Malali Quarry Inc.
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MALALI QUARRY INC.

Tiger Hill Quarry Project Summary

Prepared by: MINING AND EXPLORATION INC.

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Company: Malali Quarry Inc.

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Executive Summary

- The Area encompasses 1400 acres.
- The project location is approximately 135 kilometers south of Georgetown, 45 kilometers south of Linden, and a few meters from the Demerara River in the Malali Amerindian Reservations.
- A Memorandum of Understanding (MOU) was already signed between the Project Director (Malali Quarry Inc.) and the Malali Amerindian Village.
- The Tiger Hill Quarry Project is positioned on a regional structural trend of younger basic rocks with a significant reserve of at least 6 million tons.
- The properties have a probable 6 million tons of quarriable materials.
- The area has excellent quarry potential and straightforward logistics.
- The potential Quarry Operations has a start-up capital of USD 3.15 Million and a total investment of 13 million USD to be made.
- It is expected to produce 216,000 to 300,000 tons of stone yearly, increasing capacity by 10% every year.
- Based on estimated reserves, the Tigerhill quarry project has Fifty -year mine life.

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1.0 Introduction

A reconnaissance investigation or site visit was carried out in the third week of January to confirm the properties' potential for quarriable materials. The area is very suited for quarry operations. The entire area is embodied with rocks of gabbro and dolerite; both of these rock types possess excellent geotechnical properties and are applicable to every aspect of the construction sector. This sill/dyke extends throughout the property with an east-west trend of approximately 3.2 kilometers and a width of 2 kilometers. The Gabbro has an estimated reserve of 6,000,000 tons of aggregates.

2.0 Physiography, Location and Access

The Tiger Hill Quarry Project is centered at grid coordinates N5.65606^{O}, W58.38693^{O} in the Potaro Mining District No.2. The project location is approximately 135 kilometers south of Georgetown, 45 kilometers south of Linden, and a few kilometers from the Demerara River. The location will make this quarry the closest to the capital and along the Demerara River.

The project area is approximately 1400 acres, located in the Malali Amerindian Village.

The Project area is veneered entirely by tropical lowland forest with the canopy height ranging from approximately 10m to 22m. Aside from tracks and trails made by small scale artisanal loggers, the forest cover has essentially been preserved.

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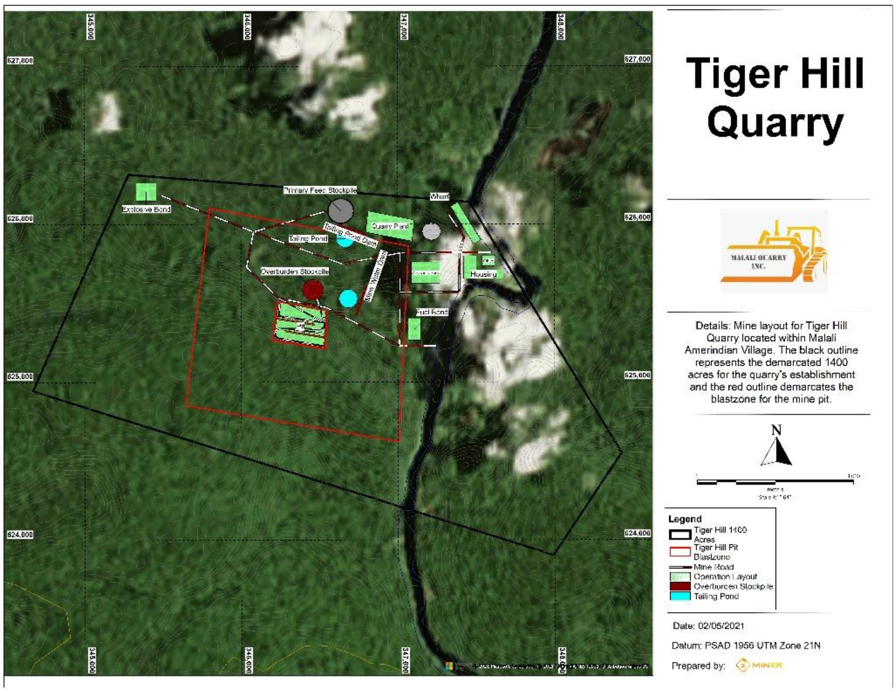

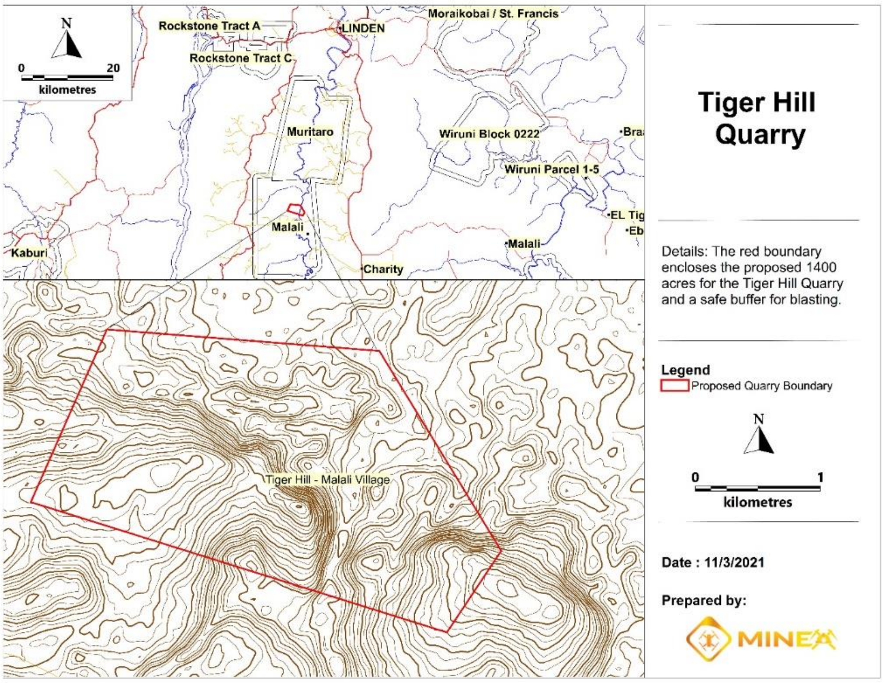

Figure 1. Location & Access and Physiography

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3.0 Property Status & Description

3.1 Property Status

DESCRIPTION OF BLOCK (M-1001/000/21)

BLOCK:

DESCRIPTION OF BLOCK

Tract of state land located in the Potaro Mining District No. 2 as shown on Terra Surveys Topographic Map 37SW, at scale 1:50,000 with reference point 'X' located at the confluence of Big Wineperu River and Yakarabaru Creek with geographical coordinates of Longitude **58º25'29.082"W** and Latitude **5º41'27.823"N**

Thence at a true bearing of **138.64º**, for a distance of **2 Miles 1306.88 yards**, to the point of commencement:

Point A, located at geographical coordinates of longitude **58º23'49.206"W** and latitude **5º39'52.369"N**, thence at true bearing of **203.78º**, for a distance of approximately **1648.3 yards**, to **Point B**, located at geographical coordinates of longitude **58º24'8.971"W** and latitude **5º39'7.715"N**, thence at true bearing of **107.4º**, for a distance of approximately **2 miles 286.137 yards**, to **Point C**, located at geographical coordinates of longitude **58º22'20.931"W** and latitude **5º38'34.023"N**, thence at true bearing of **33.6º**, for a distance of approximately **856.464 yards**, to **Point D**, located at geographical coordinates of longitude **58º22'6.830"W** and latitude **5º38'55.140"N**, thence at true bearing of **328.63º**, for a distance of approximately **1 mile 283.95 yards**, to **Point E**, located at geographical coordinates of longitude **58º22'38.485"W** and latitude **5º39'46.801"N**, thence at true bearing of **274.52º**, for a distance of approximately **1 mile 624.68 yards** to the point of commencement at **Point A**

Thus enclosing an area of approximately **1400.21 acres**, save and except all lands lawfully held or occupied.

Prepared for:
Guyana Geology and Mines Commission

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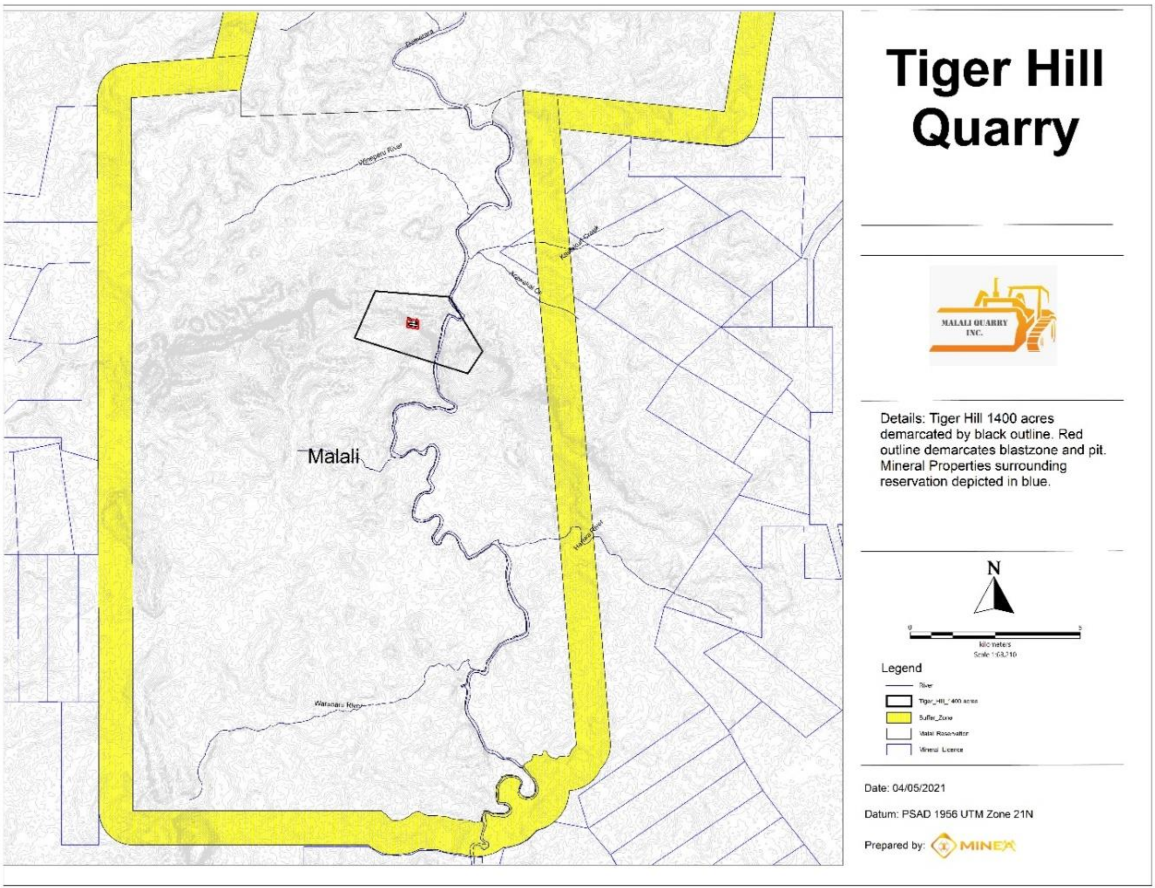

Figure 2. Property Status

4.0 Geology

Three distinct lithological units are found within the area (Figure 3). The oldest unit being the Bartica Gneiss complex with ages of 1.9 Ga – 1.8 Ga, then the pluton was emplaced (younger granites) approximately 1.7 Ga – 1.6 Ga ago. The PAPA dykes (Post Avanavero Pre Apatoe) then intruded the Bartica gneiss complex around 0.2 Ga.

4.2 Younger Basic Rocks (PAPA dykes)

Large Igneous Province or LIPs are usually made up of granitic plutons, dykes, and sills, mostly mafic, ultramafic, and gabbroic intrusions. They are primarily melanocratic rocks ranging from a fine grain matrix to a coarse grain matrix.

4.3 Younger Granites rocks.

Granodiorite is an intrusive igneous rock that has phaneritic textured. The grain sizes are visible to the naked eye. Granodiorite formation is slow cooling crystallization below Earth's surface. It is similar to granite and diorite, but it has more plagioclase feldspar than orthoclase feldspar. It appears to be a small pluton intrusion with coarse grain biotite.

4.4 Gneiss Metamorphic rocks.

In that area, distinct gneisses are present but occur in narrow zones within a belt of syn-tectonic granites with amphibolitic xenoliths and amphibolite slivers.

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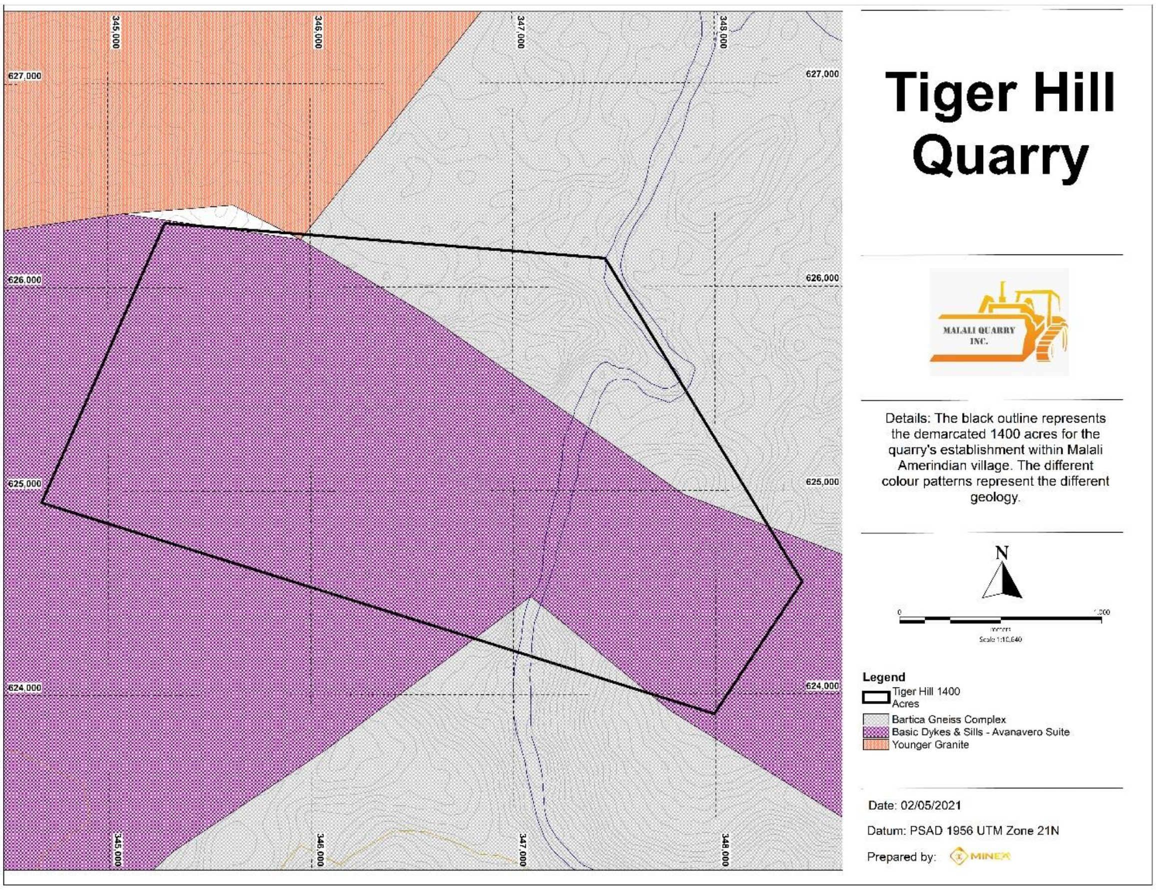

Figure 2. Local Geology

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5.0 Proposed Mine Plan activities

For this project, it is estimated that not less than 200,000 tons of rock will be produced per year for the first established production phase. The annual production for the first few years during the consolidation of operations will be 200,000 tons of aggregate. After the recovery of a substantial portion of the capital investment, the second phase of investment and expansion will increase production. The quarry will see a capital investment of not less than USD 3,000,000 and will have an initial workforce of at least 30 (local) employees. Development of this quarrying complex's facilities will be completed within 8 to 10 months of the Permit being granted (Figure 4).

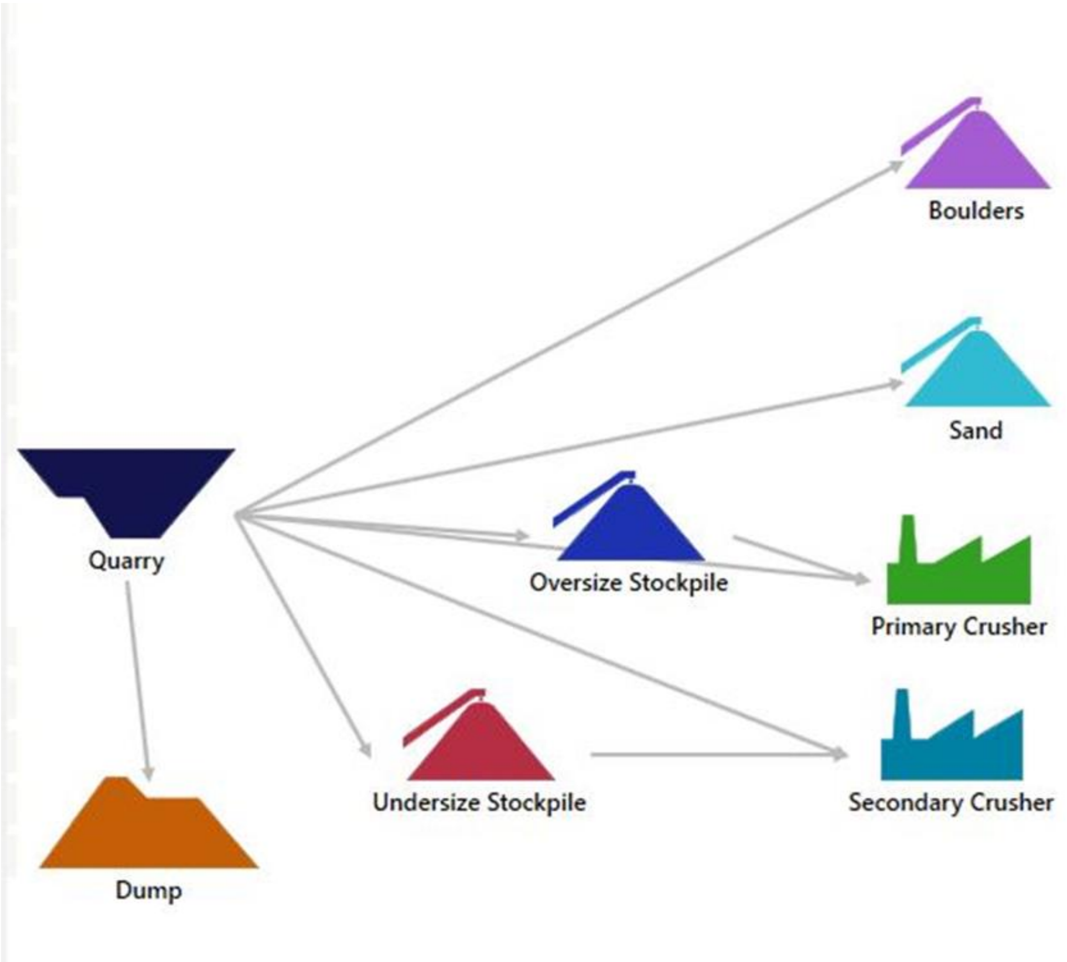

Figure 3: Design Flow of Proposed Mine Plan

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Task	**Years**								
	2021	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Construction of Dwellings & Admin Structures	■								
Production of Boulders	■	■	■	■	■				
Acquisition and Construction of Process Plant	■								
Acquisition of Haul Truck & Loader	■								
Production of Gabion Rocks & Aggregates	■	■	■	■	■				
Monitoring & Reporting Operational Phase	■	■	■	■	■				
Rehabilitation Works		■	■	■	■	■			
Monitoring & Reporting Post Closure Phase					■	■	■	■	■

Figure 4: Tiger Hill Quarry Project Schedule

6.0 Proposed Open Pit Mine Schematics and Estimate Production

Tigerhill Quarry has planned all its work activities for the next five years. This quarry intends to supply boulders, gabions, and crushed aggregates in the following fractions 7/8”, 3/4”, 5/8”, 1/2”, 1/4” minus, sifting, and quarry cleaning. Based on the volumetric calculations, the total tonnage of each pit was calculated. Based on the Pit production timeline, a total of quarriable material for each year was determined by the percentage of time (months of production for that fiscal year) multiply by the pit's total tonnage. Besides, the various size fractions production was also predetermined by the supply and demand of the market. Using all this information, a quarry resource estimate was made and estimated production of quarriable material from the proposed Quarry. A total of 6 million tons of gabbroic material is available for road construction, sea defenses and aggregates (Table 2).

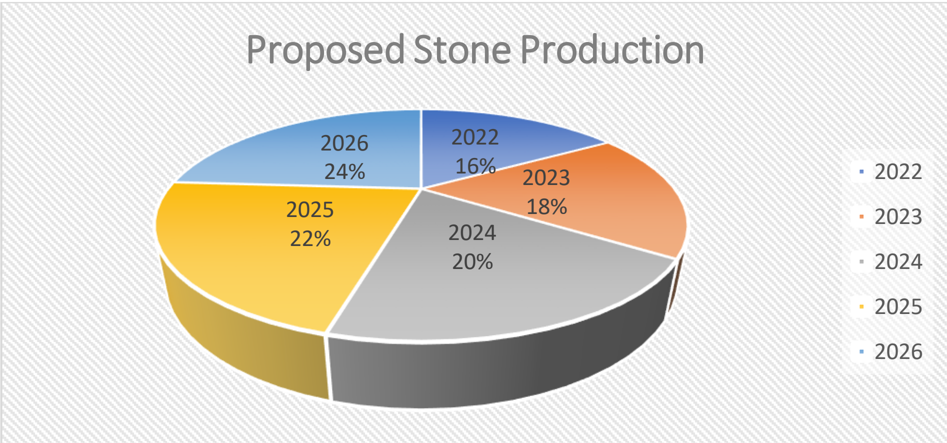

Figure 2. Chart showing how much stone to be produced yearly

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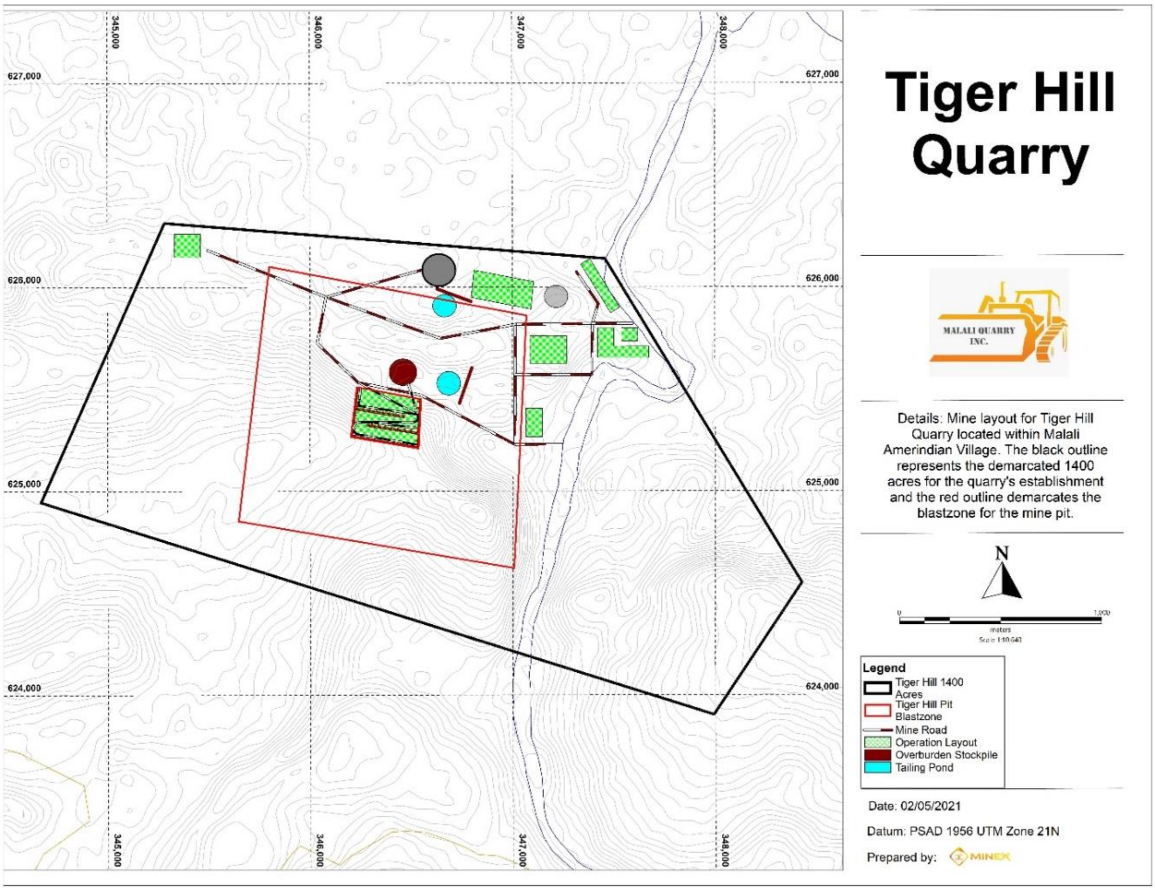

Figure 3. Mine plan Schematics and Layout

ITEM	PERCENTAGE	Year 1	Year 2	Year 3	Year 4	Year 5
1ST Grade Crusher Run	10%	21600	23760	26136	28750	31625
2nd Grade Crusher Run	2%	4320	4752	5227	5750	6325
7/8" Aggregate	2%	4320	4752	5227	5750	6325
3/4" Aggregate	40%	86400	95040	104544	114998	126498
5/8" Aggregate	2%	4320	4752	5227	5750	6325
1/2" Aggregate	15%	32400	35640	39204	43124	47437
Sifting	4%	8640	9504	10454	11500	12650
Underlayer	10%	21600	23760	26136	28750	31625
Boulder	10%	21600	23760	26136	28750	31625
Sand	5%	10800	11880	13068	14375	15812
Total	100%	216000	237600	261360	287496	316246

Table 1. Predicted Production for Malali Quarry Inc. Proposed Mine 2022-2026

6.1 Geotechnical

The pit design process consists of designing ramp access to the bottom of the pit using the geotechnical recommendations guiding the bench geometry. The ramp access will slope at 30 degrees. There are final pits for each quarry pit. All pits in a sector were considered a single pit that will be mined bench by bench.

The ramp for each pit was located on the lowest wall to minimize the hauling distance and to reduce activities along the high wall. Mining the stone was designed with the same geotechnical parameters as granite. However, since this type of material is found near the surface, the mining will be done, first, by a dozer that will pile the material and then by the loading equipment that will load the material. This technique will respect the overall slope angle of 50

6.2 Pit Optimization

Pit optimization is based on a USD 30/ton aggregate price to create a series of quarry blocks for analysis. Quarry design is based on a conventional surface mine using 76mm blast holes, 4.2m3 front end loaders and 1.5m3 excavators for stone and waste loading; and haulage by a fleet of 43.5-ton capacity trucks.

The ultimate pit design incorporates pit slope geometries (bench face angles, inter ramp angles and berm widths) for various rock types and pit sectors, includes haulage ramps, and considers minimum mining width based on the mining equipment selected.

6.3 Open Pit Mineral Reserve Estimate and Production Schedule

Total mineral reserve within the designed pit is 2.8 million. Gabbroic rocks have an estimated reserve of 2.8 million tons, whereas Mining waste volume is 5,867,4000 m^3 with a stripping ratio 1.2:1 for pit 1. The annual production for the first few years during the consolidation of operations will be 216,000 tons of aggregate. It will increase incremental by 10% depending on supply and demand.

6.4 Overburden and Waste Stock Pit

A General Site has been selected behind the pit. 20 acres in the low-lying area west of the pit has been selected as the dumpsite. Due to the distance, one waste dump will allow for reduced cycle times. Dump with ramp were held to the same design criterion:

Waste Dump Designs

• 22-degree overall slope angles

• 3 m lift offsets.

• 3 m lift heights.

• Maximum height of 50-80m (from high elevation to valley bottom).

• Location of dumps away from villages, settlements and rivers.

Dumps in a valley will have an overall slope angle of 37 degrees since the material will be dumped from a higher elevation than 3 m. Overall stripping ratio SRo (m3/tonne) - is the ratio of the volume of overburden (Vob) within the limits of the pit to the total tonnage of ore (TT) for the entire ore body. A cross section can be used to establish the relationship. Therefore, the Stripping ratio is 7 to 1 and it is within typical parameters for opening pit mining.

SRo = Vob / TT

Overburden	**Depth m**	**Area m2**	**Volume m3**	**Tonnage t**	**Overall Stripping Ratio Vob / Tt**
Pit 1	12	281,500.00	3,378,000	2,828,078.09	1.20
Pit 2	6	414,900.00	2,489,400	959,117.39	2.60

Table 2. Stripping ratio of Overburden to be dumped

Stripping and removal of overburden

Due to the geological conditions present at the proposed mine site there is a fairly uniform layer of saprolite overburden covering the fresh rock in all of the higher elevations, this overburden is generally between 30m thick and needs to be removed by stripping to allow access to and extraction of the fresh rock. The Cat. D8 bulldozers, excavators and trucks will spend 100% of their time for the first month to strip the overburden and establish the working faces. After which the bulldozer will carry on much of this work by itself with the excavators and trucks using an expected 20% of their time when necessary to help remove the overburden. Dumping of overburden will take place outside the stripping limits into valleys and other low areas; adequate dumping room is available

6.5 Stockpile Requirements

5000 Ton stockpile will be placed at the mobile crusher, to accommodate smooth operations. The Trucks will dump the quarry material to stockpile site where a dozer will feed directly into the mobile crusher. A jackhammer will be utilized to fragment oversize to the necessary screen size to allow easy processing.

6.6 Mine Manpower requirement

In the mining operations 30 personnel are handling current production with the additional 9 in supporting services. The total number of staff is expected to increase by 30% over the next five years.

Activity	Shift (hours)	No. of Shifts per day
Stripping	12	1
Loading & Hauling	12	2
Blasting	12	1
Crushing	12	2

Table 3. Shift Schedule Hours per activity

7.0 Proposed Staffing & Infrastructure

The company intends that the Quarry Project will be a model complex with facilities that are comparable with other regional and international Quarry operations. The topography is ideal with housing etc. overlooking the operation. The mine will have a full-time sanitation crew and a medic will always be on site with adequate medical supplies. Because of the threat of malaria in the area, the company will work closely with the Ministry of Health to maintain a malaria free environment at the quarry and nearby communities. A small water treatment plant for potable water supply will be constructed near at a suitable area within the quarry and water will be supplied from the treatment plant to the various sectors of the quarry. The company will employ 30 personnel, broken down as follows:

7.1 Staffing

NO	STAFF	NO OF EMPLOYEES
1	Quarry Master/Manager	1
	Engineers	
2	Mining	1
3	Mechanical/ Mechanic	1
	Supervisors and others	
4	Compressor operator	2
5	Excavator Operator	1
6	Drill operator	1
7	Heavy duty operator	2
8	Heavy duty drivers	4
9	Storekeeper	1
10	Electrician	1
11	Laborers	6
	Services	
12	Blasting Services	4
	Auxiliary Staff	
13	Cooks	1
14	Cleaners	1
15	Police officers	1
16	Security	1
17	Medic	1
Total		**30**

Table 4. Staff list

This labor force is expected to be increased by 30% or about 9 persons for the next five years.

7.2 Proposed Infrastructure

Detail of Building and Civil Works		
Description	**Covered Area sq ft**	**Cost GUY$**
Offices/Prefabricated Containers	500	$1,000,000.00
Workshop/Bond	1500	$3,000,000.00
Residential Setup /Prefabricated Containers	1,500	$3,000,000.00
Haul Road	5000	$3,000,000.00
Total	**8,500**	**$10,000,000.00**

Figure 4. Details for Infrastructure development

8.0 Proposed Environmental Management Plan

The proposed Environmental Management Plan (EMP) Malaii Quarry Inc. (MQI) will be designed to meet Guyana EPA standards and Best Management Practices (BMPs), GGMC Mining Act, and Regulations. The EMP is intended to ensure that impacts that cannot be mitigated are minimized to the maximum extent possible and that positive impacts are enhanced. The EMP will ensure that impacts that cannot be mitigated do not exceed tolerable limits. The management plan provisions do not precisely mitigate wildlife and vegetation impacts; however, there is a relative abundance of similar vegetation and wildlife in the surrounding area. The open bodies of water left after completion of the mining operations will present a more diverse ecological system in the area and may result from inhabitation by aquatic species. It is expected that wildlife will return to the area after the completion of the mining operations and site closure. Regrowth may result in the growth of some plant types not initially present in the area. The EMP and its supporting management plans will establish requirements and procedures for a comprehensive monitoring program that will include but not limited to:

•Impacts to flora and fauna during the construction, operations, and decommissioning phases.

• Stability and pH of waste rock/overburden stockpile runoff, to detect the development of potential acid rock drainage conditions.

• Integrity and geotechnical stability of the Overburden Stockpile (OS), as well as seepage and reclaim water quality; Detection and mitigation of erosion issues that may occur in disturbed areas and constructed earthworks.

• Maintenance of a water balance for the OS, freshwater pond (FWP), and mine water pond (MWP), as well as WMP seepage and discharge water quality.

• Delivery, storage, and management of fuel and other hazardous materials.

• Spill prevention, control, and contingency planning.

• Ambient air quality, noise, and vibration;

• Periodic evaluations of biodiversity in the area immediately affected by the project.

• Management of hazardous and non-hazardous wastes.

• Environmental aspects of occupational health and safety and accident prevention planning.

• The effectiveness of decommissioning and closure actions.

8.1 Construction Impacts

Floral Resources

Dust and combustion emissions generated by equipment during the clearing for mine site facilities may cause injury to plants under ambient conditions of exposure. Pollutants confirmed to cause injury to plants to include NO2 and particulate matter, both of which would be generated by equipment operations at this site. Plant injury would depend on physical and biological factors. Plants consist of four organs: roots, stems, leaves, and reproductive structures. The leaf is the principal target for damage, as it is the organ involved in gas exchange, and its damage would be most obvious. The upper surface of a leaf is overlain by a waxy layer referred to as the cutting. Below the cutting is a layer of colorless cells, the upper epidermis. Both the cutting and the upper epidermis protect the leaf from desiccation and mechanical injury. Located beneath the upper epidermis is a layer of photosynthetically active cells. Next are a mass of irregularly shaped and loosely arranged cells. The loose arrangement provides for large intercellular spaces in which gas exchange is facilitated. The lower surface of the leaf is bounded by the lower epidermis, which also functions to protect the leaf.

Emission impacts upon plants may include changes in leaf structure, which may include chlorophyll destruction (chlorosis), tissue death (necrosis), and pigment formation. Visible symptom patterns may result from either acute or chronic exposures. Acute injury may result from brief exposures (several hours) to elevated levels of a pollutant. Tissue necrosis is generally the dominant symptom pattern from acute exposures. Chronic plant injury may result from intermittent or long-term exposures to relatively low pollutant concentrations, with chlorophyll destruction or chlorosis as the principal symptom of injury. These are moderate impacts (long-term, moderate severity, local extent).

These impacts will be mitigated by employing the following measures:

• Employing dust suppression technique such as applying water or non-toxic chemicals

• Maintaining construction equipment according to manufacturer’s specifications

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

Construction works will include clearing the mine footprint and areas for campsite facilities. The access road may also be widened from its current average width. The areas occupied by the access road corridor, the areas to be mined together with the areas for other mine site facilities will be subtracted from the total area available to flora. Cutting of large tracts will make plant regeneration difficult. This difficulty arises since nutrients contained in the biomass can be washed away by rainwater after clearing. In addition, enhanced leaching, occasioned by clearing, can deplete the soil of nutrients. The absence of nutrients may result in any new vegetation consisting mainly of grass species. Aggressive grass species and shrubs will effectively prevent seed-bearing plants from finding satisfactory living conditions. These grasses serve as a food source for a significant population of birds. The surrounding area is the same ecologically as the cleared area and the area to be cleared is a very small percentage of the total area. Clearing will consequently result in only low impacts (short-term, low severity, local extent) on the overall area.

Faunal Resources

Widening of the access road and clearing of the area for the workshop, quarry plant area, and helipad will fragment the area and can potentially impact wildlife since some animal species depend on the existence of other plant and animal species within the habitat for nutrients/food, cover, etc. The areas to be cleared are relatively small in comparison to the available area. Clearing and encroachment will alter several of the physical conditions, including light, humidity, and temperature. The installation of facilities and other construction works will form temporary barriers to the movement of animals, including access to water bodies. These are moderate impacts (short-term, moderate severity, local extent). These impacts will be mitigated by minimizing the area cleared for the facilities and by maintaining wildlife corridors within the cleared areas. The implementation of the proposed mitigation measures will result in low residual impacts (short-term, low severity, local extent).

The habitat will also become fragmented if the area of land is broken up into smaller and smaller patches. This will make dispersal by native species from one patch to another difficult or impossible and may cut off migratory routes. Isolation may lead to the local decline of species or genetic effects such as inbreeding. Species that require large patches of the forest may simply disappear. These are moderate impacts (medium-term, medium severity, local extent). These impacts will be mitigated by ensuring that a single continuous area with small patches of vegetation is cleared for the mine site facilities. This will result in low impacts (short-term, low severity, local extent).

The physical disturbance and noise produced by construction equipment may impose additional stresses upon wildlife and may lead to increased migration. While disturbances may be stressful for some wildlife, other species may easily adapt to and thrive successfully in the area owing to the phenomenon of habituation. These are potentially moderate impacts (long-term, high severity, local extent). These impacts will be mitigated by ensuring that noise levels are maintained at the lowest possible and are in accordance with EPA Noise Guidelines. The mitigation measures will result in low impacts (long-term, low severity, local extent).

The construction works will lead to increased human population and increased levels of general activity in the area. The increased human presence has the potential to lead to increased impacts on fauna through harvesting, collecting, hunting, fishing, disturbance, and other activities by construction workers. This impact is considered high (long-term, high severity, regional extent). The company will enforce a policy of no hunting and fishing by its employees and will also implement measures to ensure that no fauna is harvested from the area or brought into the area. Implementation of these measures will result in low residual impacts (short-term, low severity, regional extent).

Some loss of small and/or slow-moving fauna will inevitably occur during land clearing and earthmoving activity. None of the invertebrate, amphibians, non-avian reptile, or small mammal species determined to be present in the project area is known to be threatened or endemic. More mobile fauna, including large mammals and adult birds, will very likely flee the area well in advance of any land clearing operations. The surrounding area is large enough to absorb fauna fleeing cleared areas. The loss of terrestrial fauna in the project area is estimated to be a moderate impact (medium-term, moderate severity, local extent) since the area has been disturbed by artisanal mining and exploration activities. This impact will be mitigated by minimization of the areas cleared. The residual impact will consequently below (short-term, low severity, local extent).

Aquatic Resources

The construction of the mine and associated infrastructure will result in the loss of various stream habitats within the concession area. Surveys have not identified any critical aquatic habitats. Similar aquatic habitats are common in the region. Loss of aquatic habitats in the open pit area, water management pond and other areas where major conversion of the land surface is required will be unavoidable due to the nature of the activities. These are moderate impacts (long-term, moderate severity, local extent).

These impacts would be mitigated during the construction stage of the project by constructing the water management impoundments at a rate slow enough to allow aquatic organisms to relocate outside of the footprint of the ponds. Construction will progress in the flow direction of streams to further enhance this possibility. Further retention ponds and other detention storage/sedimentation facilities will be installed to ensure that stormwater discharges do not degrade the habitat structure of the receiving bodies. None of the aquatic fauna identified in the streams or creeks within the project area is known to be threatened or restricted-range endemic. The mitigation measures will result in low impacts (short-term, low severity, local extent).

The loss of aquatic habitat in the concession area is a potentially high impact (long-term, moderate severity, local extent). These impacts will be mitigated by minimizing the extent of areas cleared for diversion channels and by installing bypass structures, where possible, to facilitate flow in the downstream section of streams that have been diverted. Application of these mitigation measures will result in low residual impacts (short-term, low severity, local extent) on aquatic habitats.

Surface runoff from cleared areas may introduce additional nutrient loads to streams. Higher nutrient levels can potentially result in eutrophication. Pollution by contaminated surface runoff can also impact water quality in the streams and lead to denitrification and increased oxygen consumption resulting in an environment less conducive to the survival of fishes. Contaminants could be ingested by aquatic organisms causing reproductive impairment, stunted growth, and other physiological effects. Also, as contaminants naturally break down, they use dissolved oxygen, sometimes significantly reducing the dissolved oxygen content of the water, which can lower spawning success for many fish species and reduce overall habitat suitability for many aquatic organisms. During construction, there could be hydrocarbon contamination of the aquatic systems from accidental spills of lubricants and fuel. Hydrocarbons introduced into aquatic environments may change aquatic plant and animal growth, mortality, and communities. These are potentially high impacts (long-term, high severity, regional extent).

Discharge to water management ponds will contain sediments which will result in decreased transparency and a reduction of light available to aquatic plants, a primary food source for aquatic organisms. Further, the suspended sediment will ultimately settle onto instream habitat features (e.g., downed wood, gravel, etc.) or the bottom substrate causing embeddedness, which will decrease the value of instream habitat for macroinvertebrates and fish. Specifically, increases in embeddedness levels decrease the space between substrate particles and limit the available area and cover for small fish, macroinvertebrates, and periphyton.

The adverse effects of increased levels of fine sediments on fish include increased mortality caused by gill damage; increased predation due to sedimentation of shelter; increased susceptibility to disease; impaired developmental rates, reduction of suitable spawning habitat, reduced spawning success, modification of migration patterns, impairment of visual feeders, and reduction of light penetration, which impedes primary production, reduces food availability, and alters food webs. These are high impacts (long-term, moderate severity, local extent).

These impacts will be mitigated by the implementation of an Erosion and Sediment Control Plan and by channeling contaminated runoff to oil-water separators prior to discharge to streams/creeks. The mitigation measures will result in low impacts (short-term, low severity, local extent).

8.2 Operation Impacts

Overburden Stockpile and Water Management Pond

Improper design, construction, and management of the overburden stockpile and water management ponds can lead to embankment failure and the discharge of contaminated water to the environment. The World Bank Operating Procedure for overburden facilities, 4.37 – Safety of Dams Requirements for Design and Review would be applied to the design, construction, operation, instrumentation, and monitoring of the dams. The ponds will be designed to ensure the stability of its embankment. Stability analysis will be performed of the embankment cross-section to optimize the structure with respect to cost and other objectives while maintaining reliability. Flow nets or an appropriate numerical method will be used to estimate seepage direction and volume and pore pressures at points within the

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embankment. A flow net is a graphical solution of **Darcy's law**[1] to show steady flow through porous media and is used to show groundwater flow. Finite-element and other analysis are also appropriate for predicting seepage direction and volume. The analyses of the tailings pond embankment stability will consider the following failure modes:

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

liquefaction Data for the analyses will be generated by conducting a detailed geotechnical investigation in the area proposed for the pond and on materials identified for use as fill for pond construction. The objective of the investigation will be to determine the geotechnical and hydrogeological conditions and characteristics of the subsurface soil and rock units as they affect the design of the structure. The investigations will include the installation of vertical boreholes through overburden units and bedrock, soil sampling, rock coring, field testing of soil and rock samples, and laboratory testing of the recovered soil and rock samples.

The initial design of the dam and other earth structures will be submitted to the EPA for review. The final design of the water management pond will be submitted to both GGMC and the EPA for approval of these structures prior to project start-up and the use of these facilities. Monitoring and preventive maintenance would be undertaken to assure optimal performance of the water management ponds. Monitoring will consist of visual observation of the embankment and the monitoring of piezometers and other instrumentation installed to assess the performance of these facilities. Preventive maintenance will be undertaken at all potential trouble spots observed during visual inspection. The preventative maintenance will be geared primarily to ensure the stability of the structure and to control seepage through the embankment cross-section. A beach will also be maintained immediately adjacent to the upstream slope of the embankments to increase the length of the seepage path and the stability of the embankment slope. Measurements and monitoring will be made after the occurrence of unusual conditions such as heavy surface runoff or peak floods. Changes could occur in crest levels, water levels, embankment slopes, cross-section geometry, seepage conditions, and material characteristics. A

[1] **Darcy's law** is an equation that describes the flow of a fluid through a porous medium. The **law** was formulated by Henry **Darcy** based on results of experiments on the flow of water through beds of sand, forming the basis of hydrogeology, a branch of earth sciences.

continuous program of inspection and maintenance would therefore be undertaken from the beginning of deposition throughout the life of the pond. Through careful monitoring, areas of concern will be noted and quickly repaired, thereby preventing failure. Visual monitoring will be done to identify typical distress signals associated with pond and overburden stockpile operation, such as cracking, wet spots on the downstream face, and critical settlement. The visual observations will be supplemented by instrumentation to enable an accurate interpretation of the extent of any problem likely to occur. The instrumentation inclusive of piezometers, settlement plates, and inclinometers will be used to show developing trends in the behavior of the water management ponds. The instrumentation would be installed in the embankment and its foundation to monitor changes that are critical to the embankment stability and to predict unstable conditions. Instruments will be installed to measure pore water pressures, seepage flows, embankment movements, and total pressures. Pore water pressure in soils will be measured with piezometers. Seepage flow emerging downstream from the embankment will be collected and directed to a weir for flow measurements. Seepage flows will be used to indicate when significant changes occur and to permit an evaluation of potential problems from the piping. Markers will be installed on the embankment surface and would be aligned in a straight line-of-sight to permit rapid detection of horizontal movement during surveys. In instances where cracks are visible on the embankment surface, successive measurements between two stakes spaced on either side of the crack will indicate any widening and acceleration in separation rate. Slope indicators will also be used to measure the horizontal movement of the embankment. The slope indicators work by telescoping cylindrical casing into the embankment during construction. A sensing element is lowered down grooves inside the casing and measures the slope of the casing in two directions at right angles. From the measured slopes, the horizontal movements occurring over the length of the casing can be calculated. The settlement will be measured by leveling of temporary benchmarks. The frequency of monitoring will depend on previous observations and on the critical nature of the parameters. The frequency of monitoring will be more pronounced during and immediately after construction. When records indicate that conditions are relatively stable, the frequency of monitoring will be extended.

Floral Resources

The removal of vegetation for mine site operations will alter the availability of food and shelter for wildlife. Mining may impact biodiversity by changing species composition and structure and may provide access to previously isolated areas, thereby enabling the exploitation of biological resources from the area. Imported species, including weedy plants and insect pests, may thrive while native species may decline. Improved access to the mine site areas may result in increased hunting, logging, and land development.

Mining can potentially reduce biodiversity either directly, through activities that remove, damage, or modify habitats, or indirectly where changes caused by project activities may create situations where species or their habitats can be damaged by activities other than those directly associated with mining. Examples of such indirect impacts include the proliferation of weeds attracted to areas disturbed by mining and exploitation of timber in forests made accessible by construction of mine site infrastructure.

During the operations, areas to be mined will be cleared of vegetation. Clearing of areas to be mined will make plant regeneration difficult since nutrients contained in the biomass can be washed away after clearing. The surrounding area is the same ecologically as the cleared area, and the area cleared is a very small percentage of the total area. Clearing will consequently result in only moderate impacts (medium-term, moderate severity, local extent) on the overall area. The potential impacts will be mitigated by revegetating the area after the completion of the mining operation. This would therefore result in low residual impacts (medium-term, low severity, local extent).

Emission impacts upon plants may include changes in leaf structure, which may include chlorophyll destruction (chlorosis), tissue death (necrosis), and pigment formation. Visible symptom patterns may result from either acute or chronic exposures. Acute injury may result from brief exposures (several hours) to elevated levels of a pollutant. Tissue necrosis is generally the dominant symptom pattern from acute exposures. Chronic plant injury may result from intermittent or long-term exposures to relatively low pollutant concentrations, with chlorophyll destruction or chlorosis as the principal symptom of injury. These are moderate impacts (long-term, moderate severity, local extent).

These impacts will be mitigated by employing the following measures:

• Employing dust suppression technique such as applying water or non-toxic chemicals

• Maintaining construction equipment according to manufacturer's specifications

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

Traffic on the access road and mine service roads during the operation phase would impact the early succession/edge and secondary forest habitats located along these roads by increasing dust, which will settle on vegetation. Given the limited geographic scope of this impact, the impact of dust accumulation on plants would be low (medium-term, low severity, local extent). Wetting roads during the dry seasons would reduce this impact to low (short-term, low severity, local extent).

The project may use equipment that was previously used on other projects. Soil pathogens, insects, and fungi can be introduced from these items unless stringent measures are taken to avoid this possibility. These are moderate impacts (long-term, high severity, local extent). These impacts will be mitigated by having all equipment fumigated prior to deployment to the mine site. This will result in low impacts (short-term, low severity, local extent).

The movement of people, equipment, and materials to the mine has the potential to cause the introduction of alien invasive species of plants. The disturbance and clearing of natural habitats can also promote the growth or colonization of alien invasive species. This impact is rated as moderate (long-term, moderate severity, local extent). These impacts will be mitigated by the implementation of the following mitigation measures:

- Monitoring of biodiversity and,
- Control of invasive species.

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

Faunal Resources

During operation, additional loss of habitats will not affect any threatened or restricted-range endemic species of fauna since much of the fauna will have likely already left the affected habitats due to disturbance during the construction phase. This impact is rated as moderate (medium-term, moderate severity, local extent). These impacts will be minimized by the implementation of the following:

- Minimization of the Project footprint and,
- Initiating restoration as soon as practicable in temporary work areas.

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

Most of the larger animals would have already abandoned the area during the construction phase. Only small fauna accustomed to disturbed environments is likely to remain in or enter mining areas and other work sites during the operation phase. It is likely that small numbers of small animals such as amphibians and snakes will experience mortality due to equipment and vehicle use. The loss of terrestrial fauna during the mining operations phase is rated as moderate (long-term, moderate severity, local extent). These impacts will be mitigated by the implementation of the following:

- Minimization of the Project footprint and
- Performance of pre-clearance surveys.

The movement of people, equipment, and materials to the mine has the potential to cause the introduction of alien invasive species of animals. This impact is rated as moderate (long-term, moderate severity, local extent). These impacts will be mitigated by the implementation of the following mitigation measures:

• Monitoring of biodiversity and

• Control of invasive species.

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

During the operation of the mine, wildlife may move away from the area. This displacement will increase competition with wildlife on the periphery of the area. This is a moderate impact (medium-term, moderate severity, local extent). This impact cannot be mitigated.

The physical disturbance and noise produced by mining equipment may impose additional stresses upon wildlife and may lead to increased migration. While disturbances may be stressful for some wildlife, other species may easily adapt to and thrive successfully in the area owing to the phenomenon of habituation. These are potentially high impacts (long-term, high severity, local extent). These impacts will be mitigated by minimizing the extent of the cleared areas and by ensuring that noise levels are maintained at the lowest possible. The mitigation measures will result in moderate impacts (medium-term, moderate severity, local extent).

Most animal species follow established patterns in their daily and seasonal movements. The areas through which animals travel on their way to and from feeding, breeding, and birthing grounds and between their seasonal ranges are known as corridors. If the mine service roads and widened access road intersects or blocks wildlife corridors, animals may cease use of the corridor since animals are reluctant to cross open spaces and maybe hit by vehicles using the roads. This may result in a potential increase in animal mortality because of collisions with vehicles or a delay in migration in search of food and for breeding and birthing. These are moderate impacts (long-term, moderate severity, local extent). These impacts will be mitigated by conducting an assessment after the roads are cleared to identify corridors, and signs will be posted notifying drivers of the existence of these corridors, and speed restrictions will be placed on the roads near the corridors. The mitigation measures will result in low impacts (short-term, low severity, local extent).

Wildlife species live in communities that depend on each other. The survival of these species depends on soil conditions, local climate, altitude, and other features of the local habitat. Mining operations will result in direct and indirect impacts on wildlife. The impacts will stem primarily from disturbing, removing, and redistributing the land surface. Most of these impacts would be short-term and would be confined to the mine site. Mining operations will displace and possibly destroy wildlife in areas to be excavated and to be used for the disposal of the mine wastes. The mobile wildlife species, like game animals, birds, and predators, will leave these areas; however, the more sedentary animals, like invertebrates, many reptiles, burrowing rodents, and small mammals, may be more severely affected.

Some animals would be attracted to the open spaces created by the mine and service roads for protection from predators, good food supplies, and better travel conditions. This may potentially lead to accidental death and poaching. These are moderate impacts (long-term, moderate severity, local extent). These impacts will be mitigated by constraining the areas cleared for the mine and service roads to the narrowest width possible and by lowering the vertical alignment. Service roads will also be designed to minimize cuts and fills and will have relatively flat side slopes with the minimal clearing of existing vegetation. The narrower rights-of-way and lower vertical alignment will make crossing easier for animals and will provide longer sightlines for drivers resulting in less frequent collisions with animals. The mitigation measures will result in low impacts (short-term, low severity, local extent).

Aquatic Resources

The operation of the mine and associated infrastructure will impact various stream habitats within the area. These habitats will have already been affected by construction phase activities, but the initiation of mining operations will bring additional impacts to these affected aquatic habitats. Impacts to aquatic habitats associated with the operation of the open pit area, the tailings pond, and other areas where major conversion of the land surface occurs will be unavoidable due to the nature of the activities. Upstream and downstream segments of streams will be affected. Water discharged from the diversion channels surrounding the waste stockpile areas will affect downstream receiving bodies and their aquatic fauna.

The loss of aquatic habitats in the concession area is a high impact (long-term, high severity, regional extent). Mining operations will include the relocation of streams. Several of these streams may contain fish, aquatic invertebrates, and amphibians. The relocation of these streams may result in the loss of these aquatic resources. This will reduce food supplies for predators which feed on these aquatic resources, which may result in the reduction or disappearance of these predators. These are high impacts (long-term, high severity, regional extent). These impacts will be mitigated by minimizing the number and longitudinal extent of streams to be relocated. The mitigation measures will result in moderate impacts (short-term, moderate severity, local extent).

Some wildlife species depend on vegetation growing in natural drainages. This vegetation provides essential food, nesting sites, and cover for an escape from predators. Mining activity may destroy vegetation near streams and reduce the quality and quantity of habitat essential for waterfowl, birds, and other terrestrial species. These are moderate impacts (long-term, moderate severity, local extent). These impacts will be mitigated by assessing the area and the alignment of streams to be diverted before the start of work. The work on both areas to be cleared and streams to be diverted will be conducted in a phased manner to identify and manage the potential environmental impacts to preclude these impacts from being realized. The mitigation measures will result in low impacts (short-term, low severity, local extent).

8.3Closure Impacts

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

While small amounts of metals are considered essential for the survival of many organisms, large quantities are often toxic. Few terrestrial and aquatic species are known to be naturally tolerant of heavy metals, although some have adapted over time. Many fish are highly sensitive to even mildly acidic waters and cannot breed at pH levels below 5. Some may die if the pH level is less than 6 (Ripley et al. 1996). In general, the number of plant and animal species decreases as the aqueous concentration of heavy metals increases. Some taxa are known to be more sensitive to the presence of heavy metals. This is particularly the case for species living in freshwater aquatic habitats. Furthermore, juvenile fish are more sensitive than adult fish, and the presence of heavy metals may affect the critical reproductive and growth stages of fish. These are high impacts (long-term, high severity, regional extent). These impacts will be mitigated by applying a non-reactive cap to all acid-generating areas. The mitigation measures will result in low residual impacts (short-term, low severity, local extent).

Weeds may be introduced to the mine site during site reclamation. Weed introduction can occur by seed contaminated with seeds of weeds which is quite common, even in commercial seed supplies. Weeds may also be introduced by plants and equipment relocated from other areas. These are high impacts (long-term, high severity, local extent). These impacts will be mitigated by requesting that all seed suppliers certify that seeds supplied are weed-free. Seedlings would also be closely monitored for signs of unwanted species. In addition, any non-native species being considered for mine rehabilitation would be carefully tried and closely monitored prior to its introduction. This will result in low residual impacts (short-term, low severity, local extent).

9.0 Monitoring Plan

9.1 Aquatic Ecology Monitoring

In addition to the monitoring of the physical and chemical quality of water in streams and rivers, Malali Quarry Inc. would perform periodic sampling to assess trends in the abundance and diversity of the aquatic biota in all streams affected by the Project. Special attention would be given to the detection of invasive alien species.

9.2 Terrestrial Ecology Monitoring

Malali Quarry Inc. would contract a firm to develop and implement a Biodiversity Monitoring Plan. This plan would identify the appropriate indicators, protocols, and frequencies to be followed. The results of the Biodiversity Monitoring would be reported to all interested stakeholders.

Monitoring would begin during the pre-construction phase and will continue throughout construction, operation, and abandonment until site closure has been achieved. The pre-construction phase monitoring would provide additional baseline data for comparison against monitoring results from later project phases.

Wildlife monitoring would be conducted concurrently with vegetation monitoring. Observations would be recorded in a wildlife-sighting logbook, and these would be periodically examined to determine if there have been any significant changes in species abundance and/or distribution. All collisions with wildlife on haul and site roads would be recorded. The record would note the proximity to cleared areas, the animal involved in the collision and the time of that collision, etc. These records would be used to evaluate the success of the measures outlined in the Management Plan.

If endangered species are observed at any time during construction or operations, special monitoring plans would be developed to track these occurrences. A record would be maintained of all animal mortality associated with Water Management Ponds. The location of the fatality, the time of day, and the process discharge at that time would be among the parameters recorded. Additional fencing around the ponds would be installed as needed based on the results of this monitoring.

Special attention should be given to the detection of invasive alien species to preemptively identify areas where control measures are required.

9.3 Forest Resources

The project is located within an area of undulating terrain covered with tall evergreen ombrophilous forest in the Guiana Shield forest region with elevations ranging between 300 – 1200 m. According to ter Steege (2000), this forest region is found on soils developed on the crystalline shield, such as granites and greenstones, and on pockets of Plio-pleistocene sediments. Rainforests of the region fringe the savannahs and are characterized by a high abundance of *Goupia glabra, Couratari, Sclerolobium, Parinari, Apeiba, Peltogyne, Catostemma, Spondias mombin,* and *Anacardium giganteum.* Other notable species of this region are *Parkia, Ficus, Sclerolobium, Trichilia, Parkia, Parinari,* and *Goupia*. *Eperua falcata* is characteristic of late secondary forest, while *Pterocarpus* and *Macrolobium acaciifolium* are common in forests along rivers in this area.

The baseline biodiversity assessment identified 13 species of mammals, including five primates that are traditionally consumed for protein in hinterland regions. Hunting, however, occurs infrequently and occurs typically twice each year. Mammals harvested included *Cuniculus paca* (Labba), *Tapirus terrestris* (Lowland tapir), *Mazama sp* (Deer), *Dasypus sp* (armadillo), and *Dasyprocta leporine* (Red-rumped agouti). None of the five primate species recorded in the project area serve as a source of proteins for persons within the concession. Two species of birds, namely, *Tinamus major* (Great Tinamou) and *Crax alector* (Powis), are used as sources of protein; however, these were not collected within the area designated for the project.

10.0 Mitigation of Impacts

Mitigation measures will be implemented to prevent/avoid, reduce, and, where possible, offset or remedy any significant adverse landscape and visual effects. Efforts will be expended initially to prevent or avoid adverse landscape and visual effects. If adverse effects cannot be prevented, they will be reduced as far as possible. Unavoidable adverse effects will be offset or remedied.

The project design will incorporate measures to minimise negative and optimise positive landscape/visual impacts.

Mitigation measures will include:

• Avoiding and much as is practicable sensitive locations and sites of highly valued historic or naturalistic landscapes, and siting project facilities to minimise visibility

• Developing the site layout to ensure the location of project elements minimise the impact on valued elements, characteristics, and views and

• Adjusting site levels and use of structured reclamation to minimise the visibility of the development

• Using the appropriate design, materials, and finishes to ensure built features integrate with, or enhance, their surroundings if it is possible or desirable to screen or hide the project

• Use of colors similar to background colors for site facilities such as green roofs

• Enhance the road corridor with new planting where possible using a planting palette that is consistent with the existing plants in the area

• Screening the building and other project facilities using plant where possible

• Maintaining and protecting existing vegetation wherever possible

11.0 Monitoring Plan

Monitoring will be performed to test whether the predicted effects occur and whether any unforeseen effects arise and to ensure that mitigation measures which are implemented are effective in avoiding or reducing the predicted effects.

12.0 Financial analysis

Life–of –Mine (LOM) Project Capital is summarized in Table 2. Initial capital Costs is USD $5.09 Million. LOM operating costs are summarized in Table 4. Operating costs are estimated at USD 16.29 million. Open pit mining will average USD 2.85/ ton of stone and waste moved. Processing is estimated at USD 3.17/ t ore crushed. G & A costs are estimated at USD 2.33/t ore and waste moved.

ITEM	COST (GUY$)
Plant, Machinery and Equipment	$753,000,000.00
Mine development expenses	$50,000,000.00
Building and civil works	$10,000,000.00
Furniture and Fixtures	$10,000,000.00
Reclamation & Closure	$20,000,000.00
TOTAL	**$843,000,000.00**
NET INITIAL WORKING CAPITAL	**$210,750,000.00**
PROJECT COST	**$1,053,750,000.00**
USD COST	**$5,090,580**

Table 2: Initial Capital Cost

ITEM	PERCENTAGE	Year 1	Year 2	Year 3	Year 4	Year 5
1ST Grade Crusher Run	10%	30000	30300	30603	30909	31218
2nd Grade Crusher Run	2%	6000	6060	6121	6182	6244
7/8" Aggregate	2%	6000	6060	6121	6182	6244
3/4" Aggregate	45%	135000	136350	137714	139091	140482
5/8" Aggregate	2%	6000	6060	6121	6182	6244
1/2" Aggregate	15%	45000	45450	45905	46364	46827
Sifting	4%	12000	12120	12241	12364	12487
Underlayer	10%	30000	30300	30603	30909	31218
Sand	5%	15000	15150	15302	15455	15609
Boulders	5%	15000	15150	15302	15455	15609
Total	**100%**	**300000**	**303000**	**306030**	**309090**	**312181**

Table 3: Predicted Production

Cost Item	LOM Costs $USD	Unit Cost $/ton-moved (USD)	Unit Cost $/ton- crushed (USD)
Open Pit Mining	4,356,133.33	2.85	
Open Pit Drilling & Blasting	3,504,390.44	2.29	
Processing	4,858,100.01		3.17
G & A	3,571,428.57	2.33	
Totals	**16,290,052.36**	**7.47**	**3.17**

Table 4: Operating Cost

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Financial Analysis summary

Economic Results are summarized in Table 5; the analysis suggests the following conclusions assuming no gearing:

Mine Life: 5 Years

Mine Life: 5 Years

Pre-Tax NPV1%: USD 27,435,395

Post Tax NPV1%: USD 18,690,815

Pay-Back Post Tax: 1 year

Total Taxes Paid: USD $8,744,580

Peak Funding of Initial Project Capital: USD 16,290,052

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	Year 1 (GUY$)	Year 2(GUY$)	Year 3 (GUY$)	Year 4 (GUY$)	Year 5 (GUY$)
SALES	**$1,800,000,000**	**$1,818,000,000**	**$1,836,180,000**	**$1,854,541,800**	**$1,873,087,218**
Operating cost	-$523,500,000	-$528,735,000	-$534,022,350	-$539,362,574	-$544,756,199
GROSS PROFIT	$1,276,500,000	$1,289,265,000	$1,302,157,650	$1,315,179,227	$1,328,331,019
Administration, Rehabilitation and other expenses	$150,000,000	$150,000,000	$150,000,000	$150,000,000	$150,000,000
NET PROFIT BEFORE TAX	$1,126,500,000	$1,139,265,000	$1,152,157,650	$1,165,179,227	$1,178,331,019
Provision for taxation 20%	$360,000,000	$363,600,000	$367,236,000	$370,908,360	$374,617,444
PROFIT / (LOSS) AFTER TAX	**$766,500,000**	**$775,665,000**	**$784,921,650**	**$794,270,867**	**$803,713,575**
USD PROFIT/LOSS After tax	$3,650,000	$3,693,643	$3,737,722	$3,782,242	$3,827,208

Table 5: Cash Flow Analysis at US$30 per ton

13.0 Conclusion

The quarrying industry's role is to provide a reliable supply of construction materials for road making, building construction, and the maintenance of road networks on which other industries depend. As observed in other industries, successful market leaders are those who provide an efficient and effective service and are mindful of all aspects of their public image. The modern community demands that these premises be managed carefully with consideration of the needs of the environment, neighbours and employees. The general objective in planning for the provision of these materials is to ensure that the supply is managed in a sustainable way, so the best balance is obtained between environmental, economic, and social considerations.