measures being considered include maximising processing during the wet seasons to create an ore stockpile at Matthew's Ridge and maximising overland transport during the dry seasons to stockpile at Port Kaituma.
- Establishing a system to store a minimum quantity of potable water required for domestic purposes at both Matthew's Ridge and Port Kaituma.
- Monitor water levels in the spring from which water is extracted for domestic purposes during dry periods to ensure that sufficient quantities are available for use.
- Establish an automated meteorological station to measure rainfall, temperature (maximum and minimum), humidity, evaporation, wind speed and direction, and hours of sunshine.

Based on the assessment, the potential impacts to the project from climate change as well as the potential impacts of the project on climate change are summarized in Table 22-2. Measures to mitigate climate change as well as build the resilience of the project are also outlined therein.

22.4.5 Biological and Ecological Resources

The biological and ecological resources within the project area of influence were assessed. The baseline resources include flora, fauna, sensitive/threatened/endemic species, and areas of biological interest. The potential impacts of the activities on the biological and ecological resources are elaborated in Chapter 12, including impact assessment which built on an earlier biological assessment executed in 2012. The impact assessment took into consideration that the area has been historically impacted as a result of manganese mining and therefore with the ongoing activities within the areas of influence, the primary ecological functions of the habitats have been modified over the years, resulting in habitat loss and species displacement. It also took into consideration that the biodiversity found within the project areas are habituated to the constantly changing and human-influenced

environments. Measures to mitigate and manage risks to biological and ecological resources are presented below:

- Measures to Mitigate and Manage Risks of Vegetation Loss During the Construction Phase:
  - Establish and implement of a vegetation monitoring plan for GMI Mining License area.
  - Develop vegetation clearing procedures to ensure that vegetation removal is staged to minimise soil erosion and unwanted loss of vegetation cover, and that remnant vegetation is preserved, particularly the riprian gallery forest habitats of the project site.
  - Maintain riparian cover vegetation to the extent practical as vegetative exclusive zones to protect the forest and aquatic habitats, which are important biodiversity corridors.
  - Conduct any vegetation clearing in a manner to maintain the aesthetics of the natural landscape and should be limited only to areas required for construction.
  - Re-vegetate the area using native vegetation where practical, particularly in areas susceptible to erosion.
  - Limit vegetation clearing for road expansion works to the area designated within the existing easement of roads.
  - Maintain, to the extent it is practical, the riparian forest along the road and creek intersections for wildlife corridors. Consideration should be given to the establish vegetation cover for animal passage particularly at stream crossings, and wildlife underpass crossings at bridges and culverts for species with reduced movement capabilities.
  - Use vegetation waste and surplus soils from land clearing as land spread to conform to the natural topography of the surrounding area to minimize water accumulation, provide general stability and to maintain relative ease of movement for wildlife.
  - Avoid clearing and creation of new areas for source materials for construction activities such as quarries and maximize the use of existing quarries and borrow pits, where practical.
  - Utilise overburden and cleared vegetation in the restoration activities to foster native plant regeneration, where practical.
  - Monitoring continuously the water quality of receiving water bodies within project impacted areas to ensure ecologically acceptable turbidity, nutrient and sediment levels are maintained during construction.
  - Retain topsoil with native seeds where available and used to regenerate areas cleared of vegetation.

- Measures to Mitigate and Manage Risks of Vegetation Loss During the Operational Phase:
  - Road wetting, where practical, during the dry seasons to reduce dust draft and settlement on vegetation.
  - Undertake hydrological studies of the Pakera Creek to determine seasonal environmental flows and replenishment regimes; industrial and processing water needs and appropriate water withdrawal rates from the pond.
  - Establish a vegetation monitoring plan for its Mining Permit area.

- Measures to Mitigate and Manage Risks to Terrestrial and Aquatic Fauna During the Construction Phase:
  - Maintain vegetated corridors and timed construction activities to enable wildlife present in the area to relocate to adjacent areas.
  - Allow animals with reduced movement capabilities to escape if encountered by construction workers.
  - Bridge areas of standing water via culverts and or bridges. Bridge spans for new bridges should be wide enough to provide under passage for animals during the wet and dry seasons.

- Design culverts to enable the passage of migratory aquatic species by incorporating baffles to slow the flow enough to allow fish and others to swim against the current, and by setting culvert bottoms below the level of the stream bed. Consideration should be given in the design of culverts to include eco-passage sizing, substrate placement, natural lighting and water level requirements for fishes, small mammals and herpetofauna.
- Maintain native vegetation in areas not earmarked for land development, particularly in areas along the riparian forest habitats of the streams at the intersection of road infrastructure.
- Sanitize worker dwellings and camp food ration and waste storage and disposal should be undertaken according to best practices.
- Develop and implement an Erosion and Sediment Control Plan and spill clean-up plan outlined in the Emergency Response Plan to mitigate potential erosion, sediment and hydro-carbon contamination impacts respectively.
- Monitor receiver water quality continuously during construction to ensure ecologically acceptable turbidity, nutrient and sediment levels.
- Prohibit hunting, fishing, trapping, harming and gathering of wildlife in the project area by construction employees. The workforce should be educated about the consequences of hunting.
- Report any occurrences of wildlife hunting, trapping and trading to the EPA and Wildlife Management Authority;
- Educate and increase the awareness of drivers on avoiding road kills of wildlife and reporting incidents of accidents with wildlife.
- Limit the width of roads to 8m or less and, if possible, retain canopy cover across roads to benefit arboreal animals especially spider monkey (Ateles paniscus); Study species migration routes to establish migration patterns (e.g. *Ateles paniscus*) and install animal crossing signage, and other forms of animal crossing awareness signalization at established crossing paths.

- Measures to Mitigate and Manage Risks to Terrestrial and Aquatic Fauna During the Operational Phase:
  - Allow animals with reduced movement capabilities to escape if encountered.
  - Maintain vegetation in place, to the extent practical, within project impacted areas, for example, the riparian gallery vegetation along the riverbanks and along the intersection of road infrastructure and river/creeks crossings.
  - Sanitize workers dwellings routinely and camp food ration and waste storage and disposal should be in accordance with best practices.
  - Prohibit hunting, fishing, trapping, harming and gathering of wildlife in the project area by employees and visitors.
  - Report any observed occurrences of wildlife hunting, trapping and trading to the EPA and Wildlife Management Authority;
  - Educate the workforce on the consequences of hunting. Educate drivers on avoiding road kills of wildlife and reporting incidents of accidents with wildlife.
  - Develop and implement an Erosion and Sediment Control Plan, and implement spill clean-up measures outlined in the Emergency Response Plan to mitigate potential erosion, sediment and hydro-carbon contamination impacts.
  - Monitor discharges and receiver water quality to ensure ecologically acceptable turbidity, nutrient and sediment levels.
  - Implement a vegetation monitoring plan.
  - Construct tailings impoundment at a rate slow enough to allow aquatic organisms to relocate outside of the footprint of the pond.

The following measures will be implemented by GMI to ensure the impacts to biodiversity during the closure phase are minimised, as well as, enhance the biodiversity of the project areas:

- Implement a weed management program to control the spread of pest species.
- Utilise native species, as far as is practical, for re-vegetation purposes.
- Develop a Rehabilitation, Closure and Decommissioning Plan after the project is operational for approval by the EPA and the GGMC. Section 22.6.5 outlines areas to be addressed by Rehabilitation, Closure and Decommissioning Plan.

Based on the assessment, the potential impacts to biological and ecological resources as well as the mitigation and management measures are summarized in Table 22-2.

22.4.6 Noise and Vibration

The baseline pressure levels for the project area were assessed and elaborated in Chapter 14 including receptors within or close to the area of influence including potential impacts of noise emissions from project activities. The main receptors which may be impacted by the planned activities were identified as workers within a range of 15 to 500 meters from the noise source; and residents, schools, medical institutions all which are located at distances greater than 500 meters from the sources. Based on the assessment, the mitigation and management measures which will be implemented by GMI to address noise and vibration impacts are listed below:

- Constructing an enclosure of the generator at Port Kaituma and power plant at Matthew's Ridge where six generators will be operational.
- Procuring generators that are sound attenuated.
- Procuring of haul trucks with built-in noise dampening technologies such as mufflers on exhaust systems.
- Issuing relevant PPE for each protection to minimise exposure to occupational noise.
- Putting measures in place to provide the residents of Matthew's Ridge with a schedule of blasting activities.
- Putting measures in place to provide notice to the Matthew's Ridge community in advance of each blasting activity.
- Conducting training and refreshing training sessions on Blasting Safety Practices with employees.
- Closing of roads within at least 500 meters of blasting locations when blasting is occurring.
- Siting of offices and workers living areas away from noise sources.

In addition to the list above, GMI should consider implementing additional mitigation and monitoring measures to manage risks of noise levels generated by the planned project activities. These measures, informed by the guidelines for noise management, are elaborated in the IFC's Environmental, Health and Safety Guidelines:

- Develop and implement a Blasting Plan.
- Install sound suppression devices (such as mufflers) on earthmoving equipment and other heavy equipment and machinery, if possible, if these technologies are not built in to the equipment.
- Install noise insulation devices in employees' living and dining areas.
- Develop a training module on noise nuisance, the importance of wearing appropriate PPEs for ear protection as well as occupational health and safety measures to be followed during blasting activities and enforce workers use of PPEs for ear protection.
- Install signage to remind workers of the proper use of PPEs.

- Conduct annual hearing tests and maintaining records for workers at risk of occupational noise exposure.
- Develop a noise monitoring programme under which ambient noise levels including occupational noise are measured at least monthly so as to ensure compliance with the permissible limits and recommended threshold levels.

Based on the assessment, the potential impacts of noise and vibrations from planned project activities as well as the mitigation and management measures are summarized in Table 22-2.

22.4.7 Transportation

The existing transportation infrastructure in the primary, secondary and tertiary area of influence was assessed, including potential impacts of planned activities. Chapter 15 provides detail information on the baseline and impact assessment. Based on the assessment, the mitigation and management measures to address the risks associated project transportation by GMI are listed below:

- Rehabilitating the Matthew's Ridge to Port Kaituma public road through the installation of drainage features, widening some sections of the road, reducing gradients, installing turning mirrors and improving sight lines.
- Reinforcing and refurbishing the Eclipse Falls Bridge.
- Constructing bypass roads at Port Kaituma and Matthew's Ridge to divert traffic from the residential areas.
- Rerouting the access road to the airport at Matthew's Ridge away from the processing plant area to reduce safety risks.
- Facilitating shared use of project bypass roads in Matthew's Ridge and Port Kaituma.
- Restricting river dredging to the turning basin adjacent to the Marine Terminal.
- Ensuring that barge captains and crews are certified by MARAD.
- Transporting explosives and detonators separately to the storage bonds and mine sites as well as ensuring that all legal requirements are followed during transport.
- Training for drivers in safe and defensive driving.
- Putting measures in place for road wetting in Matthew's Ridge and Port Kaituma.
- Developing methods to cover manganese ore being transported by haul trucks and barges.
- Ensuring that all project vehicles and machinery are serviced and have road-worthy tyres.

In addition, the following mitigation and monitoring measures should also be implemented to minimize risks associated with project transportation:

- Engage local authorities, including the RDC, and the Maritime Administration Department to determine the barging schedule. The schedule should aim to avoid shipment of ore and other materials such as fuel on particularly busy days such as Tuesdays, Wednesdays and Saturdays which are market days in Mabaruma and Port Kaituma.
- Dispatch notices to communities and local authorities on the barging schedule, once developed. The RDC should be enlisted with helping to build awareness of the barging schedule for communities located outside of the tertiary AoI but from where fisherfolk typically travel to Waini Point to fish.
- Ensure that barges are well lit with flashing lights, yellow lights and loud horns for early warning to river traffic. Functional checks should be done to each system before the barge departs from the Kaituma Terminal and reenters the Waini River.
- Host awareness sessions with local communities to increase their awareness of transportation safety practices by GMI and introduce alarm systems.
- Institute measures to facilitate safe river transportation including reducing speed when traversing through communities, having a lookout for river crafts that may be in danger and rules for yielding.

- Engage with the Ministry of Public Works to discuss rehabilitation activities which have been completed on the roadway, the bypass roads which were constructed and the design specifications which were followed.
- Install safety signage on the roadways including roadways which may intersect with heavy vehicles and mines machinery.
- Institute measures to facilitate safe road transportation including reducing speed when traversing through communities and rules for yielding with respect to non-project heavy and light vehicles.
- Implement a programme to monitor water and air quality as is outlined in Chapters 8 and 10 respectively.
- Engage with the NDC, RDC, MARAD and GWI before dredging of the new turning basin again. GMI should engage with MARAD and the NDC to develop an indicative dredging schedule for the turning basin.
- Engage with residents to receive feedback and recommendations on how project transportation can be improved. Residents should also be briefed on the road and river safety rules which GMI will adopt in project transportation and be provided with recommendations on how they can also contribute to road and river safety.

Based on the assessment, the potential impacts of project transportation as well as the mitigation and management measures are summarized in Table 22-2.

22.4.8 Hazardous Waste and Waste Management

Chapter 16 provides detail baseline information on the how waste is currently managed at Matthew's Ridge and Port Kaituma within the project area of influence. Waste generation sources across the various phases of operation – construction, operations and closure – were assessed and the potential impacts identified. The hazardous waste risks were identified in particular during the transport of waste oil and acid-containing batteries off site to the final destinations. Medical waste, and to a lesser extent sewage sludge, represent biological hazardous hazards that must be considered in handling/storage in advance or destruction or disposal. Mine waste such as soil and rock and tailings represent the largest amount of waste generated by the project. Based on the assessment, specific mitigation and management measures for non-hazardous and hazardous waste steams were identified for implementation by GMI and these are listed below:

- Detailed planning for each waste pile, minimizing forest encroachment and maximizing stability, and providing desirable aesthetics on pile completion.
- Completing removal and stockpiling of organic material and fertile soils in advance of waste pile construction.
- Terracing of embankments, with rock-armoured storm water drainage channels.
- Putting operational protocols in place to monitor mine waste management and modify waste pile development to achieve final objectives.
- Designing the Tailings Pond using an advanced engineering design and as-designed aspects minimize environmental impact and risk of instability. The performance of the facility – tailings distribution, dewatering and embankment stability will also be subject to close monitoring, on a 24-hour basis, by GMI.
- Planning to reuse process water in the processing plant.
- Developing a Waste Management Plan which outlines the potential management strategies for several general solid waste, hazardous waste and wastewater streams some of which were already being implemented during the construction phase of the project.

GMI should also implement the measures listed below to manage the various waste streams generated by the project:

- Install an incinerator on site which could be used for the disposal of multiple hazardous and non-hazardous waste including general solid waste, waste oils and medical waste.
- Engage with the NDC of the Matarkai sub-district to determine the location of waste dumps which will be created on site. In addition, the NDC should be informed of all non-biodegradable waste which will be buried with mine waste.
- Engage with MARAD and GL&SC on the disposal of any future dredging spoils.
- Engage with residents in Matthew's Ridge and Port Kaituma to determine whether the waste management techniques adopted have any adverse impacts on them.
- Develop a Chain-of-Custody Procedure for hand-over of hazardous waste which will be disposed by contractors.
- Engage with the National Trust of Guyana to determine whether any of the intact demolition waste, such as skeleton frames of process or ore transport infrastructure, may be of cultural value.
- Create a routine for the examination of all waste disposal on-site at least once per week.
- Continue to examine options for the disposal of waste oils.
- Continue to examine options for the disposal of any medical waste which may be generated on-site.
- Profile top surfaces of the waste pile on completion to facilitate closure actions (e.g. re-vegetation).
- Install barriers to limit undesirable public access to a closed-out site.
- Consider options for potentially using mined out pits for mine waste disposal. This action could modestly reduce the size and extent of mine waste piles. However, the extensive distances between proposed pits and the potential for sterilization (isolate by covering) residual manganese resources in each it, suggests this option may have low economic potential.
- Consider options for improved tailings management throughout the lifetime of the project. If warranted, as a result of monitoring, the following modifications to operating procedures could be considered:
    - Increase in slurry discharge density from 40% solids (higher densities lessen fine-coarse particle segregation and the generation of slime ponds) by changing the thickening methods in the plant.
    - Frequent relocation of tailings discharge points within the facility.
    - Discharge of tailings from embankments – this could increase embankment stability by removing pond water from the edge of the embankment.
    - Deposit a fraction of tailings in one or more mined-out pits. The use of a mined-out pit for tailings disposal. This is an acceptable strategy and was practiced by Omai, Guyana in 2004. However, it may be limited at Matthew's Ridge by the potential to sterilize mineral resources and the expected need to construct and operate a water treatment plant.

Based on the assessment, the potential impacts from managing hazardous and non-hazardous waste as well as the mitigation and management measures are summarized in Table 22-2.

22.4.9 Landscape and Aesthetics

The ways in which the project has transformed the landscape and aesthetics during the construction phase and the changes anticipated to occur during the operational phase are outlined in Chapter 17. Ideally, a mining operation as a temporary use of land, should not impose any permanent constraints on the options for future beneficial use of the site, nor have any permanent effects on the local water resources, biodiversity and overall landscape quality or associated socio-economic development. The following measures are being implemented and will continue to be implemented by GMI to manage the landscape and aesthetics of the project:

- Maintaining a high standard of “housekeeping” and site stability. An example of this is facility of storm water management. Concrete-lined trenches and ditches and measures to ensure slope stability are extensive as shown in Figure 17-15, which demonstrates the application of shotcrete to an excavated slope.
- Minimising the project footprint to previously used or brownfield sites as far as possible including the footprint of the Tailings and Water Retention Dam to the previously used tailings pond.
- 24-hour monitoring of the Tailings and Water Retention Dam for detrimental impacts such as breaches.
- Minimising vegetation clearance to construct waste dumps.
- Stockpiling topsoils and organic material to assist in reclamation and revegetation.

In addition, GMI should implement the following mitigation and monitoring measures to ensure that risks associated with landscape and aesthetics:

- Build slope-stable waste piles so as to achieve a desirable condition and perspective at the end of the mine life. Slopes should be terraced for stability and should include rock-reinforced storm water drainage channels.
- Incorporate the following mitigation and monitoring measures into tailings management:
    - Poor lateral distribution of the solids and settling characteristics, *(frequent moving of discharge points, change in concentration of the tailings in the plant);*
    - Instability of engineered structures – dams and spillways, *(mitigation following frequent inspection by experts);*
    - Physical risk to local citizens and wildlife, *(fencing, barriers and security); and*
    - Poor profiling for a stable, self-revegetating condition on closure (*planning, monitoring and management modification).*
- Engage with local stakeholders periodically to achieve a mutually desirable result for positive mine aesthetics bearing in mind the rubric “if it looks good, it must be good”.
- Ensure that there is progressive reclamation throughout the life of the mine with annual monitoring to check on the status continuous mine rehabilitation.
- Undertake measures to be taken to mitigate the risks of non-rehabilitation of the mine:
    - Development of the mine Closure and Decommissioning Plan shorting after commencing operations in keeping with the national regulations. This Plan is anticipated to demonstrate that closed out Matthew’s Ridge and Port Kaituma facilities will represent minimal long-term deleterious legacies. The Plan should be updated as the operations progress.
    - Make sure that there is a budget allocation from GMI to take care of mine closure.
    - Ensuring that progressive reclamation occurs throughout the mine life.

Based on the assessment, the potential impacts to the landscape and aesthetics of the project areas as well as the mitigation and management measures are summarized in Table 22-2.

22.5 Social Management Plan

This section summarizes the potential social impacts of the project and the specific management measures GMI is expected to implement to minimize any adverse impacts, as well as, enhancing positive benefits associated with the project through the implementation of this social management plan. It considers the socioeconomic direct or indirect impacts as a result of project implementation. This information is obtained from the detail chapters in this report and include baseline, potential direct and indirect impacts and their severity (prediction and assessment) along with mitigation/management actions. This summary highlights the sources of impact by phase of the project (Construction and Operations) and the measures to be implemented by GMI.

22.5.1 Cultural Heritage

The potential impacts to cultural heritage from project activities and risks, inclusive of potential heritage sites within the areas of influence at Mathew's Ridge and Port Kaituma were assessed. Chapter 18 provides the detail information, including the specific measures to mitigate and manage the risks associated with damage or loss of cultural heritage sites or artefacts. Although there are no known sites in the area of influence, a combination of factors significantly increases the likelihood of inadvertent discoveries during project construction and implementation. These factors include proximity of key project components to known archaeological sites, the interaction of project infrastructure with community-owned historical heritage sites, the absence of a comprehensive assessment of the cultural, archaeological and natural heritage of the project areas and the total footprint of the project areas. Based on the assessment, the mitigation and management measures to manage the impacts especially during construction to reduce the impact on any "chance finds" must be handled in accordance with the Nations Trust Guidelines for the protection of monuments and sites (2017). These procedures are:

- Immediately cease all activities in the vicinity of the remains.
- Record the find location and leave all remains in place. The record should capture the site location, using standardize format established by the GMI and the National Trust of Guyana (NTG), including picture documentation and GPS coordinates of the site.
- Immediately inform the NTG of the find and establish a 30-meter (100-foot) buffer zone around the site until an archaeologist or Conservation Officer from the NTG evaluates the site and identifies a treatment method.
- The NTG should coordinate with the relevant personnel to determine the significance of the findings and assess appropriate mitigative options.
- Collaborate with the NTG to determine the appropriate course of action, if the significance of the remains is judged to be enough to warrant further actions which cannot be avoided.
- Relocation of the artefacts for preservation and security reasons may be determined as an appropriate action. The excavation of artefacts should only be recommended by the NTG or the University of Guyana and should be done by professional archaeologist using systematic excavation techniques once the site was evaluated by a heritage professional or the NTG and validated as one of archaeological significance.
- Contact the appropriate authority in the case of human remains. In addition, a coroner and/or physical anthropologist may be involved if the remains are classified as an artefact. Options for removal and burial should be considered if the location must be disturbed.
- The National Trust of Guyana should inform GMI of when work may recommence in the specific area.

In addition, to effectively safeguard indigenous and cultural heritage, GMI should also implement the following mitigation and monitoring measures:

- Engage local heritage organizations so as to train and sensitize its employees. Such training will significantly increase the probability of effectively identifying and protecting sites causing limited disruption and damage to invaluable cultural materials, if found. This training should include the development of a handbook for mine employees to simplify the site or artefact identification process with step by step guidelines for documentation, handling and site closure.

- Engage with the National Trust of Guyana to facilitate for a comprehensive assessment and appraisal of any structures which are of historical importance (buildings, bridges and railway). This will allow GMI, community members, and other contractors working in the area, to be provided with guidelines to manage rehabilitation and repurposing of sites while maintaining their integrity.

Based on the assessment, the potential impacts to cultural heritage as well as the mitigation and management measures are summarized in Table 22-2.

22.5.2 Socio-Economic Environment

The potential social and economic impacts and risks associated with the implementation of project activities and the baseline socio-economic conditions of the five settlements in the Matarkai sub-district were identified and assessed in Chapter 19. This includes the two key project locations at Matthew's Ridge and Port Kaituma as well as the settlements of Arakaka, Four Miles and Eclipse Falls whose residents are anticipated to have the greatest social and economic interactions with the project. The measures to be implemented by GMI to manage, mitigate and monitor these impacts are listed below:

- Providing accommodation for 200 employees at Matthew's Ridge and 20 employees at Port Kaituma.
- Sourcing most water for domestic purposes for employees at Matthew's Ridge from a spring which is not used by GWI.
- Self-generating electricity for operations at both Matthew's Ridge and Port Kaituma.
- Managing all waste generated during the operational phase of the project independently from the community waste management system.
- Ensuring that all expatriate employees are permitted to work in Guyana and comply with the laws of Guyana.
- Allowing shared use of project roads, in particular the bypass roads in Matthew's Ridge and Port Kaituma, to local producers such as farmers, small-scale miners (including pork-knockers) and loggers.
- Conducting safety training with employees including driving safety courses for drivers.
- Making provisions for dust suppression by wetting the road in Matthew's Ridge and Port Kaituma during the dry seasons.
- Purchasing foods items, such as eggs, from a local producer in Matthew's Ridge.
- Informing residents and local authorities of vacancies and application procedures whenever jobs are available.

In addition to these measures, GMI should also implement the following actions to manage the risks discussed above:

- Recommit to the MoU with the NDC and fulfilling all obligations undertaken for community development including maintenance of roads in Matthew's Ridge and creating an alternative recreational facility, in consultation with residents.
- Develop and continuous update to the Stakeholder Engagement Plan.
- Engage actively with the RDC and other local authorities to provide updates on the implementation of project activities and receive feedback and recommendations. GMI should also consider directly engaging with the RDC to determine whether the company could support the work of the Regional Disaster Risk Committee and further develop the systems for emergency response for potential incidents in which GMI may be involved.
    - Develop an Indigenous Peoples Plan (IPP), in consultation with indigenous peoples, outlining the measures GMI will undertake to ensure the indigenous people from Matthew's Ridge, Port Kaituma, the Matarkai sub-district and the wider Region 1 have opportunities to equitably benefit from the project and avoid exploitation. The IPP should be prepared following the principle of Free, Prior and Informed Consent and use culturally appropriate language and non-ambiguous terminology.
    - Designate personnel, preferably locals, who will conduct all company-led stakeholder engagements with local communities.
    - Develop a Grievance Mechanism accessible to community and provides for timely and meaningful action to be taken by the company.

- Develop procedures for safe use of local transportation networks which all drivers and barge operators must follow.
- Enhance vocational training for residents of Matthew's Ridge and Port Kaituma so that required skills do not have to be imported from other parts of the country.
- Training for all employees of GMI's internal procedures for accessing training, disciplinary measures and dismissal.
- Develop an awareness programme for employees, in consultation with community members, of cultural practices in the local communities and how these should be respected. In this regard a Code of Conduct for workers may be developed.

Based on the assessment, the potential impacts to the socio-economic environment as well as the mitigation and management measures are summarized in Table 22-2.

22.5.3 Community Health and Occupational Health & Safety

The baseline conditions associated with the implementation of the project which may impact or pose a risk to health and safety to project staff and local communities were identified and assessed. Chapter 20 provides detail information on health including a health risk assessment of the project activities considering the existing health conditions in the area of influence. GMI throughout project implementation will ensure its operation adhere to the highest occupational health and safety standards to:

- Protect employee health and safety;
- Protect operational plant and equipment; and
- Assure community and administrative confidence in the execution of activities.

Occupational Health and Safety Management will be implemented through the Health, Safety and Environment Department. GMI's mission statement of Occupational Health and Safety Management is to promote an appropriate, safe and conducive working area, so far as is reasonably practicable, by fostering a culture focused on awareness, open communication, safe education, supervision and safe working methods. GMI aims to:

- Promote safe and conducive working conditions.
- Promote a safe and secure environment that is conductive to learning, and is consistent with the educational goals of the community, while building community partnerships that foster trust.
- Promote the highest quality of Health and Safety practices with a wide spectrum of activities, to meet all its legal and moral obligations.
- Provide training and support for implementing best practices creatively in the fields of safety.
- Promote the highest standard of safety, health and welfare of all employees through an effective safety and health management system.
- Reduce the number of work-related accidents and incidents.
- Minimize the risk of work-related injuries and illness.
- Develop, implement and administer comprehensive environmental health and safety services, policies, and procedures.

Measures implemented by GMI to reduce the potential health risks associated with the project are listed below:

- Employing an Occupational Health and Safety Officer.
- Developing and implementing an Occupational Safety and Health Policy which outlines, among other things, the duties of the company's Health and Safety Officer.

- Providing employees with all relevant PPEs. Issuance and adherence to the use of personal equipment underscores GMI's safety program and practice. Safety gear, inclusive of helmets, industrial boots, dust masks, earmuffs/plugs to protect the ear from noise/vibration; gloves, safety vests and safety glasses will continue to be issued depending on the activity.
- Preparing and implementing an Emergency Response Plan (ERP) to respond to any injury or disease, including occupational injuries, of its workforce. Under the emergency response plan, when a situation occurs involving a casualty, the Pakera District Hospital and the Port Kaituma District Hospital, depending on where the incident occurred, will be informed immediately. Upon arriving at the scene, the medical personnel will assess the patient and inform the senior GMI person onsite whether the Hospital can treat the patient of whether an Emergency Medical Evacuation will be required. If an emergency medical evacuation is required, GMI will put measures in place to facilitate emergency evacuation via air to the GHPC as detailed in the Emergency Response Section.
- Constructing and upgrading all septic systems in accordance with the GNBS Guidelines for the Construction of Septic Tanks and Associated Secondary Treatment and Disposal Systems.
- Sealing of the tunnels from which bat droppings and other debris containing histoplasmosis spores were excavated.
- Contributing to the local and regional response to the COVID-19 pandemic by donating masks, hand sanitisers, disinfectants and rapid test kits.
- Implementing measures to protect workers from the spread of COVID-19 including installing wash stations, temperature checks and mandatory masks for all workers.
- Designing the open pit mining systems to mitigate risks associated with pit cave in.
- Providing frequent training sessions to employees on occupational health and safety including safe driving.
- Making provisions for road wetting in Matthew's Ridge and Port Kaituma.
- Providing safe transport, handling, storage and use of explosives which will be supported with the use of a dedicated marine barge and a specialized explosive truck. Transport by armed escort explosive use will also be undertaken.
- Commencing construction of concrete drains which allows for improved drainage of the area, thus playing an important role in vector control.
- Implementing measures to prevent dust and manganese emissions by regular wetting of roads, stockpiles areas, mine sites, conveyor system and by covering trucks transporting the product to Port Kaituma. In addition, the crushers and the jigging machines are contained, so particulates of manganese would not be dispersed to surrounding areas during processing.
- Installing dams or drainage systems to prevent the water from the mining pits, stockpile areas, dumps and the processing site from contaminating the surface water which is used by community. The accumulated will be directed to the tailings pond or a designated water pond.
- Identifying the health and safety risks and determining the suitable mitigation measures as is outlined in the table below.

Table 22-1 Hazards and Mitigation Actions

Activity	Hazard	Action to Prevent, Protect and Mitigate
Stripping	Tree fall	Safety helmets, belts shoes and vests
	Snake bites	Safety shoes, anti-venin kit
Mining	Falls	Safety helmet, safety shoes, harness
	Dust	Dust masks
	Noise	Earmuffs and plugs
	Collisions	Speed control, safety vest, safety belts
	Uncontrolled Blast	Safety explosive practices
	Slope Failure, Rockslides	Safe batter angles

Activity	Hazard	Action to Prevent, Protect and Mitigate
Engine Operation Generator, Crushers, Tugs	Noise	Earmuffs and plugs
	Heat	Temperature Management
Workshop Operation	Noise	Earmuffs and plugs
	Welding	Visor
	Burns	SWPs, Equipment
	Fire	Housekeeping, control aids
On/Off-Site Spill	Water contamination	Contain, collect, absorb, remove
Water Storage	Dam overtopping, Breakout	Monitor, Repair, Collect
Heavy Equipment	Noise	Ear plugs
Light Vehicles, Haul Trucks	Collision	Safety vests, safety belts
Flooding	Inundation of equipment	Monitor, relocate
	Drowning	Boats, floats, life vests
Barge Operations	Collision, Run -aground	Watch-keeping, navigations aids, GPS
	Foundering	Load, Sea State and Sea worthiness draught and load-line monitoring.

In addition to these measures, GMI should also implement the following actions to further manage the health and safety risks:

- Occupational and Community Health and Safety
  - Establish a Health and Safety Committee to oversee Health and Safety of the operation and the implementation of the Occupational Safety and Health measures required by the regulations. The committee should meet at least monthly.
  - Strengthen the OHS Department by including additional personnel to implement and monitor the OHS requirements.
  - Develop, in partnership with the MOH and the Pakera District Hospital, a surveillance programme to identify incidence of an adverse health outcomes associated with high levels of manganese exposure.
  - Regularly fog its compounds and ensure that all employees are supplied with treated mosquito nets.
  - Install appropriate safety signage throughout each component of the operation to ensure workers are aware of the risks and hazards and the necessary OSH actions. Signage should also be erected along the roadways in hazardous areas.
  - Develop a system to prepare Job Safety Assessments (JSA) for each job at GMI and ensure that there are daily toolbox talks and briefings of these JSAs before work begins.
  - Conduct periodic meetings with local communities to receive feedback on issues related to community health and safety associated with the project activities.
  - Continue to support local and regional authorities to prevent the spread of COVID-19.
  - Cordon off and mark the areas where the bat droppings and other debris contaminated with histoplasmosis spores were buried.
  - Only competent and authorised personnel should operate machines and in a manner that does not endanger other employees or company property. Passengers should not be permitted on mobile equipment unless they are being trained to operate the machine or are required to ride on it as an unavoidable part of their duties provided it is safe to do so.
  - All waste should be properly collected, stored and disposed and monitor waste disposal pits to reduce conditions favourable to mosquito breeding.
  - Develop a Blasting Plan which should address the safety of workers as well as the community.

- Administer random drug and alcohol testing to ensure that employees are adhering to GMI's OSH and drug and alcohol policy.
- Equipment controls and alarms will continue to be maintained to ensure fail safe operation. This relates to mobile, tracked and crushing, processing and conveying equipment. Regular washing and cleaning for dust and moisture removal particularly for electronic components and contacts will be done to increase efficiency and improves performance.
- Fire response materials and equipment such as sand buckets, extinguishers, water sources and pumps will be placed at specific fire points for easy access. Employees will be trained and informed on use and location in order to respond to a fire should there be a need. Lubricants, grease and fuel will be stored and managed in accordance with the guidelines provided by the EPA and GMI will monitor use and disposal to prevent accidents in the environment and reduce risks to human health and safety.
- GMI will seek support from the GPF on the safe handling, use and storage of explosives. This will ensure there is high standards of administrative and operational safety, inclusive of safe handling, use and storage of explosives in GMI's mining activities. Marine barge and specialized explosive trucks will be used to transport explosives to maintain public safety and reduce risks to human health.
- Attention will be placed to worksite and equipment ergonomics to improve health and safety to workers. Mobile and tracked equipment with enclosed operator spaces are already on site. The construction of the new administrative buildings onsite helps to improve administrative functioning of operations, delivery related to control, reporting and housekeeping.

- Water and Air Quality
  - Develop a water quality monitoring programme, in partnership with GWI, to regularly monitor manganese levels in the Matthew's Ridge community water supply. If manganese levels exceed safe consumption levels, GMI should work with GWI to make an alternative source of drinking water available for community members.
  - Monitor water quality for physio-chemical and biological parameters and trace metals on a monthly basis.
  - Develop an air quality monitoring programme to determine levels of manganese in the air at high-risk worksites (manganese extraction and processing) and sensitive receptors down-wind of these sites.
  - Put measures in place to manage levels of dust/particulate matter from the operations to:
    - Remove dust/mud accumulations as an ongoing feature of operations.
    - Wetting of spoil piles.
    - Screening of operational sites with vegetation to trap dust.
    - Re-vegetating of reclaimed areas.
  - Cover manganese transported by truck or barge.
  - Provide N95 masks for all employees working in areas where risks of exposure from manganese dust are high in particular employees involved in manganese extraction and processing.

- Awareness and Training
  - Develop training modules on the handling of hazardous materials and waste.
  - Continuous review and training for the blasters ensuring their practice/procedures are supported by ORICA explosives supplier and the GGMC. The interface of the supplier and the institutional support and guidance of GGMC is pivotal to the maintenance of a high standard of administrative and operational safety to ensure the safe handling, use and storage of explosives in GMI's mining activities.

- Train all drivers and implement speed limits for company vehicles. All drivers should have a licence and should be made aware that extreme caution should be taken when passing through populated areas such as Four Miles and Eclipse Falls and driving during wet weather conditions.
- Field-test the provisions of the emergency response plan to ensure that the employees of GMI can expect the best possible response to any incidents.
- Train/educate workers on the dangers of substance abuse, STDs, drunk driving among other issues.

- Road Safety
  - Use and maintain safety berms and boulder lines to separate bench, ramp, sump and drainage areas to prevent employee fall, injury and equipment damage or destruction.
  - Institute traffic management measures during road construction. The roads should be carefully marked cordoned/manned in busy intersections by flag persons. Construction vehicles should be marked with reflectors to provide visibility at nights. Parked vehicles should be required to mark their location with reflective cones or triangles to warn oncoming traffic. Road construction workers should be required to wear high visibility vests during work hours. Material stockpiles should not impair sight lines.

- Hazardous Materials Storage
  - Store all hazardous materials in bunded tanks, storage bonds or under stock keeping management and accounting. Hazardous materials will be categorised based on use and chemicals required for water treatment and characterize of rocks, soils etc will be isolated in locked in storage with their Material Safety Data Sheets (MSDS) under restricted success.

Based on the assessment, the potential impacts to community health and workers occupational health and safety as well as the mitigation and management measures are summarized in Table 22-2.

22.5.4 Land Acquisition and Resettlement

Chapter 21 provides detail information on the extent of communities' occupancy within the project area of influence. While no permanent communities are within the project boundaries, communities occupy areas within the project environmental and social areas of influence. At least nine (9) occurrences are within the Tailings Pond area at Matthew's Ridge and three (3) waterfront structures located at the area designated for the Kaituma Marine Terminal. The impacts associated with planned activities during construction and operations, including displacing the individuals in the project areas have also been identified and assessed, including a risk assessment associated with resettlement, land acquisition and livelihoods. Recognising that relocation is an unavoidable measure during project implementation and to prevent disputes, mechanisms have been instituted by GMI to address/mitigate and manage the impacts from relocation. The mitigation and management measures are highlighted below:

- Engaging with the local authorities before commencing discussions with land occupants on resettlement.
- Ensuring that there was independent third-party valuation of commercial resources on the properties to be acquired.
- Engaging with occupants in a spirit of goodwill to reach mutually agreeable compensation and resettlement packages.

GMI should also implement the following measures:

- Engage with the NDC and residents to determine the most suitable recreational facility for the Matthew's Ridge community.
- Develop a Stakeholder Engagement Plan outlining the measures to be taken to continuously engage with stakeholders and the community.
- Preparation of a Grievance Mechanism to allow for individuals, residences and transient groups, if they believe that they are being unfairly denied access to traditional land engagement and livelihood activities, to have an avenue to engage with the company.
- Prepare a Relocation and Resettlement Plan if further relocation is required in the future.

Based on the assessment, the potential impacts of land acquisition and resettlement as well as the mitigation and management measures are summarized in Table 22-2.

Table 22-2: Summary of Impacts and Mitigation and Mitigation Measures

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
WATER RESOURCES			
Surface Water Quality			
Project Operations	Disruption to water balance of surface water hydrological systems used by the project	Establishing a water balance of project use of water compared with capacity and recharge rates of local hydrological systems.	Monitor water consumption of project activities and minimize make-up water required for ore processing
Land clearing for mine development; roads, storm water	Potential run-off and sedimentation adversely impacting water quality	Diversions; installation of skimmers/oily water separators; Collecting runoff and retention in settling/mine water pond. Develop and implement a Project Erosion Prevention and Sediment Control Plan); Management of drainage and storm water runoff on haul roads to minimize sedimentation. Maintenance of topsoil/organic matter stockpiles; and grading, scarifying, and re-vegetation of road ROWs, exploratory roads, and other temporarily cleared areas.	Monthly monitoring of water quality in accordance with the Water Management Plan and development of Water Quality Monitoring Programme (WQMP) to ensure that controlled discharges meet quality standards defined by the Guyana EPA and IFC guidelines
Mine pits blasting and excavation of overburden and ore, stockpiles, waste rock dumps	Modification of hydrologic flow, increased percolation, subsidence, decreased water levels. Slope failure of waste rock and ore and overburden stockpiles disrupting surface flows	Assessment and development of water balance plan to determine and manage modification of hydrologic flow.	Monitor water consumption of project activities. Periodic monitoring of the physical integrity of the waste rock and stockpiles.
Development and operation of mine pits, waste dumps, and rejects pond	Acid mine drainage and elevated metals in surface flows, creeks and streams in vicinity of mine pits, waste dump, and rejects pond	Implementation of Erosion Prevention and Control Plan and Storm water Management Plan.	Monitor in accordance with EPSCP and storm water management plan, and WQMP

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
Effluent discharge from mines and processing plant; Effluent discharge and from Rejects/Tailings pond	Contamination and elevated turbidity, manganese, heavy metals in surface flows creeks, streams in vicinity of mine pits, processing plant, and rejects pond; Tailings overflow of effluent into creeks and streams and elevating levels of manganese, heavy metals and other contaminants	Treat and reuse effluent; development of probabilistic water balance; construction and operation tailings pond with sufficient freeboard; Installation and maintenance of supernatant pond pump back/recycling system to return reclaim water to processing plant; Installation of embankment seepage interception, collection, and return systems on rejects pond; maintenance of spillways, diversion ponds; development of mine closure plan	Regular monitoring of rejects pond water quality to ensure that controlled discharges are within the EPA and IFC limits.
Mining and Blasting	Environmental exposure to manganese in drinking water	Development of a water quality monitoring programme to measure manganese levels in community drinking water supply	
Accidental Discharges and Spills	Spills of fuel and oil contaminating and elevating oil and grease levels in creeks, rivers within mine site, Port Kaituma Marine Terminal, and along road and river transportation routes	Implementation of Emergency Response and Contingency Plan; Secondary containment and engineered spill prevention and control measures; preventative maintenance,	Inspection programs of equipment and machinery; monitor in accordance with monitoring plan.
Operations at mine and associated facilities and transportation of concentrates	Litter and solid waste clogging creeks, streams, and drains in and around mine site, processing plant, rejects pond, roadways, marine terminal at port Kaituma, Kaituma canal, river, and Barima River and Mora Passage. Spills of manganese concentrates into creeks, streams along road and river transportation routes (Kaituma and Barima Rivers)	Implementation of Waste Management Plan and following safe operational practices for project vehicles.	Monitoring in accordance with WMP
Groundwater Quality			
Mine pits excavation of overburden and ore	Dewatering and lowering of ground water levels and water table		Monitor on accordance with WQMP;

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
			Monitoring of the water levels and quality in the boreholes onsite in order to monitor fluctuations
Effluent discharge from mines and processing plant and seepage from rejects pond	Contamination and elevated levels of manganese, heavy metals due to seepage from mine pits, waste dump, rejects pond into groundwater	Implement TFMP	Monitor the quality of groundwater well in vicinity of tailings throughout the project lifetime. Monitor the water level and quality of the boreholes located down-gradient of rejects pond Sampling frequency weekly-monthly and as needed
Accidental Spills	Seepage into groundwater resulting in elevated levels of oil and grease	Implementation of a SPCP to prevent, and if necessary, contain spills of fuels, oils, or other contaminants. Use of spill response kits, portable floating booms etc	Monitoring in accordance with SPCP and WQMP
Availability of Potable Water	Low extraction/demand rates	None required. Supplemented by storage of rainfall water.	GMI should however monitor rate of extraction.
Cumulative Impacts			
Ongoing small-scale gold mining	Combined contamination of surface waters, elevated turbidity levels; mercury, E. coli, and other pollutants in an around creeks within 10 km of Matthews Ridge, and Port Kaituma	Implement all environmental safeguards; meet discharge limits; Collaboration with GGMC and EPA	Monitoring in accordance with WQMP. Monthly-Quarterly inspections/monitoring of main creeks and rivers adjacent to SSM areas in Matthews Ridge and Port Kaituma
SOILS AND GEOLOGY			
Open Pit Mining	Erosion, topsoil removal and loss, AMD, land subsidence, landslides and flooding	Adherence to Operational Controls Implementation of management plans	Continuous monitoring throughout the project lifetime
Blasting	Flyrock, ground vibrations. liquefaction	Adherence to Operational Controls Implementation of management plans	Continuous monitoring throughout the project lifetime

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
Project construction and operations	Contamination of soils	Adherence to Operational Controls	
AIR QUALITY			
Fuel Combustion from Stationary and Mobile Sources	Emissions of diesel PM and pollutant gases (NOx, SOx, CO, VOCs, etc)	Adherence to Operational Controls	Monitoring of air quality parameters PMs, including manganese dust, and pollutant gases (NOx, SOx, CO, VOCs, ozone)
Overland Transportation	Emissions to particulate matter as dust generated by vehicles traversing the laterite roads	Road wetting in Matthew's Ridge and Port Kaituma. Reduced speed limits, installation of speed bump and patrols to ensure compliance of project vehicles in the Eclipse Falls community.	Monitoring of air quality parameters for PMs on project roads including the Matthew's Ridge to Port Kaituma public road
Mining and Processing Ore	Environmental exposure to high concentrations of TSP, including manganese dust	Adherence to Operational Controls	Monitoring of air quality parameters PMs including manganese dust
Mining and Processing Ore	Occupational exposure to high concentrations of TSP, including manganese dust	Adherence to Operational Controls Provision of N95 masks for high-risk staff Dust suppression of ore stockpiles and spoil piles	Monitoring of air quality parameters PMs including manganese dust
Fuel Combustion from Stationary and Mobile Sources	Formation of Ozone	Adherence to Operational Controls	Monitoring of air quality parameters PMs, including manganese dust, and pollutant gases (NOx, SOx, CO, VOCs, ozone)
CLIMATE AND CLIMATE CHANGE			
Mitigation			

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
Climate and Climate Change	Greenhouse gas emissions from fuel combustion and land cover change	Adherence to Maintenance Schedules	▪ Continuous monitoring and record keeping of fuel combustion from all combustion sources. ▪ Monitor the energy distribution to prevent losses. ▪ Staff awareness and education on energy conservation measures.
Climate and Climate Change	Land cover change from project construction impacts the Land Degradation Neutrality initiative	None required	None required
Adaptation			
Climate and Climate Change	Flooding of the project roads resulting in surface ponding of water resulting in wash-boarding that weakens road substructure, increased risk of developing or worsening potholes, and increasing erosion.	Establishing a system for drainage of the roadway including: ▪ Roadside drainage for surface runoff including turnout drains, ditches at frequent intervals, ▪ Installing structures for cross drainage of the road and ensure that these structures are sufficiently elevated.	Monitor road conditions bi-weekly, or more frequently, during the rainy seasons to rapidly identify areas in need of repair and maintenance.
Climate and Climate Change	Increased heat stress to project workforce and future users of road and bridge	▪ Developing an occupational safety and health protocol for the work force to follow during periods of high temperatures including access to emergency health care should a heat stroke occur. ▪ Building awareness of the work force to signs and symptoms of heat stresses and measures to bring relief.	Monitor the implementation and adherence of the occupational, health and safety protocol.
Climate and Climate Change	Increased emissions of dust from project vehicles passing through Eclipse Falls.	▪ Reduced speed limits, installation of speed bump and patrols to ensure compliance of project vehicles in the Eclipse Falls community.	
Climate and Climate Change	Droughts and drought-like conditions impacts water available for ore processing	▪ Continue to explore options for maximizing operational efficiency. Measures being considered include maximising processing	

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
		during the wet seasons to create an ore stockpile at Matthew's Ridge and maximising overland transport during the dry seasons to stockpile at Port Kaituma.	
Climate and Climate Change	Droughts and drought-like conditions impacts water available for domestic purposes.	▪ Establishing a system to store a minimum quantity of potable water required for domestic purposes at both Matthew's Ridge and Port Kaituma	Monitor water levels in the spring from which water is extracted for domestic purposes during dry periods to ensure that sufficient quantities are available for use.
BIOLOGICAL AND ECOLOGICAL RESOURCES			
Construction Phase – Vegetation			
Land clearing in areas identified for upgrade works	Loss of habitat and vegetation cover of predominantly secondary growth forest	▪ Vegetation clearing procedures will be developed to ensure that vegetation removal is staged to minimise soil erosion, unwanted loss of vegetation cover and that remnant vegetation is preserved, particularly the riprian gallery forest habitats of the project site. ▪ Riparian cover vegetation will be maintained in place to the extent practical as vegetative exclusive zones to protect the forest and aquatic habitats, which are important biodiversity corridors. ▪ Clearing will be conducted to maintain the aesthetics of the natural landscape and will be limited only to areas required for construction.	▪ Establishment and implementation of a vegetation monitoring plan, which will include, inter alia, the monitoring of changes in the vegetation structure of the habitats along the boundary of the tailings impoundment dams where ground water levels may rise. ▪ Water quality of receiving water bodies within project impacted areas will be continuously monitored to
Land Clearing for the new access road from Port Kaituma to the storage and wharf facility	Loss of habitat and vegetation cover of predominantly mature forest		

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
Land clearing in areas identified for upgrade works	Loss of natural habitat and the intensification of habitat fragmentation	▪ Re-vegetation utilising native vegetation will be applied where practical, particularly in areas susceptible to erosion. ▪ Vegetation clearing for the road expansion works will be limited to the area designated within the existing easement of roads. ▪ Maintaining to the extent practical the riparian forest along the road and creek intersections for wildlife corridors. Consideration will be given to the establishment of vegetation cover for animal passage particularly at stream crossings, and wildlife underpass crossings at bridges and culverts for species with reduced movement capabilities, and the maintenance of canopy cover across roads to benefit movement of *Ateles paniscus*. ▪ Vegetation waste and surplus soils from land clearing will be land spread to conform to the natural topography of the surrounding area to minimize water accumulation, provide general stability and to maintain relative ease of movement for wildlife. ▪ The clearing and creation of new areas for source materials for construction activities such as quarries should be avoided and maximize the use of existing quarries and borrow pits, where practical. ▪ Overburden and cleared vegetation may be utilized in the restoration activities to foster native plant regeneration, where practical.	ensure ecologically acceptable turbidity, nutrient and sediment levels are maintained during construction.
Land clearing in areas identified for upgrade works	Loss of vegetation cover along the riparian habitats		
Land clearing in areas identified for upgrade works	Changes in the water (nutrient) quality of the tailings pond		
Land clearing in areas identified for upgrade works	Loss of cover vegetation and the depletion of soil nutrients from enhanced leaching		

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
Land clearing in areas identified for upgrade works	Loss of vegetation cover and increases of nutrient loads in receiver water bodies	▪ The Project will establish a vegetation monitoring plan, which will delineate the vegetative exclusive zones, and clearing zones, and establish a monitoring regime to ensure vegetative zones are not inadvertently encroached or destroyed. ▪ The tailings pond will be scraped of topsoil material, grasses and trees as part of the preparation process for the facility to receive tailings.	
Construction Phase – Terrestrial and Aquatic Fauna			
Land clearing in mature forests areas - the new access road from Port Kaituma to the new storage and wharf facility	Loss of vegetation and intensification of the barrier effect	▪ Vegetated corridors will be maintained, and construction activities timed to enable wildlife present in the area to relocate to adjacent areas. ▪ Animals with reduced movement capabilities will be allowed to escape if encountered by construction workers. ▪ Areas of standing water will be bridged via culverts and or bridges. Bridge spans for new bridges will be wide enough to provide under passage for animals during the wet and dry seasons. ▪ Culverts will be designed to enable the passage of migratory aquatic species by incorporating baffles to slow the flow enough to allow fish and others to swim against the current, and by setting culvert bottoms below the level of the stream bed. Consideration will be given in the design of culverts to include eco-passage sizing, substrate placement, natural lighting and water level requirements for fishes, small mammals and herpetofauna.	▪ Receiver water quality will be continuously monitored during construction to ensure ecologically acceptable turbidity, nutrient and sediment levels
River dredging of Kaituma canal and the Waini Mora Passage	Habitat loss and displacement of benthic fauna		
Construction and rehabilitation of project infrastructure - newly laid culverts and or bridges	Blocking of wildlife corridors		
Land clearing in areas identified for upgrade works	Loss of vegetation cover and increase of sediments transported to receiving water bodies from eroded soil		

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
Construction activities and physical disturbances	Noise produced by equipment, imposing additional stresses upon wildlife, leading to increased displacement	▪ The maintenance of native vegetation not earmarked for land development, particularly in areas along the riparian forest habitats of the streams at the intersection of road infrastructure. ▪ Worker camps and dwellings will be routinely sanitized and camp food ration and waste storage and disposal will be according to best practices. ▪ Develop and implement an Erosion and Sediment Control Plan, and implement spill clean-up measures outlined in the Emergency Response Plan to mitigate potential erosion, sediment and hydro-carbon contamination impacts. ▪ Hunting, fishing and gathering of wildlife in the Project area by construction employees will be strictly prohibited. The workforce will be educated about the consequences of hunting. ▪ Drivers will be educated on avoiding road kills of wildlife and reporting incidents of accidents with wildlife. ▪ Species migration routes will be studied to establish migration patterns and animal crossing signage, and other forms of animal crossing awareness signalization installed at established crossing paths.	
Construction activities	Hydrocarbon contamination of the aquatic systems		
Construction activities - presence of workers and work camps	Increase in domestic and synanthropic species		
Construction activities - presence of workers and work camps	Increase in hunting and roadkill of wildlife		
Operation Phase - Vegetation			
Operation of the tailings facility	Rise in the level of the ground water level/table in surrounding areas of the tailings impoundment, resulting in the proliferation of vegetation more adapted to abiotic conditions	▪ Wetting roads where practical during the dry seasons to reduce dust draft and settlement on vegetation. ▪ Hydrological studies of the Pakera Creek will be undertaken to determine seasonal environmental flows and replenishment regimes, industrial and processing water needs and the appropriate water withdrawal rates from the pond.	
Abstraction of water from Pakera for industrial processing	Intensive extraction of water from the pond, inducing water stress in		

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
	the ecosystems of the pond and the adjoining Pakera creek	▪ The Project will establish a vegetation monitoring plan, which will include inter alia, the monitoring of changes in vegetation in areas along the margin of the tailings pond where the ground water levels may rise.	
Traffic on access roads	Dust impacts on early succession/edge and secondary forest habitats		
Operation Phase – Terrestrial and Aquatic Fauna			
Process discharge to the tailings pond	Impaired water quality in the pond, resulting in a direct, permanent loss of aquatic habitat within the pond	▪ Animals with reduced movement capabilities will be allowed to escape if encountered. ▪ Vegetation will be maintained in place to the extent practical within Project impacted areas, for example, the riparian gallery vegetation along the riverbanks and along the intersection of road infrastructure and river/creeks crossings. ▪ Worker camps and dwellings will be routinely sanitized and camp food ration and waste storage and disposal will be according to best practices. ▪ Hunting and gathering of wildlife in the Project area by employees and visitors will be prohibited. ▪ The workforce will be educated about the consequences of hunting. Drivers will be educated on avoiding road kills of wildlife and reporting incidents of accidents with wildlife. ▪ Develop and implement an Erosion and Sediment Control Plan, and implement spill clean-up measures outlined in the Emergency Response Plan to mitigate potential erosion, sediment and hydro-carbon contamination impacts. ▪ Implementation of a vegetation monitoring plan, which will include, inter alia, the monitoring of changes in the vegetation structure of the habitats along the boundary of the tailings	▪ Monitoring of receiver water quality to ensure ecologically acceptable turbidity, nutrient and sediment levels
Increase in marine traffic	Incremental increase in temporary avoidance behaviour and displacement of aquatic fauna within the trans-shipment route		
Operation activities	Hydrocarbon contamination of the aquatic systems		
Operation activities - presence of workers and work camps	Increase in domestic and synanthropic species		
Operation - presence of workers and work camps	Increase in hunting and roadkill of wildlife		
Operation activities and physical disturbances	Noise produced by equipment, imposing additional stresses upon wildlife, leading to increased displacement		

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
		impoundment dams where ground water levels may rise. ▪ Construction of the tailings impoundment at a rate slow enough to allow aquatic organisms to relocate outside of the footprint of the pond.	
Closure Phase			
Regeneration of the project areas	Encroachment by particularly aggressive and unwanted plant species (pests)	▪ A weed management program will be implemented to control the spread of pest species. ▪ As far as is practical only native species will be utilized for re-vegetation purposes. ▪ GMI will prepared a detail Closure Plan prior to closure.	
NOISE AND VIBRATIONS			
Noise including Noise from Blasting Activities	Noise Nuisance to Sensitive Receptors	▪ Adherence to Operational Controls Informing communities in advance activities with significant potential for noise generation	Monitor daily during blasting for first few weeks of operations and intermittent monitoring as necessary thereafter.
Noise	Hearing impact to workers	▪ Blast management Plan and adherence to Operational Controls ▪ Noise insulation of workers living and dining areas	▪ Company should conduct regular (weekly/monthly) on spot SPL checks as part of their HSE programme. It is recommended that a detailed bi-annual assessment of SPLs be conducted by independent assessor. ▪ Frequent training sessions on OSH practices for noise management ▪ Frequent refresher trainings on the Blast Management Plan
Vibrations from project activities	Potential damage to buildings, Nuisance to Sensitive Receptors	Blast Management Plan and adherence to Operational Controls	Monitor daily during blasting for first few weeks of operations

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
			and intermittent monitoring as necessary thereafter.
TRANSPORTATION			
Rehabilitation of Matthew's Ridge to Port Kaituma Public Road	Replacing road surfaces, widening of the road, improving sight lines, installation of drainage features	Engagement with Ministry of Public Works on design specifications and works already undertaken	Periodic meetings with residents and local authorities to receive feedback and recommendations
Construction of Port Kaituma Bypass Road	Increase access to previously inaccessible areas		
Maintenance of Matthew's Ridge Internal Roads	Non-fulfilment of MoU with the NDC	Fulfilling all obligations made to local authorities	
Road Rehabilitation and Maintenance	Improper storage of material stockpiles, inadequate traffic management	Adherence to Operational Controls Development of Grievance Redress Mechanism	
Contamination of soils and surface water during construction of transportation infrastructure	Spills of fuel and waste oil, improper disposal of garbage	Adherence to Operational Controls	Development of water quality monitoring programme
Heavy vehicles transporting ore or other supplies; Other project vehicles	Increased traffic resulting in greater dust emissions from laterite roads	Adherence to Operational Controls	Development of air quality monitoring programme
Heavy vehicles transporting ore or other supplies; Other project vehicles	Increased traffic contributing to increased frequency of vehicular incidents and accidents	Training to Drivers on Safe and Defensive Driving; Developing rules for road safety Installation of safety signage along the road Installation of mile markers Engaging with communities on proper and safe use of the roads	Periodic meetings with residents and local authorities to receive feedback and recommendations
Project Transportation	Shared use of project bypass roads contributing to socio economic development		

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
Project Transportation	Shared use of project bypass roads contributing to increased accidents and incidents	Training to Drivers on Safe and Defensive Driving; Developing rules for road safety Installation of safety signage along the road Engaging with communities on proper and safe use of these roads	Periodic meetings with residents and local authorities to receive feedback and recommendations
Project Transportation	Heavy vehicles and machinery contributing to road deterioration	Engage with the Ministry of Public Works to develop a schedule of maintenance activities which can be conducted by GMI	Monitor conditions of roads used by the project
Heavy vehicles transporting ore or other supplies; Other project vehicles	Slush generated from wet laterite road contaminates surface runoff during the rainy seasons	Adherence to Operational Controls	Develop a water quality monitoring programme
Accidental Discharges and Spills	Spills of fuel, oil and sewage contaminating and elevating oil and grease levels in Port Kaituma Marine Terminal, and along road and river transportation routes	Adherence to Operational Controls	
Barging of manganese concentrates	River incidents and accidents involving collisions with small and large vessels	Development of barging schedule in consultation with MARAD, local authorities and residents Notices of barging schedule Instituting safety measures for barging which will be checked before leaving the Terminal Development of a Grievance Redress Mechanism	Engaging with communities in the tertiary AoI receive feedback and recommendations
Transportation of Explosives	Accidental detonation during transport	Separate transportation of explosives and detonator Inspection by the relevant authorities Armed escort from the Guyana Police Force	
Air transportation	Increased revenues for local air service operators		

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
HAZARDOUS WASTE AND OTHER WASTE MANAGEMENT			
Tailings management	Failure or escape of tailings from the Tailings and Water Retention Dam	Adherence to Operational Controls	Monitoring lateral distribution and settling of solids, instability of engineered structures
Dumping of mine waste (rocks and soils)	Landslides and subsidence under load of mine waste	Adherence to Operational Controls	Monitoring of land stability in waste dumps
Management of mine waste	Acid Mine Drainage	N/A	Development of a water quality monitoring programme
Discharge of mine water	Sedimentation or discolouration of waterways		
Management of general solid waste	Significant accumulation of non-biodegradable waste on site	Establishment of waste-disposal pits and scrap yards Engage the NDC on determining a location for these pits Installation of an incinerator	Management of waste disposal pits, covering as necessary and establishing new pits
Dredging of the Kaituma Canal	Improper disposal of dredge spoils	N/A	Engagement with MARAD and the GL&SC on disposal of dredge spoils
Disposal of Food Waste	Improper disposal of food waste attracts pests/vectors and leads to malodours	Creation of covered pit for the disposal of food waste Donating waste to community members for poultry rearing or composting	Routine monitoring of conditions at the disposal pit
Discharge of Domestic Wastewater	Discharge of unsettled sewage; discharge of unfiltered kitchen wash water	Upgrading all septic systems to meeting GNBS specifications Installation of oil/water separators for kitchen wash water	Routine monitoring of fill capacities of septic systems and oil/water separator to determine when cleaning is required
Project Construction and Operations	Spills from the improper collection and storage of waste oils including on long transport trips	Store all waste oil in an impervious bunded containment with an attached oil/water separator	Monitor condition of the bund and arrange for repairs as necessary
Project Construction and Operations	Spills and leaks from used oil filters	Drainage of used oil filters before disposal with general solid waste	

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
		Establish a drainage rack	
Project Construction and Operations	Improper disposal of used batteries	Consolidate storage of used batteries in an impervious covered area Only sell to EPA authorized dealers	Monitor the stockpile of used batteries to determine when sale is necessary
Project Construction and Operations	Spills of used chemicals	Consolidate storage of chemical waste in a restricted storage area Explore options for destruction of chemical waste locally (in Georgetown)	
Sewage Management	Biohazards arising from disposal of untreated sewage sludge	Sewage sludge removed and disposed only by commercial contractors	Monitor fill capacities of the septic systems
Raw Ore Storage	Disturbance of materials contaminated with histoplasmosis spores	Create ore stockpile over the area where contaminated materials were buried to prevent accidental excavation	
Project Construction and Operations	CFC-22 or PCBs contaminants	Avoid procurement of materials containing CFC-22 and PCBs	Monitor materials on-site to determine whether any contain these compounds
Project Construction and Operations	Potential for Scrap Metals becoming Hazardous	Draining all hazardous materials and chemicals prior to lay-down	Monitor laydown yard for spills
Transportation of hazardous chemicals and waste	Large spills of hazardous chemicals or waste	Adherence to Operational Controls	
Transportation of hazardous chemicals and waste	Frequent small spills of hazardous chemicals or waste	Proper fuel handling practices Use of drip trays	Training in proper handling practices
Disposal of general solid waste	Open containers and used tyres becoming breeding grounds for vectors	Cover all containers Fill tyres with overburden before using on the roads Bury excess tyres in mine waste dumps	Monitor waste disposal areas to determine whether any water accumulation is occurring
Disposal of Electronic Waste	Leaching of toxic compounds from improper disposal	Monitor materials on-site to determine whether any components contain toxic compounds	N/A

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
CULTURAL HERITAGE			
Cultural Heritage	Destruction of and looting	Comply with Chance Find Procedures. Train staff in handling chance finds. Engage with the National Trust of Guyana prior to and during rehabilitation of potential heritage sites.	
SOCIO-ECONOMIC ENVIRONMENT			
Project Construction and Operation	Employment	N/A	N/A
Planned and Unplanned Migration for Employment	Pressure on natural resources and social services, increased populations, increased crime, new transmittable diseases loss of culture	Continuous stakeholder engagements to manage expectations for employment Community consultations to develop CSR programme Development of Grievance Resolution System	
Project Construction and Operation	Unrealistic expectations for employment, negative perceptions of project and company	Fulfilling all obligations made to local authorities Consulting residents of Matthew's Ridge on the new recreation facility Expanding local procurement of goods and services Informing local communities well in advance of planned project activities such as blasting, ore shipment schedule Development of Grievance Resolution System	Periodic meetings with residents and local authorities to receive feedback and recommendations
Project Construction and Operations	Impacts on indigenous peoples including pollution, economic exclusion, inadequate emergency response, labour exploitation, sexual exploitation, loss of culture	Development and implementation of IPP Development of Grievance Resolution System	Periodic meetings with indigenous communities to receive feedback and recommendations

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
Vulnerable Groups	Vulnerable groups do not equitably benefit, increased sexual harassment and sex work	Development and implementation of IPP Stakeholder Engagement Plan and stakeholder consultations are gender responsive Development of Grievance Resolution System	Periodic meetings with residents and local authorities to receive feedback and recommendations
Overland Transportation of Ore	Road accidents and dust pollution	Implement road safety procedures all company drivers must follow	Periodic meetings with residents and local authorities to receive feedback and recommendations
Riverine Transportation of Ore	River accidents	Implement river safety procedures all company barge operator must follow	
Project Operation and Mine Expansion	Land Use Conflicts	Establishing boundary of lands leased and licensed by GMI Development of Grievance Resolution System	
Project Operations	Economic development and improved community well being	N/A	N/A
HEALTH			
Tailings pond, solid waste disposal pits	Increased incidence of vector borne diseases	Adherence to waste management practices Frequent fogging of GMI's properties Sleeping in nets or in meshed rooms	Malaria infection rate amongst workers Staff awareness and education on best health practises for malaria and other vector illnesses
Fuel Combustion	Respiratory effects	N/A	Implementation of an air quality monitoring programme
Road Transportation	Respiratory effects	Watering of Roads in dry season	Community engagement including with Eclipse Falls
Blasting, ore transportation	Environmental exposure to airborne manganese		Air quality monitoring programme to measure manganese levels

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
Project Construction and Operations	Water pollution resulting in increased incidence of water borne diseases	Proper disposal and management of solid waste and sewage	Water quality monitoring programme for physio-chemical and biological parameters as well as trace metals
Project Construction and Operations	Water pollution from accidental spills of fuel or other hazardous materials or waste	Proper handling and management of fuel, hazardous materials and hazardous waste	
Project Construction and Operations	Water pollution of groundwater resources	Proper disposal and management of solid waste and sewage Proper handling and management of fuel, hazardous materials and hazardous waste	
Project Construction and Operations	Environmental exposure to manganese in drinking water	Development of a water quality monitoring programme to measure manganese levels in community drinking water supply	
Occupational Exposure to Hazardous Materials	Negative health impacts		Training and awareness for employees on proper handling and management
Mining	Injury or death from mining pit cave in	Safe mine design parameters informed by local geological conditions	
Blasting and Explosives	Injury or death from blasting activities or explosives transport and storage	Separate transport and storage of explosives and detonators with armed guards Development of Blasting Plan	
Ore Mining and Processing	Occupational exposure resulting in manganism	Use of N95 masks for high-risk workers	Air quality monitoring programme to measure manganese levels
Project Construction	Injury or death from poor construction practices		Enforcement of safety and health measures Training in appropriate health and safety measures
Project Operations	Histoplasmosis Outbreak	Sealing of contaminated tunnels	

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
		Cordoning off areas where contaminated droppings and debris were buried	
Project Operations	COVID-19 Outbreak	Adherence to COVID-19 guidelines Hand-washing stations Employee Temperature Testing Mandatory masks	Enforcement of all COVID-19 mitigation measures
Project Operations	Injury or death from riverine accidents and incidents	Implement river safety procedures all company barge operator must follow	Periodic meetings with residents and local authorities to receive feedback and recommendations
Project Construction and Operations	Injury or death from road accidents and incidents	Implement road safety procedures all company drivers must follow	
Project Construction and Operations	STDs, drug and alcohol abuse	Random drug and alcohol testing	Training and awareness about the dangers of STDs and drug and alcohol abuse, etc
LANDSCAPE AND AESTHETICS			
Cleaning up of old infrastructure at Matthew's Ridge (MR) and construction of new infrastructure	Scrap and junk removal, some structures renewed; attractively designed infrastructure	Continue during operations and on closure Continue with neat and small footprint	Critical component of waste management. Some old waste components requiring responsible disposal. Robust housekeeping and construction waste management
Mining and mine waste management (including tailings containment)	Open pit mining at 9 locations, waste rock/soil at 4 dumps, new tailings facility built over old facility	Minimise footprint Consider alternatives including pit backfill	Essential component of project; cannot be significantly changed Technical review of embankment construction and tailings deposition during operations and on closure

Impact Producing Activity	Potential Impact	Mitigation/ Management	Monitoring
Bypass roads in Matthew's Ridge, Matthew's Ridge to Port Kaituma road and Eclipse Falls Bridge	Upgrade road and bridge to permit continuous passage by Project vehicles and by public	Continuous maintenance	
Shipping port on canal and access road	Modest degradation of historically altered landscape	Minimise footprint	
LAND ACQUISITION, RESETTLEMENT AND LIVELIHOODS			
Land acquisition and resettlement at Port Kaituma and Matthew's Ridge	Physical displacement and resettlement impacts	Providing compensation and assisting in relocation.	Regular engagement, implementation and Grievance Mechanism in place.
Land acquisition and resettlement at Port Kaituma and Matthew's Ridge	Livelihood and economic displacement impacts	Providing compensation and assisting in relocation.	
Restriction of access to Pakera Lake	Recreational displacement	Assist in providing alternative facility.	

22.6 Supporting Plans to be Prepared

Several Plans and Mechanisms should be prepared to support the implementation of this ESMP. These plans include:

- Erosion and Sediment Control Plan
- Water Management Plan
- Waste Management Plan
- Blasting Plan
- Closure and Decommissioning Plan
- Relocation and Resettlement Plan (only if additional resettlement is required when the project is operational)
- Stakeholder Engagement Plan
- Indigenous Peoples Plan
- Training Plan

Details on the areas to be addressed by these plans are outlined below.

22.6.1 Erosion and Sediment Control Plan

Planned project activities will include soil disturbance during construction and implementation and therefore, an Erosion and Sediment Control Plan should be prepared to mitigate the risks associated with erosion and sedimentation. The Plan may require modification as the project progresses and as onsite conditions warrant. Prior to developing an Erosion Prevention and Sediment Control Plan, it is important to have minimized the areas of disturbed soils and the duration of exposure. It is also imperative to control water at upslope site perimeters, control water on-site, control sediment on-site, and control sediment at the downslope site perimeters.

Objectives of the Erosion and Sediment Control Plan

The objective of the Erosion and Sediment Control Plan should be to:

- Identify potential pollutant sources that may contribute to erosion and contribute to the sediment loads of storm water runoff.
- Document the best practices that will be implemented in order to prevent, to the maximum extent practicable, erosion from occurring and sedimentation from leaving the site and entering the storm drain system during all phases of construction.
- Document erosion control, sediment control, and good housekeeping that must be implemented.

Components of the Erosion and Sediment Control Plan

The Erosion and Sediment Control Plan should comprise of five key components:

- A Location Map, and maps showing greater details, showing the proximity of the site to any surface water bodies and road among other project features.
- A Site Plan showing the existing conditions and should also soils map for the project locations.
- A Grading Plan and Construction Timetable showing the proposed finished contours and outlining the sequencing of the project, a key component of erosion control. The timetable does not have to contain specific dates, but should show how each phase of the project relates to the others. This plan should also show the measures taken steps to minimise the amount of exposed soil at any time.

- The Erosion Prevention and Sediment Control Site Plan and timetable should be prepared using the grading plan as a base. The site plan depicts the location of all erosion and sediment control measures and the sequencing of control measures. This may be combined with the grading and erosion control plans.
- The Erosion and Sediment Control Measures should briefly describe the four plans; highlight erosion control measures and why they will be effective, site characteristics, and erosion control done in the planning stages, such as phasing the project.

Issues to be considered in GMI's Erosion and Sediment Control Plan

Based on the recommendations of the EIA, the Erosion and Sediment Control Plan should include provisions for the following issues:

- Maintaining natural features, including vegetation, terrain, watercourses and similar resources should be preserved or installed, wherever possible.
- Restricting topsoil removal from the any areas outside the active mining areas on Hills 1 to 9.
- Putting measures in place to ensure that stockpiled topsoil and other organic matter is protected from rainfall and wind.
- Phasing site clearing operations to prevent large increases in sediment loads of discharge.
- Installation of sediment traps and screens to control run-off and sedimentation from active mining and developed areas.
- Designing a drainage system for spoil piles to minimize erosion and storm water runoff including such measures as a soil containment berm around the stockpiles.
- Examining one or a combination of erosion control blankets, geotextile fabrics and seeding to control erosion.
- Managing the process for dewatering of the mine sites.
- Undertaking efforts 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.
- Building slope-stable waste piles so as to achieve a desirable condition and perspective at the end of the mine life. Slopes should be terraced for stability and should include rock-reinforced storm water drainage channels.
- Using of a variety of techniques to stabilize or retain slopes including mechanical means via use of cement, limestone or other chemical agents; diverting and controlling surface runoff; and using terracing methods.
- Mine design parameters and mining methods, such as the layout of mine workings and the geometry and strengths of slopes and pit characteristics so as to mitigate risks of erosion.

22.6.2 Water Management Plan

Planned project activities will require the consumption of significant quantities of freshwater for ore processing and other industrial and domestic processes and therefore, a water management plan will be required. The Plan may require modification as the project progresses and conditions onsite change seasonally and as a result of climate change

Purpose of the Water Management Plan

The primary purpose of the Water Management Plan is to support the achievement of long- and short-term water management and to set realistic and achievable water use efficiency and conservation goals.

Components of a Water Management Plan

A comprehensive water management plan includes five components:

- Benchmarking current water consumption: Establishing a baseline against which future use is measured should be the first step. Once a baseline has been established, GMI should continue to measure consumption on an ongoing basis.
- Developing a water use profile: To quantity water use by various project components.
- Assign dedicated resources: Dedicated personnel should have the responsibility for tracking water use and making recommendations to improve management.
- Set targets and track progress: Create targets that demonstrate water use efficiency and track progress in achieving these targets.
- Training and education: Staff should be trained in water use conservation techniques.

Issues to be considered in GMI's Water Management Plan

Based on the recommendations of the EIA, the Water Management Plan should include provisions for the following issues:

- Establishing a water balance (including probable climatic events) for the water required by the project for processing as well as other industrial and domestic purposes and the recharge rates of surface water bodies particularly the Pakera Creek, Pakera Lake and spring used by GMI for domestic water.
- Minimizing the impact to natural systems by managing water use, avoiding depletion of aquifers, and minimizing impacts to water users. This should also include consideration of the water balance of aquifers prior to dewatering activities.
- Instituting measures to minimize the amount of make-up water required by the processing plant.
- Developing systems to monitor water consumption by the project on a monthly basis.
- Developing a water quality monitoring programme, in partnership with GWI, to regularly monitor manganese levels in the Matthew's Ridge community water supply. If manganese levels exceed safe consumption levels, GMI should work with GWI to make an alternative source of drinking water available for community members.
- Monitoring water quality for physio-chemical and biological parameters and trace metals on a monthly basis. This should include frequently monitoring of water sources at high risk of contamination including the Hill 5 spring, GMI's spring and upstream and downstream of operations at the Canal Bank, among others.

22.6.3 Waste Management Plan

GMI has developed a conceptual Waste Management Plan that provides potential waste management strategies for the disposal of waste generated from various waste streams throughout the project including waste management techniques which were practiced during the construction phase and measures that will be put in place to continue to manage waste during the operational phase. The conceptual Waste Management Plan prepared by GMI is presented in Table 22-3.

Table 22-3: Waste Management Plan Prepared by GMI

Waste Category	Potential Project Management Strategies
Food and domestic	▪ Pit disposal on site ▪ Food waste donated for composting to community members
Used Tyres	▪ Road safety barriers (tires are filled with overburden) ▪ Disposal and burial in pits of surplus tires

Waste Category	Potential Project Management Strategies
Construction, operations scrap and packaging	▪ Sort for recycle, or disposal in mine waste piles
Used PPEs	▪ Isolation, collection, and specific site disposal ▪ Incineration may also be a waste disposal option
Sewage Sludge	▪ Dedicated pit disposal on site with handling by a commercial operator
Used Batteries	▪ Assemble for sale to an EPA authorised dealer
Waste Oils	▪ Combustion in BOSAI kilns in Linden, Guyana ▪ Transfer for use as chain saw lubricants ▪ Transfer to commercial agent for recycle ▪ Incineration may also be a waste disposal option
Petroleum-Contaminated Soils	▪ Dispose in low permeability sections of mine waste at Matthews Ridge
Refrigerants and Transformer Oils	▪ CFCs, HCFCs and PCB-contaminated transformer oils and ballasts will be collected and stored for disposal in waste pits.
Mine Soils and Waste Rock	▪ Dispose in selected locations close to mine pits. ▪ Profile with dozers to minimize instability and gulley erosion – perimeter terraces with rock-armored drainage channels
Mine Pit Water	▪ Local discharge of pit water to sediment collection basin and the Tailings and Water Retentions Dam. ▪ Overflow will be released into the environment
Tailings	▪ Discharge as a 40% solids slurry into an engineered containment. ▪ Discharge at locations in north central tailings facility via a spillway, as necessary
Dredge Spoils	▪ Used a fill for lands in construction at Port Kaituma

The project is expected to generate significant quantities of waste throughout its lifetime in three main waste streams: hazardous waste, non-hazardous waste and potentially hazardous waste. In order to ensure that these waste are effectively and appropriately managed, a comprehensive Waste Management Plan should be prepared.

Purpose of the Waste Management Plan

The Waste Management Plan should provide guidance for the reduction, handling and disposal of waste throughout the lifetime of a project including the construction and operational phases of the projects. It should:

- Identify all of the waste streams and waste types to be generated from planned project activities and detail their origins.
- Provide information on the steps taken to lower the quantities of waste generated from the project.
- Provide an overview of the methods to be used for waste recovery, recycling and disposal.

In addition, the waste management strategies employed should be guided by the Waste Hierarchy outlined below:

- Reduce: Waste reduction measures can consider whether it is possible to reduce materials used by the work processes of the project while maintaining the safety and efficiency of planned project activities. For example, the reuse of water from the Tailings Pond for ore processing reduces the quantity of effluent generated by the project.
- Reuse: Waste reuse considered whether any of the waste generated may still be used by other project components. For example, the reuse of vehicle or machinery parts from scrap metals and reusing demolition and construction waste.
- Recycling: Waste recycling measures typically turn waste materials into other usable products such as composts.
- Recover: Waste recovery typically considers other methods in which waste disposal may be avoided and may include incineration.
- Disposal: Waste disposal involves the dumping of waste in specially created pits and should be considered as a measure of last resort within GMI's Waste Management Plan.

Components of the Waste Management Plan

When developing and implementing a Waste Management Plan the following key elements should be considered:

- **Waste Streams:** identify which waste streams are likely to be generated and estimate the approximate amounts of material.
- **Waste Avoidance:** Proactively outline ways in which the quantities of waste generated may be avoided.
- **Service Providers:** Given the remote location of the project, GMI should identify appropriately qualified waste management contractors who will provide services for the waste streams generated.
- **Waste Management System:** Outline how the waste management system will work on-site, including bin placement and access.
- **Assign Responsibilities:** Personnel in waste management are aware of their responsibilities in relation to the implementation of the Plan.
- **Train and Educate Personnel:** Educate personnel on all the various elements of the Waste Management Plan and ensure personnel have an opportunity to provide feedback.
- **Monitor and Evaluate:** On-site monitoring is important to ensure that the plan is being implemented. Adjust the Waste Management Plan to better cater to the operations if any challenges are identified.

Waste Types to be Considered in GMI's Waste Management Plan

Based on the findings of the EIA, the waste streams and waste types presented in Table 22-4 below should be considered in GMI's Waste Management Plan.

Table 22-4: Waste Streams and Waste Types for Inclusion in Waste Management Plan

Non-Hazardous Waste	Hazardous Waste	Potentially Hazardous Waste
Mine waste namely waste rocks, soils and tailings both from the historical mining activities and GMI operations	Contaminated/used oils, lubricants and filters and sludge from oil-water separators.	Scrap metal particularly retired vehicles and machinery
Mine water discharges	Used lead acid batteries.	Soils contaminated by hazardous materials or waste
Demolition waste	Chemical waste	Electronic waste

Non-Hazardous Waste	Hazardous Waste	Potentially Hazardous Waste
Construction and Operational waste including wood, containers, metal, plastics and used tyres, etc.	Used safety supplies	Open containers such as spent tyres that hold rain water (malaria mosquito risk)
Dredge spoils	Explosives residue	
Food and domestic waste	Sewage sludge	
Wastewater from domestic sources including liquid discharge from septic system, hauled sewage and kitchen wastewater	HCFC-22 refrigerants, if present and PCB-contaminated transformer oils and ballasts, if present.	

22.6.4 Blasting Plan

Planned project activities will require blasting to facilitate the establishment of the open pit for extraction and mining of manganese ore. As a consequence, a Blasting Plan should be prepared to guide the blasting operations and ensure that all blasts are conducted safely.

Objectives of the Blasting Plan

The objectives of the Blasting Plan will be to:

- Identify risks, hazards and controls.
- Identify site-specific requirements.
- Introduce blasting as part of the overall task.
- Control the blast process from design to initiation, evaluation and misfire treatment.
- Implement a review process to ensure that the objectives are met.
- Ensure the safety of the public, site personnel and surrounding properties.

Issues to be considered in GMI's Blasting Plan

Based on the recommendations of the EIA, the Blasting Plan should include provisions for the following issues:

- Examine or model various scenarios for blast design taking account of best management practices and operational controls to prevent harmful impacts to various receptors. Ultimately, the blast design selected should aim to limit airblast overpressure to lower than 120 dBA and that PPV to lower than 10 millimeters per second.
- Minimising PPV at critical points including the Mathew's Ridge settlement, at the Pakera reservoir dam, at the tailings pond dam, on the slopes of waste dumps and on the saprolite/saprock sections of open pit slopes.
- Adjusting the blast pattern if fly rock is observed or PPV values are too high at critical points.
- Establishment of a blast exclusion and safety zone so as to create a safe blast.
- Establishment of a blast exclusion and safety zone so as to create a safe blast. The Plan should evaluate whether the minimum safe blast radius of 500 to 600 meters established by the GGMC is appropriate for this site.
- Clearly outline procedures for engaging the residents of Matthew's Ridge to provide adequate notice prior to blasting exercises and to receive feedback from community members on any adverse impacts they experienced as a result of blasting activities.
- Occupational health and safety measures that should be followed by workers during blasting activities.
- Designing blast patterns based on geotechnical data within a high safety factor and adhering strictly to the blast design.

- Certification and experience of blasting personnel.
- Measuring flyrock, PPV and seismic impacts each time blasting is conducted.
- Engaging with residents to determine whether any significant adverse impacts of blasting are being experienced such as PPV, noise and dust emissions

22.6.5 Closure and Decommissioning Plan

Ideally, a mining operation as a temporary use of land, should not impose any permanent constraints on the options for future beneficial use of the site, nor have any permanent effects on the local water resources, biodiversity and overall landscape quality or associated socio-economic development. As such, GMI will be required to implement measures to ensure that project site is rehabilitated, decommissioned and closed. In this regard, GMI will have to prepare a Rehabilitation, Closure and Decommissioning Plan to be approved by the EPA and GGMC prior to closure of the operation. The reclamation process should allow for improvement to the current situation by properly closing out some of the existing deleterious legacies from the previous mining operation, such as the abandoned mining pits and overburden dumps. The aim of reclamation process should be to mitigate any adverse effect of the project by restoring as close as possible the pre-mining environment and the respective conditions, which is a self-sustaining ecosystem consisting of native flora and fauna or any other land-use to the benefit of the local community. The objectives of GMI's closure and reclamation process should be to:

- Produce safe and sustainable final landforms that will evolve over time in a manner compatible with the surrounding landscape;
- Produce a diverse mosaic of sustainable native ecosystems within the forest landscape with the aim of conserving biodiversity and maintaining evolutionary potential;
- Control erosion and develop self-sustaining water management infrastructure;
- Mitigate any exposure hazard from residual chemicals and/or mining waste; and
- Provide suitable conditions for establishment of a vegetation cover where practical.

Reclamation should be an ongoing process throughout the life of the mine and should be done progressively. There should be annual monitoring to check on the continuous mine rehabilitation efforts and progress

A detail Rehabilitation, Closure and Decommissioning Plan will be developed by GMI after operations begin for approval by EPA. This Plan is anticipated to demonstrate that closed out Matthew's Ridge and Port facilities will represent minimal long-term deleterious legacies. The Plan should be updated as the operations progress and should be informed through engagements with the community and relevant government institutions.

The principle closure issues relating to the project which should be addressed by the Rehabilitation, Closure and Decommissioning Plan includes:

- Removal of all machinery and equipment from the site;
- Dismantling of all buildings and structures;
- Closeout of haul roads;
- Restoration of watercourses, if practical or required;
- Rehabilitating overburden/waste rock stockpiles; and
- Addressing pit voids.

22.6.6 Resettlement and Relocation Plan

A Relocation and Resettlement Plan should be prepared if further relocation is required in the future. The findings of the EIA should be taken into consideration when planning such initiatives, including

the involvement of local government officials and stakeholders. The objective is to treat customary and formal rights as equally as possible in devising compensation rules and procedures. The plan should address the issues raised by the different tenure systems found in a project area, including the compensation eligibility so as to improve or restore, the livelihoods and standards of living of displaced persons, and to improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.

22.6.7 Stakeholder Engagement Plan

A Stakeholder Engagement Plan (SEP) should be developed for the involvement of all actors on the activities developed within the AoI, as necessary during the construction and implementation phase. Stakeholder engagements are critical for projects and or activities which may directly and or indirectly affect people; and it is equally as important to recognize that the environment is a public good. With this in mind it is essential to understand and document what these individuals' opinions and suggestions are, as they can contribute meaningfully to the implementation of project activities. The unique political, economic, social and cultural structures of indigenous peoples should also be taken into consideration in developing the SEP particularly given the relatively large populations of indigenous groups including Lokono, Caribs and Warrau within the project areas. It is also critical to initiate engagement with both Governmental agencies which have oversight of various planned project activities, local authorities including the RDCs and NDC, and non-governmental organizations such as conservation groups, youth groups and women's organizations among others. The SEP should be prepared prior to the project becoming operational.

Aim of the SEP

The aim of GMI SEP should be:

- To develop a stakeholder analysis of the project;
- To initiate open, two-way dialogue while seeking to communicate project activities to stakeholders;
- To foster involvement and identify issues and possible solutions face by stakeholders; and
- To charter a communication roadmap throughout the life of the project.

Issues to be addressed in the SEP

Based on the recommendations of the EIA, the SEP should be prepared and continuously updated (for example on a quarterly basis) to make provisions for the following:

- Continuous engagements with local authorities and residents to share updates on the project and receive feedback. This will also aid in managing expectations regarding the employment and economic benefits which may accrue from the project.
- Informing local communities, including communities along the river transportation route, of the planned project activities which may negatively impact them including mine blasting and barging of ore, among others.
- Periodically schedule meetings, quarterly or biannually, with representatives of the NDC and residents of Matthew's Ridge to discuss needs and opportunities for CSR interventions. This should also consider support to local communities to enable local producers to purchase equipment, tools or other supplies required to get their business ventures off the ground (such as micro-credit schemes and grants to encourage agricultural development, etc).
- Periodically schedule meetings with the CDCs and Village Councils of other communities to receive feedback on impacts they may be experiencing and get feedback.
- Inform community members of the types of goods, including fresh produce and food, which could be procured locally. This can motivate and empower vulnerable groups including

indigenous people and women allowing them to engage in commercial farming while earning to provide for their families.

- Gender responsiveness of all engagements with the community. Vulnerable groups like women and youth should be encouraged to play an active role in contributing to decision making in the community.

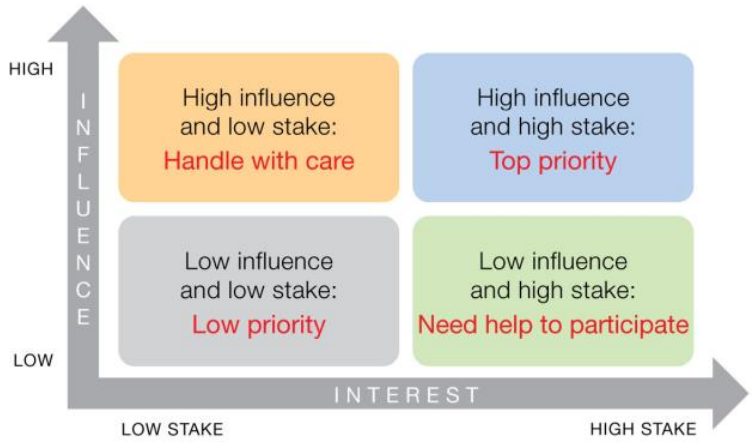
Stakeholder Identification

Project stakeholders are defined as individuals, groups or entities who are:

- Impacted or likely to be impacted directly or indirectly (positively or adversely by the project); or
- Interested parties in the project, including individuals, groups, communities and agencies, whose interest is affected by the project or who have the potential to influence the project outcomes.

Stakeholder Analysis and Mapping

Stakeholder analyses originated in the business world as a tool to guide relationships with stakeholders, the different criteria of power, importance, influence, and position that are used in such analyses is important in decision making in any sector. Many different methodologies for doing stakeholder analyses exist. The proposed methodology looks at the criteria of power, importance, influence and position of different stakeholders and seeks to qualitatively compare and contrast the levels of importance, power, position and influence of each stakeholder. It is recommended that GMI use the stakeholder map presented in Figure 22-1 to classify the stakeholders identified as either impacted or interested parties and tailor engagement methods to these stakeholders.



Source: International Atomic Energy Agency

Figure 22-1: Stakeholder Map Showing the Power/Influence Dynamic

Engagement Methodology

The engagement process should adhere to the following practices:

- Openness and life-cycle approach: Key stakeholder consultation during the project implementation phase, all of which should be free of external interference.

- Informed participation and feedback: distribution of information to all stakeholders in appropriate format, providing opportunities for feedback, to ensure two-way dialogue.

- Inclusiveness and sensitivity: identification of stakeholders to foster better communication and build effective relationships, to ensure all stakeholders are informed and involved in the decision-making process. This process will also shape the method of engagement, with special emphasis on vulnerable groups.

Stakeholder Engagement Methods

Use of clear and appropriate methods to engage stakeholders is critical, these engagements will allow the project team to better understand and map their stakeholder groups. The key of this process is to be able to provide a clear plan on the way forward in engaging interested stakeholders throughout the project. Two contingency methods are presented for stakeholder engagement. The first assumes that COVID-19 restrictions have been lifted and meetings with large groups of people can be facilitated. The second assumes that COVID-19 restrictions remain in place and meetings of more than 10 persons are prohibited.

Engagement Methods if COVID-19 Restrictions are lifted

- Public meetings: provide an opportunity to consult with larger numbers of people and can be organized for small group discussion.
- Focus Groups: regular meeting of people who represent groups or organizations to discuss issues or specific matters relating to the project.
- Print Materials: provide project updates and schedule of planned project activities such as schedules for blasting and barging.
- Radio/Audio Broadcasts: providing reminders to stakeholders of key project activities which may impact them such as blasting activities or barging.

Engagement if COVID-19 Restrictions remain in place

The current COVID-19 pandemic poses a number of challenges in the stakeholder engagement process locally. Nonetheless, it is important to evolve and adapt new forms of communication to safely engage stakeholders without increasing their risk of exposure to COVID-19. The intent is to deliver project related information to key stakeholder groups and receive timely feedback while implementing a far as possible appropriate safety steps in the engagement process and ensuring that stakeholders are abreast of project activities which may impact them. These methods could include:

- In-Person Meetings: Limit meeting sizes to not more than 10 persons per engagement. Ensure that Social Distancing measures are followed during engagements (spacing of seating arrangements, use of masks, sanitisation, etc.).
- Telephone: small group calls or individual calls are usually effective to discuss issues and receive feedback from stakeholders where possible.
- Web-based engagements: a variety of platforms exist for effective web-based engagement. However, given the remoteness of the project and its stakeholder audience the utility of this approach is limited.
- Print Materials: provide project updates and schedule of planned project activities such as schedules for blasting and barging.
- Radio/Audio Broadcasts: providing reminders to stakeholders of key project activities which may impact them such as blasting activities or barging.

Areas for Engagement

In addition, stakeholder engagement methods should be targeted based on the information that has to be communicated. Based on the recommendations of the EIA, this includes the following issues:

Issues for Community Engagement

- Liaise regularly with nearby stakeholders to determine if they are being affected by dust and other emissions, in particular dust generated by project transportation. This should include engagement with the Eclipse Falls community.
- Engage with residents to determine whether any significant adverse impacts of blasting are being experienced such as vibrations, flyrock, noise and dust emissions.
- Engage with communities and local authorities to determine whether there are any adverse impacts from the company operations to water resources in the project footprint at Matthew's Ridge and Port Kaituma.
- Providing the residents of Matthew's Ridge with a schedule of blasting activities and notice in advance of each blasting activity.
- Host awareness sessions with local communities to increase their awareness of transportation safety practices by GMI.
- Engage with residents to receive feedback and recommendations on how project transportation can be improved. Residents should also be briefed on the road and river safety rules which GMI will adopt in project transportation and be provided with recommendations on how they can also contribute to road and river safety.
- Engage with residents in Matthew's Ridge and Port Kaituma to determine whether the waste management techniques adopted have any adverse impacts on them.

Issues to be Addressed in Engaging with the NDC

GMI will put the following measures in place to enhance engagement with the NDC:

- Frequently sharing photos of road repair and maintenance with the NDC.
- Meeting the NDC or the NDC representatives on a regular basis, at least monthly or bi-monthly, to provide progress updates on the operations. This will include, inter alia, updates on dredging schedule for the turning basin and the establishment of waste disposals sites among others.
- Submitting a CSR report to the NDC on a quarterly basis that outlines the social initiatives undertaken by the company.

Issues for Engagement with Government Agencies and Regional Authorities

- Develop a water quality monitoring programme, in partnership with GWI, to regularly monitor manganese levels in the Matthew's Ridge community water supply. If manganese levels exceed safe consumption levels, GMI should work with GWI to make an alternative source of drinking water available for community members.
- Engage with GWI before conducting any future dredging activities in the Kaituma Canal.
- Engage local authorities, including the RDC and MARAD to determine the barging schedule. The schedule should aim to avoid shipment of ore and other materials such as fuel on particularly busy days such as Tuesdays, Wednesdays and Saturdays which are market days in Mabaruma and Port Kaituma.
- Dispatch notices to communities and local authorities on the barging schedule, once developed. The RDC should be enlisted with helping to build awareness of the barging schedule for communities located outside of the tertiary AoI but from where fisherfolk typically travel to Waini Point to fish.

- Engage with the Ministry of Public Works to discuss rehabilitation activities which have been completed on the roadway, the bypass roads which were constructed and the design specifications which were followed.
- Engage with the RDC, MARAD and GWI before dredging of the new turning basin again. GMI should engage with MARAD to develop an indicative dredging schedule for the turning basin.
- Engage with Hydromet and GWI to obtain the relevant permissions for abstraction of surface and ground water to support operations and to register existing wells at Matthew's Ridge. Engagement with these agencies may also contribute to the future development of the water quality monitoring plan (outlined in Section 22.9) as the project progresses.
- Engage with MARAD and GL&SC on the disposal of any future dredging spoils.
- Engage with the National Trust of Guyana to determine whether any of the intact demolition waste, such as skeleton frames of process or ore transport infrastructure, may be of cultural value.
- Actively engage with the RDC and other local authorities to provide updates on the implementation of project activities and receive feedback and recommendations. GMI should also consider directly engaging with the RDC to determine whether the company could support the work of the Regional Disaster Risk Committee and further develop the systems for emergency response for potential incidents in which GMI may be involved.
- Develop, in partnership with the MOH and the Pakera District Hospital, a surveillance programme to identify incidence of an adverse health outcomes associated with high levels of manganese exposure.

Meaningful Engagement

GMI should designate a staff member to fulfill the role of project communications and community liaise on and should be positioned to address the concerns of stakeholders in matters large and small. His or her role should be to address all grievances or concerns in a timely manner. This person should work closely with the HSE Officer and the project administration department and managing the recording and distribution of minutes arising out of meetings.

22.6.8 Indigenous Peoples Plan

An Indigenous Peoples Plan (IPP) provides guidelines and procedures to address potential project impacts on indigenous peoples (IPs) and outlines means by which IPs can be integrated into the project in order for the development to meaningfully contribute to their social and economic wellbeing. The plan should safeguard their rights in accordance with domestic and international laws, and social safeguard Policies.

Objectives of the IPP

This IPP is guided by several local and international and policies and its objectives are:

- To ensure free prior and informed consultations among affected indigenous groups.
- To avoid and/or minimise any adverse impacts the project may have on indigenous communities living around the project area.
- To ensure the project benefits are accessible to indigenous groups in the area.
- To ensure indigenous peoples are involved in the implementation and monitoring of activities.
- To minimise socio economic and socio-cultural impacts within communities as a result of direct and indirect impacts of project related activities.

The development of an IPP for the project should be based on potential impacts on traditional rights of use and access to land and natural resources, the environment, socio-economic and cultural

systems, health, education, livelihoods and social security status, and impacts that may influence changes in indigenous knowledge and customary institutions.

Designing the IPP

The IPP should be designed based on the results of robust stakeholder consultations and information disclosure with indigenous communities within the AoI while also taking in consideration data presented in the EIA. The objectives of these consultations are:

- Provide communities and IPs with detailed information on the project.
- Ascertain community feedback on the potential positive and negative impacts of the project on the community infrastructure (cultural, social, economic and vulnerable groups including the elderly, women and children).
- Identify mitigation measures to inform the IPP.

IPP Action Plan

The IPP should be designed so that IPs will receive due attention and support during project implementation. The plan should also demonstrate how the project authorities will ensure equitable distribution of project benefits among all indigenous populations and others in a culturally appropriate manner. The suggestions and concerns of all the stakeholders including IPs who participated in the consultation process should be taken into consideration in developing the Action Plan.

The Action Plan within the IPP should highlight issues arising as it relates to the project, strategies and activities which will be implemented to address or combat issues raised during consultations and identify the responsible parties to address and implement systems. The IPP can also make recommendation for the formation of local community organisations to work in the best interest of the IPs and make representation for support where applicable for example, the formation of a farmers group or association

Provisions should be made for monitoring and reporting to ensure the successful implementation of the IPP and the project as to allow for the evaluation of the plan to identify gaps and areas which requires improvement as the project progresses. In addition, the Grievance Mechanism should play an integral role in the process and should be designed in a culturally appropriate format to give voice to IPs in an accessible way.

22.6.9 Training Plan

During the construction phase of the project, GMI developed and continuously provided training to relevant employees on the following HSE issues:

- Accident Prevention
- Basic First Aid Techniques
- Communication
- Conflict Management
- Defensive Driving
- Emergency Response for Fires
- HR Procedures for Disciplinary Measures including Dismissal
- Hazard Identification
- Conducting Risk Assessments
- Industrial Hygiene
- Personal Protective Equipment
- Process Safety Management

Figure 22-3: GMI Staff Training Session

Given the number of employees expected to work for the company during throughout the lifetime of the project and the occupational safety and health risks to which they would be exposed, the Company should prepare a comprehensive Training Plan for employees training.

Purpose of the Training Plan

A Training Plan should support the streamlining of employees training and education efforts in a way that ensures that operations are conducted safely, there is compliance with laws and regulations, and that support more effective work processes that increases production while reducing risks, waste and inefficiencies.

Components of a Training Plan

The following components should be including in the development of a Training Plan:

- **Training Needs Assessment:** Develop a clear understand of all of GMI's training needs based on the skills current employees have and new hires require, training to improve safety of work processes and training to support the efficiency and productiveness of the business.
- **Identify the Learning Objectives:** For each training need, identify the learning objectives which are expected to be achieved at the end of each training module.
- **Design the Training Materials:** Training materials should be appropriate to the subject matter being covered as well as baseline level of competence of participants. In particular, the following principles should be considered when developing the training materials:
    - Adult Learning Principles that recognize that adult learners are self-directed, come to training with knowledge, experience and opinions, want training programmes that are relevant to them and task-oriented, want to feel respected, and learn better when they see how they can benefit from the training.
    - Practical learning or hands-on practice should be integrated as much as possible to help personnel to learn by doing. This is especially important for emergency response measures such as first aid, fire-fighting and spill clean-up.
    - Opportunities for employee interaction and feedback should be built in to the training materials.
    - Integrate audio-visual media, such as videos, as much as possible.
    - Make hand-outs providing a summary of the training materials available for continued learning post-training.

- **Evaluation:** The Training Plan should make provisions for personnel to provide a response to the training and may also include knowledge-based questions to determine actual learning from the training session.
- **Repeat and Refresher Training:** The periodicity with which each training module will be implemented should be implemented.

Issues to be considered in GMI's Training Plan

Based on the findings of the EIA, the following issues should be considered within GMI's Training Plan:

- Provide training for employees on proper collection, handling and management measures for hazardous waste.
- Training workers in proper fuel handling and management measures.
- Practical training in clean-up of fuel spills and the use of spill kits.
- Conducting training and refreshing training sessions on safety practices which should be followed during blasting operations.
- Develop a training module on noise nuisance, the importance of wearing appropriate PPEs for ear protection as well as occupational health and safety measures to be followed during blasting activities and enforce workers use of PPEs for ear protection.
- Training in safe and defensive driving.
- Training in change finds identification and management.
- Training for all employees of GMI's internal procedures for accessing training, disciplinary measures and dismissal.
- Providing frequent training sessions to employees on occupational health and safety.
- Training in operating heavy machinery.
- Field-test the provisions of the emergency response plan to ensure that the employees of GMI can expect the best possible response to any incidents.
- Training in resource use and conservation such as water and energy.
- Train/educate workers on the dangers of substance abuse, STDs, drunk driving among other issues.
- Training all workers on appropriate waste management techniques.
- Industrial training to employees to better educate them how to comply with those policies as well as promote a culture of continuous improvements and commitment to safety and training.
- First Aid Training

The Training Plan should also consider how GMI trainers can support efforts to enhance vocational training for residents of Matthew's Ridge and Port Kaituma so that required skills do not have to be imported from other parts of the country.

22.7 Grievance Mechanism

The Grievance Mechanism (GM) is intended as a complaint and proposal for resolution mechanism that provides a readily available or accessible means for the submissions of complaints and provision of feedback to individuals and or communities. The intent of the GM is to improve the efficiency and accountability of responses to beneficiaries and ensures that prompt feedback, processing and resolutions are met out to stakeholders. The GM is not intended to bypass any legal redress process, nor the provisions of the constitution, but it is intended to address concerns and complaints of the affected persons promptly. This makes it readily accessible to all affected and is scaled to the risks and impacts of the project. The GM is efficient and also considers the interest of indigenous peoples. All cost associated with the process including, communication, reporting, meetings and resolution should be covered by the project through GMI. The main objectives of the grievance mechanism are to:

- Provide stakeholders at different levels with a clear mechanism to channel grievance;
- Provide an accessible, transparent and efficient complaint procedure; and
- Provide and define clear roles and responsibilities of the parties handling the grievance.

The following categories of stakeholders may submit a grievance:

- Individuals
- Groups of individuals
- Organizations
- Project (GMI) workers
- Common interest groups
- Companies or services providers

The following types of grievances may be addressed by this procedure:

- **Work related grievance:** This relates to grievances at the construction and operational phases of the project and include major issues as it relates to working conditions, wages, benefits, health and safety matters among others;

- **Social grievance:** This relates to grievance that may arise at any stage of the project as a result inadequate consultation and sensitization, and or disruption to social life by project related activities;

- **Environmental Grievance**: Environmental-related grievances may arise at any stage of the project as a result of disturbance of natural ecosystems, poor management of project impacts and failure to consult with others; and

- **Resettlement and land acquisition and compensation**: These grievances are mainly caused by poor management and consultations and sensitization. This may also occur if compensations are delayed and if the inadequate efforts were made to appropriately relocate individuals.

The following measures will be implemented for the handling of grievances:

- **Establishment of a Grievance Committee:** A Grievance Committee should be established and will be chaired by the GMI's General Manager or any other identified and agreed upon person. The Grievance Committee should be comprised of the HSE Officer, a workers' representative, a member of the RDC/NDC, village representatives (in this case a representative from each of the main villages: Port Kaituma, Matthew's Ridge, Eclipse Falls and Four Miles), a representative from the Guyana Geology and Mines Commission, and a representative from the Ministry of Indigenous Peoples Affairs, in this case the local Community Development Officer. The Committee should include at least two women members.

- **Grievance Log:** This is for the purpose of record keeping, an electronic log and data base would be established to meticulously log/ document all grievances received and their resolution. This log should be captured in the project reports.

- **Awareness of Procedure:** One of the first step of the Grievance Mechanism involves information disclosure, whereby stakeholders would be informed of the mechanism itself, including publicizing ways in which a complaint or grievance can be communicated to the necessary project officials as well as, the procedure in which a complaint or grievance would be handled or addressed.

- **Receiving Grievances:** Grievances may be received by multiple means. Persons/stakeholders will be encouraged to send in written reports of any grievances they may have. In addition, designated Company personnel can be contacted directly in person, or at GMI's Offices. Further, GMI will establish a telephone contact which will serve as a hotline for receiving grievances.

- **Grievance Forms:** To enhance the efficiency of the grievance redress mechanism, forms will be printed and made available in key offices including the NDC Offices, the RDC Office, Village Offices and any other suitably determined areas. A copy of this form is presented in Appendix K-1. Upon submission of all complaints a receipt of submission should be issued to the complainant.

The procedure for addressing a grievance is presented in Table 22-5.

Table 22-5: Steps in the Grievance Procedure

Step 1	In the event of any grievance, the complainant can make clarifications and or file a formal complaint to GMI personnel of at the office. GMI shall review the complaint and launch an investigation if necessary, and should respond to the complainant and have the situation resolved within one week (7 days). Once a resolution is arrived the process stops. However, if the matter is not resolved see **step 2**
Step 2	The GMI will forward the grievance to the Grievance Committee. The Grievance Committee will determine if the complaint is within their scope and acknowledge receipt of complaint within 3 days. If the complaint is a matter which has placed a neighbouring community in distress (lack of access, loss of livelihood, security, project related flooding, etc.) GMI and Grievance Committee should engage the community and or persons to derive a reasonable resolution.
Step 3	Once it within their scope the Grievance Committee will try to resolve the matter and respond to the complainant within 14 days.
Step 4	Once the complaint or grievance is resolved monitoring and evaluation of response measures used for resolving complaints or grievances will be done. This is done in order to ensure that the measures implemented are functional and long-term so as to avoid a repeat of the complaint/ grievance. In the event a suitable resolution is not derived the complainant can take legal actions.

22.8 Emergency Response and Contingency Plan

The Emergency Response and Contingency Plan (ERCP) outlines the response procedures and preventive measures that are essential for effective and timely management of an emergency. This Plan is intended to provide for a prompt and effective response to any incident which compromises the environmental safety of the project site and its adjacent environs, and the health and safety of employees, contractors, the public or visitors arising out of the existence and use of GMI's site, facilities and operational assets.

Consistent with GMI's philosophy of the maintenance of compliant environmental standards and risk mitigation, the ERCP provides for a robust and systematic response to any incident. The emergency response philosophy identifies its priority actions as follows:

- Protection of human health and safety.
- Prevention of harm to animals.
- Prevention of environmental and facility damage.
- Confinement of the area of incident.

- Incident reporting.
- Making safe the site and involved materials.
- Site clean- up and restoration.
- Incident review.

Critical for the ERCP is the identification of the likely emergencies, given the nature of the mining, processing and logistical operations and the varying operational environment. These include but are not limited to:

- Accidental injury, damage or loss resulting from the operation of mobile, fixed plant or marine equipment.
- Explosive Mishap.
- Release of fuel due to spillage or containment failure.
- Fire and flooding.

22.8.1 Emergency Protocol Policy

GMI has developed an Emergency Protocol Policy (EPP) which outlines the procedures to be followed in the event of an emergency. The EPP provides the procedures in case of any accidents, incidents or emergencies within GMI's area of operation. These may be caused by vehicle or other accidents, incidents, such as wounding or fights, falling trees, drowning, snake bites, pregnancies, etc. and may be GMI's employees or other persons in the area. The EPP aims to provide corporate support for emergency medical attention at the site, assess the nature of the accident, incident and how serious or life threatening is the issue and provide appropriate action. The EPP will be communicated to all staff, clearly outlining roles and responsibilities.

GMI's EPP mission is that all actions must be aimed at saving a life or lives. The mission must be seen as a dictation that NO ONE WILL DIE ON OUR PROPERTY. It requires medical/ security personal to be trained in trauma care. The assessment of the accident/incident must be made very early on whether the patient can be treated locally onsite or at the hospital, or has to be medically, or casualty evacuated by air. Personal should err on the side of conservation and caution to personal life. When a situation occurs involving a casualty, the hospital should be informed immediately.

All personnel must be aware of potential risks and take steps to cope with hazards in their work area. In addition, all personnel are expected to alert the HSE Officer if they discover an accident, fire or spill, in keeping with the procedures set out in this Plan. However, the HSE Officer has the authority to take control of any emergency situation which may occur. This individual has the authority to take the decision to close down all or any part of the operations following an incident.

22.8.2 Emergency Procedures

Emergency response measures will be applied to both minor and major incidents/accidents and adequate information and equipment will be maintained onsite to respond to emergencies. The approved company procedures to be followed in the event of an emergency are as follows:

<u>Injury to Person</u>

1. Notify site and summon help;
2. Make safe/isolate equipment;
3. Remove injured person and perform First Aid;
4. In the event of serious injury notify General Manager while rushing injured to Matthew's Ridge or Port Kaituma Hospital or Airstrip for medical evacuation;
5. Inform next of kin;

6. General Manager to inform GGMC, OHSD and/ or EPA, and Mathews Ridge or Port Kaituma Police;
7. Prepare and review incident report;
8. Investigation; and
9. Institute corrective actions.

Explosive Mishap

In the event of an explosive mishap the following procedure is to be adhered to:

1. Warning and notification to site;
2. Removal and injury assistance / treatment as per “Injury to Person”;
3. Notification of GPF, GGMC, OHSD and EPA by General Manager;
4. Making safe of site by qualified blasters;
5. Recovery of unexplored blasting materials;
6. Notification of explosive supplier;
7. Incident recording and statements to be collected;
8. Incident review and investigation; and
9. Institution of corrective actions.

Fuel Release

The inadvertent release of fuel or oil into the environment by spillage from pipeline breakage or failure of the means of storage is to be responded to as follows:

1. Notify site management;
2. Isolate area from vehicle movement, fire and water sources;
3. Notify GGMC, EPA and /or MARAD depending on amount, type or location of incident;
4. Plug or contain leak and spill point respectively;
5. Contain area, recover where possible, by scooping or pumping fluid;
6. Use spill collection kit, dry sawdust and / or sand to absorb remaining surficial fluid;
7. Excavate and remove in doubled plastic bags contaminated absorbents and soil;
8. Remove and bury contaminants in a plastic lined pit;
9. Record and review incident; and
10. Institute corrective actions.

Fire Response

The emergency response to a fire is enabled by the location of firefighting means in buildings, operating sites and equipment. Operatives are tasked with knowing the location, maintenance and safe use of available and sand buckets, fire extinguishers, and water sources. Discovery of a fire must trigger the following response, according to awareness and drills:

1. Raising of fire alarm and evacuation of building or area;
2. Accounting for all persons related to the affected location;
3. Fighting of fire with all available means at hand to containment and extinguishment;
4. Reporting to the management and to the GFS where necessary;
5. Recording and review of incident;
6. Replenishment of firefighting equipment; and
7. Instituting corrective actions.

Flooding

Flooding can be caused by extreme weather events, such as thunderstorms, impacting the mine pits and overwhelming the installed pump and sump storage capacities. Swollen creeks with high local water tables, normal for the rainy seasons, can contribute to localized flash flooding at the lower slopes and flats from hillsides. A flood event may, also, result from tailings or water impoundment dam failure. These are particular risks at the Matthew's ridge mining, processing, administrative and accommodation site. The terminal location of the Port Kaituma Canal Bank connected to the Kaituma River poses the risk of cyclical tidal and weather flood associated events which can have catastrophic

impacts if emergency contingencies are not catered for. It is thought that flash flooding with associated tidal impacts can have significant transient impacts. Moreover a 50- or 100-year flooding event can result in the longer-term shutdown of operations particularly if equipment damage is occasioned. The monitoring and prediction of the Hydromet Department's weather predictions are of importance along with the information on websites such as 'TideForecast.Com'.

The following measures are to be followed on-the-go event of flooding:

1. Notification of site and management;
2. Removal of personal and belongings to safety;
3. Identify sources of food, water and possibility of temporary repairs;
4. Removal of mobile equipment to higher ground;
5. Shutdown of threatened generators and / or isolation of risk circuit;
6. Impound by berms, if practicable sites, under threat;
7. Removal of higher ground of static equipment electrical motors;
8. Removal of threatened fuel a d oils to higher ground;
9. Utilisation of tugs, barges and boats to effect movement and temporary storage;
10. Monitoring and recording of floods levels;
11. Event ready riding and request review;
12. Institution of corrective measures from lessons learnt.

22.8.3 Medical Evacuation

Upon arriving at the scene, the medical personnel will make an assessment of the patient and inform the senior person on site that the patient requires an Emergency Medical Evacuation. The decision to evaluate is a medical decision. Dependent on the patient's injuries or the weather situation, one of the following plans will be put into effect:

- Good weather, aircraft available and patient is fit to be moved: The Security Department will ensure that an accurate message is sent to GMI's Office in Georgetown by completing an Emergency Evacuation Order Form with information obtained from the doctor at the incident site. One form should be completed for each injured person**.** The form should be completed, and all information forwarded to Georgetown. The GMI representative in Georgetown must send the aircraft to the mining site with minimum delay, bearing in mind that a Doctor/Consultant/Surgeon may have to join the aircraft based on the nature of the medical emergency. The GMI representative must inform the nominated hospital of all the information received from the Emergency Evacuation Order Form. The Hospital must stand by to receive the casualty ensuring that the required staff is ready when the patient arrives in Georgetown. Transportation must be arranged to transfer the patient to the determined Hospital from Ogle Airport. As part of the Georgetown call out, it is prudent to call the Senior Georgetown Officer and driver. All personal documentation must be prepared for the possibility of a move overseas, if necessary. This must include those of the patient and the medical personnel in attendance.

- Good Weather, Aircraft available and Patient cannot be moved:
    1. GMI representative in Georgetown is to standby and the aircraft ready to fly awaiting passengers.
    2. Contact several designated surgeons and an anesthetist and request that they prepare to travel giving them all the information from the Emergency Evacuation form.
    3. Transportation must be sent to collect the surgeon and anesthetist to take them immediately to Ogle Airport.
    4. Plan (a) should then be put into operation and the Security Supervisor standby to received further information.

Once a decision at the site is taken for an air medevac, the flight must be approved by the senior official at the site. The patient or patients must be prepared for the flight and the airstrip must be inspected and vehicles positioned. Telephone messages must be sent to GMI'S Office in Georgetown as well as to Mr. Norman McLean. Everyone is to be informed promptly and communication should be to more than one official. Time is critical which can save a life. In the absence of appropriate airstrip lighting in the case of a night flight, ATV's and vehicles will have to be positioned at each end of the airstrip with flambeau/lantern being positioned where possible on the sides of the runway.

A suitable aircraft will provide such services to Georgetown and beyond for air ambulance facilities. An aircraft will be dispatched from Ogle Airport within one (1) hour during the day and one and a half (1½) hours during the night in receipt of the request. An ambulance will be called as soon as possible to be advised to have the ambulance on standby at Ogle to move to the hospital of choice.

22.8.4 Emergency Contacts

As a means of giving effect to any emergency response GMI has identified the following agencies and individuals to be contacted in an emergency:

Name/Designation	Contact Details
Guyana Manganese Inc.	
General Manager (Jason Wang)	608 3070
Deputy Manager (Andy Hao)	667 1032
Health & Safety Officer (Leon Daniels)	681 7122
Region 1 Hospital	
Matthew's Ridge Hospital	777 5057/ 9283
Port Kaituma Hospital	777 4047
Regional Hospital Mabaruma	777 5057
Region 1 Police Station	
Matthew's Ridge Police Station	455 2222
Port Kaituma Police Station	777 4007
Mabaruma Police Station	777 5007
Government Ministries and Agencies	
Ministry of Natural Resources	231 2506-11
Guyana Geology and Mines Commission	225 3047/ 2862-5
GGMC Eclipse Falls Office	670 2161
GGMC Port Kaituma Office	662 9467
Environmental Protection Agency	225 5467/ 5471/ 6044
Maritime Administration Department	225 9350/ 226 7842
Hydromet Department	225 4247/ 225 9303

22.8.5 Incident Reporting

After every incident/ accident several reports will be required. The HSE Officer would have direct responsibility for the preparation of such reports. The formats to be used for the preparation of these reports are presented in Appendix K-2.

22.8.6 Emergency Preparedness and Response Equipment and Systems

GMI has implemented or plan to implement measures to ensure emergencies do not occur, as well as to respond to any emergency occurring. Measures relating to the specific emergency which can occur at GMI's operation are detailed below. Other general measures are also in place such as the installation of signage around the site, provision of PPEs for workers, etc.

Fire Response

- **Alarm Systems:** There will be smoke detectors and fire alarm systems onsite.
- **Fire extinguishers:** Fire extinguishers will be located strategically around the facility and will be regularly maintained. There will be signage at the location of each fire extinguisher to ensure easy visibility. Only trained personnel will be authorised to use fire extinguishers in an emergency.
- **Sand Buckets:** Sand buckets may also be stored around the site to support firefighting in an emergency.
- **Fire trucks:** GMI will utilise the three water trucks which will be routinely used for road wetting in Matthew's Ridge and Port Kaituma to support response to fires. Water will be sourced from water tanks at the Matthew's Ridge Facility, the Pakera Lake or the Kaituma Canal.

Fuel

- **Bunded Secondary Containment Structures:** Fuel will be stored in bunded secondary containment structures which have impervious bases.
- **Spill Kits:** Spill kits would be located in proximity to fuel storage areas and should contain absorbent booms and pads for use in cleaning up of spills.

Medical Emergencies

- **First Aid Kits:** First Aid Kits will be available in operational areas to support first response in the case of a workplace injury.
- **Project Vehicles:** Project vehicles will be available and used to transport any injured personnel to the Pakera District Hospital or the Port Kaituma District Hospital for treatment. If medical evacuation is required, project vehicles will transport personnel to the airstrips in Matthew's Ridge or Port Kaituma.
- **Aircraft:** GMI will utilise privately owned third-party aircraft to support medical evacuations to Georgetown.
- **Communication Devices:** Radio and cell phones are available will be used by GMI personnel for communication to respond to medical emergencies and to prepare for medical evacuations. Internet communication is also available if needed.

Tailings Dam Failure

- Constant monitoring of dam stability through installed monitoring devices and visual observations.

- Monitoring of freeboard level within the Tailings Pond.
- Installing a Spill Weir to discharge excess water from within the pond.
- Regular maintenance of the Tailings Pond structures, including dams.
- A fleet of heavy-duty equipment available to conduct any emergency works.

22.8.7 Training

As part of any emergency preparedness and response system training of personnel is key to firstly prevent an emergency from occurring, and secondly to respond to any emergency which may occur. GMI has recognized this importance and has placed emphasis on ensuring workers are trained in the relevant health and safety and emergency response areas. Training in these areas have been ongoing, as is described in Section 22.6.9. Additional areas for training are recommended and would be included in GMI's Training Plan.

22.9 Monitoring Plan

A Monitoring Plan has been developed by GMI to ensure the environmental and social safeguards identified and implemented are effective to minimize, mitigate and manage the impacts from the project. The implementation of the monitoring plan allows GMI meet its statutory obligations and demonstrate compliance with its various permits. GMI will continue to institute, maintain and monitor the environmental status of its operations through scheduled collection of samples, data, interpretation against standards and the recording and reporting of any critical issues or trends.

Consistent with its policy of continually improving and sustaining environmental management practices and ensuring worksite safety, the identification of hazards and the measures taken to monitor, mitigate, and prevent reoccurrences will be managed via the inspections by the site management and the HSE representatives. The introduced monthly safety review, along with tool box meetings, and walk around inspections, will complement measures to monitor hazard identification, management, mitigation, and prevention.

Table 22-6 identifies the key parameters, roles, frequency and locales to be monitored to ensure compliance accordance with the environmental permit requirements.

Table 22-6: GMI Monitoring Plan

Parameter	Monitoring Location	Frequency
Physical Environment		
Weather: ▪ Meteorological Conditions	Matthew's Ridge and Port Kaituma	Daily
Air Quality: ▪ $PM_{2.5}$, PM_{10}, ▪ Relevant Gases, ▪ Manganese Dust	100 meters downwind of operating crushers, loading, transport, tipping locations, processing plant and power plant at Matthew's Ridge, and at the Kaituma Marine Terminal	Quarterly
Noise: ▪ Decibels	15 meters from source such as power plant, crushers, etc., and at critical receptor locations such as nearest residents	Quarterly; During blast operations
Seismic Monitoring	Matthew's Ridge settlement, at the Pakera reservoir dam, at the Tailings Pond dam, on the slopes of waste dumps and on the saprolite/saprock sections of open pit slopes	During blast operations
Tests for AMD and NP	Open pit mines	Annually
Erosion	Slopes and soil stockpiles	Weekly
Surface Water Quality: ▪ pH ▪ Conductivity ▪ Turbidity ▪ Dissolved Oxygen ▪ Total Dissolved Solids ▪ Total Metals ▪ Total Suspended Solids ▪ Sulphates ▪ Oil and Grease ▪ Total Coliform ▪ Faecal Coliform ▪ E. Coli ▪ Trace metals (manganese, iron, arsenic)	Manikuru River, Pakera Lake Dam, Port Kaituma Canal, Process and Potable Water Intakes and Outflows, all discharges and receiving water bodies.	Quarterly
Ground Water Quality: ▪ pH ▪ Conductivity ▪ Oil and Grease ▪ Total Coliform ▪ Faecal Coliform ▪ E. Coli ▪ Trace metals (manganese, iron, arsenic)	Springs Seep discharges from Pit Faces	Biannually
Waste Management: ▪ Compliance with Waste Management Plan ▪ Waste Accumulation	Waste bins; pits and works sites	Weekly Biannually
Wildlife: ▪ Hunting	Operation Area	On Observance

Parameter	Monitoring Location	Frequency
▪ Trapping		
Vegetation: ▪ Ensure vegetative zones are not inadvertently encroached or destroyed. ▪ Monitor changes in the vegetation structure of the habitats along the boundary of the tailings impoundment dams where ground water levels may rise. ▪ Monitor for any unauthorized clearance	Operation Area	On Observance
Tailings Pond: ▪ Dam Stability ▪ Operational Freeboard	Tailings Pond Dams	Weekly
Socio-Economic Environment		
Health and Safety: ▪ Use of protective gear ▪ Condition of firefighting stations and equipment ▪ Adequate and appropriate signage for emergencies ▪ Location of Emergency Procedures ▪ In-house training to keep employees abreast with safety procedures ▪ Health condition of staff, such as respiratory ailments	All operating areas	Daily Biannually Monthly
Employment and Benefits: ▪ Number of residents, indigenous persons and women employed ▪ Conditions of employment ▪ Assistance to residents by company	Entire operations	Biannually
Community Concerns: ▪ Any grievances which may exist ▪ Any emerging issue ▪ Corporate Social Responsibility	Communities in proximity to the project areas.	Monthly

22.10 ESMP Implementation

The implementation of the ESMP will be the responsibility of the HSE Department. The HSE Department will be headed by a HSE Officer, who will be in charge of the overall HSE aspects of GMI. Three to four technicians, who will have responsibility for different aspects in accordance with their professions will be employed and will report to the HSE Officer. The HSE Officer will report to the Vice General Manager of the Company.

Responsibilities of HSE Officer:

- Maintain a safe and healthy workplace for all employees in compliance rules and regulations.

- Promote a positive attitude towards work.
- Establish health, safety and environmental objectives for all levels of management and employees.
- Ensure and provide management and leadership and require all employees to take responsibility of his/her and ownership for safety.
- Stop all jobs/task to prevent an unsafe incident from occurring.
- Assure compliance with company safety and health and security programs and practices.
- Provide industrial primary training to employees to better educate them how to comply with those policies as well as promote a culture of continuous improvements and commitment to safety and training.
- Develop a systematic approach to HSE management, designed to ensure compliance with the law and to achieve continuous performance and improvements.
- Set targets and measures for improvement such as appraises and performance reports.
- Design and maintain facilities, establish effective management systems, provide training, and conduct operations in a manner that safeguards people and property.
- Respond quickly, effectively, and with care to emergencies or accidents resulting from its operations, cooperating with industry organizations and authorized government agencies.
- Comply with all applicable laws and regulations and apply responsible standards where laws and regulations do not exist.
- Work with government agencies and others to develop responsible laws, regulations, and standards based on sounds science and risk consideration.
- Conduct and support research to extend knowledge about the safety effects of its operations, promptly applying significant findings and as appropriate, sharing them with employees, contractors, government agencies, and others who might be affected.
- Stress to all employees, contractors, and others working on behalf of GMI their responsibility and accountability for safe performance on the job and encourage safe conduct.
- Undertake appropriate reviews and evaluations of its operations to measure progress and to ensure compliance with this safety policy.
- Strives to prevent any and all kinds of accidents, injuries and occupational illnesses through the active participation of every employee. Continuous efforts should be made to identify and eliminate or manage the safety risks associated with its activities.
- Ensure timely and thorough reporting and investigation of all incidents, accidents that includes causal factors and establishment of effective corrective actions.
- Coordinate environmental monitoring and reporting, ensuring monitoring is done in accordance with the Monitoring Plan.

- Identify areas of environmental non-compliances and recommended and oversee the implementation of corrective actions.
- Coordinate the preparation of environmental related plans and reports.
- Liaise with stakeholders including communities, regional and local institutions, etc., to keep them informed of project activities, and address any concerns or emerging issues.
- Ensure the requirements of the Environmental Permit is adhered to.
- Develop procedures for the conduct of various activities to ensure these are done in a safe and environmentally friendly manner.

CONCLUSION

GMI has undertaken the resuscitation of manganese mining at the historic, formerly abandoned, Mathew's Ridge. The Company plans to rehabilitate, and in some cases, replace plant and buildings; rehabilitate and upgrade several mine sites; install a new processing plant; upgrade and widen the Matthew's Ridge to Port Kaituma road; construct a new wharf facility with access road at Port Kaituma; and invest in a new mobile fleet and barging assets. The project will create direct employment for over 400 persons. The annual production and shipment of manganese ore concentrates is targeted at 500,000 tonnes. The project investment is estimated at US$75 million.

It is recognized that the project is neither technically complex nor inherently threatening to people or to the environment since most of the project's physical components are situated in "brownfield" locations where were impacted by the previous mining operation.

Construction activities has been ongoing in the project areas in preparation for the operational phase of the project. GMI proceeded with construction once it was granted two Construction Permits by the EPA. Nevertheless, the EIA still addressed impacts associated with both the construction and operational phases of the project. The potential impacts of project activities were assessed across the various phases using the baseline conditions of the project areas and the planned project activities. This was done by establishing the potential interactions between the activities and the characteristics of the existing physical, biological and socio-economic environment. The mitigation and management measures which GMI has committed to implement, or which implementation has already commenced during the construction phase of the project, have significantly reduced the risks associated with potential impacts of the planned project activities. As a consequence, the significant majority of impacts assessed in this EIA are of Low or Medium Risk. Moreover, none of the potential impacts assessed were associated with Critical Risks to any of the resources considered. Nevertheless, there are potential impacts which were assessed to be associated with High Risks even after all mitigation measures were implemented.

In addressing the impacts the mitigation and management measures currently in place were examined. In addition, planned mitigation measures to be implemented by GMI were also considered. Where it was felt that gaps still existed or there was need for additional mitigation and management measures these were identified and recommended. In this regard, the ESMP was prepared. It is expected that GMI will fully implement the ESMP, which should be updated periodically to reflect adjustments which may be made as the implementation of the project progresses.

This EIA has examined the project and assessed its potential impacts. The EIA Team is confident that there is a clear understanding of the current and potential impacts from the implementation of the project and has recommended the required mitigation and management actions that need to be taken. Once there is adherence by GMI the potential negative impacts can be avoided or mitigated and the project could realize social, economic and ecological benefits.

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