FIGURE 3-10: WIND ROSE FOR THE YEAR 1999

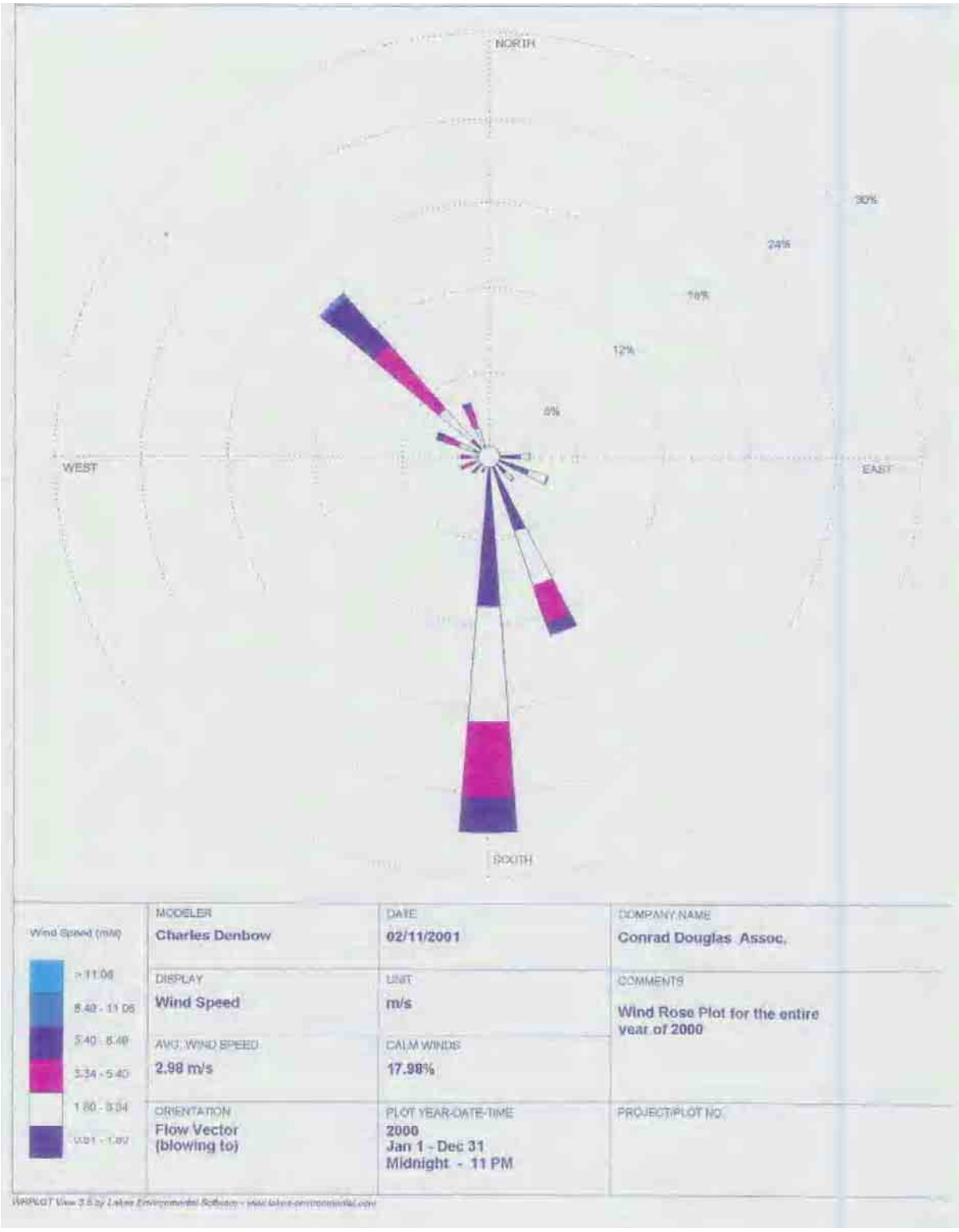

FIGURE 3-11: WIND ROSE FOR THE YEAR 2000

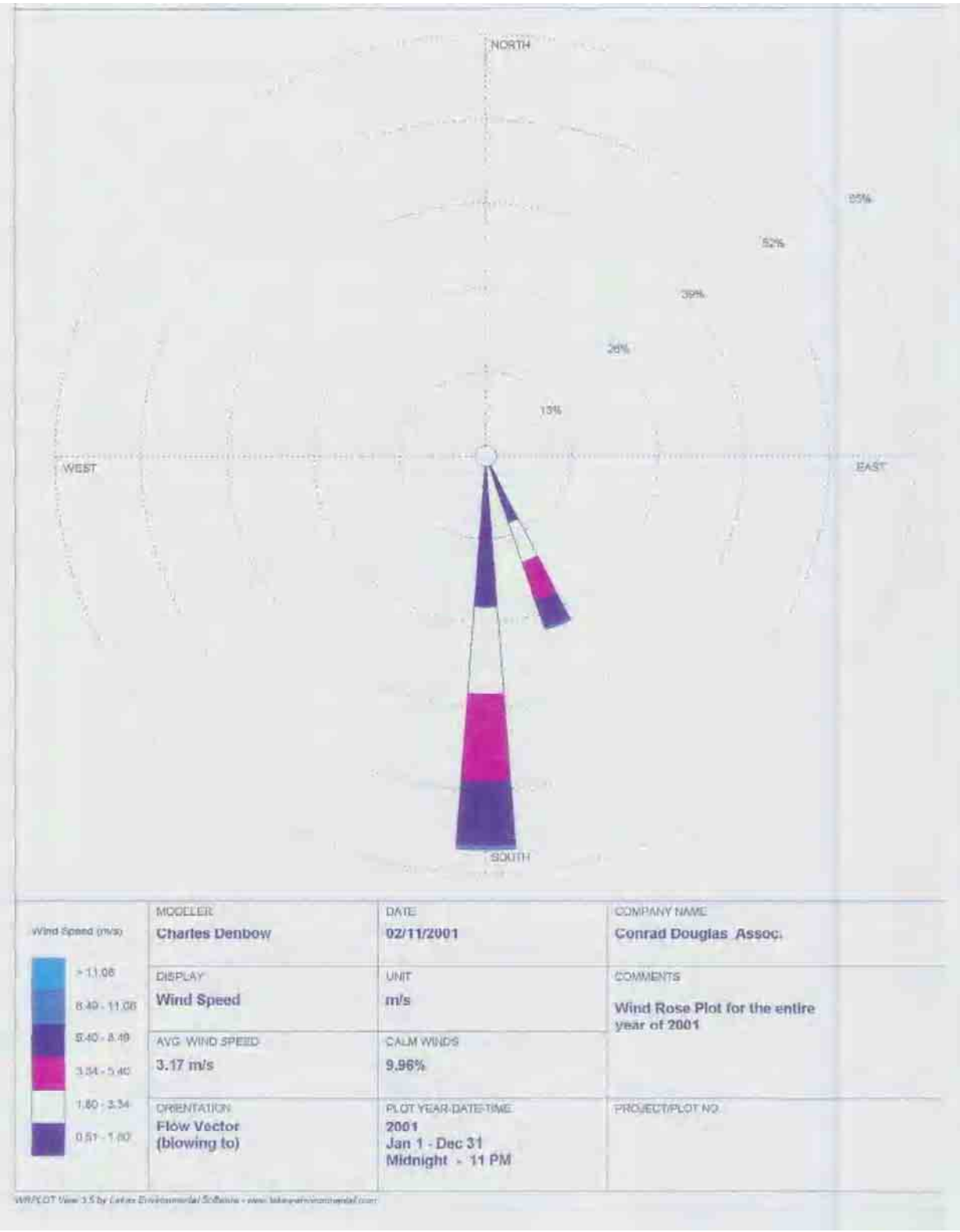

FIGURE 3-12: WIND ROSE FOR THE YEAR 2001

3.6 WILDLIFE AND VEGETATION

3.6.1 INTRODUCTION

Bauxitic soils are considered infertile because they do not support mature vegetation that could typically be found on other soil types under the influence of the same prevailing climatic conditions. Few tree species are found on bauxite deposits, most are found on the limestone hillocks with mainly grasses and small shrubs in areas overlying the bauxite in the depressions. Bauxite mining operations are normally confined to the depressions interspersed with these hillocks and this is reflected in the profile of mined areas.

The proposed mode of transport of bauxite ore from the new mining site to the plant is by rail and truck. The rail line is an existing one owned by the Jamaica Railway Corporation, portions of which have been out of operation for over 20 years and require refurbishing and upgrade. Works to be conducted on the railroad corridor will have impacts on vegetation along the corridor.

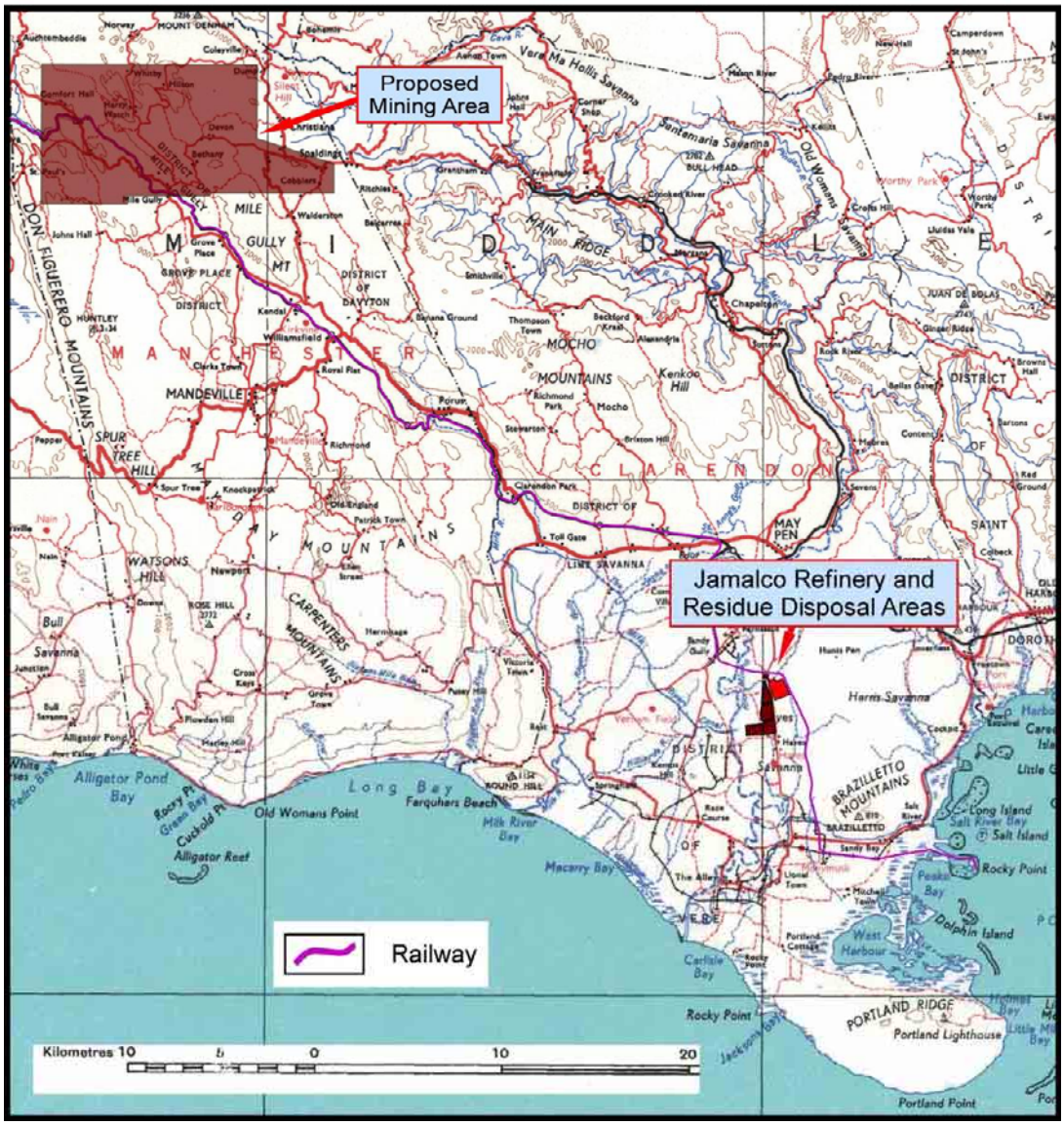

FIGURE 3-13: LOCALITY OF THE PROPOSED PROJECT SITE[1]

3.6.2 METHODOLOGY

The ecological assessment was conducted primarily through qualitative methods supported by literature research. The literature review was based on a series of relatively current studies which employed the use of quantitative methods for several areas in the sphere of influence of the project sites. Methods employed included the following:

- Aerial photography and land use classification mapping to identify plant species distribution and classification.
- Ground- truthing to confirm land use classification and vegetation type and distribution
- Plant collection and plant identification through the aid of a recognized taxonomist and herbarium
- Literature research of information related to the geographical influence of the proposed project to generate species inventories .
- Animal identification through field guides, photography, vocalization, tracks, fecal deposits, burrows among others.

3.6.3 ECOLOGICAL CONTEXT

The gradation of vegetation types is influenced by several factors, namely:

- elevation,
- temperature,
- degree of rainfall, and
- soil types

Inland areas such as North Manchester Plateau experiences cooler temperatures and frequent rainfall which have influenced the evolution of hydrophillic species.

3.6.3.1 NATIONAL BIOLOGICAL DIVERSITY – INTERNATIONAL AND NATIONAL LEVELS

Jamaica is rated fifth highest in endemic plants of any island, worldwide. Based on information through the National Strategy and Action Plan on Biological Diversity in Jamaica- 2003, of the 3,304 known vascular species to occur in the country at least 28% are endemic.

TABLE 3-3-Flora diversity[3]

Terrestrial flora	# of indigenous species	# of endemic species	% endemicity
Bromeliads	60	22	36.7
Orchids	230	60	26
Ferns	579	67	11.5
Cacti	20	10	50
Palms	10	7	70
Grasses	~200	1	0.5

Faunal species similarly have high levels of endemicity with land birds showing 45% and amphibians and reptiles showing a 100% and 76%, respectively

TABLE 3-4- Fauna diversity[3]

Terrestrial fauna	# of indigenous species	# of endemic species	% endemicity
Land snails	514	505	98.2
Grapsid crabs	9	9	100
Jumping spiders	26	20	76.9
Fireflies	48	45	93.8
Butterflies	133	20	15
Ants	59	6	10.3
Amphibians	22	22	100
Reptiles	43	33	76.7
Shore & Seabirds	39	1	2.6
Land birds	67	30	44.8
Bats	21	2	9.5
Other mammals	2	2	100

In order to protect this diversity, the Government, through the Forestry Department, has entered into an arrangement with Jamalco, guided by a 'no-net-loss' policy where the two organizations will work to compensate for the loss of forest cover due to mining operations. This will see the

[3]Source: National Strategy and Action Plan on Biological Diversity in Jamaica - 2003

establishment of new forests on selected reclaimed bauxite mined out areas as well as the protection and preservation of existing forests. The full text of the MOU is presented in Appendix VI

3.6.4 FINDINGS

3.6.4.1 DESCRIPTION OF VEGETATION TYPES

Based on information found in an EIA done in 2004 by Conrad Douglas & Associates Limited, EIA for 2.8 Million Metric Tonne per Year Efficiency Upgrade at Jamalco, at least four distinct vegetation types were identified in the project area covering the study area;

- Wet limestone vegetation (various degrees of disturbance)
- Agricultural and pastureland
- Thorn scrub

Ground truthing of this data has revealed that conditions along the North Manchester Plateau's mining areas have remained consistent with that report.

3.6.4.1.1 WET LIMESTONE FOREST (RUINATE)

The vegetation found in the areas of Mile Gully, Christiana, Coleyville etc was composed primarily of Wet Limestone Forest vegetation interspersed with hillside cultivation and pastureland.

In forested areas trees were thin boled (basal diameter ranged from 6 to 72 cm) and branched high off the ground, perhaps a result of competition for light. The canopy was shallow but continuous, with few openings possibly from the effects of Hurricanes Ivan (2004), Dennis and Emily (2005). The understorey was quite open with low light penetration and primarily had saplings of the larger species. Epiphytes and climbers were well represented.

Leaf litter was high and, based on the leaf structure decomposition rates appeared slow. Soil was shallow and dark in colour indicating high organic matter. The substrate was fragmented limestone rock. Fungi, particularly Bracket fungi were common here and seem to be responsible for decomposition of plant material.

PLATE 3-3: TYPICAL VEGETATION RECORDED IN THE PROPOSED MINING AREA - WET LIMESTONE RUINATE

For convenience, two ecological zones were demarcated in the mining area: "Wet Limestone Ruinate" at the higher elevations and "Wet Limestone Lower Region" as presented in the 2004 report. A listing of the species, typical of these two areas is presented in Table 3-5 and Table 3-6 respectively.

TABLE 3-5: Wet Limestone (Ruinate)

Family	Scientific Name	Common Name	Habit	Status	Area Located
Anacardiaceae	*Mangifera indica*	Mango	Tree up to 15m	Common cultivated	Pasture, ruinate
Araliaceae	*Dendropanax arboreus*	Angelica Tree	Tree 3-16m	Common in damp sheltered area	Natural vegetation
Asteraceae	*Eupatorium odoratums*	Jack-in-the bush	Erect or scrambling shrub; 2-3m	Common weed	Pasture, Ruinate
Bignoniaceae	*Spathodia campanulata*	African Tulip tree	Tree up to 16m	Common	Orchard
Bombaceae	*Ceiba pentandra*	Silk Cotton Tree	Tree 10-40m	Occasional, perhaps planted	Ruinate Forest
Boraginaceae	*Bourreria sp.*	***	Shrub	Common	Ruinate
Bromiliaceae	*Tillandsia sp.*	Bromeliad	Epiphyte	Common	Orchard, Ruinate (on Guango)
Caesalpiniaceae	*Haemotoxylum campechianum*	Logwood	Gnarled Tree up to 10m	Common	Ruinate

Family	Scientific Name	Common Name	Habit	Status	Area Located
Caesalpiniaceae	*Cassia sp.*	***	Shrub	Common	Ruinate, Pasture
Compositae	*Bidens cynapiifolia*	Spanish Needle	Herb, 15-20cm	Common	Pasture, Ruinate
Lauraceae	*Nectandra antillana*	Long-leafed Sweetwood	Tree to 15m or more	Common	Pasture
Malvaceae	*Hibiscus elatus*	Blue Mahoe	Tree up to 25m	Common, often planted	Pasture
Mimosaceae	*Samanea saman*	Guango	Tree up to 20m	Common	Ruinate, Orchard
Moraceae	*Castilla elastica*	Central American Rubber	Tree up to 20m	Common	Ruinate, Orchard
Myrtaceae	*Psidium guajava*	Guava	Cultivated Tree or Shrub; 7m	Common on site	Orchard
Nyctaginaceae	*Pisonia aculeata*	Cockspur	Shrub up to 6m	Common	Ruinate
Papaveraceae	*Bocconia frutescens*	John Crow Bush	Shrub 2-3m; Tree 5m	Frequent in woodlands	Ruinate
Papilionaceae	*Gliricidia sepium*	Quick stick	Tree up to 6m	Common	Orchard
Poaceae	*Axonopus compressus*	Carpet Grass	Perennial grass	Common weed	Orchard, Pasture
Rutaceae	*Citrus sp. (C. aradise & C.. reticula)*	Ugli	Cultivated Tree	Occasional on site	Orchard
Rutaceae	*Citrus auranthum*	Sour Orange	Cultivated Tree	Common on site	Orchard
Rutaceae	*Citrus sinensis*	Sweet Orange	Cultivated Tree	Common on site	Orchard
Rutaceae	*Citrus reticulata*	Tangerine	Cultivated Tree	Occasional on site	Orchard
Rutaceae	*Citrus sp. (Citrus sinensis & Citrus reticulate)*	Ortanique	Cultivated Tree	Occasional on site	Orchard
Sapindaceae	*Cupania glabra*	Wild Ackee	Tree up to 12m	Widely scattered	Forest
Sapindaceae	*Matayba apetala*	Coby Wood	Tree 5-10m	Widely distributed	Forest
Urticaceae	*Pilea sp.*	***	Shrub	Common	Forest

Family	Scientific Name	Common Name	Habit	Status	Area Located
Verbenaceae	*Lantana camara*	White Sage	Climbing aromatic shrub, 1-6m	Common in pasture areas	Pasture
Species present -27					

Families represented -22 Endemics – none

TABLE 3-6: Wet Lime Stone Lower Region

FAMILY	SPECIES	COMMON NAMES	STATUS	HABIT
Agavaceae	*Agaves sobolifera*	Maypole	Common	Shrubby plant
Anacardiaceae	*Mangifera indica*	Mango	Common	Tree up to
Bignoniaceae	*Enallagma latifolia*	Gourd tree	Common	Tree up to 5m
Boraginaceae	*Ehretia tinifolia*	Bastard Cherry	Common	Tree 6 - 15m
Bromeliaceae	*Tillandsia sp.*	Bromeliads	Common	Epiphyte
Burseraceae	*Bursera simaruba*	Red birch	Common	Tree up to 25m
Cactaceae	*Hylocercus triangularis*	Cactus, climbing	Endemic-common	Climber/creeper*
Caesapiniaceae	*Haemotoxylum campechianum*	Logwood	Common	Tree up to 10m
Caesapiniaceae	*Delonix regia*	Poinciana	Common	Tree, 5 -15m
Euphorbiaceae	*Ricinus communis*	Castor Oil Plant	Common	Short-lived shrub/small tree
Gramineae	*Bambusa vulgaris*	Bamboo	Common	Arborescent up to 10m
Mimosaceae	*Albizia lebbeck*	Woman's tongue	Common	Tree up to 20m
Mimosaceae	*Samanea saman*	Guango	Common	Tree up to 16m
Moraceae	*Cecropia peltata*	Trumpet tree	Common	Tree up to 20m
Musaceae	*Musa sp.*	Banana	Common	Tree
Palmae	*Thrinax parviflora*	Bull Thatch	Endemic-common	Tree
Rhamnaceae	*Ziziphus mauritiana*	Byrie/Coolie plum	Common	Tree up to 15m
Sapindaceae	*Melicoccus bijugatus*	Guinep	Common	Tree deciduous 6 -18m

Species -18
Families represented -16
Endemics-2

Twenty-two families representing twenty-seven species of higher plants were found in the “Wet Limestone Ruinate” zone. Emerging tree species noted included African Tulip, Silk Cotton, Angelica and Guango. None of these are considered rare or endangered species and none are endemic. The general area is characterized by the appearance of cultivated agricultural tree species interspersed with the non–agricultural tree species. Among the crop species were fruit trees such as Orange, Mango and Guava. A few epiphytic specimens were noted.

PLATE 3-4: EPIPHYTIC SPECIMEN ON LARGE TREE SPECIES[1]

The vegetation in the Lower Region of the mining area is typical of that to be expected in drier areas and could be indicative of more freely draining soils. Of the sixteen families found, two are common endemics, Bull Thatch and Climbing Cactus. Eighteen species were identified. Anthropogenic intrusion is evidenced by the presence of species such as banana (*Musa sp*), Bastard Cherry (*Erhritia tinnifolia*) and Coolie Plum (*Ziziphus mauritiana*).

3.6.4.1.1.1 *SUMMARY*

Elevation and human influence impacted on the species composition in these areas. Within the more remote and higher elevations at least twenty-seven species were recorded. However, no endemics were recorded. In the lower elevations, at least eighteen species were recorded with two endemics noted.

3.6.4.1.2 AGRICULTURAL CROP SPECIES

Anthropogenic influences were particularly strong in the areas of Mile Gully, Devon, and Bethany. Extensive farm plots in the area primarily featured yam *(Diosocea sp)* (See Plate 3-1), but other crops included corn (*Zea Mays*), sweet potato (*Ipomoea batatas*) and cassava (*Manihot esculenta*). In areas visited these farming areas in combination with buildings and recreational areas, to a great extent, replaced the natural vegetation of the valley floor.

3.6.4.2 OTHER IMPORTANT ECOLOGICAL AREAS

In close proximity to the proposed mining area are two areas of ecological importance; Bird Cage Rock and Quaco Rock. Earlier studies revealed a high level of endemicity of species within these two areas. Bird Cave Rock showed potentially 14 plant families existing in the area accounting for 46 species. Of this number at least13 were endemic. For Quaco Rock, 31 families were noted accounting for 62 species. Endemicity was at 62.9%. These areas speak to the potential for high biodiversity levels in the general area but indicate more exceptional habitats rather than representative ones. Care needs to be exercised to mitigate indirect impacts from bauxite mining as well as anthropogenic intrusion through relocation of human settlements.

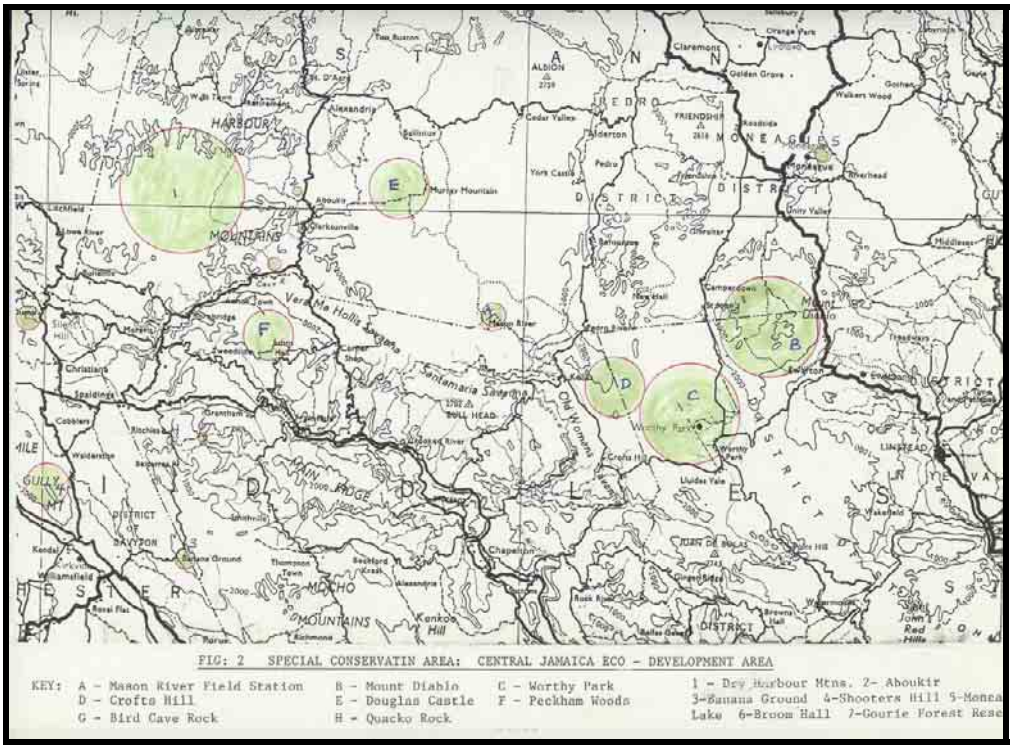

FIGURE 3-14: Location of Important Ecological Areas[1]

3.6.4.3 RAILWAY ROUTE - MINE TO PLANT

The transportation corridor will remain similar to what is currently in use in the area. However, there will be the need for haul roads from mining areas to the loading station. Rehabilitation and upgrading of the railroad will involve construction activities within several ecological zones moving from the wetter limestone forest type vegetation to thorn scrub on the plains. In some areas, lands may need to be cleared and graded to facilitate the upgrade of the railroad. A recent study by Conrad Douglas and Associates (EIA for 2.8 Million Metric Tonne per Year Efficiency Upgrade at Jamalco, 2004) provides details on the vegetation typical of some of these communities. For ease of reference, the relevant sections of this study dealing with "The Biological Environment" are presented below.

a) Wet Limestone forest

The wet limestone forest typically has a uniform canopy of 15 - 18m (50 - 60 ft) but emergent trees may be as high as 30 m. Canopy depth is not wide being formed by thin boled trees (0.3-0.6m) with wide spreading crowns. Naturalized species included Red Birch, made conspicuous by its red, flaky bark and the Trumpet tree.

The subcanopy has an average height of 12 m (40 ft) and is very dense. The shrub and field layers were sparser and merge in some areas. The herb or ground layer is not well represented due to the influences of substrate and/or availability of sunlight (shading from taller species).

The moist, cool micro-conditions favour climbers such as ariods and epiphytes such as *Tillandsia.* Only the latter was observed but the hanging roots of the former added to the thickness of the sub canopy layer.

Topographic variations exerts a major influence on physiognomyl of the vegetation. In the valley regions accumulation of soils, leaf litter contributions and percolation can induce changes, supporting larger and more robust individuals and may have a higher concentration of epiphytic plants.

b) Dry limestone Forest

This type was obvious in the hills immediately west of the proposed railhead site, and effectively starts at the boundary between plains and the rocky limestone of the contiguous hills. Physiognomy was essentially reflective of typical dry limestone forests. However at the lower elevations (along access roads and paths) the presence of uncharacteristic species such as wild cerasee *(Momordica charantia)* confirmed interference by human activity.

Canopy height of the vegetation was estimated to be between 5 - 15m (15 - 45 ft). Plants were very thin boled, with branched rooting systems to gain anchorage on the rocky substrate. Leaf litter was evident but in the early stages of decomposition. Termite mounds were also noted. Termites act as an important nutrient recycler by digesting cellulose of dead or fallen trees.

Stratification was not distinct in forming upper, middle or lower canopies. Though the canopy was continuous, it was not deep. The dominant species was *Thrinax parviflora* (Bull thatch) which grew in obvious clusters. *Simaruba bursei* (Red Birch) was the dominant emergent tree, prominent for its burnt red, flaky bark. Its prevalence is probably due to fire resistance and unsuitability for lumber or charcoal. Specimens of *Agave soblifera* (Maypole) with their bright yellow inflorescence were also readily identifiable.

Climbing, scrambling and epipihytic plants were represented by climbing cacti and the common orchid, *Broughtonia sanguinea.* No rare or endemic species were identified.

Increasing altitude (cooler conditions), and increasing distance west on the Manchester Plateau (higher rainfall), result in an increase in species wl1ich prefer wetter environments such as mosses and bromeliads.

Field observations confirm that plant diversity was lower in the environs of the railhead than was observed in the hillslopes above Harmons Valley, and was not stratified and as complex as the hillside vegetation.

At the proposed railhead and storage area species diversity was low with two species dominating the area, a stoloniferous grass resembling Carpet grass and Wild poponax. The grass provided 100% coverage, leaving bare areas only in places with obvious disturbances

One coal kiln was observed in the environs of the railhead indicating that local forest species were being harvested for charcoal production. Others were reported.

c) Thorn savannah

The vegetation here is generally exposed to dry and hot conditions and it spanned from the railhead storage area through the entire length or pathway of the proposed railway.

Succulent plant parts, mircrophyllous leafs, compound leaves and thick cuticles were all adaptations to the dry hot environment which are geared towards reducing excessive water loss.

Wild poponax had an even distribution with specimens having an average height of 3 m (9ft). The plants were highly branched with deep canopies, accounting for an estimated 60% of the plants height. However, the plants did not form a continuous canopy. A herb or sub-canopy was not represented in the savanna area.

At Spring Plain the species composition comprised almost pure stands of Logwood. This community may be the result of previous economic cultivation of the species (use in the production of dyes). Other conspicuous tree species included Poinciana and Guango.

Historically introduced pasture grasses are found in the area. These include include Guinea grass *(Panicum maximum)* and species from the genus *Andropogon.*

d) Aquatic (Riverine) vegetation

At least three water ways cut through or run close to the proposed railway corridor, the Milk River, Baldwin gully and the Rhymesbury gully. These waterways contribute significantly to changes in the otherwise xerophytic vegetation of the Thorn savannha. Species, which prefer wetter conditions, thrive in proximity to these waterways.

There is considerably more biodiversity in the environs of these waterways. Observed communities included Cotton tree, Guinep, Mangoes, Gourd tree, Bamboo, Water grass and Guango.

The Baldwin Gully had the most developed vegetation with a closed canopy over the water, creating a dim and cool environment. Canopy height was an estimated 10m with vegetation forming a narrow belt about 16 m wide along the gully.

The forest is in most part experiencing levels of disturbance. By virtue of mining in the region, the impact of human induced disturbance should be kept at a minimum with Jamalco's security precautions, a key facet of all its mining operations.

3.6.4.4 FAUNAL STUDIES

3.6.4.4.1 GENERAL FAUNAL DESCRIPTION

The primary focus of the faunal studies was on the avifauna in the area and for the other species noted such as insects, reptiles and amphibians. Not all observed species were identified.

Analysis of avifauna species was conducted in relation to habitat types as outlined above in the vegetation analysis.

At least 18 bird species were observed with 15 of these identified. Of this number, 73.33% (11) were residents, 13.33% (2) were migratory and 6.66% (1) introduced. It is likely, however, that one of the unidentified birds was migratory.

According to the Gosse Bird Club of Jamaica, all the birds identified are given a status of one (1), indicating 'Common in suitable habitat'. The number of sightings also indicated that many of the identified birds were common in the area. There were no endemic, rare or endangered species noted in the area. However, a number of species, particular grass quits and warblers were seen collecting nesting material.

Literature sources confirmed that major nesting periods are between January and May.

3.6.4.4.2 THORN SCRUB

The vegetation types identified in the study area have the potential to support a number of bird species, providing habitats particularly for columbids, and passerines. The vegetation types have also been known to support a large number of migrant warblers in the winter season.

Generally, bird counts conducted over the study period did not confirm a large number of bird species and only one migrant was identified in the total of fifteen (15) species identified.

3.6.4.4.3 WET LIMESTONE (RUINATE) AREAS

Of the species identified the following feeding categories were represented:

- Frugivores (fruit and seed eaters) - 28.6% (6)
- Insectivores (predominantly insect eaters) - 14.3%(3)
- Omnivores (a combination of the above two feeding groups) - 23.8% (5)
- Scavengers (carrion feeders) - 4.8 %(1)

There were trends in the locations at which these feeding types were sighted. The majorities were found in the mining area, which showed more organized and developed vegetation types, 76.2% of the birds species were identified.

3.6.4.4.4 ESTUARIES AND RIVERS

Of the species identified the following feeding categories were represented in the railway route:

- Frugivores (fruit and seed eaters) - 19.1% (4)
- Omnivores (a combination of the above two feeding groups) - 19.1% (4)
- Carnivores (meat eaters) - 4.8 % (1)
- Shore feeder/Wader (feeds on mollusks, annelids etc.) - 4.8% (1)

38.1% of the total number of birds identified was observed along the proposed railway area, which consisted of dry scrub. Of the 38.1% total, 14.3% of the birds were in altered habitats due to the effects of rivers or streams. These wetter areas showing similar type vegetation structures as that of the mining area.

Only 14.3% of the bird species was shared between the mining area and railway route and included the columbids.

The figures strongly suggest that the habitats provide mainly for fruiting, seeding structures and insects, these food types being maximized by the omnivores. The second largest group was the frugivores. It is apparent that the mining area provides these habitats to a greater extent based on the number of species recorded there.

Please see Table 3-7 and Table 3-8

TABLE 3-7: Limestone Forests

FAMILY	SCIENTIFIC NAMES	COMMON NAMES	FEEDING HABIT
Accipitridae	Buteo jamaicensis	Red-tailed Hawk	Carnivore
Ardeidae	Bubulcus ibis	Cattle Egret	Omnivore
Coerebinae	Coereba flaveola**	Bananaquit	Frigivore
Cucilidae	Crotophaga ani	Smooth-billed Ani	Omnivore
Columbidae	Columbina passerina	Common Ground Dove	Frugivore
Columbidae	Zenaida asiatica	White-winged Dove	Frugivore
Columbidae	Columba leucocephala	White-crowned Pigeon	Frugivore
Columbidae	Zenaida aurita	Zenaida Dove	Frugivore
Emberizinae	Tiaris olivacea	Yellow-faced Grassquit	Frugivore
Mimidae	Mimus polyglottos	Northern Mockingbird	Omnivore
Parulinae	Dendroica pharetra**	Arrow-headed Warbler	Insectivore
Parulinae	Dendroica caerulescens	Black-throated Blue Warbler	Insectivore
Parulinae	Setophaga ruticilla	American Redstart	Insectivore
Picidae	Melanerpes radiolatus**	Jamaican Woodpecker	Omnivore
Psittacidae	Aratinga nana**	Olive-throated Parakeet	Frugivore
Thraupinae	Euphonia jamaica**	Jamaican Euphonia	Frugivore
Todidae	Todus todus**	Jamaican Tody	Insectivore
Trochilidae	Anthracothorax mango**	Jamaican Mango	Nectarivore
Trochilidae	Trochilus polytmus polytmus**	Red-billed Streamertail	Nectarivore
Turdidae	Turdus aurantius**	White-chinned Thrush	Omnivore
Tyrannidae	Myiarchus barbirostris**	Sad Flycatcher	Insectivore
Tyrannidae	Myiarchus stolidus	Stolid Flycatcher	Insectivore
Tyrannidae	Tyrannus caudifasciatus	Loggerhead Kingbird	Omnivore
Tyrannidae	Tyrannus dominicensis	Gray Kingbird	Omnivore

Families -15
Species -24
Endemics ** -10 (41.7%)

TABLE 3-8: Coastal and Thorn Scrub

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/RANK	FEEDING HABIT
Apodidae	*Tachornis phoeicobia*	Antillean Palm Swift	R1	Insectivore
Apodidae	*Streptoprocne zonaris*	White-Collard swift	R1	Insectivore
Ardeidae	*Bubulcus ibis*	Cattle Egret	R1	Omnivore
Cathartidae	*Cathartes aura*	Turkey Buzzard	R1	Scavenger
Charadriidae	*Charadrius vociferous*	Killdeer	R1	Omnivore
Columbidae	*Columbina passerine*	Ground Dove	R1	Frugivore
Columbidae	*Zenaida aurita*	Mourning Dove	R1	Frugivore
Cucilidae	*Crotophaga ani*	Smooth-billed Ani	R1	Omnivore
Emberizinae	*Tiaras olivacea*	Yellow-faced Grass quit	R1	Frugivore
Falconidae	*Falco sparverius*	American Kestrel	R1	Carnivore

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/RANK	FEEDING HABIT
Mimidae	*Mimus polyglottos*	Northern Mockingbird	R1	Omnivore
Scolopacidae	*Actitis macularia*	Spotted sandpiper	W1	Omnivore
Sturnidae	*Sturnus vulgaris*	European Starling	I1	Frugivore
Trochilidae	*Mellisuga minima*	Vervain	R1	Nectarivore
Tyrannidae	*Tyrannous dominicensis*	Gray Kingbird	S1	Insectivore

Families -13
Species - 15
Endemics -none

3.6.4.5 OTHER FAUNA

Insects were fairly well represented, with butterflies and bees being the most obvious of the group. Lepidoptera (butterflies etc,) were represented with at least 5 different species noted. More importantly is the ecological functions of these insects where they act as pollinators. Other insect's species included ants, beetles, stinkbugs, wasps and honeybees.

3.6.4.5.1 AMPHIBIANS AND REPTILES

Reptiles and amphibian were not noted during surveys however literature reviews indicated the likely occurrence of certain species in the study area. Please refer to Table 3-9 below, which a list of potential amphibians and reptiles in study area.

There are at least four species of *Arrhyton sp.* of which three are endemic. The snakes feed on other reptiles and amphibians such as *Anolis spp, Eleutherodactylus* adults and eggs as well as *Sphaerodactylus spp*. Of the *Sphaerodactylus spp* one, not endemic, has a range extending to the study area.

In addition, at least six *Anolis spp* are suspected to occupy the area. Of these six species at least five are endemics with one species thought to be extinct.

Of the amphibians at least 15 species are thought to have the potential to occur in the study area and of these fifteen, twelve are endemic. Furthermore, nine of those species are *Eleutherodactylus spp.*

TABLE 3-9: TERRESTRIAL INVERTEBRATE FAUNA KNOWN TO INHABIT NORTH MANCHESTER[4]

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/RANK
COLUBRIDAE	*Arrhyton funereum*	Jamaican Black Groundsnake	E
	Arrhyton callillaemum	Jamaican Red Groundsnake	E
TYPHLOPIDAE	*Typhlops jamaicensis*	Jamaican Thunder Snake, Jamaican Blindsnake	E
GEKKONIDAE	*Sphaerodactylus argus*	Jamaican Stippled Sphaero	-
ANGUIDAE	*Celetes duquesneyi*	Blue-Tailed Galliwasp	E
	Celetes d crusculus		E
	Celetes barbouri	Limestone Forest Galliwasp	-
IGUANIDAE	*Anolis valencienni*	Jamaican Twig Anole	E
	Anolis sagrei	Cuban Brown Anole	-
	Anolis opalinus	Opal-Bellied Anole	E (Possibly extinct)
	Anolis garmani	Jamaican Giant Anole	E
	Anolis grahami	Jamaican Turquoise Anole	E
	Anolis lineatopus	Jamaican Gray Anole	E
TEIIDAE	*Ameiva dorsalis*	Jamaican Ameiva	-
EMYDIDAE	*Trachemys terrapen*	Jamaican Slider	-
HYLIDAE	*Osteopilus brunneus*	Jamaican Laughing Frog	E
	Hyla wilderi	Green Bromeliad Frog	E
	Hyla marianae	Yellow Bromeliad Frog	E
LEPTODACTYLIDAE	*Eleutherodactylus planirostris planirostris*	Cuban Flathead Eleuth	-
	E. pantoni pantone	Jamaican Yellow-Bellied Eleuth	-
	E.junori	Rock Pocket Eleuth	E
	E.jamaicensis	Jamaican Bromeliad Eleuth	E
	E.grabhami	Jamaican Pallid Eleuth	E
	E gossei gossei	Jamaican Forest Eleuth	E
	E. gossei oligaulax		E
	E. cundalli	Jamaican Rock Eleuth	E
	E. cavernicola	Portland Ridge Eleuth	E
	E. calyptahyla crucialis		E

Families -10
Species - 28 E - Endemics - 21

There are at least four species of *Arrhyton sp.* of which three are endemic. The snakes feed on other reptiles and amphibians such as *Anolis spp, Eleutherodactylus* adults and eggs as well as *Sphaerodactylus spp*. Of the *Sphaerodactylus spp* one, not endemic, has a range extending to the study area.

[4] Additional information from Caribherp: West Indian Amphibians and Reptiles, http://evo.bio.psu.edu/caribherp/lists/JAM-LIST.HTM, Accessed September 8, 2005

In addition, at least six *Anolis spp* are suspected to occupy the area. Of these six species at least five are endemics with one species thought to be extinct.

Of the amphibians at least 15 species are thought to have the potential to occur in the study area and of these fifteen, twelve are endemic. Furthermore, nine of those species are *Eleutherodactylus spp.*

3.6.4.5.2 BUTTERFLIES

As with amphibians and reptiles, this group was not surveyed and unfortunately literature did not yield concrete data on species distribution. Information from the Begs report 2000, which focused on faunal studies in Southern Manchester, indicated the likely occurrence of certain species. The report identified seven families accounting for 41 species. Of which nine are endemic species or subspecies.

3.6.4.5.3 OTHER INVERTEBRATES

The Begs report (2000) also identified species such as moths and, microlepidoptera. Please refer to the species list below:

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/ RANK
ORDER: LEPIDOPTERA [Moths & Butterflies]			
Arctiidae	*Ammalo helops*		
	Calidota strigosa		
	Eunomia rubripunctata		Endemic
	Cosmosoma achemon		
	Cosmosoma auge		
	Cosmosoma fenestrata		
	Horama grotei		Endemic
	Empyreuma anassa		Endemic
	Phoenicoprocta jamaicensis		Endemic
	Composia credula		Rare
	Correbidia sp.		Rare
Hyponomeutidae	*Atteva auria*		
Pyralidae	*Diaphina hyalinata*		
	Epipagis huronalis		
	Anania florella		
Sphingidae	*Enyo biosduvali*		
	Erinnyis alope		
Geometridae	*Nepheloleuca foridata*		

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/ RANK
ORDER: ODONATA [Dragonflies and Damselflies]			
Aeshnidae	*Coryphaeschana adnexa*	Needle case	
Libellulidae	*Erythemis simplicollis*		
	Erythemis plebeja	Needle case	
	Tramea abdomiinalis	Needle case	
	Tramea insulris	Needle case	
	Tramea binotata	Needle case	
	Erythrodiplax aunrata	Needle case	
	Erythrodiplax bernice	Needle case	
	Dthemis rufinervis	Needle case	
	Macrothemis celeno	Needle case	
	Lepthemis vesiculosa	Needle case	
	Anax junius	Needle case	
	Micrathytyria didyma	Needle case	
	Pantala flavescens	Needle case	
Zygoptera (Damsel flies)	*Unidentified sp.*	Needle case	
ORDER: MANTODEA [Praying Mantis]			
	Stagmomatis domingensis	Praying mantis	
ORDER: ISOPTERA [Termites]			
	Nasutitermes nigricepes	Termite; Duck ants; white ants	
	Procyptotermes cornicepes	Termite; Duck ants; white ants	
ORDER: ORTHOPTERA [Grasshopers & Crickets]			
Gryllidae	*Halpithus sp*	Cricket	
Acrididae	*Orphullela punctata*	Small Grasshopper	
	Neoconocephalus affinis	Grasshopper	
	Stilpnochlora laurifolium	Grasshopper	
Noctuidae	*Ascalapha odorata*	Black Witch, Duppy Bat	
	Melipotis sp.		
	Sylectra ericata		
	Leucania juncicola		
	Thysania xenobia		
	Cinccia sp.		
ORDER: DERMAPTERA [Earwigs]			
	Euborellia annulipes	Earwig	
	Cabidora rip aria	Earwig	
ORDER: HOMOPTERA [Plant bugs]			
Membracidae	*Tyolzygnus fasciatus*		
Cidadidellidae	*Poeciloscata laticepes*		
ORDER: HEMIPTERA [True bugs]			
Gerridae	*Gerris sp.*		
Pentatomidae (Stink bugs)	*Loxa viridis*	Stink Bug	
	Nezara viridula	Stink Bug	
	Proxy victor	Stink Bug	

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/ RANK
	Euschistatus bifibulous	Stink Bug	
	Alcaeorrhyndicus grandis	Stink Bug	
	Proscys victor	Stink Bug	
Cydinidae	*Tominotus communis*		
Rediviidae		Stick insect	
Pyrrhocoridae (Stainers**)**	*Dysdercus jamaicensis*	Police man bug; Love bug	
	Oncopertus sanderchatus		
	Oncopertus pictus		
ORDER: NEUROPTERA [Lace wings & ant lions]			
Chrysopidae	*Chrysopa bicornea*	Ant lion; Nanny Goat	
Myrmelontidae	*Hesperoleon sp.*	Green lace wing	
ORDER: DIPTERA [Flies]			
Tipulidae	*Limonira sp.*	Daddy long leg; crane fly	
Syrphidae (Flower flies)	*Ornidia obesa*		
	Copestylum inatoma		
	Copestylum tamaulipanaum		
	Pseudodorus clavatus		
	Toxomerus pulchallus		
Bombylidae	*Paecillathrax lucifer*	Bee fly	
Stratyomyidae (Soldier flies)	*Hermatia illuscells*	Soldier fly	
Assilidae	*Leptogaster jamaicensis*	Robber fly; bee fly	
	Cerotainia jamaicensis	Robber fly; bee fly	
	Ommatis alexanderi	Robber fly; bee fly	
Tephritidae	*Anastrepha sp*	Fruit fly	
Stphylinidae	*Carpelimus petomus*		
	Carpelimus sp.		
Tenebrionidae	*Tarpela metabilis*		
ORDER: COLEOPTERA [Beetles]			
Cincindellide	*Cicindela carthagena jamaicana*		
Coccinellidae	*Chalieorus cacti*	Lady bird beetle	
	Cycloneda sauguinea	Lady bird beetle	
Scolytidae	*Xyleborus sp.*	Shotgun borers	
Chrysomelidae	*Coptocyia jamakana*		
	Metriona flavolineata		
	Diabrotica bivittata		
	Disonycha laevigate		
	Homophoeta albicellis		
	Cerotoma ruficornis		
Cerambycidae	*Eburia postica*		
	Oreodera sp.		
	Chlorida festiva		
	Elaphidon spinicorne		
	Neoptychodes trilineta		

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/ RANK
	Neoclytus longipes		
	Neoclytus sp.		
Scarabeeidae (Scarab beetle)	*Paragymentis lanius*		
	Ligyrus fossor		
	Macraspis tetradactyla		
	Strategus sp.	News bug	
	Oniticellus cubiensis	Dung beetle	
	Phanaeus vindex		
Dyticidae	*Unidentified sp.*		
ORDER: HYMENOPTERA [Ants, Wasps & Bees]			
Scolidae	*Compsomeris dorsata*		
	Campsomeris attrata		
Ichneumonidae	*Icheumonus sp.*	Night wasp	
Apidae	*Euglossa jamaicensis*		
	Centris sp.		
	Apis mellifera	Honey bee	
	Exomolapsis sp.		
Megachilidae	*Megachile concina*	Leaf cutter bee	
	Megachile poyei	Leaf cutter bee	
Sphecidae	*Sceliphron asimile*	Mud wasp	
	Zeta abdominalae	Mud wasp	
	Pachydynerus nasidens	Mud wasp	
Vespidae	*Polistes crinitus*	Red wasp	
	Polistes hunteri	Red wasp	
	Polistes major	Big red wasp	
Chalcidae	*Spilochalsis sp.*		
Formicidae	*Paratrechina longicornis*		
	Crematogaster sp.	Black ant	
	Pheidole sp.	Biting ant	
	Camponutus sp.	Carpenter ant; Big red ant	
	Trachymymex jamaicensis	Gardening ant	Endemic
ORDER: COLLEMBOLA [Springtails]			
	Unidentified sp.	Springtail	
SPIDERS			
	Peucetia sp.	Anancy Spiders	
	Argiope aurunita	Anancy Spiders	
	Micrathena sp.	Anancy Spiders	
	Phalaugium sp.	Anancy Spiders	
MILLIPEDES			
	Julida sp.	Forty leg	
ORDER: IXODES [Ticks]			
	Boophilous microplus	Cattle tick	
ORDER: ISOPODA			
	Unidentified sp.	Woodlouse	

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/ RANK
ORDER: OLIGOCHAETA [Earth Worms]			
	Pheretima sp.	Earthworm	
	Proto scolex sp.	Earthworm	
SNAILS			
	Thelidomus aspreera		
	Sagda jayana		
	Sagda anodon		
	Sagda torrefactor		
	Plectocycoltus jamaicensis		
	Lucidella granulosa		
	Lucidella anroela		
	Lucidella sp.		
	Urocoptis aspera		
	Urocoptis brevis		
	Urocoptis sp.		
	Orthalicus undatus		
	Eutrochatella sp.		
	Pleurodonte autalucena		
	Tudora jayana		
	Tudora tectilabris		
	Tudora banksiana		
	Tudora sp.		
	Dentelaria sp.		

Families -50
Endemics - 5

3.6.4.6 ECOLOGICAL RELATIONSHIPS

- **Soil fertility and Trees.** It is well established that the presence of trees contribute significantly to soil amelioration. Trees provide a number of functions; physically, they prevent soil erosion by protecting the soil from direct rainfall through interception with their canopies, and they improve soil stability through their root systems. Chemically, they improve soil quality by additions of organic matter (leaf litter, decomposing branches and root exudates) and through leaching from stem and leaves.

  The species *Samanea saman* (Guango) may play a greater role in this regard. The plant is a nitrogen fixing tree, and large specimens are frequent in several areas

- **Plant dispersal and Pollination.** Several of the plant species have specialized relationships with birds to ensure pollination and seed dispersal. One such case occurs with bromeliads being pollinated by *Trochilus polytmus polytmus* (Red-billed streamertail) and the *Cecropia peltata* (Trumpet tree) whose seeds are dispersed by birds.

- **Habitats** Several plant species provide valuable habitats for animals species. In general provide feeding and nesting grounds for bird species. In addition to creating microhabitats , suchs as bromeliads and other epiphytes . These plants in turn support the breeding species as tree frogs and crabs.

3.6.4.7 BIODIVERSITY LEVELS

In summary a general survey of the project locations, the mining area, along the railway routes, the plant and port site, reveal no rare or endangered plant species. A comparison of species diversity in study areas, with the potential species likely to occur in a more extensive study against the national levels

Jamalco has commissioned a more extensive study of the proposed mining area. The reslts of which will be used to inform decisions regarding the protection of any valuable species that may be identified

The committement of the company to the preservation and conservation of Jamaica's biodiversity is underscored by the alliance established with the Forestry Department

FIGURE 3-15: Comparison of Biodiversity Levels

	Observed species	Endemics	Potential species from literature	Endemics	National levels	Endemics
Plants	60	2	47	Not indicated by study	3,304	167
Birds	39	10	144	19	106	31
Bats	0	N/a	9	1	21	2
Butterflies	5	unknown	41	9	133	20
Amphibians	0	N/s	14	12	22	22
Reptiles	0	N/a	16	11	43	33
Snails	2	unknown	19	Not indicated	514	505

Note- numbers include bird migratory species
Listing from Quaco rock and Bird Cave rock omitted

3.6.5 CONCLUSIONS & RECOMMENDATIONS

3.6.5.1 CONCLUSIONS

The proposed project although wide in its geographical scope will only impact (in a reversible manner) on the ecology of the specific mining areas, the area in Green Vale selected for the loading station and points along the railroad corridor. This will involve the clearing of vegetation and its associated disruption to fauna to facilitate the removal of bauxite ore and construction of facilities.

Jamalco has made significant preparations for this unavoidable aspect of the industry through its ground breaking Memorandum of Understanding with the Forestry Department to implement a “Land Care Management Plan” for areas slated for mining. In respect of other elements of the project the impacts willl be minimal:

- The railway network and transportation corridor is already in existence and its rehabilitation and upgrade will pose a limited but reversible impact on existing vegetative cover and the environment in general.

- Species noted in the study area are relatively common. Key species such as those noted in Hellshire, Bird Rock and Quaco Caves are out of the zone of influence of the project.

3.6.5.2 RECOMMENDATIONS

The area of concern will be the proposed mining areas, where vegetation will have to be removed to facilitate mining. In such cases the following steps should be taken:

- Land clearance should be kept to a minimum to reduce unnecessary habitat loss

- Care should be exercised to minimize anthropologic influences on nearby areas of significant biological value.

- Where possible, important plant species should be removed for preservation. The involvement of such groups as the Jamaica Orchid Society to do sweeps of the areas before clearance should be considered. The same should apply to smaller animals such

as tree frogs or snakes. This is a good opportunity for the involvement of local NGO's to aid with this rescue effort.

- Jamalco should consider organizing a response team through NGO and community contacts to deal with any important species that may be displaced during mining.

- Indigenous species should be preserved for use in the rehabilitation programme to promote re-establishment of similar vegetation types, in keeping with Jamalco's policies and the MOU with the Forestry Department.

In the case of the SEML proposed for mining in Northern Manchester, it is strongly recommended that Jamalco continue to study the area to capture the seasonal variations in vegetation, fauna and habitat types and their ecological relationship right up to the commencement of mining.

3.7 ARCHAEOLOGICAL AND HISTORICAL RESOURCES

3.7.1 SUMMARY [5]

Manchester was separated from the adjoining parishes of St. Elizabeth, Clarendon and Vere in 1814, and was named after the Duke of Manchester, who was the Governor of the island at the time. The chief town, Mandeville, was named after his eldest son.

In the Parish Church yard is the tombstone of Sir William Scarlett, Chief Justice of the island from 1821 to 1832.

[5] Historic Jamaica by Frank Cundall New York: Johnson Reprint Corp., 1971

3.7.1.1 HISTORIC SITES AND BUILDINGS IDENTIFIED IN THE SEPL

3.7.1.2 CHURCHES

3.7.1.2.1 THE BETHANY MORAVIAN CHURCH

This offers a majestic view of the Don Figueroa Mountains and Mile Gully Valley. It is located within the SEML.

3.7.1.2.2 THE MIZPAH MORAVIAN CHURCH

The Mizpah Church which dates from 1866 is also set on a hill. Its name as well as that of the surrounding community was given by its first priest, Theodore Sondermann. Mizpah means: “the Lord watches over us”. Sondermann left for Europe with the church uncompleted, though he hoped to return. He died in Europe and it was left to Swiss missionaries and Surveyor Heinrich Walder to complete the church. It is probably due to this that the church resembles an alpine chalet.

Other Churches of significance in and around the mining areas include:

- Devon Missionary Church
- St. Simon’s Anglican Church
- Medina United Church
- St. Georges Anglican Church Ruins

3.7.1.3 GREAT HOUSES

- Medina Great House Ruins
- Derry Great House Ruins
- Wear Pen Great House
- Green Vale Great House

- Rippon Great House
- Richmond Hill Property Great House
- Rippon Property House

3.7.1.4 RELEVANT HISTORICAL FEATURES

- Skull Point
- Gourie Cave
- Mile Gully High School
- Mile Gully Railway Station

3.8 NOISE LEVELS AND VIBRATION

3.8.1 MINING

During mining operations, it is anticipated that the potential for noise impact will come primarily from the utilization of heavy equipment and blasting (where necessary). Because of the location of Jamaica's bauxite deposits atop limestone deposits, it is usually easy to access the ore by simply removing the overburden, blasting is not widely practiced in bauxite mining.

Noise will be generated by heavy equipment and machinery, however, the identification of bauxite deposits in the proposed mining area in North Manchester makes it difficult to predict the closeness of residents to mining activities. What is known is that Jamalco has a noise management policy that has governed its mining operations in Jamaica for many years which will continue to be implemented. Additionally, from time-to-time Jamalco utilizes the service of third-party monitors to collect noise data.

Monitoring of nearby residences and communities will be undertaken as necessary to collect both baseline noise level data and measurements to ensure that the residential limit of 70 db (A) is not exceeded. All complaints related to noise will be addressed as Jamalco is committed to complying with the regulations.

3.8.2 AUDIOMETRIC SURVEY

The audiometric survey was conducted using calibrated handheld digital audiometers., Noise levels were measured at various locations selected because of their proximity to planned activities and residential areas within communities and along the temporary truck transportation corridor.

Survey results indicated noise levels in the small rural communities ranged between a "quiet" reading of 41 dBA to a "normal" high reading of 75-80 dBA. During situations such as vehicles passing by or horns being blown, readings would enter the mid to high 80's dBA.

In a District Town Center like Porus, reading ranged from a “quiet” reading of 47 dBA to a “normal” high reading of low to mid 80’s dBA. Traffic through the town center and blowing of horns represented the highest readings recorded.

Additional baseline noise data will continue to be collected for comparative analysis when mining related operations begin in the area.

3.8.3 VIBRATION ANALYSIS

Vibration and impacts related to vibration will have a greater potential in structures located in proximity to active mines or along the railroad corridor. All sensitivities, precautions and regulatory considerations will be taken into consideration during mining and train movement through communities.

Data from vibration analysis studies of the proposed mining areas, surrounding communities inclusive of the northern rail corridor and the proposed loading station were not available at the completion of this EIA report.

To derive truly conclusive scientific data on vibration potential and mitigation if necessary, a detailed program of investigation should be developed and implemented throughout these areas on an objective basis using scientifically approved criteria and techniques.

Sufficient vibration data should be generated which would be subjected to rigorous statistical analysis over all operational conditions. This should also take into account other factors in the environmental baseline which may contribute to the introduction of errors and inaccuracies in these observations.

Based on the fact that many of the northern Manchester communities that exist along the railway corridor have not heard or seen a train pass by in over 20 years it is important that sensitisation and consideration be given should the project be approved for implementation. The consultant recommends that Jamalco conduct structural assessment of homes and buildings closest to the rails and include periodic vibration measurements or review of structural assessments in its monitoring programme.

3.9 NATURAL HAZARD VULNERABILITY

3.9.1 NATURAL HAZARD VULNERABILITY - MANCHESTER

3.9.1.1 FLOODING

Although flooding has occurred in the limestone regions of Manchester Parish in times of unusually heavy and/or prolonged rainfall (e.g. at Porus, Harmons and Content in 2002), there are no historical records of flooding in the proposed mining area. Due to the predominant gentle slopes of the area and the physical impacts of the mining activities, mined out areas will be utilised (in some cases) as stabilisation areas for rainwater to control surface drainage and run-off that may impact on communities. Stormwater control and management are features of mining plans implemented by Jamalco.

3.9.1.2 LANDSLIDES

There appear to be no historical records of major landslides in the area. However, the near vertical slopes on some limestone hills bounded by faults or with mature karst topography makes such slopes susceptible to rock falls. Also, on steep slopes where cultivation has resulted in soil erosion there is the potential for the accumulation of screes, which could become unstable (See Figure 3-16). Mining activities conducted within the guidelines of the mining and rehabilitation plans will not increase the likelihood of landslides in the area.

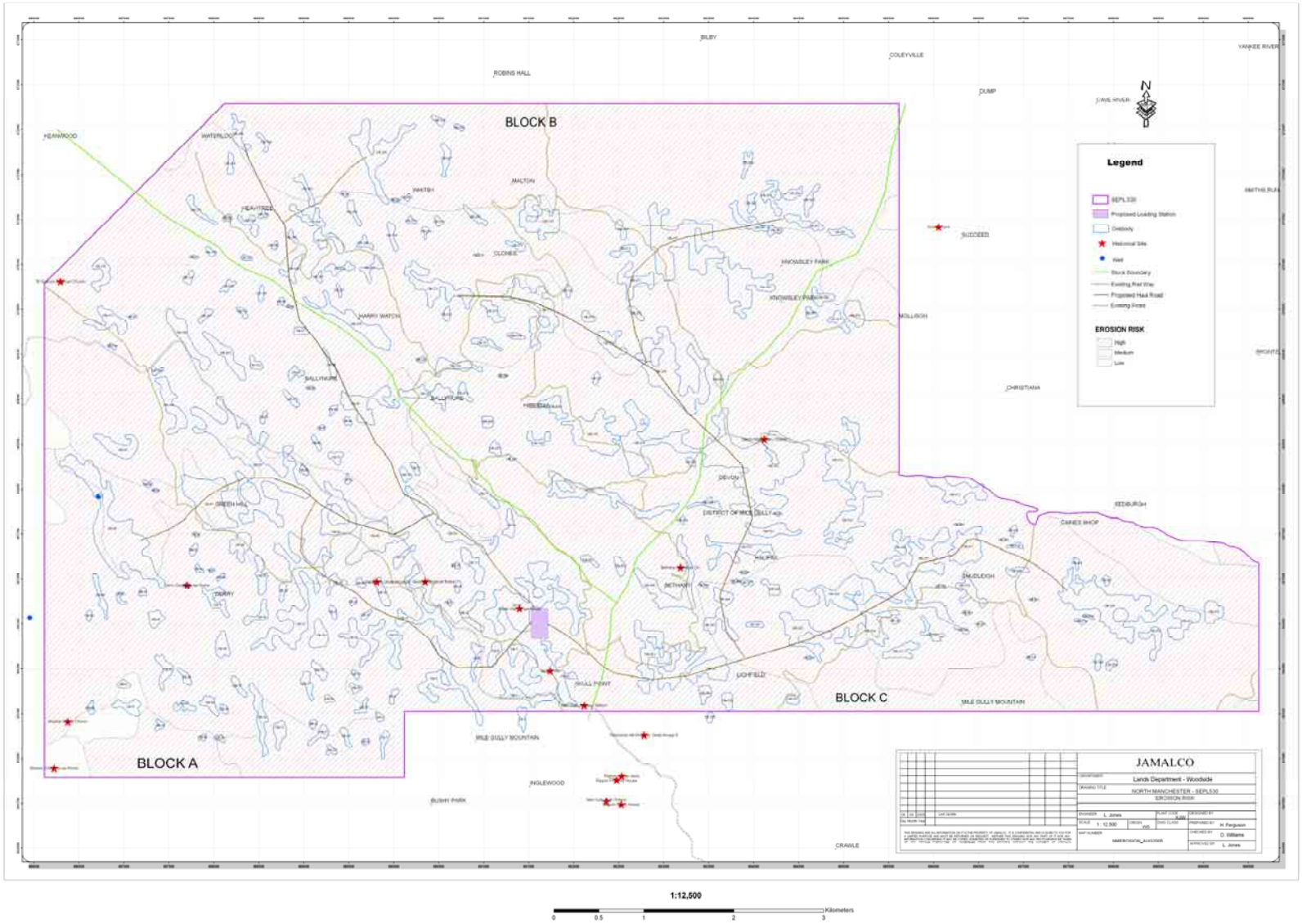

FIGURE 3-16: SOIL EROSION RISK MAP FOR SPL530

3.9.1.3 TECTONICS AND FAULTING

3.9.1.3.1 TECTONIC HISTORY

The highlands of northern Manchester are in the structural form of a syncline of which the axis is centred more or less along the depression of Mile Gully. This structure is named the Kendal-Porus Trough (Zans and others, 1963). This suggests that the relief of the area, following the structure, is relatively young geologically. Uplift of Jamaica above the sea occurred in this region within the last 10 to 25 million years (Hill &Ostojic, 1982), perhaps significantly less.

3.9.1.3.2 LOCATION OF FAULTS

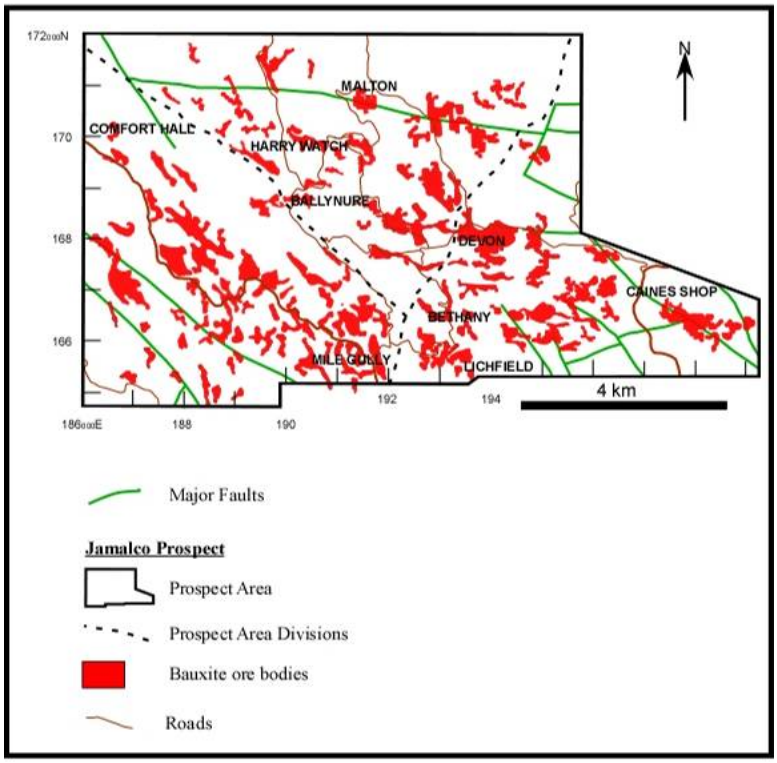

FIGURE 3-17: Fault Map of Jamalco of the Jamalco Mining Prospect Area in Manchester. [1]

The distribution of major faults on Figure 3-17 is derived from Geological Sheets 9 and 12 of the Mines and Geology Division (1974). Major fault trends are northwest – southeast, the same as the axis of the Kendal-Porus Trough.

3.9.1.4 SEISMIC ACTIVITY

3.9.1.4.1 LOCAL

Local earthquakes occur but are unlikely to affect mining operations.

Figure 3-15 below shows the maximum expected Maximum Mercalli Intensity (MMI) across various regions of the island; Figure 3-15 also allows for a 10% probability in the possible exceedance of these expected values within 50 years of each occurrance. Jamalco's mining operation in the North Manchester area is expected to feel tremors from earthquakes between 7-8 MMI. The expected effects from such tremors range from small slides and caving in and/or along sand or gravel banks, to the cracking of wet ground and steep slopes.[6]

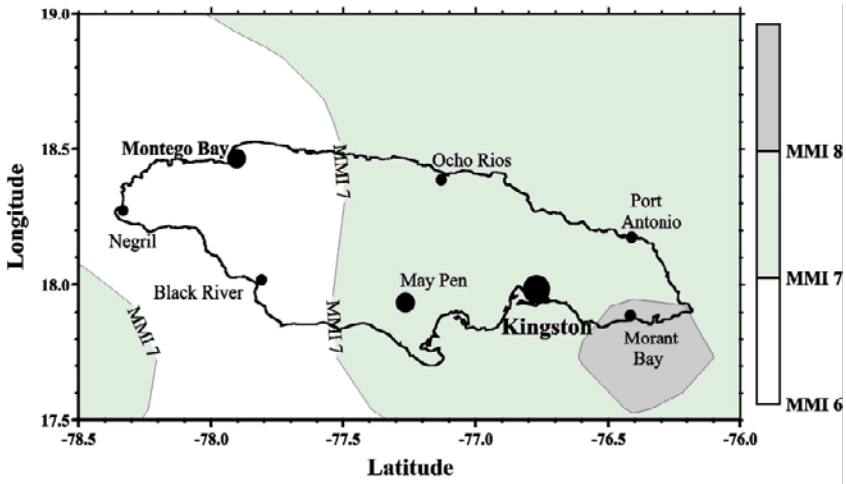

FIGURE 3-18: MAXIMUM MERCALLI INTENSITY IN JAMAICA[7]

[6] http://www.uwiseismic.com/Earthquakes/eq_monitoring.html#Anchor-MEASURIN-48543
[7] http://www.oas.org/CDMP/document/seismap/

The proposed mining area consists of Karst areas showing various lanform characteristics. The Karstlands showing greatest bauxite deposits are the Karstlands with ridges and cones, which are separated by bauxite filled glades (Manchester Plateau), and the Karstlands with flat sloping high level plain covered with thick bauxite soil (Roberts Run-Bousue area). In both Karstland landforms, the bauxite deposits are located in areas where the terrain is essentially flat and not steeply sloped. Therefore, these areas are unlikely to experience the cavings or landslides associated with the expected earthquake intensities.

The proposed transportation corridor from the mining area in North Manchester to the bauxite refinery in Clarendon will utilize haulage trucks and rail carts. These proposed methods of transportation will use infrastructure (road and rail) that is unlikely to be damaged severly or potentially by the expected earthquake intensities, such damage is commonly associated with earthquakes of the order of 10-12 MMI.

3.9.1.5 CONCLUSIONS

- There appear to be no impediments from a geological standpoint, to mining bauxite in the proposed area of northern Manchester Parish.
- The mining operations are not likely to encounter problems or unique situations that will require any major adjustment in methodology or management protocol different from previous experiences.
- In instances where residences and structures have to be relocated, Jamalco also has a proven track record in providing satisfactory solutions.

3.10 TRAFFIC COUNT SURVEY

3.10.1 INTRODUCTION

Traffic Count Surveys were conducted at three locations along the proposed temporary truck route between the Green Vale Load-out Station and the St. Jago Railhead. The Surveys were conducted by staff from the National Works Agency (N.W.A). The locations surveyed were:

- Willaimsfield Main road (Before Roundabout) August 25, 2005
- Porus Main Road (Trinity near Highway) on August 24, 2005
- Clarendon Park Main Road (Between Train Line and Juicy Beef) on August 25, 2005

Each survey was conducted over fourteen (14) continuous hours. Measurements were recorded as isolated totals every hour, and were classified according to the type of vehicles that were counted. The vehicle classes that were used for the survey were:

- Car
- Light Commercial Vehicle (L/Comm)
- Bus
- Truck
- Minibus (M/Bus)

The raw data for the survey along with relevant summary tables are found in Appendix III: Traffic Count Data

3.10.2 OBSERVATIONS – WILLAIMSFIELD MAIN ROAD (BEFORE ROUND-ABOUT)

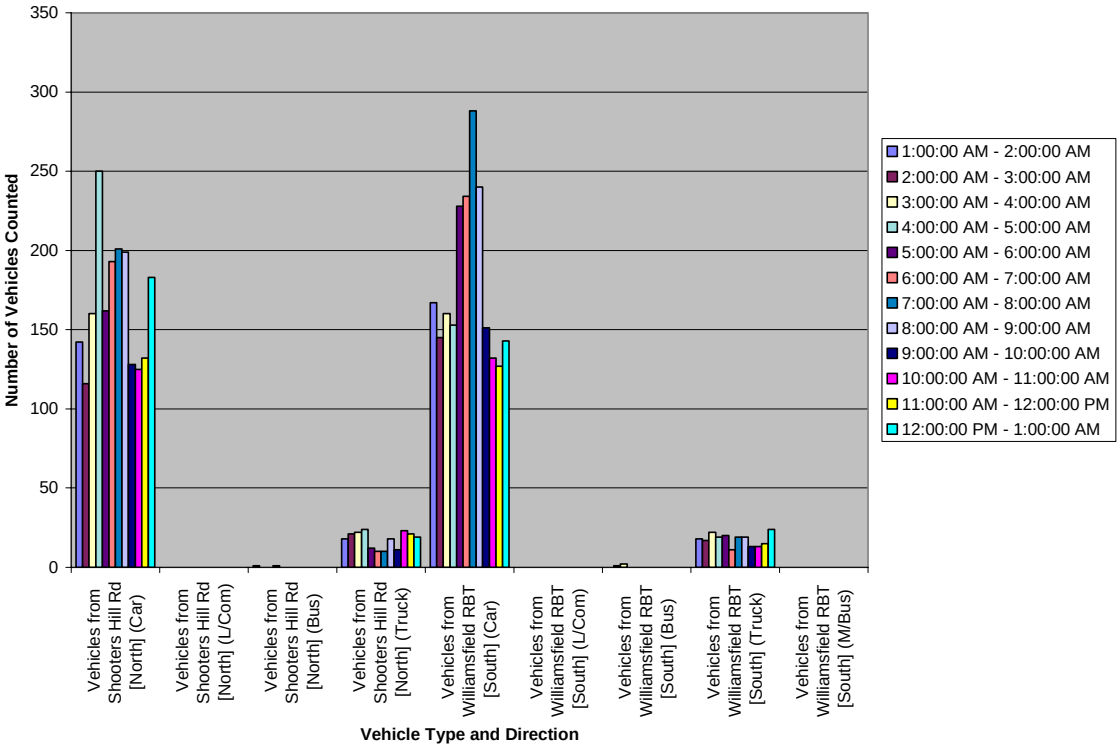

FIGURE 3-19: VEHICLE TYPE AND QUANTITY VARIATION FOR WILLIAMSFIELD MAIN ROAD

3.10.2.1 DEDUCTIONS FROM FIGURE 3-19

- Of all the vehicles, cars are consistently higher in frequency from Shooters Hill Rd [North] and from Williamsfield Roundabout [South] than the other vehicles, for each of the observed time periods.
- The period during which there is the most vehicular traffic on the monitored route, traveling in opposite directions, is between 7a.m – 8.a.m.
- The period during which there is the least traffic on the monitored route, traveling in opposite directions, is 10a.m – 11a.m
- The period during which there is the most vehicular traffic from Shooters Hill Rd [North] is between 7a.m – 8.a.m.
- The period during which there is the most traffic traveling from Williamsfield Roundabout [South] is between 12p.m (night) – 1a.m., and 3a.m – 4a.m

- It is viable to note that, on average, the collective traffic from Shooters Hill Rd [North] accounts for approximately 95% of the total traffic traveling in either direction.

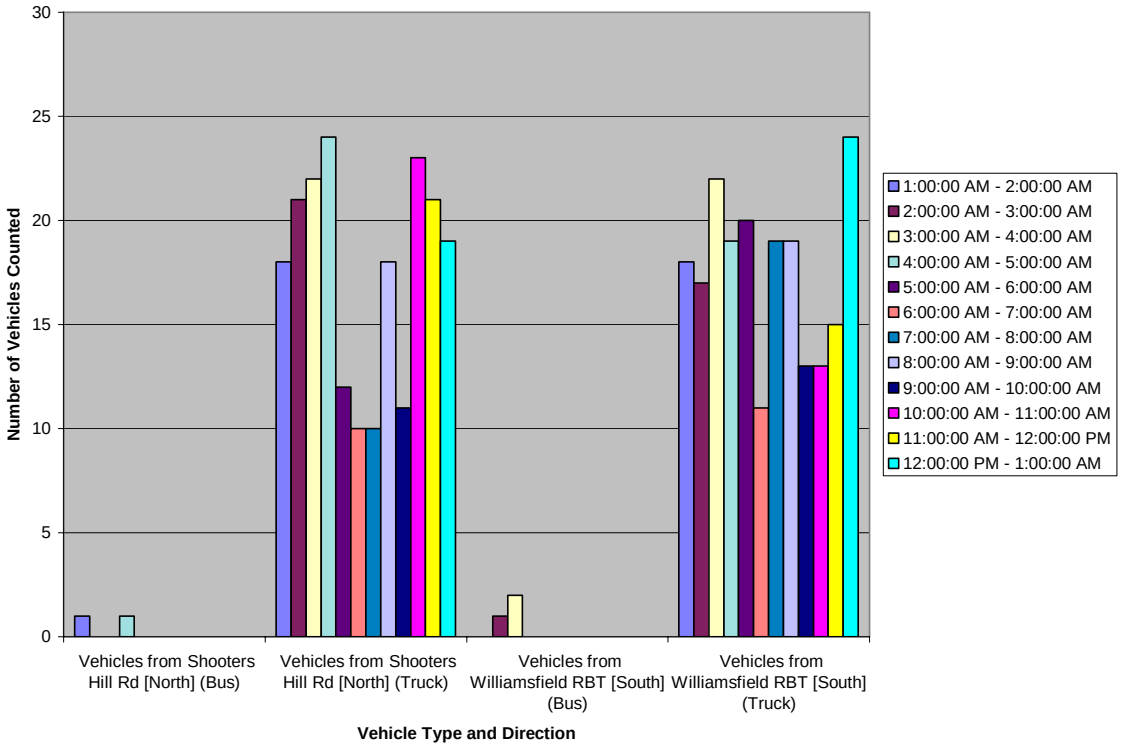

FIGURE 3-20: BUS AND TRUCK QUANTITY VARIATION FOR WILLIAMSFIELD MAIN ROAD

3.10.2.2 DEDUCTIONS FROM FIGURE 3-20

- Of the heavier vehicles (i.e. buses and trucks), trucks are consistently higher in frequency from Shooters Hill [North] and from Williamsfield Roundabout [South] than buses for each of the observed time periods.
- The time period during which there is the most traffic from trucks traveling from Shootershill Rd [North] is 4a.m to 5a.m.; of notable significance are the time periods from 2a.m to 3a.m, 3a.m to 4a.m, 10a.m to 11a.m, and 11a.m to 12p.m (afternoon) which are comparable to the highest observed numbers for the traffic from trucks traveling from Shootershill Roundabout [North].
- The time period during which there is the most traffic from trucks traveling from Williamsfield Roundabout [South] is 12p.m (night) to 1a.m.; of notable significance are

the time periods from 3a.m to 4a.m, and 5a.m to 6a.m which are comparable to the highest observed numbers for the traffic from trucks traveling from Williamsfield [South].

- The time period during which there is the most collective traffic from trucks traveling in opposite directions is 3a.m to 4a.m.
- The collective traffic from trucks traveling in opposite directions reaches two equilibriums: the first is between 1a.m and 3a.m; and then the second is from 5a.m to 12p.m (afternoon).

3.10.3 OBSERVATIONS – PORUS MAIN ROAD (TRINITY NEAR HIGHWAY)

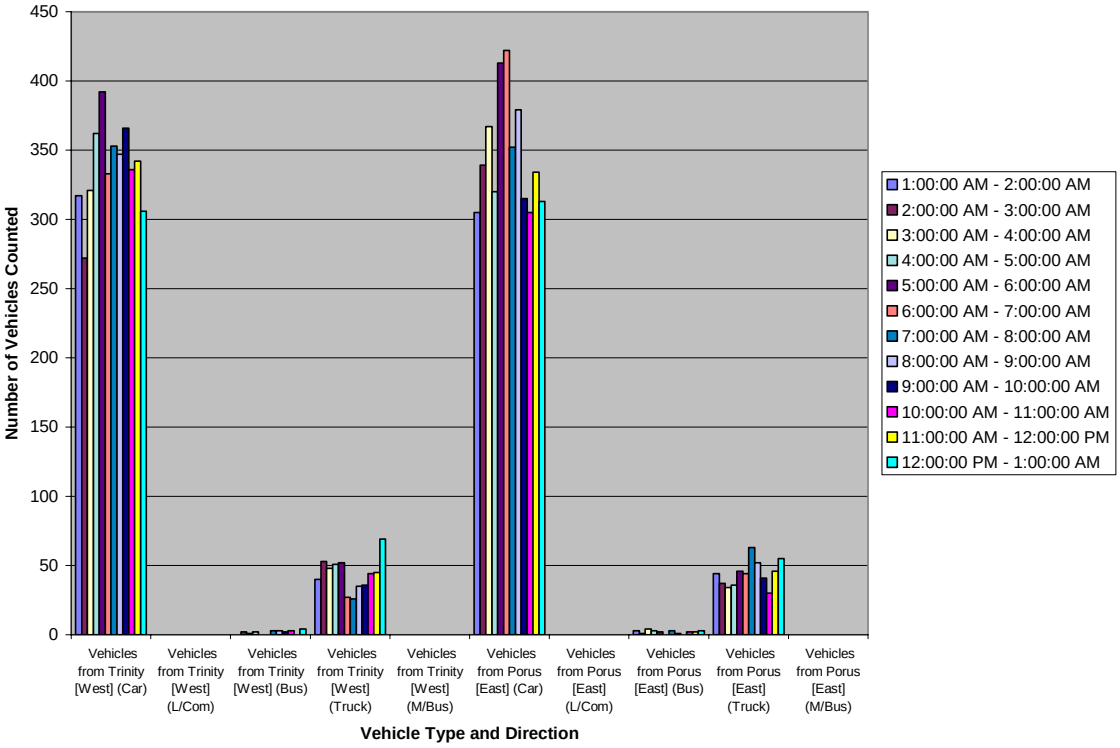

FIGURE 3-21: VEHICLE TYPE AND QUANTITY VARIATION FOR PORUS MAIN ROAD

3.10.3.1 DEDUCTIONS FROM FIGURE 3-21

- Of all the vehicles, cars are consistently higher in frequency from Porus [East] and from Trinity [West] than the other vehicles, for each of the observed time periods.
- The period during which there is the most vehicular traffic on the monitored route, traveling in opposite directions, is between 5a.m – 6.a.m.

- The period during which there is the least traffic on the monitored route, traveling in opposite directions, is 1a.m – 3a.m
- The period during which there is the most vehicular traffic from Trinity [West] is between 5a.m – 6.a.m.
- The period during which there is the most traffic traveling from Porus [East] is between 5a.m – 7a.m.

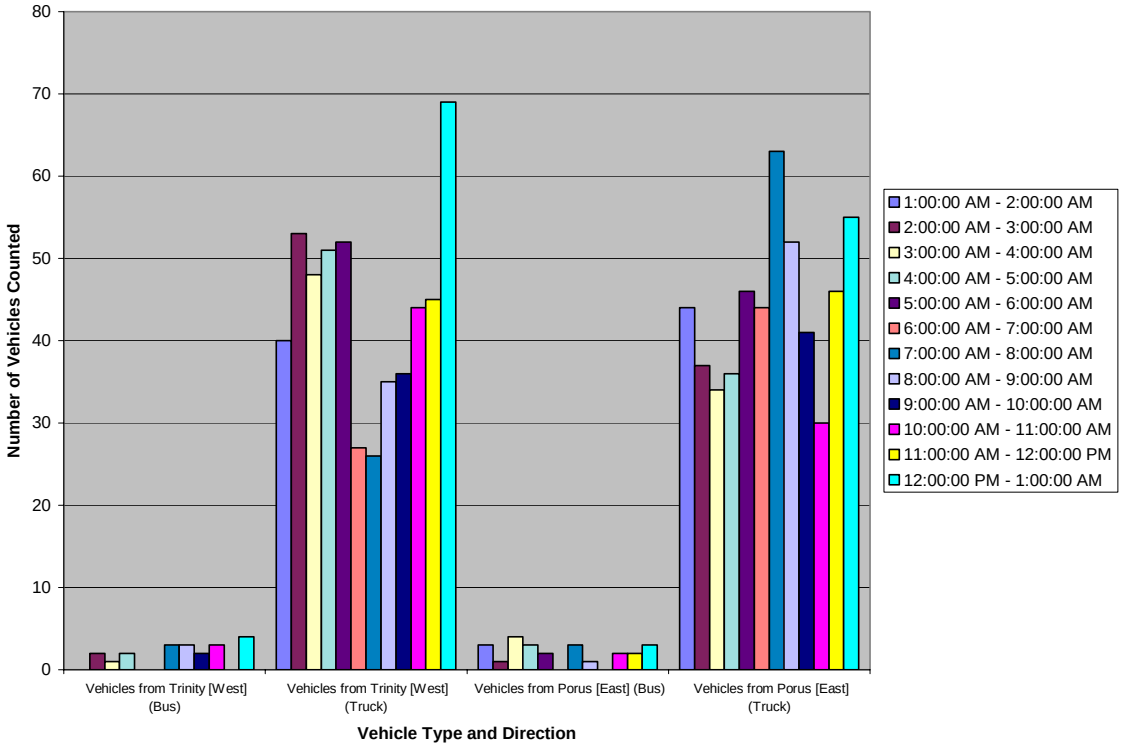

FIGURE 3-22: TRUCK AND BUS QUANTITY VARIATION FOR POROUS MAIN ROAD

3.10.3.2 DEDUCTIONS FROM FIGURE 3-22

- Of the heavier vehicles (i.e. buses and trucks), trucks are consistently higher in frequency from Porus [North] and from Toll Gate [South] than buses for each of the observed time periods.
- The time period during which there is the most traffic from trucks traveling from Porus [East] is 7a.m to 8a.m.; of notable significance are the time periods from 4a.m to 5a.m and 8a.m to 9a.m which are comparable to the highest observed numbers for the traffic from trucks.

- The time period during which there is the most traffic from trucks traveling from Trinity [West] is 4a.m to 5a.m.
- The time period during which there is the most collective traffic from trucks traveling in opposite directions is 12p.m (night) to 1a.m.
- The collective traffic from trucks traveling in opposite directions reaches two equilibriums: the first is between 1a.m and 5a.m; and then the second is from 7a.m to 12p.m (afternoon)

3.10.4 OBSERVATIONS – CLARENDON PARK MAIN ROAD (BETWEEN TRAIN LINE AND JUICY BEEF)

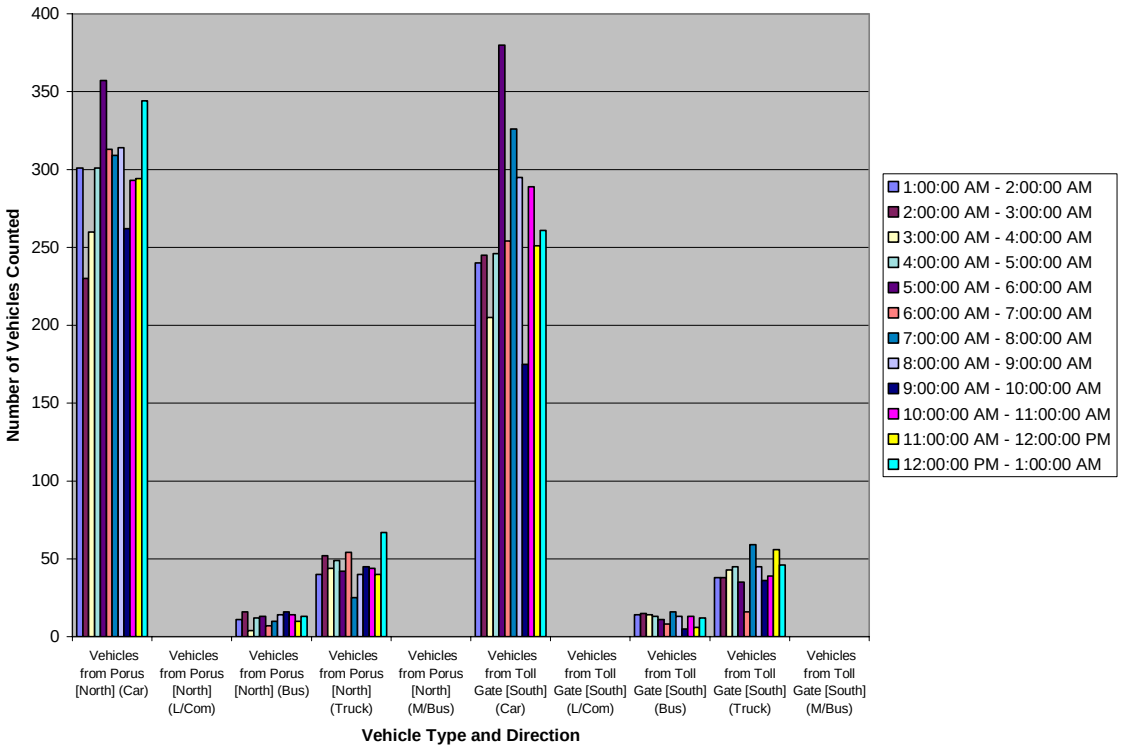

FIGURE 3-23: VEHICLE TYPE AND QUANTITY VARIATION FOR CLARENDON PARK MAIN ROAD

3.10.4.1 DEDUCTIONS FROM FIGURE 3-23

- Of all the vehicles, cars are consistently higher in frequency from Porus [North] and from Toll Gate [South] than the other vehicles, for each of the observed time periods.

- The period during which there was the most vehicular traffic on the monitored route, traveling in opposite directions, is between 5a.m – 6.a.m
- The period during which there is the least traffic on the monitored route, traveling in opposite directions, is 9a.m – 10a.m
- The period during which there is the most vehicular traffic from Toll Gate [South] is between 5a.m – 6.a.m.
- The percentage of traffic from trucks on the monitored route is less than 1/6 of the average number of cars.
- The period during which there is the most traffic traveling from Porus [North] is between 12p.m – 1a.m. However, the variation between the number for the mentioned time period, and the time period between 5a.m and 6a.m is not significant enough to differentiate between the significance of both. The more meaningful number would be the one that is correlated to some other observed trend. As such, the Time Period that is more meaningful to quote is from 5.a.m to 6a.m., as this is generally the period exhibiting the highest traffic counts for the collective classes of vehicles.

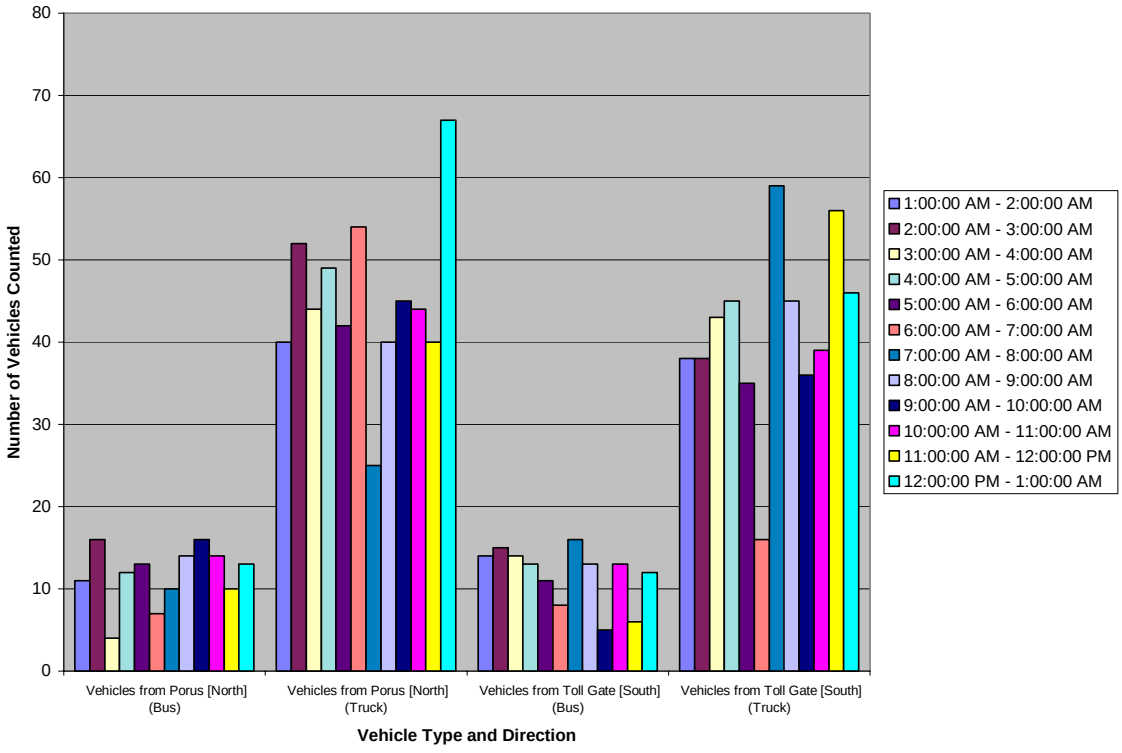

FIGURE 3-24: TRUCK AND BUS QUANTITY VARIATION FOR CLARENDON PARK MAIN ROAD

3.10.4.2 DEDUCTIONS FROM FIGURE 3-24

- Of the heavier vehicles (i.e. buses and trucks), trucks are consistently higher in frequency from Porus [North] and from Toll Gate [South] than buses for each of the observed time periods.
- The time period during which there is the most traffic from trucks traveling from Porus [North] is 4a.m to 5a.m.; of notable significance are the time periods from 5a.m to 6a.m and 6a.m to 7a.m which are comparable to the highest observed numbers for the traffic from trucks, and also fall within the time period for the highest observed numbers for the collective vehicular traffic.
- The time period during which there is the most traffic from trucks traveling from Toll Gate [South] is 7a.m to 8a.m.; of notable significance is the time period between 11a.m and 12p.m which shows comparable traffic from trucks to the highest observed counts of trucks.
- The collective traffic from trucks traveling in opposite directions reaches equilibrium between 12p.m (night) and 6a.m.

3.10.5 CONCLUSIONS

- Jamalco proposes to utilize a maximum of ten (10) trucks in total to temporarily move bauxite from Green Vale to St. Jago while the railroad is upgraded.
- Jamalco does not intend to dispatch any trucks during peak hours and will modify truck travel as necessary to limit congestion and bottlenecks along the corridor.
- Based on the survey completed, it does not appear that the addition of ten (10) trucks to the existing numbers on the road will pose a difficulty, or create a significant additional hardship on motorists using the surveyed roadways.