August 2007

ENVIRONMENTAL IMPACT ASSESSMENT

WINDALCO NEW LIME KILN – SHOOTERS HILL, MANCHESTER

Prepared for:

West Indies Alumina Company

Kirkvine Works, Manchester

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EXECUTIVE SUMMARY

1 Executive Summary

1.1 Introduction

The production and consumption of lime (CaO) is integral to the efficient production of alumina from bauxite. Lime is used for a number of critical applications in the American variant of the Bayer process. Included among them are:

- Pre-coat in the filtration of highly saturated sodium aluminate solution or pregnant liquor
- Filter aid
- Phosphorus control
- Internal and external causticization
- Oxalate control and
- Liquor stability

Owing to its relatively high phosphorus content, Jamaican bauxite could not have been processed without a dependable supply of high grade lime. For this reason, except for Ewarton Works, which obtains its lime supply from Kirkvine Works, all alumina plants in Jamaica have been built with lime kilns as a standard, integrated unit operation.

1.2 Project Objective and Conceptual Description

WINDALCO, the proponent of this project, plans to construct two new solid fuel, coal and petcoke, fired 400 mtpd lime kilns at its Shooters Hill Quarry, a brownsite quarry licensed under the Mining Act. The quarry is located in proximity to Kirkvine Works; Jamaica's first alumina plant. This represents the centre of greatest mass, in the demand nodes of the proposed development which will supply lime to Kirkvine Works, Manchester, Ewarton Works, St. Catherine and ALPART alumina refinery located at Nain, St. Elizabeth.

Sized limestone feed for the kilns will be supplied from the existing quarry. The sized limestone will be stored in an open stockpile, a standard currently practiced in the supply of stones for the existing rotary kiln

The Mining Act requires that Mining plans, Rehabilitation plans and Life of Mine plans be submitted to the Commissioner of Mines for approval and in the case of EIAs also to the National Environment and Planning Agency (NEPA).

The existing inefficient 'bunker C' fired, rotary kiln at Kirkvine Works will be taken out of service and mothballed, while that at ALPART will be ultimately taken out of service and its attendant limestone supply from an existing quarry also discontinued. Establishment of the two new, vertical *state-d-art,* Maerz lime kilns will also result in the termination/reduction of high cost imported lime, presently required for supplementing WINDALCO's and ALPART's internal production.

The lime kilns are fitted with efficient dust collectors and the emission will meet national air quality standards under the Clean Air Act. Limestone and product lime, act as internal scrubbers in the lime production process, reducing SOx emission.

The solid fuel required for the project will be imported through Port Esquivel, St. Catherine, from which it will be transported by road to the kiln site at Shooters Hill. Both the traffic and atmospheric baseline emission will change qualitatively and quantitatively, in each case being reduced and improved overall.

Consequent on falling into NEPA's prescribed categories of projects; requiring Environmental Impact Assessments (EIAs) under Section 17 of the Natural Resources Conservation Authority (NRCA) Act of 1991, WINDALCO selected Conrad Douglas & Associates Limited to carry out this EIA. This EIA Report, represents the processes and studies undertaken in order to enable its preparation.

1.2.1 *Approach & Methodology:*

An interactive approach was undertaken between the design team and the environmental assessment team. This involved a combination of meetings, desk, literature and field investigations covering all aspects of the NEPA approved Terms of Reference (TOR). The studies involved complete analysis and documentation of all aspects of the proposed project. The following were done:

- NEPA's requisite Permit application forms and Project Information Forms were completed
- The TOR for the EIA was submitted in Draft form and approved by NEPA with appropriate amendments
- Bio-physical surveys were undertaken in the area of the proposed project
- Socio-cultural surveys were undertaken in the area of the proposed project
- The natural and manmade attributes as well as potential impact receptors of the environment were noted.
- The design and equipment selection as well as the field surveys were guided by the regulatory framework which included international and national policies, conventions, protocols, legislation, regulations and standards.
- Public consultations with the potentially affected members of nearby communities were carried out.
- The potential negative and positive impacts were identified and described for the pre-construction, construction and operating phases of the project.
- The methods to avoid or mitigate the potential negative impacts were developed
- Natural hazards and risks were identified and assessed
- The parameters for and an outline of an environmental monitoring plan was developed

1.3 Regulatory Framework

The major policies and legislation relevant to the project are as follows:

- Agenda 21
- The NRCA Act of 1991
- The Wildlife Protection Act
- The Forestry Act
- The Mining Act
- The Quarries Act
- The Water Resources Authority Act
- The National Solid Waste Management Act
- The Anti- Litter Act
- The Road Traffic Act
- The Jamaica National Heritage Trust Act

1.4 Impact Identification

The following potential negative impacts were identified:

- Loss of bio-diversity
- Change in land use
- Change in topography
- Visual intrusion and negative aesthetic impact
- Change in the drainage regime
- Limestone dust formation and dispersion
- Lime dust formation and dispersion
- Coal dust formation and dispersion
- Noise and vibration

The following positive impacts were identified:

- ✓ Discontinuation or reduction in the importation of costly lime, thereby saving foreign exchange

- ✓ Using indigenous raw materials
- ✓ Reduced SO_x emission
- ✓ Increased energy efficiency, conservation and reduced imports
- ✓ Sustained production of bauxite and alumina
- ✓ Preservation of jobs in the bauxite-alumina sector
- ✓ Direct foreign investment
- ✓ Job creation during construction

1.5 Impact Mitigation:

Impact mitigation actions will involve the following:

Loss of bio-diversity is unavoidable. However, creative conservation will be applied in the rehabilitation of the quarry in accordance with the regulations of the Mining Act.

The change in land use from natural, pastoral and agricultural to quarrying is unavoidable. Rehabilitation will result in the area being restored to secondary and tertiary growth dry limestone and extant remnant dry limestone forests.

Visual intrusion and negative aesthetic impact, while limited is unavoidable. Rehabilitation of mined out areas, which is required to start within three years after an area has been exhausted under the regulations of the Mining Act, will substantially mitigate visual intrusion and negative aesthetic impacts.

Change in the natural drainage regime is unavoidable. Rehabilitation will ensure that acceptable gradients are established in respect of the regulations of the Mining Act.

Limestone, lime and coal dust formation and dispersion are the major sources of particulate matter. Point sources for limestone dust are the blasted limestone and roadways, while that for lime and coal are the lime kilns, lime conveying systems, coal stockpile, coal crushing and handling operations. Limestone dust will be controlled through an irrigation regime for the roads and quarry. Limestone stockpiles are packed with washed stones and as such minimum dust is associated with the stockpiles, instead it is associated with off-loading conveying points. Lime dust will be controlled through the use of baghouse filters. Lime dust

will be used for quarry rehabilitation. Coal dust from the stockpile will be controlled through irrigation with water and use of surfactants. Coal dust from the comminution operations will be controlled through bag house filters.

Noise and vibration will be controlled through effective mobile and stationary vehicle maintenance and controlled state of the art blasting technology, guided by the regulations of the Mining Act.

The positive impacts will be maximized where possible and practicable.

1.6 Conclusions

WINDALCO's new lime kiln project is an efficiency upgrade which will utilize state-of the art technology in the production of critically important lime with its diverse end use structure in the production of alumina by the Bayer process.

The new lime kiln project is an impact mitigating action in itself. This will result in reduced energy consumption, reduced multiple handling and storage of lime, reduced atmospheric emissions and reduced road traffic. Limestone quarry sites for lime production will be ultimately reduced from two to one, facilitating concentrated and more efficient management.

The proposed project is significantly more efficient than the operations which now obtain to produce critically important lime for alumina production.

1.7 Recommendations

Given the fifty seven (57) years baseline of operations for Kirkvine Works and the associated support infrastructure and support services, the mining and environmental management regulations now in place and the economic and social importance of the bauxite alumina industry to Jamaica it is recommended that the project be permitted for implementation.

PROJECT DESCRIPTION

2 Project Description

2.1 Introduction

The proponent of the project, West Indies Alumina Company (WINDALCO), is seeking permission from the Natural Environment and Planning Agency (NEPA) to establish lime kilns at the WINDALCO Quarry at Shooters Hill in the parish of Manchester

The proponent intends to quarry approximately 1,000,000 metric tonnes of limestone per annum to produce lime at the order of magnitude of 280,000 metric tonnes per year.

WINDALCO will be constructing two new state-of-the-art lime kilns to support its various bauxite processing operations on the island. These new lime kilns will ultimately replace two older inefficient rotary kilns located at the WINDALCO Plant at Kirkvine, Manchester and the ALPART Plant, in Nain, St. Elizabeth.

WINDALCO operates two bauxite refineries on the island, Kirkvine Works, Manchester and Ewarton Works, St. Catherine. Additionally, its main shareholder owns 65% of the Alumina Partners of Jamaica (ALPART) bauxite refinery located in Nain, St. Elizabeth.

At present, lime kilns are located at Kirkvine and ALPART, but these are known to be inefficient, unreliable and possibly environmental liabilities. Both kilns are unable to meet the demands of the combined operations and resulted in the purchase of approximately 77,894 tonnes of the required 230,000 tonnes of lime used by the facilities in 2005 (approximately 34%). The lime kilns will each be of 148,000 metric tonnes production capacity.

Lime is a very important component of environmental management worldwide. Its uses as a cost effective scrubber and absorber of gaseous pollutants and its uses in neutralisation, precipitation, coagulation and sludge conditioning of sewage and trade effluents make it a vitally important product in light of the increased need for environmental management the world over.

The lime industry is a highly energy-intensive industry with energy accounting for up to 50% of total production costs. Kilns are fired with solid, liquid or gaseous fuels.

The major project elements are as follows:

- Quarry Development
    - Mobile crusher for quarrying
    - Quarry Plan and Management Systems
    - Limestone conveying systems
- Two (2) new 400 tpd Parallel Flow Regenerative lime kilns
    - Kilns
    - Associated auxillaries (hydraulics, electronics, PLC control etc.)
    - A 4500 L above ground diesel storage tank
- Lime Storage
    - Four 1250 m^3 enclosed silos
- Fuel System
    - Solid fuel (petcoke and coal) pulverizer
    - Two 150 m^3 enclosed silos for storing 2.2% sulphur crushed coal/petcoke

The preliminary project schedule will be 24 months with commissioning expected in July 2009. The mobile crusher should be in place by September 2007. The 1 year Quarry Plan is expected to be completed by September 2007, and the kiln delivery by May 2008. This project will improve environmental aspects, particularly air emissions to meet NRCA air emissions standards. It will also improve plant and kiln efficiencies and produce more lime to meet demands. This project represents a US$50 million investment to Jamaica.

2.2 Project Location and Layout

The proposed location of the new lime kilns is within the Shooters Hill quarry, a brownsite quarry owned and operated by WINDALCO. Plate 2-1 and Figure 2-1 below show the project location and proposed site layout of the Proposed Lime Plant at Shooters Hill in Manchester.

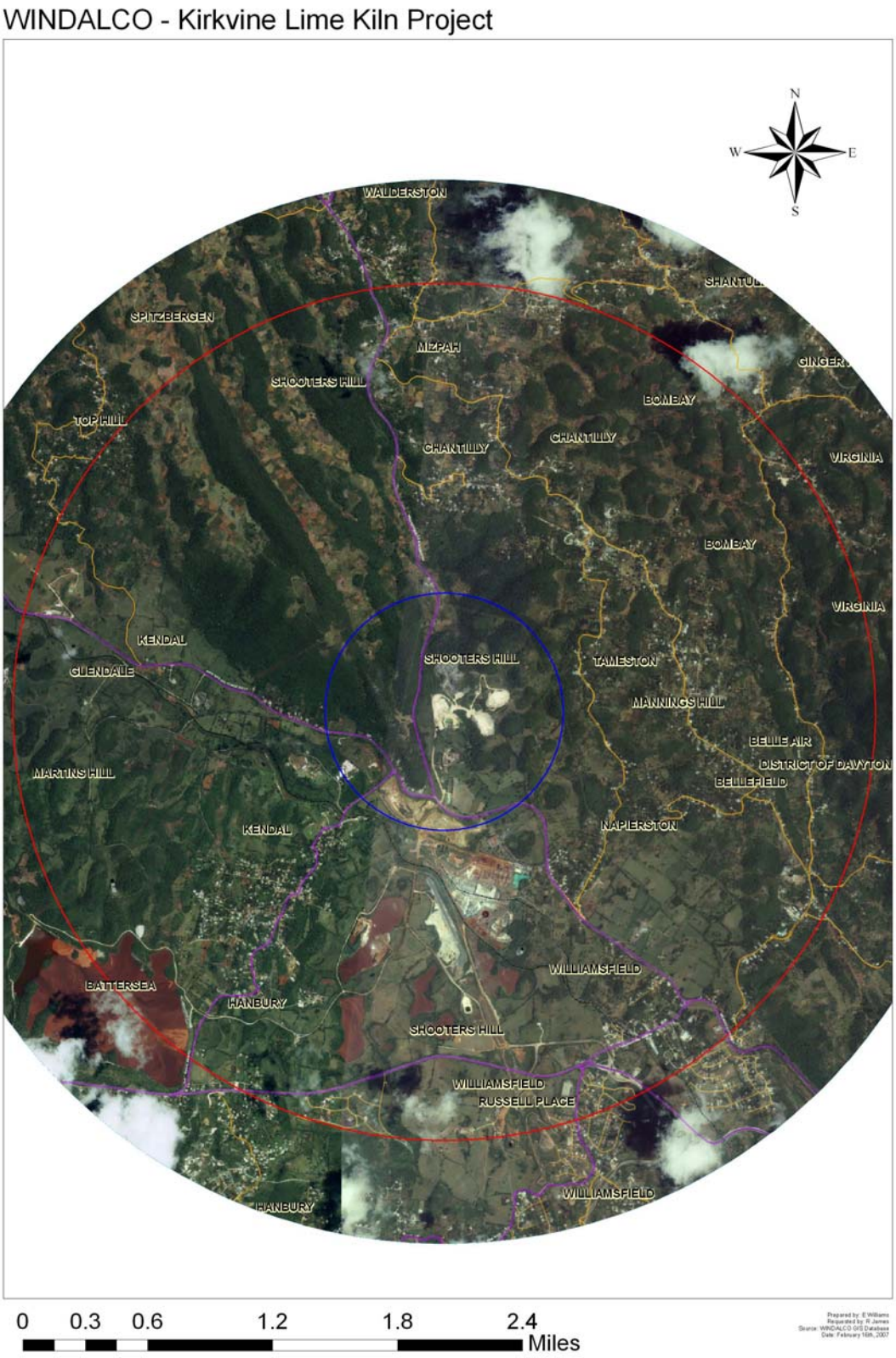


Plate 2-1: WINDALCO - Proposed New Lime Kiln Site - Shooters Hill Quarry, Manchester

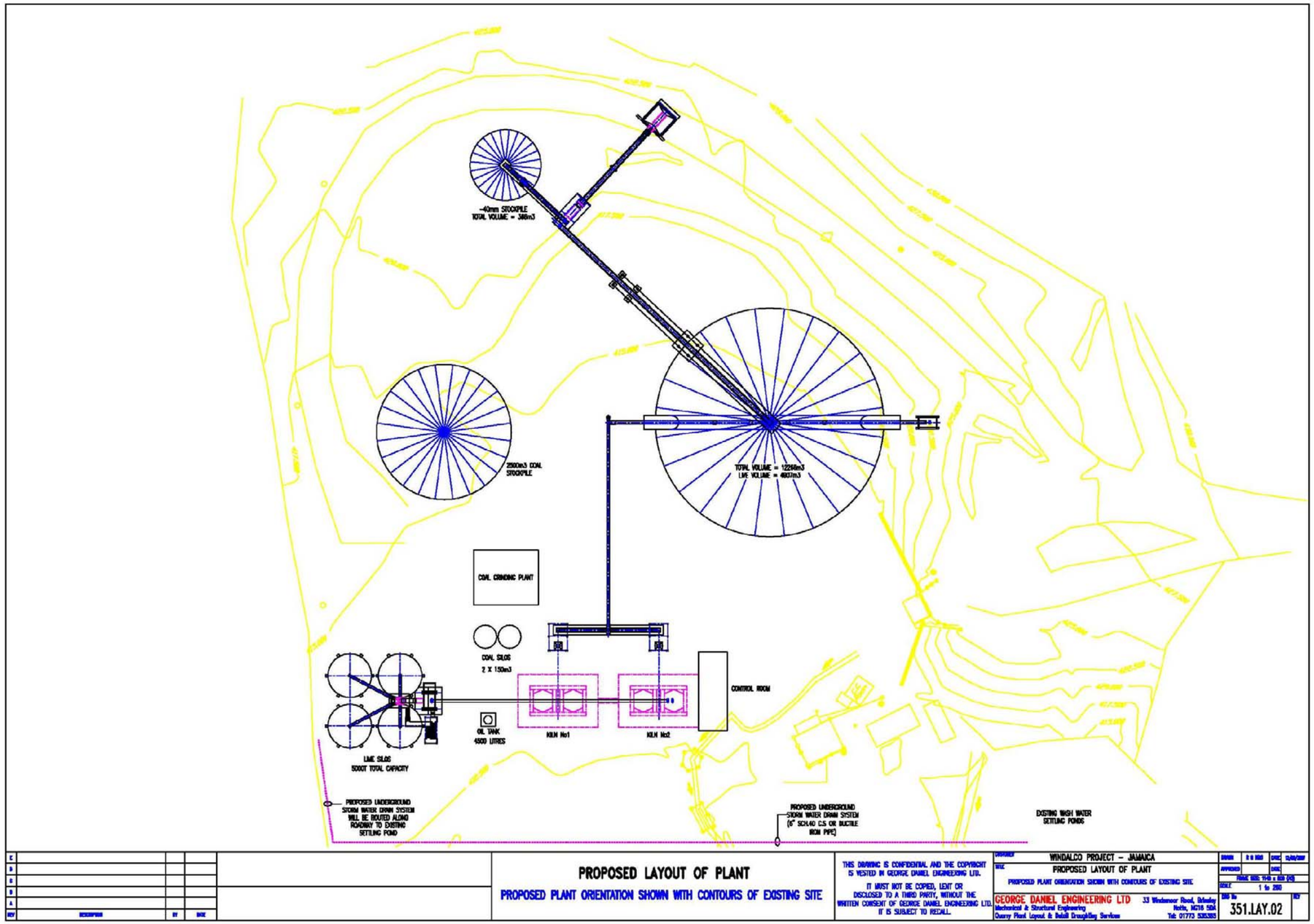


Figure 2-1: Layout of Kiln and Associated Structures at the Southern end of the Shooters Hill Quarry

2.3 Process and Equipment Description

Lime is used in a wide variety of different applications such as steel and non-ferrous metal production, liquid waste treatment, construction, flue gas desulphurisation, sugar refining, and agriculture. There are, therefore, various specifications for finished lime products dependent on the end use. For instance, some uses of hydrated lime may require low levels of impurities such as iron oxide, silica, magnesium oxide, fluoride and a specified surface area. Steel making processes using quicklime require limits on such things as calcium carbonate and sulphur contents.

Lime specifications are controlled by raw material/fuel selection and the type of kiln process used.

Lime processes follow the following basic steps:

- limestone quarrying, usually from an onsite quarry;
- limestone size reduction;
- fuel handling (grinding if solid fuels are used);
- kiln processing (where limestone is heated to produce quicklime and drive off CO_2);
- quicklime size reduction;
- storage and dispatch of quicklime to consumers;

Major releases are generally from the kiln to air. However, significant releases of particulates can occur from any part of the process.

The lime making process consists of the burning of calcium carbonates at a temperature ranging between 900 to 1500°C, which is sufficiently high to liberate carbon dioxide, and to obtain the derived calcium oxide.

Thermal decomposition of calcium carbonate produces 56% (by weight) calcium oxide and 44% carbon dioxide. Consequently, lime production produces a very large quantity of carbon dioxide.

The calcium oxide product is transported from the kiln to silo storage. From the silo, the burnt lime is taken to the end user for use in the form of quicklime.

Essentially the main unit operations of the process are:

1. quarrying activities (stripping, drilling, and blasting),
2. loading, hauling and temporary storage,
3. crushing
4. size segregation
5. calcination, and
6. storage, crushing and loading of product

Figure 2-2 illustrates the process flow diagram of the proposed development within WINDALCO's limits, it incorporates the unit operations, from size segregation, processing, through to product storage, crushing and loading.

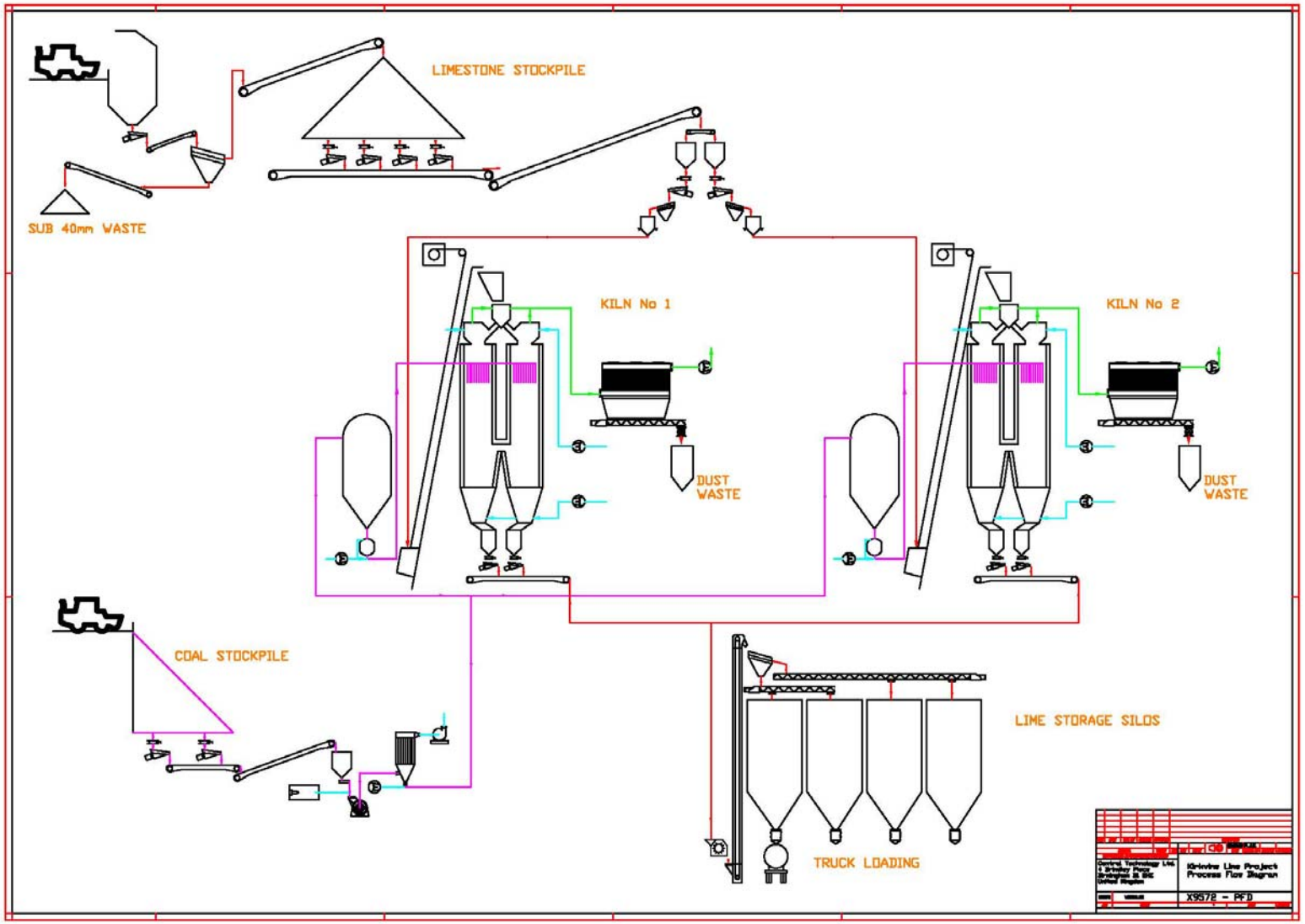


Figure 2-2: Process Flow Diagram

A detailed description of the lime manufacturing activities is outlined in the section below.

2.3.1 *Quarry Development (Limestone Quarrying and Handling)*

The Shooters Hill quarry is being expanded to meet the increased demand for limestone from the new kilns. The expansion involves the development of a number of faces in the quarry using modern drilling and blasting techniques. The stone will be crushed near to these faces using a mobile plant consisting of two crushers together with intermediate screening and recycling facilities. The equipment is set up to give three streams:

a) High quality kiln stone of the required size range
b) Clean aggregate below the required size range
c) Waste material including mixed limestone dust and bauxite

The mobile plant allows considerable flexibility of operation and minimises stone transportation. The waste material (c) above will be used locally for quarry rehabilitation. Some of the aggregate (b) is also used for this purpose whilst the remainder will be sold locally.

The lime kilns are designed to run on a nominal lump limestone of range 40 – 120 mm. Total requirement of kiln stone is around 500,000 tonne per annum with a quarrying requirement of just less than 1 million tonnes per annum. However, the aim is to reduce the minimum stone size thus using more of the quarried stone. This involves operating the two kilns on different stone sizes and at slightly different throughputs. It is expected that the lowest stone size will be around 30 mm. Should this development give the required lime output, there will be significant reduction in quarrying requirements, with a consequent reduction in the production of (b) and (c) above.

Kiln stone is moved by truck from the site of the mobile crusher to a stone hopper on the kiln site. Stone is conveyed by vibratory feeder and belt conveyor onto a triple deck washing screen where any remaining small stone and dirt is removed. The modern quarrying methods and equipment produce a clean stone for use in the kilns. Stone washing is not necessary, but if required, water from the existing washing and settling system is circulated to the screen.

Clean sized stone is conveyed to a stockpile with capacity for around ten (10) day's operation. Waste fines are conveyed to a separate stockpile for disposal as (b) and (c) above. The equipment is sized to operate for 30 – 40 hours per week and operates independently from the kilns.

2.3.2 *Parallel Flow Regenerative (PFR) Kiln Technology*

Two main types of vertical shaft kilns exist. The single shaft counter flow heating kiln and the multiple shaft parallel flow heating kiln. Limestone is fed into the top of the shaft and lime is withdrawn at the bottom. The shaft is theoretically described as three zones:

a) The preheating zone, where limestone is heated up to the calcination temperature by exhaust gases.
b) The burning zone, where fuel is injected and limestone converts into lime
c) The cooling zone, where air enters to recover heat allowing the lime to be discharged near to ambient temperature

Unfortunately the thermodynamics of this simple model do not allow maximum heat recovery from the exhaust gases and it has therefore been the kiln designer's challenge to introduce features which overcome these difficulties. One such design is the PFR kiln which is arguably the most successful of the thermally efficient shaft kiln designs. Other designs are slightly less efficient but are able to produce hard burnt lime which is needed in some industries.

The standard PFR kiln is a two-shaft kiln defined by alternating burning and non-burning operation of the two shafts (Figure 2-3 below).

There are two distinguishing features of the PFR kiln:

1) The parallel flow of hot gases and stone in the burning zone, and
2) The regenerative preheating of combustion air in the process.

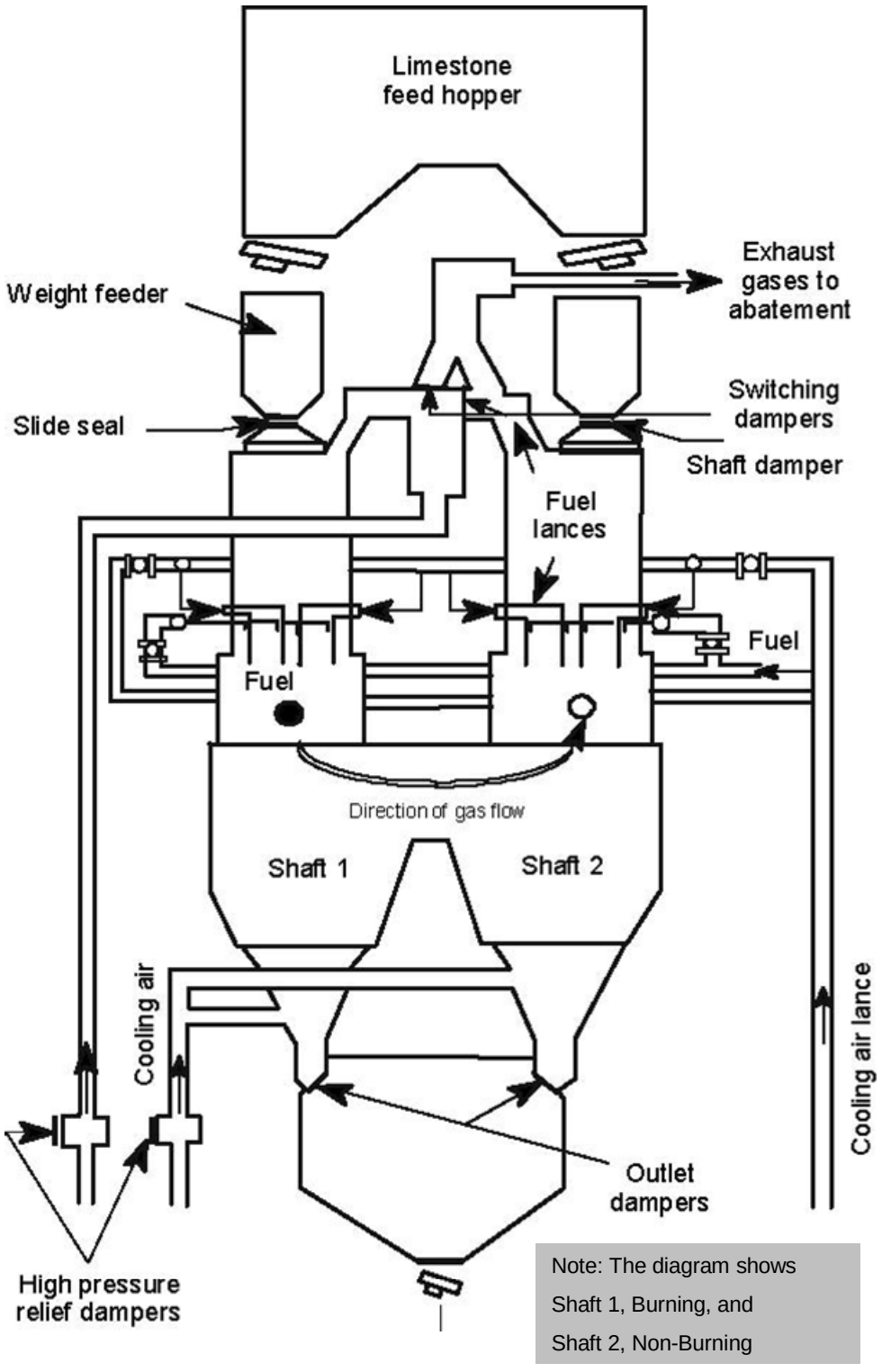


Figure 2-3: Schematic of a Parallel Flow Regenerative Kiln

This type of kiln is ideally suited to produce soft burned, high reactive lime because of the conditions created by the parallel flow of stone and combustion gases in the burning shaft.

Additionally, the regenerative process provides the lowest heat consumption of all modern kilns available today. The difference in the temperature profile of conventional single shaft kilns and PFR-Kilns is depicted in Figure 2-4, where the curves show the temperatures of the material, of the air and of the combustion gases flowing through the kiln.

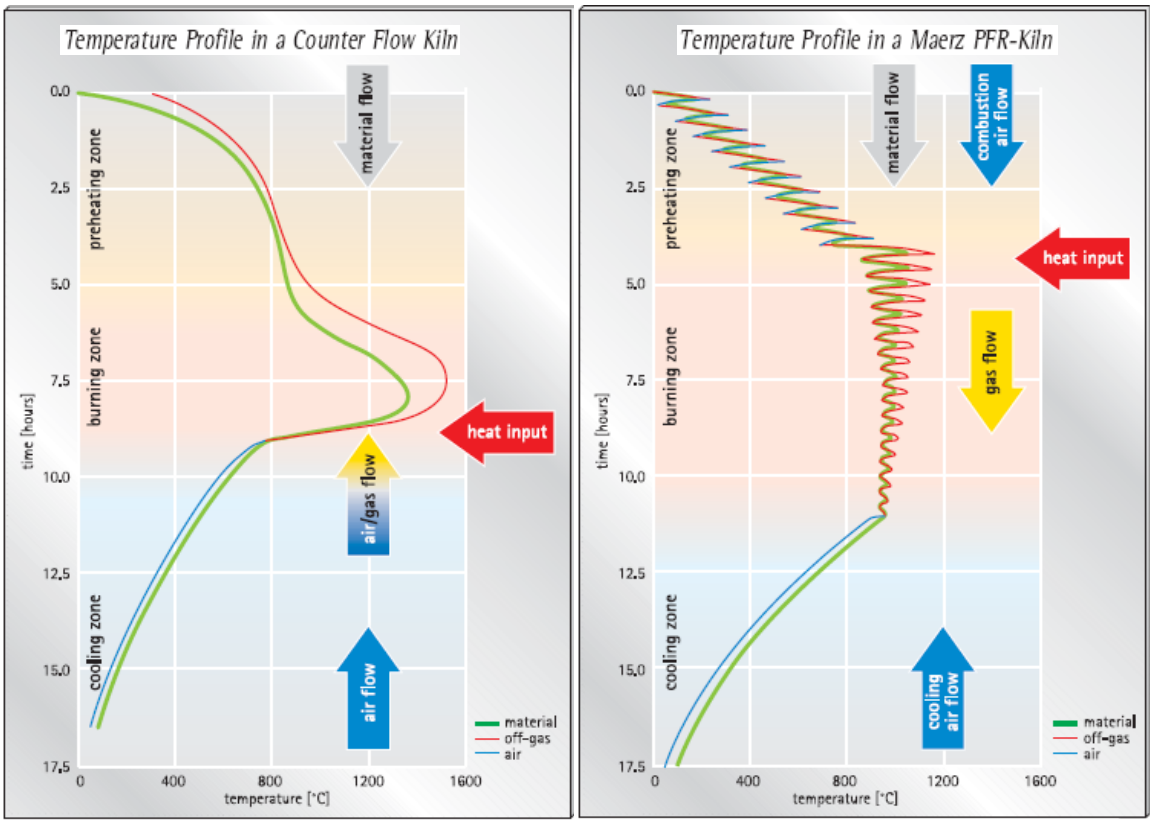


Figure 2-4: Temperature Profile in a Counter Flow Kiln vs. a PFR Kiln[1]

In single shaft kilns usually counter flow heating is applied, a typical temperature profile is shown in Figure 2-4 above. The green line shows the temperature of the material, the blue line the temperature of the cooling air and the red line the temperature of the combustion gas and kiln exhaust gas. As the amount of cooling air is not sufficient for complete combustion of the fuel, additional air has to be introduced via lateral burners. As in this type of kiln, the fuel is introduced at the lower end of the burning zone - where the material is already

[1] The Maerz Parallel Flow Regenerative Lime Kiln , Maerz Ofenbau AG, Zurick, Switzerland: www.maerz.com

calcined - the temperature in this area is significantly higher than required for the production of high reactive lime.

In parallel flow kilns the fuel is introduced at the upper end of the burning zone and the combustion gases travel parallel to the material. The second image in Figure 2-4 shows a typical temperature profile where the green line represents the material temperature, the blue lines in the preheating and cooling zone, the relevant air temperatures and the red line, the combustion gas and kiln exhaust gas temperatures. As the fuel is injected at the upper end of the burning zone where the material can absorb most of the heat released by the fuel, the temperature in the burning zone is typically as low as 950 °C on average. Due to this, parallel flow heating is the best solution for the production of soft burned, reactive lime as required in most applications.

The second important characteristic of the PFR-Kiln is the regenerative preheating of the combustion air. In kilns with counter flow heating, the combustion air is preheated in the cooling zone by the sensible heat contained in the calcined lime. The amount of preheating is limited, however, by the enthalpy of the lime. In the counter flow heating process there is a surplus of usable sensible heat contained in the exhaust gas that is not recovered prior to being exhausted. As a consequence, some single shaft kiln designs have incorporated recuperators in an effort to recover this waste heat, but such heat exchangers are susceptible to operating problems caused by dust contained in the hot exhaust gases.

In the parallel flow regenerative kiln the combustion air is preheated in an optimal way. The regenerative process requires two connected kiln shafts. Each shaft is subject to two distinct modes of operation, burning and non-burning. One shaft operates in the burning mode and simultaneously the second shaft operates in the non-burning or exhaust mode. Each shaft spends an equal amount of time in both the burning and non-burning modes of operation.

In the burning mode a shaft is characterised by the parallel flow of combustion gases and raw stone whereas in non-burning mode a shaft is characterised by the counter-current flow of exhaust gases and raw stone. The combustion gases exit the burning shaft through a crossover channel into the non-burning shaft. The alternating burning/non-burning shaft

sequence serves as a regenerative preheating process. Heat is transferred to the raw stone from the exhaust gases during the non-burning mode and then reclaimed by the combustion air from the raw stone during the burning mode.

The preheating zone acts as a regenerator with the stone charge acting as a heat reservoir. This kind of regenerator is completely insensitive to dust-laden or corroding gases and, at the same time, shows excellent heat transfer characteristics. The regenerative preheating of the combustion air makes the thermal efficiency of the kiln practically independent the amount of excess air.

This considerably simplifies the setting of the correct flame length required to achieve the desired degree of lime reactivity. A larger quantity of excess air produces a shorter flame and less excess air produces a longer flame. The length of the flame is one of the key factors to control the reactivity of burned lime. Generally shorter and hotter flames reduce the reactivity of the burned product.

2.3.2.1 Operation of the PFR kiln

Figure 2-5 below shows the basic operating principle of the PFR-Kiln and illustrates the two phases of gas flow.

Two shafts, designated 1 and 2, contain the material to be calcined. The stone charging system, the reversal traps for fuel, combustion air, and exhaust gas, and the lime discharge system have been omitted from this diagram. The shafts are alternately charged with limestone. Lime is discharged continuously at the bottom of both shafts.

Fuel is supplied to only one of the two shafts. In Figure 2-5 it is supplied to shaft 1 this being designated the burning shaft and shaft 2 is designated the non-burning shaft. The fuel is introduced through multiple lance tubes that vertically extend to the bottom of the preheating zone. Fuel is injected through these lances and evenly distributed over the cross sectional area of the shaft. Combustion air is introduced under pressure at the top of the preheating zone above the stone bed and is heated by the stone prior to mixing with the fuel. The lower

end of the lance tubes is considered to be the boundary between the burning zone and the preheating zone. The complete kiln system is pressurised.

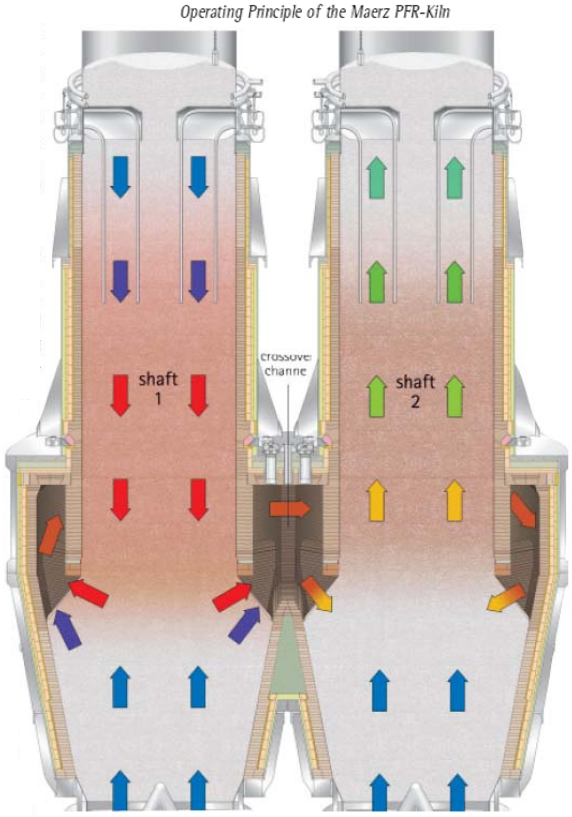


Figure 2-5: Operating Principle of a Maerz Kiln

The air/fuel flame is in direct contact with the stone as it passes through the burning zone from top to bottom (parallel flow heating). The exhaust gases leave the burning shaft and enter the non-burning shaft through the crossover channel, travelling up in counter flow to the stone. The exhaust gases transfer heat to the stone bed in the non-burning shaft and even calcine it to a small degree. The exhaust gases then regenerate the stone bed in the preheating zone in preparation for the next burning cycle on that particular shaft.

Each shaft cycles through the burning and non-burning mode at intervals of approximately 12 minutes. The changeover from burning to non-burning is called “reversal period”. Lime is discharged from both shafts continuously throughout the burning cycle by discharge tables into a pressurised hopper. Cooling air is continuously introduced at the bottom of both shafts to reduce the temperature of the product prior to being discharged into the lime storage

hopper. During reversal periods, when the kiln is depressurised, the product is discharged from the storage hopper onto vibrating feeders and conveyor belts.

2.3.2.2 Thermal Efficiency and Heat Consumption

Typical heat consumption of coal fired PFR kiln is between 850 and 950 kcal/kg of lime. Compared to the theoretical heat requirement for dissociation of lime, the PFR kiln design has a thermal efficiency of around 85%. It is the most fuel efficient of all the vertical shaft kiln designs.

By comparison the fuel consumption on rotary kilns without stone preheater is typically 1500 to 2000 kcal/kg and thermal efficiency less than 50%

Heat and Material balances were conducted based on the equipment and instrumentation proposed for the plant. The result illustrates the use of shaft kilns with the capacity to handle 280,000 metric tonnes per year of lime, fuelled with petcoke/coal. The composition of the raw material fed to the kilns is based on chemical analysis shown in Table 2-1.

Table 2-1: Composition of Limestone Feed

Formula	Scientific Name	Feed
CaO	Calcium Oxide	55.29
MgO	Magnesium Oxide	0.24
$CaCO_3$	Calcium Carbonate	98.58
SiO_2	Silicon Oxide	<0.01
$MgCO_3$	Magnesium Carbonate	0.45 % – 0.55 %
Al_2O_3	Aluminium Trioxide	0.01 %
Fe_2O	Iron Oxide	0.01
H_2O	Water	0.23
CO_2	Carbon Dioxide	43.35
S	Sulphur	636 ppm
LOI	Loss on Ignition	44.3

2.3.2.3 Kiln Plant

The plant consists of two Maerz type E6 kilns with a combined capacity of 800 tonnes/day of lime. It is operated from a central control room located adjacent to the kilns and incorporates control of all plant feeding limestone and fuel to the kilns together with all lime handling and storage. A similar solid fuel fired E6 kiln is shown below.

Plate 2-2: Typical PFR Kiln

Limestone is removed on demand from underneath the stockpile by a series of vibratory feeders and belt conveyor operating inside a tunnel. The stone is conveyed up to a reversible cross conveyor which diverts it to feed either of the kilns. Stone is then fed into a storage hopper and through a vibratory screen (to remove any broken stone) and discharged into a

weigh hopper. On demand, a batch of stone is then discharged into a skip hoist to transport to the top of the kiln where it is stored in a feed hopper.

The level of stone within each shaft of the kiln is continuously measured and compared to the theoretical level determined from discharge of lime. This ensures that each shaft is neither over nor under filled. When a low level is reached stone is discharged from the feed hopper into the shaft via twin flap valves. Stone can only be fed into the non-burning shaft since the burning shaft is pressurised. The non burning shaft is also under slight suction from the exhaust gas fan which prevents emission of gases when the flaps are opened.

The top of the kiln is fully enclosed and all limestone transfer points in the feed system are fitted with stone boxes and/or rubber lining to minimise noise emissions.

Exhaust gases are passed through a bag filter unit before discharge via a stack to atmosphere. The bag filter dust is discharged into a skip for disposal in land reclamation. The dust mainly contains particles of limestone and surface dirt together with small quantities of lime, ash and unburnt coal.

The ash content is considered to be minuscule given <2% ash content of the input solid fuel to be used.

Lime is discharged almost continuously at the base of each shaft by a hydraulically operated discharge table and is stored in a pressurised hopper until “shaft reversal” takes place.

One of the key features of successful kiln control is the accurate measurement of fuel and limestone input to ensure a constant ratio between the two. Each shaft firing cycle burns a specific weight of coal and the fuel firing system is designed to achieve fine control over the ratio. The system consists of a pulverised coal storage silo fitted with inertisation and fire/explosion protection components. This feeds into a pressurised blowing vessel mounted on weigh cells.

During shaft reversal the vessel is depressurised and a weighed quantity of coal enters from the storage silo above. The base of the vessel is fitted with a series of rotary valves connected

to individual blowing lines which feed coal to two lances inside the “burning” kiln shaft. After “shaft reversal” the vessel is pressurised and coal is fed through the rotary valves and into the kiln. The rotary valves are fitted with variable speed control so that the rate of delivery of coal is uniform within the burning cycle

The kiln is not built as a pressure vessel and as such air pressures used within the system are limited to a maximum of 400 mbar. Should any pressures exceed this level the control system will shut down the kiln. All the air for the various duties, including combustion, lime cooling, coal transport and lance cooling is provided by a number of Rootes type rotary blowers located in a sound proofed blower room adjacent to the kilns. Volumetric control of the airflow for these duties is achieved by the use of variable speed drives

Each kiln is operated by its own programmable logic controller (PLC) with additional PLCs controlling the remainder of the plant including fuel supply, limestone handling and lime handling and storage. The PLCs are linked together by a distributed SCADA system incorporating several computers and display screens. Full safety systems are programmed through both software and hardware to ensure that the kilns can be operated automatically and without risk to personnel and environment.

The following figures show the kiln layout, kiln foundation, loads on kiln foundation, earthquake loads on kiln foundation, and settlement loads on kiln foundation (Figure 2-6 to Figure 2-10).

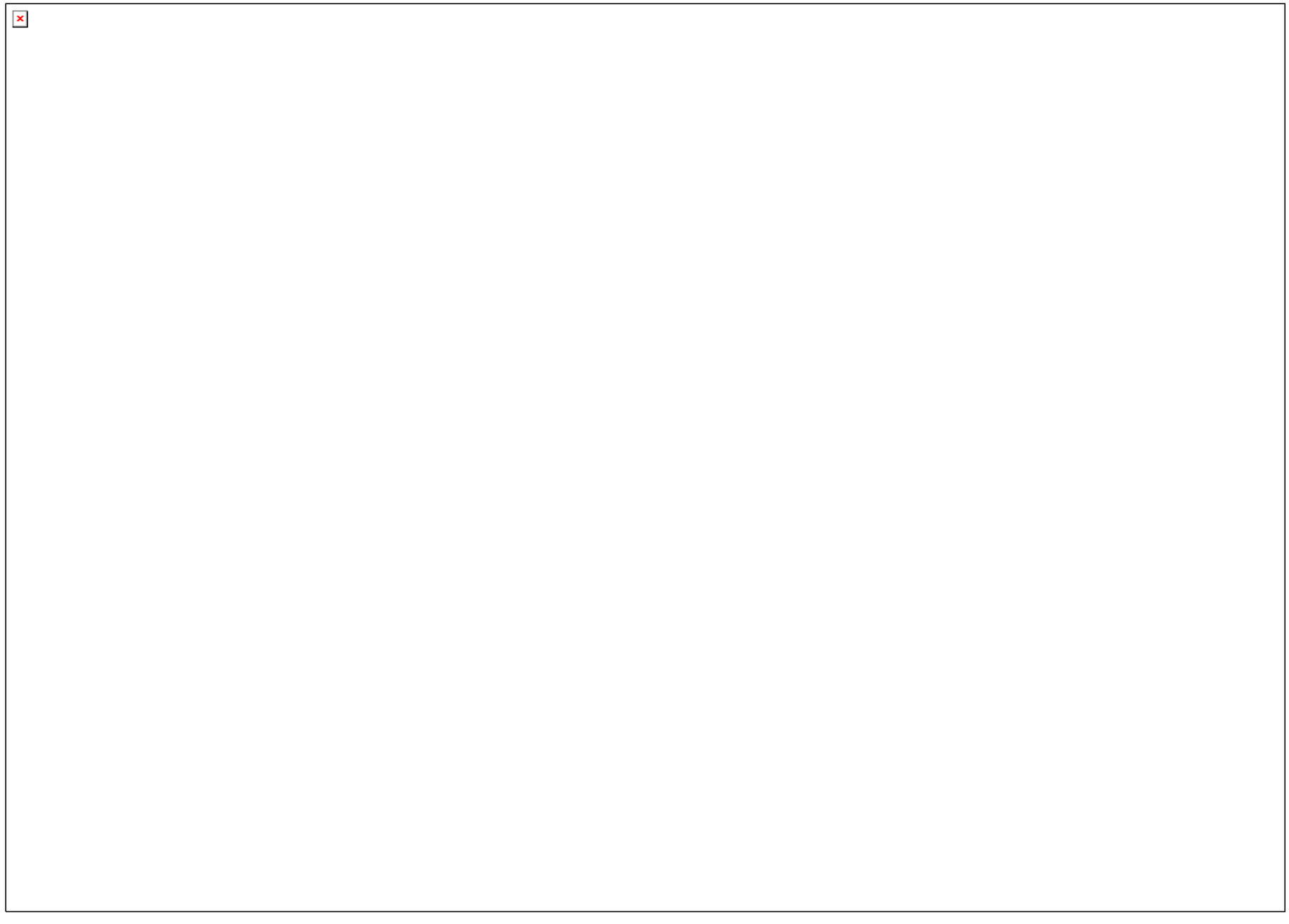


Figure 2-6: Kiln Layout

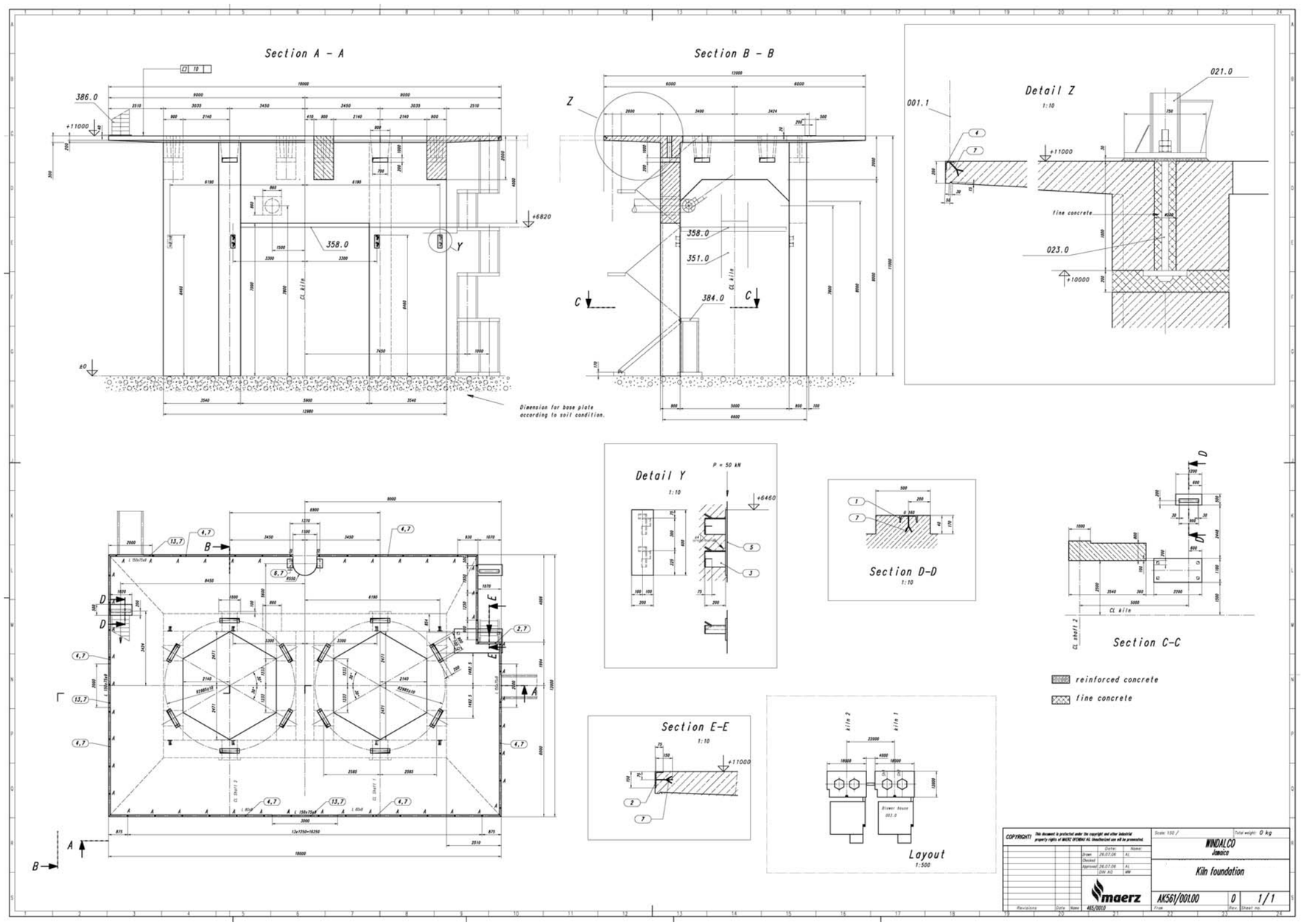
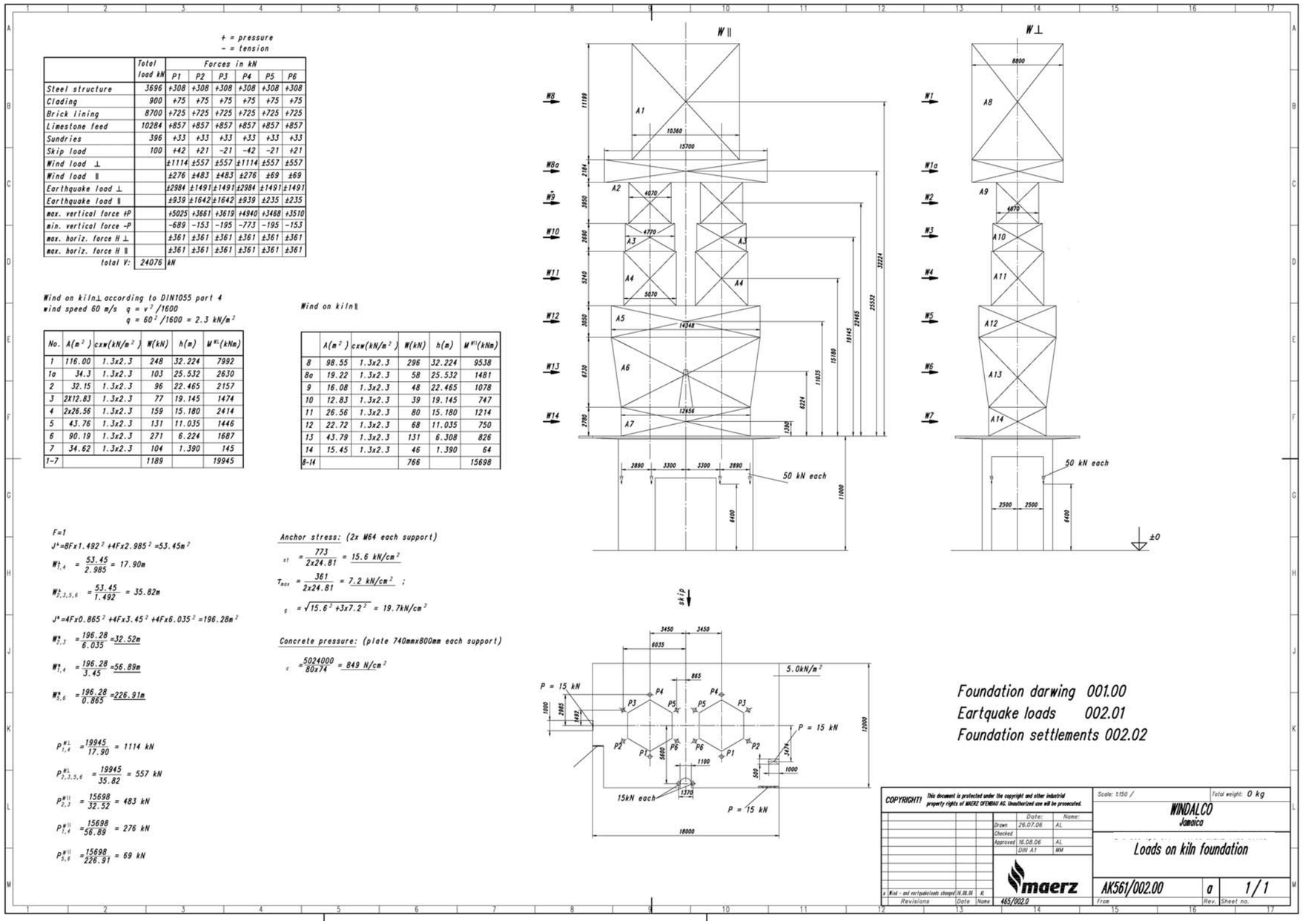


Figure 2-7: Kiln Foundation



	Total load kN	Forces in kN					
		P1	P2	P3	P4	P5	P6
Steel structure	3696	+308	+308	+308	+308	+308	+308
Cladding	900	+75	+75	+75	+75	+75	+75
Brick lining	8700	+725	+725	+725	+725	+725	+725
Limestone feed	10284	+857	+857	+857	+857	+857	+857
Sundries	396	+33	+33	+33	+33	+33	+33
Skip load	100	+42	+21	-21	-42	-21	+21
Wind load ⊥		±1114	±557	±557	±1114	±557	±557
Wind load ∥		±276	±483	±483	±276	±69	±69
Earthquake load ⊥		±2984	±1491	±1491	±2984	±1491	±1491
Earthquake load ∥		±939	±1642	±1642	±939	±235	±235
max. vertical force +P		+5025	+3661	+3619	+4940	+3468	+3510
min. vertical force -P		-689	-153	-195	-773	-195	-153
max. horiz. force H ⊥		±361	±361	±361	±361	±361	±361
max. horiz. force H ∥		±361	±361	±361	±361	±361	±361
total V:	24076 kN						

No.	A(m²)	cxw(kN/m²)	W(kN)	h(m)	M^W⊥(kNm)
1	116.00	1.3x2.3	248	32.224	7992
1a	34.3	1.3x2.3	103	25.532	2630
2	32.15	1.3x2.3	96	22.465	2157
3	2X12.83	1.3x2.3	77	19.145	1474
4	2x26.56	1.3x2.3	159	15.180	2414
5	43.76	1.3x2.3	131	11.035	1446
6	90.19	1.3x2.3	271	6.224	1687
7	34.62	1.3x2.3	104	1.390	145
1-7			1189		19945

	A(m²)	cxw(kN/m²)	W(kN)	h(m)	M^W∥(kNm)
8	98.55	1.3x2.3	296	32.224	9538
8a	19.22	1.3x2.3	58	25.532	1481
9	16.08	1.3x2.3	48	22.465	1078
10	12.83	1.3x2.3	39	19.145	747
11	26.56	1.3x2.3	80	15.180	1214
12	22.72	1.3x2.3	68	11.035	750
13	43.79	1.3x2.3	131	6.308	826
14	15.45	1.3x2.3	46	1.390	64
8-14			766		15698

$J^{\perp} = BFx1.492^2 + 4Fx2.985^2 = 53.45m^2$

$W^{\perp}_{1,4} = \frac{53.45}{2.985} = 17.90m$

$W^{\perp}_{2,3,5,6} = \frac{53.45}{1.492} = 35.82m$

$J^{\parallel} = 4Fx0.865^2 + 4Fx3.45^2 + 4Fx6.035^2 = 196.28m^2$

$W^{\parallel}_{2,3} = \frac{196.28}{6.035} = 32.52m$

$W^{\parallel}_{1,4} = \frac{196.28}{3.45} = 56.89m$

$W^{\parallel}_{5,6} = \frac{196.28}{0.865} = 226.91m$

$P^{W\perp}_{1,4} = \frac{19945}{17.90} = 1114\ kN$

$P^{W\perp}_{2,3,5,6} = \frac{19945}{35.82} = 557\ kN$

$P^{W\parallel}_{2,3} = \frac{15698}{32.52} = 483\ kN$

$P^{W\parallel}_{1,4} = \frac{15698}{56.89} = 276\ kN$

$P^{W\parallel}_{5,6} = \frac{15698}{226.91} = 69\ kN$

Anchor stress: (2x M64 each support)

$\sigma_1 = \frac{773}{2x24.81} = 15.6\ kN/cm^2$

$\tau_{max} = \frac{361}{2x24.81} = 7.2\ kN/cm^2$;

$\sigma_v = \sqrt{15.6^2 + 3x7.2^2} = 19.7kN/cm^2$

Concrete pressure: (plate 740mmx800mm each support)

$\sigma_c = \frac{5024000}{80x74} = 849\ N/cm^2$

Scale: 1:150 /	Total weight: 0 kg
Drawn 26.07.06 AL	
Checked	
Approved 16.08.06 AL	
DIN A1 MM	
485/002.0	
From	Rev. a	Sheet no. 1/1

Figure 2-8: Loads on Kiln Foundation

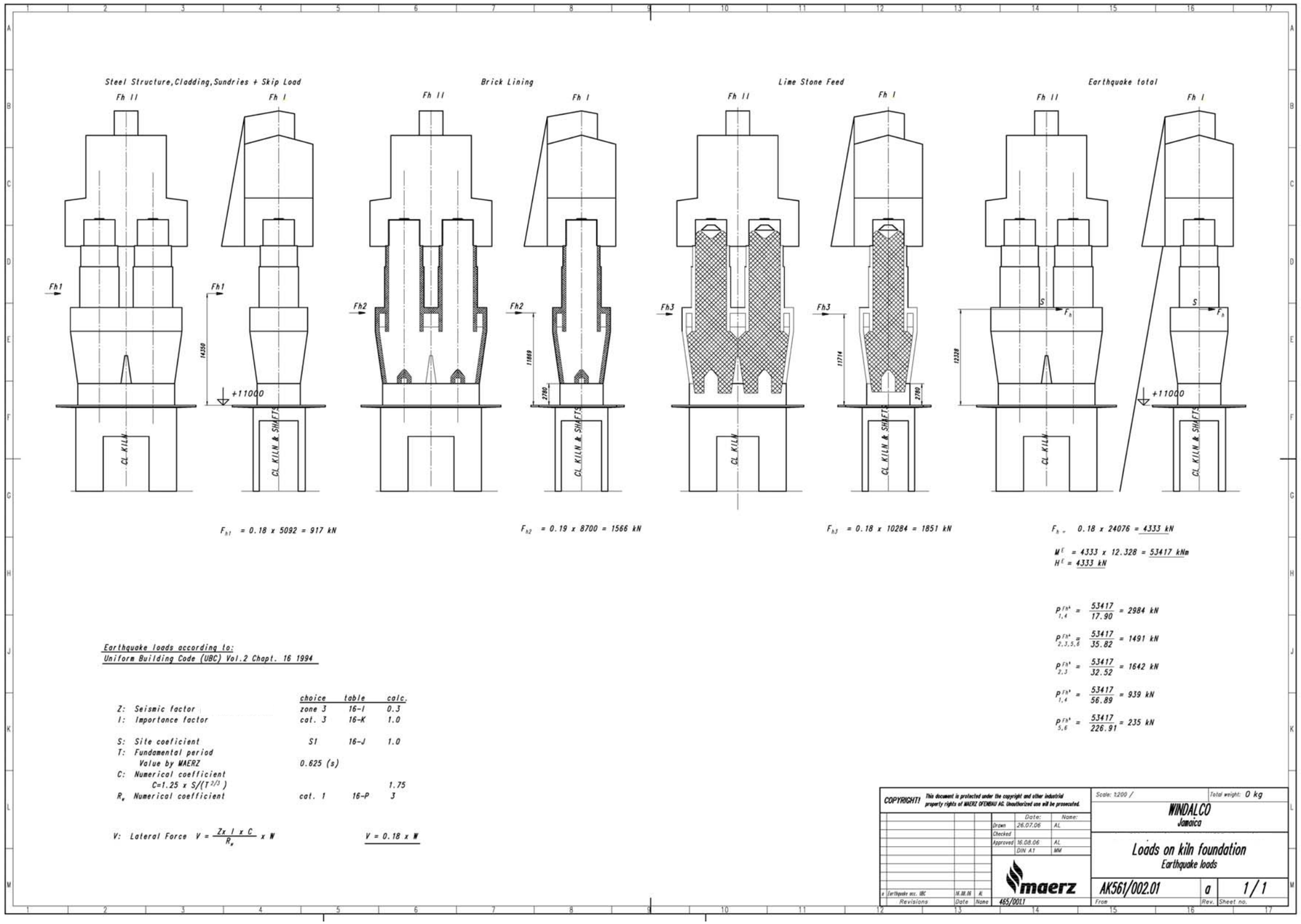


Figure 2-9: Loads on Kiln Foundation – Earthquake loads

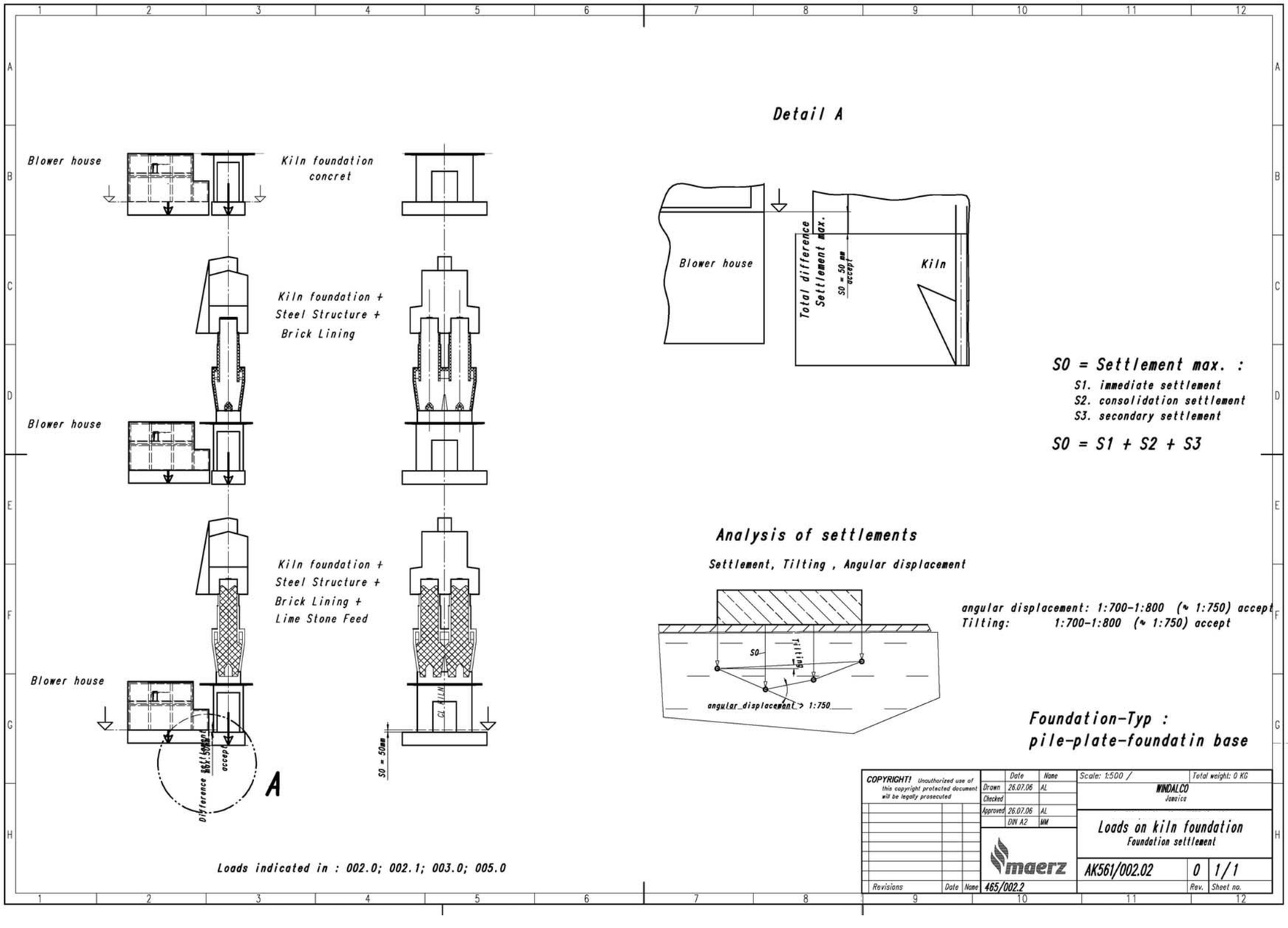


Figure 2-10: Loads on Kiln - Foundation Settlement

2.3.2.4 Fuel Supply

The kilns are fired with solid fuel depending on price and availability. The kilns require a dry fine powdered solid fuel, petcoke and coal, with a typical particle size distribution of 80% to 90% less than 0.09 mm, which is milled on site.

The fuel will be delivered by sea in bulk to Port Esquivel and transported to the site where a strategic stockpile will be maintained. The kilns will use around 100 tonne/day of coal and weekday deliveries to the site are scheduled to ensure a stockpile of a few thousand tonnes. The fuel will be in lump form with a variety of sizes typically up to 75mm. Both coal and petroleum coke are usually stored in the open and have intrinsic moisture content, apart from any surface moisture from exposure to the elements.

At the Shooters Hill facility, the fuel will be stored adjacent to the edge of a quarry face. This will ensure that the stockpile has limited exposure to wind which could entrain surface dust. The fuel will be extracted from under the pile through a tunnel similar to that employed for stone handling. One of the benefits of this method is that once tipped the fuel does not need to be moved again by mobile plant, apart from minor tidying of the pile edges. It also allows continuous rather than daytime operation of the grinding plant leading to smaller equipment, lower capital and operating labour costs.

The fuel will be conveyed from the stockpile by belt conveyors into a feed hopper located in the coal grinding building. It may sometimes require drying to remove excess moisture which would otherwise cause blockage of the kiln firing system. Hot air will be supplied to the air swept mill from a burner fired with diesel oil. The mill will incorporate an air separation system to recycle oversize particles back for milling. Milled coal is collected in a bag filter unit and hot air is part recycled and part exhausted to atmosphere from the filter. Finished milled coal is transferred pneumatically to the two kiln coal silos.

All the milling systems will be controlled automatically from the kiln control room. It incorporates full local control of the burner system with its attendant safety features.

These include nitrogen inertisation of the milled coal system. The building will be fully enclosed to prevent emission of fugitive dust and to minimise noise.

Kiln manufacturer basic required specifications for petcoke is outlined below:

- Heat value (CV) 22,000 – 38,000 kJ/kg
- Volatile matters 10 % (ignition temperature <450C)
- Ash content <10 %
- Sulphur <6 % (as low as possible)***
- Ash fusion P. (ST) >1250 °C
- Swelling index <1.5 ASTM
- Oil residue <1.0 % (petcoke)
- Grain size 80–90 % of pulverized fuel <0.09 mm
- Moisture <1.5 %
- Density approx 0.6 kg/m^3

*****Industry standards indicate at least 90% of the sulphur is absorbed by the limestone**

General Specification for Pulverized Fuel suitable for the PFR Kiln

- Net CV 26 to 38 MJ/kg
- Volatiles >15 %
- Sulphur Content as above
- Swelling Index <1.5 % ASTM (applicable for coal)
- Ash Content <2 %
- Ash fusion temperature
    - Initial deformation temperature >1250C
    - Hemisphere temperature >1250C
    - Fluid Temperature >1250C
    - Ignition Temperature <450 C

The transport of solid fuels has a potential fugitive emissions (dust) and fire hazard. Petcoke, the preferred fuel source is significantly less volatile than coal and is not subject to

spontaneous combustion. Hence, the fire protection required for petcoke would be less than that for coal. WINDALCO will install a durable liner as a mitigation measure to prevent petcoke/coal-pile runoff from entering the groundwater. The storage of petcoke requires no specific precaution other than normally adopted, i.e. open ground storage[2]. To combat potential fugitive emissions and fire hazard the occupational health and safety protocol of WINDALCO will be initiated. It will be extended to include safe handling and transportation of solid fuels. The primary impacts expected are:

- Dust emissions from transportation, crushing and storage of fuel source,
- Fire hazard associated with transportation

The mitigation measures proposed will include, but not be limited to, the following:

- Tarpaulin covered trucks during transportation
- Wetting of fuel source prior to transportation to prevent possible fires
- Equipping trucks with fire extinguishers
- Training of drivers and operators in Emergency Response Procedures
- Crushing fuel in an enclosed area
- Inertization of pulverised fuel
- Installation of sprinkler system at fuel stockpiles
- Storage of pulverised fuel in two (2) enclosed steel silos
    - Crushing to be done in a fully enclosed Pulverising Mill equipped with air dryer, bagfilter and/ or cyclone

These measures are further examined in Section 7. The following plates show an example of the intended open storage for the fuel source at Port Esquivel and Shooters Hill (Plate 2-3 and Plate 2-4).

[2] IPPC BAT 2004. Reference Document, European Chemical Industry Council, http://www.cefic.be/files/Publications/ESAPA_Soda_Ash_Process_BREF3.pdf

Plate 2-3: Bunded Hydrate Area of Port Esquivel [Note: Ramped entrance will be used to access the fuel storage area at Port Esquivel and Shooters Hill]

Plate 2-4: Bunded Area for Hydrate [Note: Fuel will be covered with tarpaulin similar to that used here]

2.3.2.5 Lime Handling, Transportation and Storage

Lime will be stored in pressurised hoppers at the base of each shaft. At the point of "shaft changeover" the pressure in the kiln will be released and lime discharged onto a belt conveyor. The size of the lumps is similar to that of the limestone entering the kiln *viz.* 40 – 120 mm and the lime must therefore be crushed for subsequent conveying, storage and delivery.

The belt conveyor will deliver lime intermittently to a storage hopper above a single roll crusher. This device will reduce the lime lumps to less than 40 mm with minimum dust production. Crushed lime will be conveyed to the top of 4 storage silos by a bucket elevator. This discharges into a vibratory screen to separate the lime into different size fractions for the various end users.

The lime will be stored in four 1250 tonne capacity silos arranged with a roadway underneath. Delivery chutes will be extended from the bottom of the silos to load covered lime delivery trucks. Loading will be performed under negative pressure to avoid dust emissions.

A bag filter unit adjacent to the silos will provide ventilation for all the equipment and loading operations in the area. This filter will discharge lime dust back into the conveying system.

It is proposed to transport the lime by trucks from the proposed lime kiln site at Shooters Hill to the Kirvine Plant which is less than 1 mile south of the quarry, and to the ALPART Plant in Nain, St. Elizabeth. Lime will also be delivered to WINDALCO Ewarton Works via railcars as currently practiced. The increased production of lime will replace imported lime and hydrated lime resulting in reduced net truck movements. Transport between the kiln and Kirkvine Works will be over a maximum distance of 100 m on public roads. There will be approximately 20 truck movements per day and a reduction of 6 lime hydrate movements per day between Port Esquivel and Kirkvine. At a consumption of 400 tpd, an increase of 20 truck movements per day is expected between Kirkvine and ALPART. To mitigate this, a

reduction in truck movements will be realised between Port Kaiser and ALPART, and Rugby Lime and ALPART. All truck movements will utilise main roads.

The primary impacts expected are:

- Dust emissions during loading and transportation resulting in impacts to air pollution and human health,
- Fire hazard associated with spilt lime coming in contact with moisture
- Noise nuisance from night transportation

Aspects of handling and transportation will include, but not be limited to, the following:

- Trucks will be enclosed (steel covered) or covered with tarpaulin for delivery to Kirkvine Works and ALPART. Tarpaulin will be of good integrity to prevent ingress of water and a possible exothermic reaction between water and lime
    - Trucks using tarpaulin will be filled with sufficient space left to minimise contact between tarpaulin and lime
- Trucks will utilise only main roads
- Equipping trucks with fire extinguishers
- Training of drivers in Emergency Response Procedures
- Transportation to Ewarton Works will be by covered rail cars as currently practiced
- Loading of trucks will be via a telescopic loading chute fitted with dust extractors
- WINDALCO's traffic management system will guide the night-time transportation regime
- Lime produced will be transported via covered conveyors from the kilns to fully enclosed structural steel silos fitted with baghouse filters

These measures are further examined in Section 7.

2.3.3 *Machinery & Equipment*

A very exhaustive list of machinery and equipment is specified for the kiln site. However, for the purpose of the EIA the equipment are generally categorized for various elements of the project as follows:

- Limestone feeding system
- The lime kilns
- Firing system
- Combustion and cooling air system
- Hydraulic system
- Waste gas filtering system
- Electrical power and control system, and
- Equipment for fuel oil

2.3.3.1 Equipment Technical Description of the MAERZ Lime Kiln

2.3.3.1.1 Lime kiln

Type: MAERZ Parallel Flow Regenerative Lime Kiln

Number of kilns in plant	2
Number of shafts per kiln:	2
Shaft dimensions:	Rectangular cross section of approx. 8 m^2 each
Production capacity:	400 tons per day of discharged burnt lime
Limestone grading:	40 - 125 mm or similar
Number of burner lances:	22 in each shaft
Height of kiln	46 m

2.3.3.1.2 Kiln Structure

The kiln is completely of a steel structure starting with the limestone hopper before the skip until the discharge vibrating feeder underneath the kiln, comprising:

- Kiln supporting structure
- Kiln shell
- Platforms and stairs on the kiln
- Supporting structure for kiln top housing from and including the burner lance platform

- Cladding for kiln top housing down to the charging platform (sheeting only, no sound insulation panels)
- Discharge tables and discharge hopper
- Kiln flaps
- Weigh charging hopper before the skip
- 2 x 44 Burner lances, stainless steel 316
- Coal dust piping from dosing system to burner lances
- Ring mains for lance cooling air
- Combustion air piping
- Cooling air piping
- Piping for lance cooling air
- Piping for coal transport air
- Waste gas ducts from kiln to waste gas filter
- Emergency stack on kiln
- Waste gas stack from filter fan to kiln top supported on the kiln structure
- 2 x 1 Petcoke silo 150 m^3 with supporting structure
- Skip bridge and skip bucket

Total weight: approx. 848 tons for two kilns

Thereof are:

- Stainless steel: approx. 2 x 2 tons
- Steel for Burner lances approx. 2 x 4 tons

Corrosion protection is applied according to the following table:

Table 2-2: Corrosion Protection Parameters

	Total surface	Inside	Outside
Kiln shell	-	6	1:3
Steel structure inside housing	1:4	-	-
Steel structure outside housing	1:4	-	-
Piping and ducting without insulation (transport in protected container)	-	2	1:4
Piping and ducting with insulation (transport in protected container)		2	1:4
Machined parts without painting	5	-	-
Welding necks	5	-	-

1. Sand blasting SA 2.5
2. Unless transported in a protected container, untreated pipes / duct ends have to be closed with caps.
3. The areas specified as high temperature areas have to be painted with heat resistant paint, which is temperature proof for +300 °C, consisting of 2 layers, 40 microns each.
4. To be painted with paint good for at least +100 °C, consisting of 1 layer primers of 40 microns.
5. Protection against corrosion (sea water). Such protection is removable without damaging the surface.
6. Untreated

2.3.3.1.3 Kiln Refractory Lining

Complete refractory lining of the kiln.

- Preheating zone: Non-basic refractories backed with insulation
- Burning zone: Basic refractories backed with insulation
- Cooling zone: Non-basic refractories backed with insulation.

2.3.3.1.3.1 Basic Refractories

- special magnesite bricks

- magnesite bricks
- magnesite ramming mix
- magnesite mortar

Total weight: approx. 225 tons for one kiln (approx. 450 tons for both kilns)

2.3.3.1.3.2 Non-Basic Refractories and Auxiliary Materials

- special hard fireclay bricks
- compressed fireclay bricks
- light fireclay bricks
- insulating plates
- insulating ramming mix
- fireclay castable
- fireclay mortar
- slag wool
- ceramic fibre mats and plates

Total weight: approx. 302 tons for one kiln (approx. 604 tons for both kilns)

2.3.3.1.3.3 Gunning Mass in kiln top area

To minimise corrosion and reduce noise emissions the kiln shafts are lined with a refractory gunning mass in the area above the refractory brickwork. Steel wire anchors welded onto the shell hold the 100 mm thick gunning mass layer.

Total weight: approx. 28 tons for one kiln (approx. 56 tons for both kilns)

2.3.3.1.4 Limestone

The limestone matches the following specifications:

Chemical composition:

- $CaCO_3$ 98.58 % (as per chemical analyze)

- $MgCO_3$ 0.50 % (as per chemical analyze)
- Fe_2O_3: 0.01 % (as per chemical analyze)
- Al_2O_3: 0.01 % (as per chemical analyze)
- SiO_2: <0.01 % (as per chemical analyze)
- Moisture: max 2 %, free from clay and mud

Physical:

- Limestone grading: 40 - 125 mm (free from clay and mud)
- Under- / oversized Material: less than 3 %
- Distribution: linear screening curve

2.3.3.1.5 Fuel

The kilns will be fired with Petcoke according to the following specification:

2.3.3.1.5.1 Specification for Petcoke

Consumption at 400 tpd:	approx. 1,750 kg/h per kiln
Calorific value (net):	approx. 35.0 MJ/kg
Density:	approx. 0.60 kg/m^3
Grain size:	80 - 90 % of pulverized Petcoke <0.09 mm (1/300”)
	100 % of Pulverized Petcoke < 0.315 mm (1/80”)
Volatile materials:	>10 % (ignition temperature < 450°C)
Oil residue:	<1.0 %
Sulphur content:	<5% (as low as possible)
Moisture:	<1.5 %

The Petcoke finally chosen will be tested by Maerz to ensure that it is suitable for the use in Maerz kilns.

2.3.3.1.5.2 General specification for pulverized fuel suitable for Maerz kilns

- Net calorific value (dry):	26.0 to 38.0 MJ/kg
- Volatile materials:	>15 %
- Sulphur content:	as low as possible, depending on requested lime quality
- Swelling index:	<1.5 % ASTM (in case of coal dust)
- Ash content:	<10 %
- Ash fusion temperature	
Initial deformation temperature (IDT) :	>1250 °C
Hemisphere temperature (HAT) :	>1250 °C
...Fluid temperature (FT):	>1250 °C
- Ignition temperature:	<450 °C
- Grain size:	80 - 90 % of pulverized fuel < 0.09 mm 100 % of Pulverized fuel < 0.315 mm
- Oil residue:	<1.0 % (Petcoke)
- Moisture:	<1.5 %

2.3.3.1.6 Compressed Air

The required quantities are as follow (per kiln):

- For Petcoke dosing system:	approx. 100 Nm^3/h
- For waste gas filter bag cleaning:	approx. 150 Nm^3/h
- For valve / instrument operations:	approx. 50 Nm^3/h
- For auxiliary purposes:	approx. 100 Nm^3/h

The compressed air shall be supplied at 6 bars gauge, dry.

2.3.3.1.7 Power Supply / Voltage

Specification:

- Main power:	3 x 415 VAC / 50 Hz
- Control power for motor circuits:	1 x 110 VAC / 50 Hz
- Power supply for solenoid valves:	1 x 110 VAC / 50 Hz
- PLC digital input signals:	24 VDC
- PLC digital output signals:	24 VDC
- PLC analogue signals:	4 - 20 mA

2.3.3.1.8 Site Conditions

Plant location above sea level:	max. 500 m [The actual elevation (ground floor) of the kilns is at approx. 420 m above sea level]
Earthquake factor:	0.18
Wind velocity:	60 m/s (due to Hurricanes)
Max. Ambient temperature:	10°C
Min. ambient temperature:	40°C
Rainfall:	1000 mm/year, average
Relative humidity:	45 % - 90 %

2.3.3.1.9 Controls and Software - Lime Kiln

The system will be monitored by computer programme for all control, alarm and monitoring functions of the programmable logic controller (PLC) of the electronic control system and the visualisation system of the kiln based on Allen Bradley software for the PLC and InTouch / Windows software for the visualisation system.

PLC Allen Bradley Control Logix 1756 will be supplied. Therefore the following Allen Bradley devices will be installed into the PLC Cabinet:

- PLC Allen Bradley ControlLogix 1756-L55M14

- Control Logix – Chassis 13 slots
- Ethernet module 1756-ENBT
- Media Converter 10/100 TX 100FX Microsens type MS650461
- Modulo Rete Device Net 1756 –DNB in order to connect the Distributed I/O module (FLEX I/O)
- Power supply Allen Bradley 1756-PA72B
- Input digital modules , (32 DI a 24 VDC) 1756- IB32
- Output digital modules (32 DO a 24 VDC) 1756 –OB32
- Analogue input modules (16 AI a 4…. 20 mA) 1756 –IF16
- Analogue output modules (8 AO a 4… 20 mA) 1756- OF8

The PLC cabinet will be complete with all necessary automatic switches in order to protect the I/O modules and the field instruments.

All required output relays will be mounted inside the PLC cabinet.

All the I/O signals will be pre-wired to terminals in the PLC cabinet.

Further the PLC, the cabinet shall be equipped with the following devices:

- Main line circuit breaker
- Automatic circuit breakers
- Power supply system to provide the auxiliary 24 V DC
- Power supply system to provide the auxiliary 110 V AC
- Duplicating relays for output signals terminal strips screw type
- Sitrans Tax converters
- Galvanic isolation units P&F
- Cabinet lighting system
- Auxiliary socket

All the equipment shall be completely mounted and wired up to the terminal strips

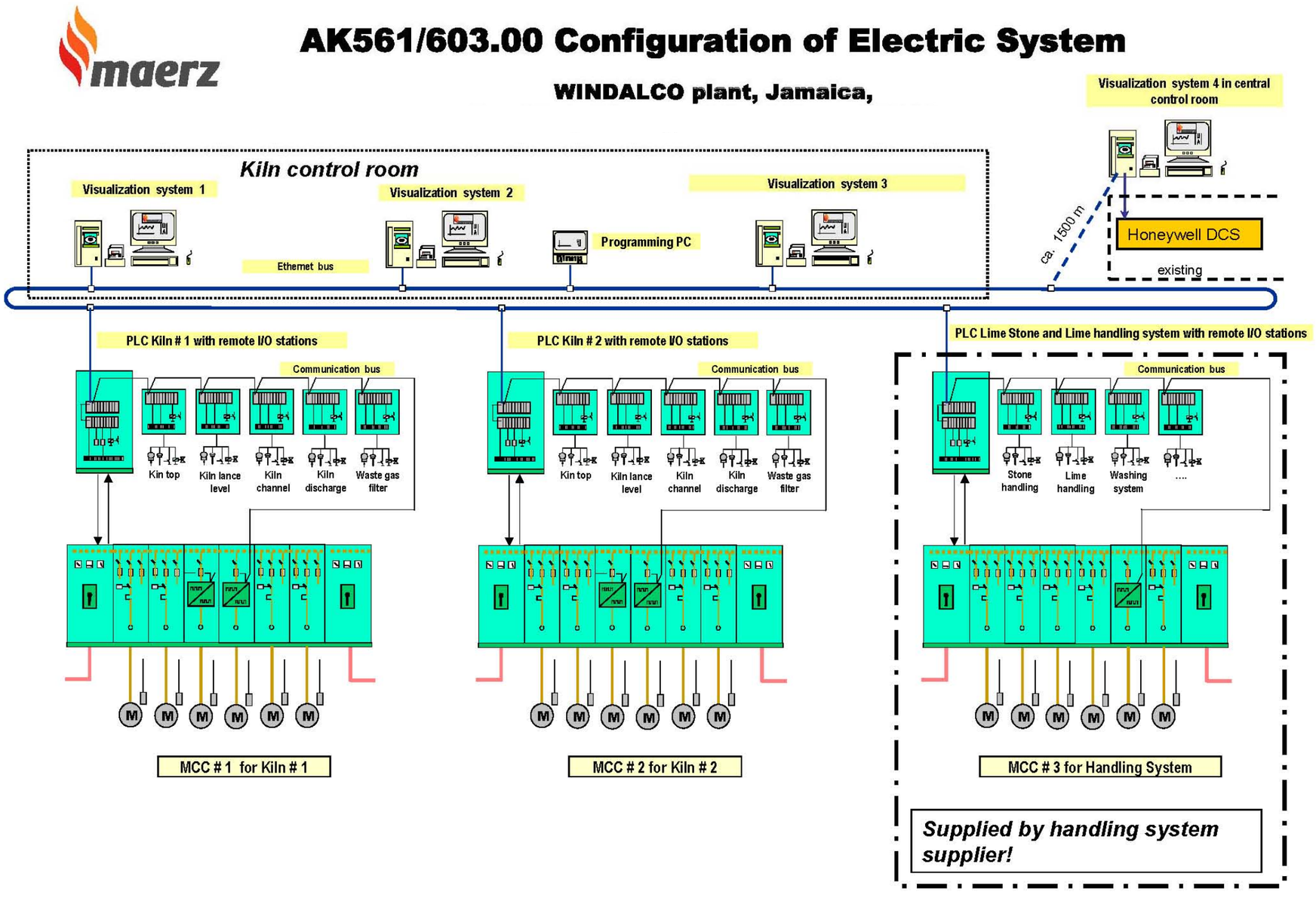


Figure 2-11: Configuration of Electric System

2.3.3.1.10 Air Blowers

Roots type blowers will be provided for the supply of:

- combustion air: 2 x 3 units, each at unit, at 8'000 m^3/hr, 400 mbar
- cooling air for burnt lime: 2 x 2 units, each at unit, at 8'600 m^3/hr, 350 mbar
- cooling air for burner lances: 2 x 2 units, each at unit, at 3'100 m^3/hr, 600 mbar
- Conveying air for Petcoke: 2 x 1 units, each at unit, at 2'000 m^3/hr, 700 mbar

Total numbers of blowers are given for two kilns.

All blowers are equipped with suction filters, suction and pressure silencers, non-return valves and safety valves. The blowers are mounted on frames resting on anti-vibration pads.

2.3.3.1.11 Blower Motors

- 2 x 1 AC motor, 132 kW, 250 - 1'500 rpm, with frequency control, for one variable speed combustion air blower at each kiln
- 2 x 1 AC motor, 132 kW, 250 - 1'500 rpm, with frequency control, for one variable speed lime cooling air blower at each kiln
- 2 x 2 AC motors, 132 kW, 1'500 rpm, for two fix speed combustion air blowers blower at each kiln
- 2 x 1 AC motor, 132 kW, 1'500 rpm, for one fix speed cooling air blower at each kiln
- 2 x 2 AC motors, 75 kW, 250 - 1'500 rpm, with frequency control, for two variable speed lance cooling air blowers at each kiln
- 2 x 1 AC motor, 75 kW, 1'500 rpm, for one fix speed Petcoke conveying air blowers blower at each kiln

Total numbers of motors are given for two kilns

2.3.3.1.12 Firing Equipment for Petcoke Dust

Conical outlet portion of 150 m³ pulverised Petcoke bin with compressed air aerating device, inert gas connections, pneumatically operated slide valve, hydraulically operated shut-off valve, injector and all necessary accessories

- Complete set of accessories for the 150 m³ Petcoke bin, including filter, explosion flap, etc.
- weighing hopper, complete with framework, filter, stirrer with motor, rotary dosing valves with motors, load cells, flexible hoses, solenoid valves and all accessories
- Accessories for pulverised Petcoke transport air system, comprising air collector pipe, flow control device for each air pipe, etc.
- hydraulically operated two-way switch valves for Petcoke flow reversal from one shaft to the other
- Y-pipes for Petcoke distribution to the lances
- set of non-return valves, orifice plates, flexible hoses
- Set of two start-up burners for light fuel oil with all accessories.

The take-over point for the pulverized Petcoke is at the silo bottom. The Petcoke dust will be filled into the silo by pneumatic conveying. The filling device (pneumatic conveying system) is part of the conveying system delivering the Petcoke.

2.3.3.1.13 Hydraulic Equipment

Complete hydraulic equipment to operate all movable parts of the kiln, such as the traps in the charging device for limestone, the discharging device for burnt lime, air and waste gas reversal valves, relief valves for combustion and cooling air, etc.

The hydraulic equipment comprises an oil reservoir, pumps, filters, cylinders as well as all necessary control and shutoff valves and the correspondent mounting material, such as pipes, fittings, clamps, etc.

2.3.3.1.14 Waste Gas Dust Cleaning System

Waste gas dust cleaning installation (suction type bag house filter with Nomex® bags) based on the following basic layout data:

- Max. waste gas volume from kiln: 68'000 m^3/hr at 140°C
- Waste gas temperature: 70 - 140°C
- Max. quench air volume: 8’000 m3/hr at 40°C
- Max. waste gas volume to filter: 76'000 m3/hr at 140°C
- Waste gas filter suction fan: 87’000 m3/hr at 140°C
- Filter surface: approx. 1’120 m2
- Dust load in raw waste gas: 5 - 10 g/m3n
- Dust load in clean gas: less than 50 mg/m3n

The waste gas filter ID fan (132 KW) is equipped with a variable speed drive for waste gas pressure regulation at the kiln outlet.

The bag house filter will be fitted with predictive control sensors which will detect the conditions of the bag allowing for requisite maintenance control. These sensors will be linked to the kiln PLC system.

2.3.3.1.15 Dust Handling System

Dust handling system from waste gas filter outlet (rotary air lock valve) comprising:

- Screw conveyor approx. 10'000 mm
- Dust silo approx.15 m^3
- Truck loading spout

Dust from the baghouse filter (approximately 8-tons per kiln per day) will be removed via conveying systems to a top fed silo. These refuse will be emptied into a truck and used in quarry and bauxite mine rehabilitation programme.

2.3.3.1.16 Limestone Transport (Skip)

Two (2) sets of equipment for the limestone skip hoists, electrically operated, (winch, ropes, motor, gear box, brake, etc.).

- skip bucket capacity: approx. 3.50 m^3
- speed: approx. 25 m/min
- motor: approx. 45 kW

2.3.3.1.17 Insulation

Insulation will prevent condensation in the following kiln parts:

- waste gas ducts
- waste gas filter

2.3.3.1.18 Kiln Housing

The housing of the kiln will extend from top down to the charging platform with corrugated steel sheets.

2.3.3.1.19 Air Cannons

Two (2) air cannons per kiln including all accessories to prevent dust build-up in the ring channel and crossover channels of the kiln.

2.3.3.1.20 Firing Equipment

2.3.3.1.20.1 Diesel Oil Tank

Diesel oil tank will be in close proximity to the kilns (<150 m). The diesel oil is needed for start up with auxiliary burners.

2.3.3.1.21 Compressed Air System

This is required for atomising for fuel oil of the start up burner and cleaning of the bag house filter, including:

- 2 air compressor as stand-alone unit, intake capacity 1,000 m^3/h each with 6 bar operating pressure designed and set up for 90°C exit temperature
- 2 air dryer for compressed air
- 1 buffer tank for compressed air, 10 m^3
- 1 set of shut-off valves

2.3.3.1.22 Vibrating Feeders for Limestone and Burnt Lime

Two (2) vibrating feeders, one (1) for each kiln, for charging limestone into the hopper before the skip with the following characteristics:

- length: approx. 1,500 mm
- width: approx. 650 mm
- capacity: approx. 0 - 80 t/hr
- limestone size: 45 - 125 mm

Vibrating feeders to be equipped with stainless steel wear lining and covered with dust suppression covers

Four (4) vibrating feeders, two (2) for each kiln, for discharging of burnt lime at kiln bottom with following characteristics:

- length: approx. 1,500 mm
- width: approx. 650 mm
- capacity: approx. 0 - 60 t/hr
- quicklime size: 0 - 125 mm

2.3.3.1.23 Mobile Equipment on site during construction of kiln facility

The following list of erection equipment is typical and may vary according to local conditions and practical experience of the erection contractor.

- 1 200 tonne mobile crane with 40 m mast
- 1 x 120 tonne mobile mast with 40 m mast

- 1 x 50 tonne mobile crane with 20 m mast
- 1 x 10 tonne mobile crane with 20 m mast
- 1 300 tonne mobile crane or rotary-tower crane with a 60 to 70 m mast, depending on kiln size, for temporary use
- 1 10 tonne electric winch with 200 to 300 m rope
- 1 5 tonne electric winch with 100 m rope
- 6 electric welding machines 300 A ED with all necessary accessories

2.3.4 *Manpower & Utility Requirements*

The proposed operations will require a range of specialized and professional skills and labour at all stage of project development. These skills are required at various locations which make up the chain of activities that characterizes raw material procurement, quarrying, processing, and distribution. Some of the skills the site may employ are as follows:

- Management and administration
- Engineering and technical services
- Process plant operations
- Technicians and artisans, among others

It should be noted however, that the staff that currently operates the existing rotary kiln may be retrained to operate the new kiln facility and the quarry currently has its own staff for quarrying operations and as such staff recruitment is expected to be minimal for the operational phase of this project.

For each phase of development all staff will undergo training. Jamaica has been engaged in relatively high technology operations for over fifty years, primarily in the following industries: bauxite-alumina, petroleum refining, power generation, and various manufacturing and minerals extraction industries. Hence, most of the skills needed during the pre-construction and construction phases are readily available.

The manpower requirement will be approximately 120 persons during construction and 24 during operation.

In addition, the internal policy of WINDALCO facilitates the training for all its employees inclusive of safety and operations training.

The site specific and regional context within which the project will be implemented has been supporting large-scale industries for many years including major sugar factories and bauxite operations. It is also the company's intention to employ local contractors, as needed, to conduct specific tasks.

2.3.4.1 Power Requirements

Electrical power will be supplied by WINDALCO's powerhouse that is capable of providing on average 1.5 to 2.4 megawatts of electricity per operational day.

2.3.4.2 Water Requirements

WINDALCO's production wells will continue to supply domestic water to the site. The proposed lime plant is a dry process operation; the water requirement will therefore mainly be for domestic purposes only and can be met by the cumulative average abstraction volume of 180 m^3 per day.

2.3.5 *Sewage Requirements*

The existing septic tank/absorption pit system will be used as system can accommodate the small increase in numbers of persons working at the site. During construction, WINDALCO and/or their contractors will provide portable chemical toilets to be placed in ideal locations within the quarry.

Under circumstances of reasonable usage, sewage can be anticipated to be generated at a rate of 12.5 litres per individual per shift (for a one shift system). At this rate it is estimated that with at least 20 employees, 250 litres per day of sewage will be generated from the facility. The sewage facilities at the site can accommodate this load.

2.3.6 *Wind and Earthquake Design Parameters*

2.3.6.1 Wind Design

The facility will be constructed in accordance with the Caribbean Uniform Building Code – CUBIC. The basic wind design speed for Jamaica is 40 m/sec with a 3 second gust of 60 m/sec.

The kiln will be designed to withstand a wind velocity factor of 60 m/sec. The wind velocity translates to a category 4 hurricane which has wind speeds of 210-250 km/h (131-155 mph).

2.3.6.2 Earthquake Design

The facility will be constructed in accordance with the Structural Engineers Association of California - SEAOC - Zone 3 Code and within the following parameters:

- Max ambient temp:- 40°C
- Min ambient temp:- 5°C
- Altitude:- ~ 420 m
- Relative Humidity:- ~40-90%

The kiln is designed with an earthquake factor of 0.18. The earthquake factor translates to below what is expected from the 50-year seismic maps, i.e., the effective peak acceleration in fractions of g, where g equals the earth's gravity acceleration.

ANALYSIS OF ALTERNATIVES

3 Analysis of Alternatives

3.1 Introduction

The alternatives considered for the establishment of the proposed lime kilns and transportation corridor were analysed within the context of social, environmental and economic ramifications of an essential raw material used in the bauxite/alumina industry.

This section analyses the alternatives in respect of siting, kiln types and transportation options and includes the no-action alternatives, which are essential to a project of this nature.

The following criteria are important in the selection of a site to establish a lime plant:

- Consistent hardness of stone
- Local infrastructure (roads etc.)
- Good weather protection
- Suitable site topography
- Availability of electricity
- Availability of adequate water supply
- Complementarity with other land uses/cumulative effects
- Permanent labour force
- Strong community support
- Resilience of natural environment

Using the above mentioned criteria as the basis for selection, the following alternatives were examined:

1. The No-Action Alternative
2. The Proposed Location at Shooters Hill
3. Alternative Lime Kiln Locations
4. Alternative Technology
5. Alternative Fuel Source

3.2 No-Action Alternative

According to the Geological Survey Division, estimates of Jamaica's reserves of limestone are approximately 150 billion metric tonnes, inclusive of the Swanswick, Somerset, Newport, Montpelier, Troy, Gibraltar/Bonny Gate, Walderston and Brown's Town formations of the White Limestone Group.

The positive implications of the No-Action Alternative are:

- Preservation of the visual aesthetic character of mountain ridges, i.e. maintain greenery
- No noise from the use of heavy machinery and equipment, and
- No generation of the dust or gaseous emissions from the operation of a lime plant

Despite the positive environmental and socio-cultural implications, the facts have proven that of necessity locally available limestone and lime must be extensively used in the domestic and industrial sectors. This has been done traditionally and has continued to the present time, where the use of modern technologies and environmentally sound practices can effectively mitigate against potentially negative environmental impacts.

The bauxite industry use lime in their production process for a number of purposes, chief of which are highlighted below:

- Phosphorous removal
- Sodium oxalate removal
- Liquid stabilisation (mud circuit)
- Filter aid and pre-coat
- Causticisation
- Neutralising agent

Lime is a very important component of environmental management worldwide. Its uses as a cost effective scrubber and absorber of gaseous pollutants and its uses in neutralisation, precipitation, coagulation and sludge conditioning of sewage and trade effluents make it a vitally important product in light of the increased need for environmental management.

To favourably consider the No-Action alternative is to deny the growth and development and possibly closure of a sector which is of vital importance to Jamaica's economy, occasion a loss of market opportunity to substantial investment and to ignore the potential of a basic raw material which is of valuable importance to the field of environmental management.

It should be stated also, that at the present time, lime is imported into Jamaica at a cost in excess of US $100 per tonne. This is significantly higher than locally produced lime which approximates to less than US $85 per tonne. To do nothing will result in missed opportunities to save and retain substantial in foreign exchange and will also deny economic and social opportunities such as job creation and relevant technology transfer.

Based on the aforementioned pros and cons the No-Action Alternative was not selected.

3.3 Kiln Site Location Alternatives

Three options have been explored with regards to the most suitable location for the lime kiln

1. **At the Western-most Gate at KVW. This area is** located west of the 150 ft. high Powerhouse Stacks. The sulphur effluents from the stacks are carried in this general direction. The 150 ft kilns would be in the direct path with disastrous impact on the structural integrity given that sulphur has corrosive impact on steel**.**
2. **In the vicinity of the Existing Rotary Kiln.** The real estate/space in this area could not sufficiently host two kilns and associated auxillaries.
3. **Shooter's Hill Quarry.** This area has sufficient space to accommodate the footprints for two kilns and all supporting facilities for limestone and fuel handling. With the significantly increased requirement for stone (2,000 TPD for new kilns versus 200 TPD requirement of the existing rotary) there will be an increase in truck movements. This is best controlled within the quarry rather than movements across the public roads.

3.3.1 *Proposed Location:-Shooters Hill, Manchester*

This area possesses all of the necessary attributes for site selection. It is rich quantitatively and qualitatively in limestone deposits, and the active exclusive prospecting license covering the area is held by WINDALCO. This in many respects guarantees a steady supply of

limestone aggregate and subsequently greater plant availability, particularly with regard to WINDALCO Kirkvine, and ALPART operations. As such, the event of transportation mishaps over long journeys is reduced, although experience has shown that these occurrences are rare and unlikely. This site is within sight of the main plant at Kirkvine, and in relatively close proximity to the ALPART plant in Nain, St. Elizabeth.

The project proponents have also found it to be very feasible to establish the lime kiln at the site due to the availability of land at the quarry site for siting the structures. On this basis the Shooters Hill site is considered the preferred alternative.

3.4 Lime Kiln Technology Alternatives

There are two main types of modern kilns being used today, primarily:

1. Shaft kilns
    a. Counter-current shaft kilns
    b. Regenerative kilns
    c. Annular kilns
2. Rotary kilns

There are four basic designs of kiln in use: shaft, rotary, rotating hearth and fluidised bed. All are designed to dry and calcine the limestone feed and cool the product quicklime.

Table 3-1: Comparison of Various Types of Kiln Technology

Kiln type	Feed size range(mm)	Fuel consumption(kcal/kg quicklime)	Power consumption(kWh/quicklime tonne)
Shaft			
Simple	50-250	1100-1700	4-15
Mixed feed	90-200	950-1050	4-15
Double inclined	25-55	1000-1150	22-29
Annular shaft	20-150	950-1150	25-30
Parallel flow regenerative	20-200	850-950	15-34
Rotary			
Long	10-65	1500-2000	14-24

Kiln type	Feed size range(mm)	Fuel consumption(kcal/kg quicklime)	Power consumption(kWh/quicklime tonne)
Short with grate pre-heater	10-50	1200-1450	20-25
Short with shaft pre-heater	10-60	1150-1450	17-45
Short with cyclone pre-heater	0-2	1100-1300	23-37
Rotating hearth	8-75	1400-1500	29-36
Fluidised bed	0-2	1100-1300	20-25

The most critical elements of significance in the selection of kilns are as follows:

1. Capital and operating cost
2. Technology
3. Product quality, and
4. Environmental implications

3.4.1 *Shaft Kilns*

The theoretical heat (the standard enthalpy) of reaction required to make high-calcium lime is around 3.15 MJ per kg of lime, so the batch kilns were only around 20% efficient. The key to development in efficiency was the invention of continuous kilns, avoiding the wasteful heat-up and cool-down cycles of the batch kilns. The first were simple shaft kilns, similar in construction to blast furnaces. These are counter-current shaft kilns. Modern variants include regenerative and annular kilns. Output is usually in the range 100-500 tonnes per day.

3.4.1.1 Counter-Current Shaft Kilns

The fuel is injected part-way up the shaft, producing maximum temperature at this point. The fresh feed fed in at the top is first dried then heated to 800°C, where de-carbonation begins, and proceeds progressively faster as the temperature rises. Below the burner, the hot lime transfer heat to, and is cooled by, the combustion air. A mechanical grate withdraws the lime at the bottom. A fan draws the gases through the kiln, and the level in the kiln is kept constant by adding feed through an airlock. As with batch kilns, only large graded stone can

b[3]e used, in order to ensure uniform gas-flows through the charge. The degree of burning can be adjusted by changing the rate of withdrawal of lime. Heat consumption of as low as 4 MJ/kg is possible.

3.4.1.2 Regenerative Kilns such as PFR Kilns (Preferred Alternative)

These typically consist of a pair of shafts, operated alternately. In shaft A, combustion air and fuel are added near the top and pass downward, cross to shaft B and pass upward to exhaust. The direction of flow is reversed periodically (typically 5-10 times per hour). The cycling produces a long zone of constant, relatively low temperature (around 950°C) that is ideal for lime quality. PFR kilns produce less CO_2 emissions than rotary kilns/tonne of lime produced. WINDALCO and ALPART will mothball the existing rotary kilns which have higher greenhouse gas (GHG) emission.

3.4.1.3 Annular Kilns

These contain a concentric internal cylinder. This gathers pre-heated air from the cooling zone, which is then used to pressurize the middle annular zone of the kiln. Air spreading outward from the pressurized zone causes counter-current flow upwards, and co-current flow downwards. This again produces a long, relatively cool calcining zone.

3.4.2 *Rotary Kilns*

Rotary kilns started to be used for lime manufacture at the start of the 20th century and now account for a large proportion of new installations. The early use of simple rotary kilns had the advantages that a much wider range of limestone size could be used, from fines upwards, and undesirable elements such as sulphur can be removed. On the other hand, fuel consumption was relatively high because of poor heat exchange compared with shaft kilns, leading to excessive heat loss in exhaust gases. Modern installations partially overcome this disadvantage by adding a preheater, which has the same good solids/gas contact as a shaft

[3] IPPC, *Guidance for Cement and Lime Sector*, Environment Agency, SEPA.

kiln, but fuel consumption is still somewhat higher. In the design shown, a circle of shafts (typically 8-15) is arranged around the kiln riser duct. Hot limestone is discharged from the shafts in sequence, by the action of a hydraulic "pusher plate". Kilns of 1,000 tonnes per day output are typical.

3.5 Lime Source Alternatives

3.5.1 *Installation of a Single 400 TPD Kiln at the Kirkvine Works*

Though it is less aggressive than the preferred proposal, and takes cognisance of any Technical Risk involved in the project, it does not deal with the entirety of the problem and postpones significant cost benefits that are readily attainable with the preferred alternative. To be realised a second kiln would have to be added at a later date.

3.5.2 *Construction of a Single 900 TPD Kiln*

Though the supplier has designs for this size of kiln, none have been built to date. At present an 800 tpd kiln is under construction by MAERZ in Brazil and MAERZ is awaiting commissioning of this before undertaking any similar or larger sized units. There would be a significant technological risk in building a kiln of this size and the manufacturer is not comfortable with this.

The logistics of shutting down a kiln of this size for the four-week shutdown that is required when kiln refractory replacement takes place would be immense. This would represent a shortfall of 25,000 tonnes of lime over this period. Installing two 400 tpd kilns greatly simplifies these shutdowns. At times of low lime requirement e.g. aftermath of a hurricane it is possible to turn down these kilns to 60% of their capacity.

In the case of the 900 tpd kiln this represents 540 tpd whereas with the two 400 tpd one kiln could be shut down and the second kiln brought down to 240 tpd. The 2 x 400 tpd option therefore gives much more flexibility.

If a 900 tpd kiln was available the capital cost of such a unit would be lower than the cost of 2 x 400 tpd kilns. This would be offset by the cost of increased storage facilities. Fuel, electricity and labour would all be the same. However, this option is not readily available.

3.5.3 *Placement of Long-Term Supply Contract with Argos Group (Colombia)*

Discussions have been held with Argos on this proposal and indeed Argos plans to build a coal fired 400,000 tpd rotary kiln and one of their market targets would be supplying all the needs of WINDALCO and ALPART. Their proposal is not very well advanced and they need to do some further work. Preliminary indications are that a price reduction in the range US$5 to US$10 per tonne may be possible. In this scenario this present proposal continues to be more attractive. There are also very significant strategic reasons why it might not be prudent to have the entire lime supply for both plants coming from Colombia. This alternative is therefore not being considered.

3.6 Fuel Alternatives

Parallel Flow Regenerative Kilns are operated worldwide using Heavy Fuel Oil, Solid Fuel, Natural Gas and Wood.

Bunker C Oil- Heavy Fuel Oil

Current Plants and Ports have storage for heavy fuel oil. It would be advantageous to obtain the sources of oil from the Kirkvine Works oil storage thus reducing the need for capital investment for oil handling and storage. However, increasing prices of oil has resulted in a reassessment of fuel source.

Natural Gas

Clean, expensive fuel but unavailable in Jamaica.

Solid Fuel (Petcoke and Coal)

Less solid fuel is required per tonne of lime produced than that of heavy fuel oil. Thus making it a preferred economic alternative, where the cost per tonne is US$70/tonne solid fuel versus US$220/tonne for heavy fuel oil.

Solid Fuel is the preferred source of fuel.

Wood

Wood is used on approximately 2% Parallel Flow Regenerative Kilns. This was not explored for this project.

LEGISLATION, POLICY, STANDARDS AND REGULATORY FRAMEWORK

4 Legislation, Policy, Standards and Regulatory Framework

4.1 Introduction

This section provides a background on WINDALCO's Environmental Policy and International & National Policies, Legislation and Regulations applicable to WINDALCO's proposed Lime Kiln Project.

4.2 WINDALCO's Environmental Policy

WINDALCO's has an environmental Policy statement that drives their operations. This is attached in the Appendix (Appendix VIII).

4.3 Applicable National Legislation, Standards and Policies

The following represents descriptions of applicable legislative requirements with which activities of this proposed upgrade must comply:

- Natural Resources Conservation Authority (NRCA) Act, 1991
- Wildlife Protection Act, 1945
- Watershed Protection Act, 1963
- Mining Act, 1975
- Minerals (Vesting) Act, 1947
- Quarries Act, 1983
- Town & Country Planning Act, 1987
- Forestry Act, 1937
- Water Resources Act, 1995
- Underground Water Control Act, 1959
- Jamaica National Heritage Trust Act, 1985
- Public Health Act, 1985
- Disaster Preparedness & Emergency Management Act, 1993
- National Solid Waste Management Authority Act, 2001
- Occupational Safety & Health Act, 2003 (Draft)
- Manchester Parish Provisional Development Order, 1974

4.3.1 *The NRCA Act, 1991*

The Act is the overriding legislation governing environmental management in the country. It also designates National Parks, Marine Parks, Protected Areas and regulates the control of pollution as well as the way land is used in protected areas.

This Act requires among other things, that all new projects or expansion of existing projects which fall within a prescribed description or category must be subjected to an Environmental Impact Assessment (EIA).

The regulations require that fourteen (14) copies of the EIA Study Report must be submitted to the Authority for review. There is a preliminary review period of ten days to determine whether additional information is needed. After the initial review the process can take up to ninety days for approval. If on review and evaluation of the EIA the required criteria are met, a permit is granted.

Specifically, the relevant section(s) under the Act which addresses the proposed project activities are:

s.10:(1) Subject to the provisions of this section, the Authority may by notice in writing require an applicant for a permit of the person responsible for undertaking in a prescribed area, any enterprise, construction or development of a prescribed description or category-

(a) to furnish the Authority such documents or information as the Authority thinks fit; or

(b) where it is of the opinion that activities of such enterprise, construction or development are having or are likely to have an adverse effect on the environment, to submit to the Authority in respect of the enterprise, construction or development, an EIA containing such information as may be prescribed, and the applicant or, as the case may be, the person responsible shall comply with the requirement.

s.12: Licenses for the discharge of effluents etc.

s.17: Information on pollution control facility

s.18: Enforcement of Controls – threat to public health or natural resources

s.32-33: Ministerial Orders to protect the environment

s.38: Regulations

All the necessary applications have been submitted and found acceptable to the Agency. This EIA document satisfies the final review process before the required licences and permits can be issued. An applicant for a Permit and License was completed and submitted to NEPA as well as a Project Information Form (PIF) and Terms of Reference (ToR). The approved ToR for this EIA is included in the appendix of this document (Appendix I)

4.3.1.1 The Natural Resources Conservation Authority (Air Quality) Regulations, 2006

These regulations were gazetted on July 12, 2006. This regulation speaks to the quality of the airshed within which an industrial entity is discharging emissions (gases or particulate matter). Discharge license requirements are outlined in Part I of this Act, and Part II speaks to the stack emission targets, standards and guidelines.

The environmental impact from any air emissions (gasses or particulate matter) will be influenced by the ambient meteorological conditions within the area, such as wind (speed and direction), and rain.

Table 4-1 below outlines the ambient air quality standards as issued by NEPA.

Table 4-1: Air Quality Standards for Jamaica (NEPA)

Pollutant	Averaging Time	Standard (maximum concentration in µg/m3)
Total Suspended Particulates Matter (TSP)	Annual	60
	24 hour	150
PM10	Annual	50
	24 hour	150

Pollutant	Averaging Time	Standard (maximum concentration in µg/m3)
Lead	Calendar Quarter	2
Sulphur Dioxide	Annual	80 primary, 60 secondary
	24 hour	365 primary, 280 secondary
	1 hour	700
Photochemical oxidants (ozone)	1 hour	235
Carbon monoxide	8 hour	10,000
	1 hour	40,000
Nitrogen Dioxide	Annual	100

The proposed facility has the potential to impact on the residential communities surrounding the proposed site location in Shooters Hill, Manchester. The design specifications are of superior technology to the kiln technology currently in use. All the necessary technical mitigations in design will be taken by the kiln manufacturer and geared towards the existing local setting. WINDALCO has established programmes and policies to monitor air quality at all its facilities. This type of monitoring is currently practiced and will be continued if the proposed project is given approval.

4.3.1.2 Trade Effluent Standards

The Trade Effluent Standards have existed in draft format since 1996. These standards regulate the quality of effluent discharged from any entity into public drains/sewers and all surface and water bodies such as ponds, sea or lake. Similar to the Air Quality regulations, a discharge license is required to release any trade effluent and guidelines set forth for acceptable water quality standards including sewage effluent.

No new effluent treatment is proposed for this project. There is currently an amenity block with showers and toilet facilities used by the quarry site workers. There will be a very small increase in number of workers during operation, and this will not pose a problem for the load capacity. Portable chemical toilets will be utilised during the construction phase when larger number of workers are expected.

4.3.1.3 Noise Standards

Noise Standards for Jamaica have been proposed by NEPA based on the World Bank standards. The guidelines for daytime perimeter noise is 75 decibels and 70 decibels for night-time noise.

WINDALCO has policies in place to monitor noise in its operations. Blasting and quarrying noise is currently monitored at the Shooters Hill Quarry. The protocols will be updated to include the new lime kiln facility to be built. Additionally, the kiln and associated mechanical equipment that may generate noise will be fitted with manufacture specified silencers and other devices to ensure noise levels do not exceed standards. The design specification will be in keeping with the following standards:

- 6 a.m. to 7 p.m. – 55 db
- 7 p.m. to 6 a.m. – 42 db

4.3.2 *The Mining Act 1975;*

The Mining Act regulates the activities of the mining sector including the various intricacies involved in the granting of licenses, prospecting rights and regulations, compensation payments and the utilization of special lands under a mining lease.

This Act is of special importance to the proposed mining activities and would be administered by the Commissioner of Mines.

WINDALCO has a licence to operate the Shooters Hill Quarry. This quarry has been in operation for a very long time. All permit and licence conditions will continue to be met by WINDALCO, including all monitoring and reporting to the required regulatory bodies.

4.3.3 *The Minerals (Vesting) Act, 1947*

The Minerals (Vesting) Act, through the Minister, has the power to declare that all minerals being in, on or under any land or water, whether territorial waters, rivers, or inland sea, are vested in and are subject to the control of the Crown. As such this Act governs the extent to which royalties are payable to landowners.

WINDALCO has a licence to operate the Shooters Hill Quarry.

4.3.4 *Quarries Control Act, 1983*

The Quarries Control Act of 1983 designates the establishment of quarry zones, and controls licensing and operations of all quarries. A Quarries Advisory Committee is mandated under the act to regulate this industry. The Committee advises the Minister with responsibility for quarries (Minister of Mining and Energy) on the general policies that relates to quarries.

A license is required for establishing or operating a quarry under Section 5 of the Quarries Act. This requirement may be waived by the Minister if the mineral to be extracted is less than 100 cubic metres. The Application procedures are outlined in Section 8. WINDALCO has a licence to quarry at Shooters Hill (Appendix II).

4.3.5 *The Watershed Protection Act, 1963*

This Act governs the activities operating within the island's watersheds, as well as, protects these areas. The watersheds which are designated under this Act include the Gut – Alligator Hole watershed area, in which this project lies.

Determinations will be made to identify any potential impacts that this project may have on the various watershed areas and will propose mitigative actions where impacts are identified.

Large sections of Northern Manchester are considered a watershed. Much of the land contained in the quarry licence is under vegetative growth and will continue to be so until the existing quarry faces have been exhausted. WINDALCO has no intention to strip the entire area of vegetation at the onset of this proposed kiln construction.

4.3.6 *The Wildlife Protection Act, 1945*

This act involves the declaration of game sanctuaries and reserves, game wardens, control of fishing in rivers, protection of specified rare or endemic species. The Act also provides for the protection of animals and makes it an offence to harm or kill a species which is protected. It stipulates that, having in one's possession "whole or any part of a protected animal living or dead is illegal.

This Act has to be considered for the proposed project, ecological assessments will determine if rare or endangered species will be impacted. Six species of sea turtle, one land mammal,

one butterfly, three reptiles and several species of birds including rare and endangered species and game birds are protected under this Act.

No threatened or rare wildlife species were discovered during the ecological survey. As such, the proposed project is not expected to have any significant impact on wildlife reserves in the area.

4.3.7 *The Forestry Act, 1937*

This Act provides for the management and the declaration of Forest Reserves on Crown Lands and regulates activities in Forest Reserves. This Act will be reviewed to determine if the upgrade activities (particularly mining) will impact on Forest Reserves and to what extent.

The Shooters Hill Quarry is not found within any designated Forest Reserves and as such will not impact any forest reserves. Two endemic plant species were discovered; however, both can be found in other regions of Jamaica and are neither classified as rare or threatened nor regionally sensitive.

4.3.8 *Water Resources Act, 1995; Underground Water Control Act, 1959*

The Underground Water Control Act of 1959 is the legal instrument and is enforced by the Water Resources Authority (WRA). The Water Resources Act is expected to provide for the management, protection, controlled allocation and use of water resources of Jamaica. Thus the water quality control for both surface and ground water are regulated by this Act.

If the proposed facility intends to utilize any existing ground water, permission would be needed, in the form of an issued license for this activity. Under this Act exploratory activities such as the boring/drilling of wells for the purpose of searching for underground water without the written consent would be a violation.

In addition, any activity which negatively influences the quality of existing water, whether ground or surface, would be relevant to this Act.

The proposed project will not impact on groundwater reserves. Water is supplied from WINDALCO's production wells and is used in various areas of operation. At the Shooters Hill Quarry, water usage is mainly for the amenity block (toilets and showers), and for washing of limestone. The proposed facility will utilise less water than currently practiced. Additionally, wash water will be recycled into operations where it can be facilitated. Boreholes drilled to a depth of 50 m did not come into contact with groundwater. The WRA has indicated that groundwater depth is approximately 300 m in Content, a community south of the quarry and at a lower elevation.

4.3.9 *The Clean Air Act, 1964*

The Clean Air act speaks to entities such as the proposed lime kiln, which is an industrial facility. This facility has the potential to discharge to the atmosphere gases or particulate matter. This act makes reference to the use of inspectors to inspect any premises, carry out tests, and take samples of any substance that he/she considers necessary or proper for the performance of duties.

This project will be regulated by this Act in accordance with the NRCA (Air Quality) Regulations.

4.3.10 *The Town and Country Planning Act, 1987*

This Act governs the development and use of land. Under this law the Town Planning Department is the agency responsible for the review of any plans involving industrial development. The law allows for specific conditions to be stipulated and imposed on any approved plans. This planning decision is based upon several factors, these include;

- the location of the development
- the nature of the industrial process to be carried out
- the land use and zoning
- the effect of the proposal on amenities, traffic, etc.

This Act is applicable to the proposed kiln plant and quarry activities. The new kiln plant will necessitate increased quarrying. All conditions regarding the nature of the proposed industrial

activity will be adhered to under this law, all necessary permits and licences will be applied for.

4.3.11 *The Jamaica National Heritage Trust Act, 1985*

The Act is administered by the Jamaica National Heritage Trust, formerly the Jamaica National Trust. This Act provides for the protection of important areas, including the numerous monuments, forts, statues, buildings of historic and architectural importance in Jamaica.

During this project, an Archaeological and Heritage Retrieval Plan may be implemented to protect any historical or archaeologically significant item encountered. WINDALCO will utilise the services of the JNHT should any archaeological remains be found during the construction activities for the kiln and subsequent advances into the quarry as production increases.

4.3.12 *The Public Health Act, 1974*

This Act controls and monitors pollution from point sources. Any breaches of this Act would be sent through the Central Health Committee which takes action through the Ministry of Health, Environmental Control Division (E.C.D.). The ECD has no direct legislative jurisdiction, but works through the Public Heath Act to monitor and control pollution from point sources. Action against any breaches of this Act would be administered by the Central Health Committee. The functions of the department include:

- The monitoring of waste water quality, including regular water quality analysis, using water standards published by NEPA;
- Monitoring of occupational health as it relates to industrial hygiene of potentially hazardous working environments;
- Monitoring of air pollutants through its laboratory facilities.

In addition, there are various sections of this legislative instrument which governs and protects the health of the public. Relevant sections under the Public Health Act of 1985, are Sections 7.- (1) *A Local Board may from time to time, and shall if directed by the Minister to do so, make regulations relating to (o) nuisances* and 14.- (1) *The Minister may make*

regulations generally for carrying out the provisions and purposes of this Act, and in particular, subject to section 7, but without prejudice to the generality of the foregoing, may make regulations in relation to (d) air, soil and water pollution.

Aspects of the project related to odour have been considered since odour is a part of the Air Emissions regulations to be promulgated in 2004. WINDALCO will continue to monitor air emissions as currently practiced.

4.3.13 *Disaster Preparedness and Emergency Management Act, 1993*

The principal objective of the Act is to advance disaster preparedness and emergency management measures in Jamaica by facilitating and coordinating the development and implementation of integrated disaster management systems. WINDALCO has established procedures and guidance documents in place in terms of disaster preparedness and emergency management.

4.3.14 *The Factories Act, 1968*

The Factories Act regulates factories and makes conditions for their inspection. The major points under this act that may affect this project are:

- The safe means of approach or access to, and exit from, any factory, or machinery
- The fencing and covering of all dangerous places or machines;
- Life-saving and first aid appliances;
- Securing safety in connection with all operations carried on in a factory
- Securing safety in connection with the use of cranes, winches, pulley-blocks and of all engines, machinery, mechanical gear, and contrivances generally
- The periodic inspection, testing and classification, according to age, type or condition, of boilers
- The duties and responsibilities assignable to any person generally, and in particular to employers, owners, and managers in charge of factories, in connection with any one or more of such regulations;
- The proper ventilation of any factory, having regard to the nature of the process carried on therein;

- The sanitation, including the provision of lavatory accommodation (having regard to the number of workers employed) at any factory

4.3.15 *National Solid Waste Management Authority Act, 2001*

The National Solid Waste Management Authority (NSWMA) under this Act has the responsibility to manage and regulate the solid waste sector. It includes requirements for licences for operators and owners of solid waste disposal facilities (in addition to permit requirements of NEPA).

WINDALCO will utilise it existing industrial dump for all solid waste generated from this proposed project. WINDALCO will also practice recycling as much as possible of the materials used within its operation. For example, they intend to utilise quarry waste for rehabilitation of the quarry and to recycle scrap metal.

4.3.16 *Occupational Safety & Health Act, 2003 (Draft)*

This Act oversees the prevention of injury and illness resulting from conditions at the workplace, the protection of the safety and health of workers and the promotion of safe and healthy workplaces.

Sampling of sections from the Draft Act that are relevant to this project, include:

4. (1) This Act applies to all branches of economic activity and to all owners, employers and workers in all such branches.

5. (1) The owner of every industrial establishment or mine which carries on business on or after the appointed day shall, subject to subsection (8), apply to the Director in the prescribed form to be registered under this Act.

18. (1) Provides a description of the duties of employers, outlining the need for quality work areas and work environments, procedures and guidelines that will result in safe and healthy workplaces.

19. (1) discusses the duties of employers at construction sites in terms of employee safety and health during work activities.

25. (1) an employer shall make or cause to be made and shall maintain an inventory of all hazardous chemicals and hazardous physical agents that are present in the workplace.

26. (1) this section provides guidelines and procedures for employers to follow in terms of identification of hazardous chemicals. This includes labeling and identification protocols.

30. (1) Basically, this section of the Act requires an employer to provide training of its employees with a potential for exposure to hazardous chemicals or physical agents.

It is expected that this Draft Act will be Gazetted in the near future. WINDALCO has an understanding and appreciation for the contents of this policy. WINDALCO also has its own occupational, safety and health policies that it regulates and reports on, this policy will be extended to the proposed project.

4.3.17 *Manchester Parish Provisional Development Order, 1974*

This document provides the development plan for the Parish of Manchester. It clarifies the role and responsibility of the local planning authority and provides guidance on how development of the parish should proceed. All activities in this proposed lime kiln project for WINDALCO operations that requires local planning authority approval will be properly identified and the appropriate permits and licenses will be secured.

4.4 International Policy

4.4.1 *Agenda 21*

In June 1992, Jamaica participated in the United Nations Conference for Environment and Development (UNCED) in Rio de Janeiro, Brazil. One of the main outputs of the conference was a plan of global action, titled Agenda 21, which is a “comprehensive blueprint for the global actions to affect the transition to sustainable development” (Maurice Strong). Jamaica is a signatory to this Convention. Twenty seven (27) environmental principles were outlined

in the Agenda 21 document. Those most relevant to this project, which Jamaica is obligated to follow are outlined below:

Principle 1: Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

Principle 2: States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies.

Principle 4: In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.

Principle 8: To achieve sustainable development and a higher quality of life for all people, States should reduce and eliminate unsustainable patterns of production and consumption and promote appropriate demographic policies.

Principle 10: Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes.

Principle 15: In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Principle 16: National authorities should endeavour to promote the internationalisation of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.

Principle 17: Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.

WINDALCO, as part of an international organisation, is cognisant of and abides by international treaties and protocols. The principles of Agenda 21 that relate to this project will be applied throughout the project lifespan.

DESCRIPTION OF THE ENVIRONMENT

5 Description of the Environment

5.1 Introduction

The proposed lime kiln area is located in Shooters Hill in Northern Manchester. This section outlines the baseline meteorological data as it relates to the project location.

Major settlements in the sphere of influence of the proposed mining area include:

- Shooters Hill
- Comfort Hall

This area comprises communities of varying sizes and population. The sphere of influence of the proposed lime kiln activities is not anticipated to extend outside of the prescribed 8 km (5 mile) radius.

5.2 Physical Environment

5.2.1 *Meteorology*

5.2.1.1 Climate

Mean annual average rainfall is 2,032 mm (80 inches) per year. The historical pattern has light rains in May, a summer dry season marked by brief but torrential thunderstorms, a main rainy season from September to November and a marked dry season from November to April. However, both annual totals and daily rainfall patterns are highly variable. The stationary weather system over central Jamaica in June and July 2002 produced two-thirds of the parish's annual rainfall in 15 days.

Annual rainfall gradients decrease from north to south and west to east. The northern mountains have the highest volumes, often in the form of heavy fog. In the centre, Mandeville averages over 80 inches while amounts are lower in sheltered parts, such as Grove Place to the south.

5.2.1.2 Rainfall

Rainfall is the most variable of the climatic parameters exhibiting a bimodal nature. The thirty (30) year (1951-1980) average monthly rainfall values, highlight the typical rainfall pattern for the region (Figure 5-1). The driest period runs from December to March and is associated with cold fronts migrating from North America. There are two distinct wet seasons, May to June and September to November occurring as regularly yearly cycles.

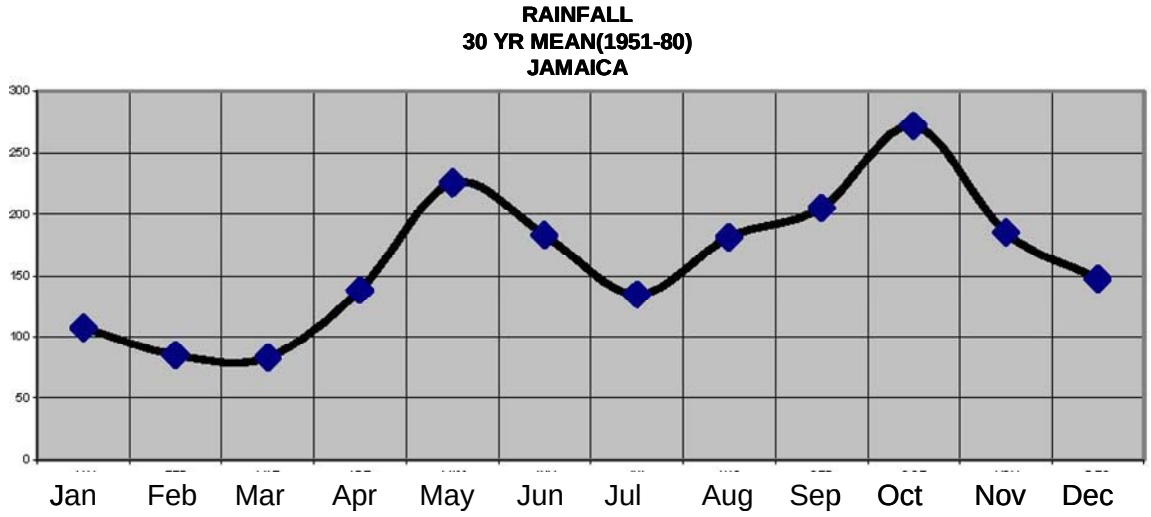


Figure 5-1: Jamaica 30 Year Rainfall Mean (1951-1980)

Of the weather parameters, rainfall is the most variable. Islandwide, during the period 1951 to 1980, annual rainfall ranged from a maximum of 2593 mm (102.09 in) in 1963 to a minimum of 1324 mm (52.13 in) in 1976, with an average of 1940 mm (76.38 in) annually. The hundred-year (1881-1990) mean annual rainfall is 1895 mm (74.61 in). Historically, the wettest year on record was 1933 with an annual rainfall of 2690 mm (116.54 in) whilst the driest year was 1920 with an annual rainfall of 1299 mm (51.14 in). Figure 5-2 shows the mean long-term mean rainfall for the parish of Manchester for 1951-1980.

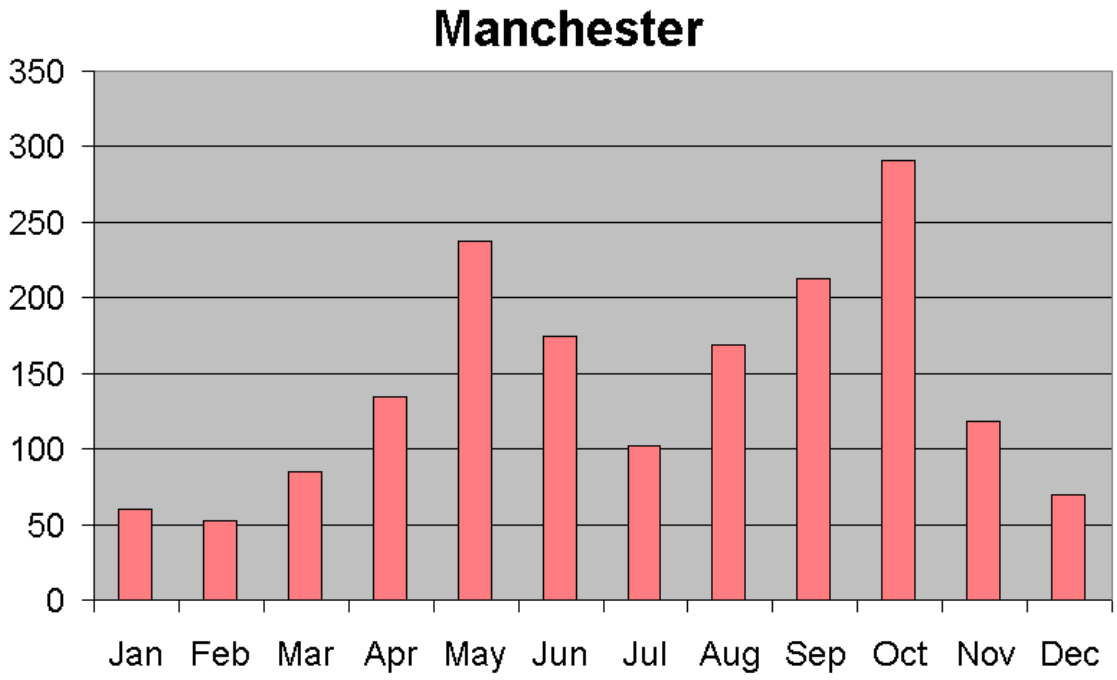


Figure 5-2: Manchester Long-Term Mean Rainfall (mm) 1951-1980[4]

Whether during the dry or rainy season, however, other rain-producing systems are influenced by the sea breeze and orographic effects which tend to produce short-duration showers, mainly during mid-afternoon.

The parish of Manchester receives an annual average of 1706 mm of rainfall per year mainly during the rainy period, between the months of May and November. The driest period occurs from January through March, with less than 56 mm per month. Figure 5-3 shows the average yearly rainfall for Grove Place, the closest available rainfall monitoring site.

[4] Jamaica Meteorological Service, Climatological Data

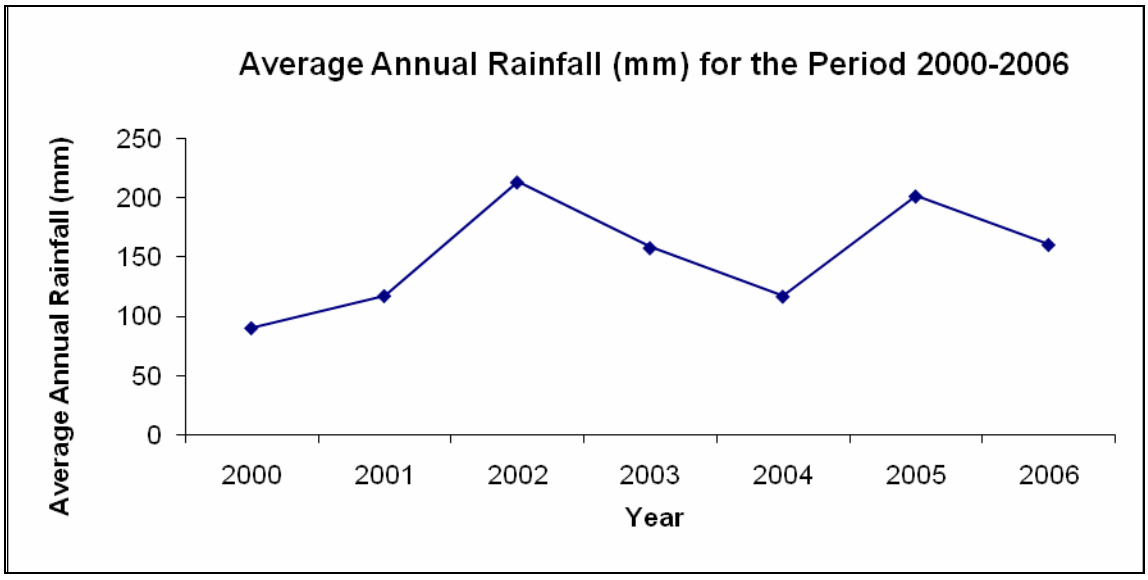


Figure 5-3: Average Annual Rainfall for the Period 2000-2006 for Grove Place, Manchester[5]

5.2.1.3 Wind Speed and Direction

The daily wind pattern is dominated by the Northeast Trades. During the day, the sea breeze combines with the Trades along the South Coast to give an east-southeasterly wind with an average speed of 18 knots (21 miles per hour). In the period December to March, however, the Trades are lowest and the local wind regime is a combination of trades, sea breeze, and a northerly or northwesterly component associated with cold fronts and high-pressure areas from the United States.

By night, the trades combine with land breezes which blow offshore down the slopes of the hills near the coasts. As a result, on the South Coast, night-time winds generally have a northerly component with a mean speed of 7 knots (8 miles per hour). By day, from June to July, mean onshore winds often reach a maximum of up to 26 knots (30 miles per hour) along the South Coast during mid-afternoon.

The closest available data that could be considered reliable was from the WINDALCO Met Station in Kirkvine which is just south of the project area.

[5] Jamaica Meteorological Service, Climatological Data

The predominant wind blows from the south and/or south-east with wind speeds ranging between 3.6 m/s (7 knots) and 8.7 m/s (17 knots) most of the time. Only 2003 and 2004 showed any difference with wind equally blowing out of the north and southeast, particularly in 2004. The kiln design will not be affected by the predominant wind gust in this area. The kiln is designed for wind speeds up to 60 m/s.

5.2.1.4 Noise

Noise levels were recorded in the following communities:

- Chantilly
- Content
- Shooters Hill (at the Farm)

The audiometric survey was conducted using calibrated hand-held digital audiometers (Norsonic 118). Noise levels were measured at various locations selected because of their proximity to planned activities and residential areas within the communities closest to the proposed project.

Of the three areas sampled, the ambient background noise was highest in the community of Chantilly (19.48 dBA) and lowest below the quarry at the Dairy Farm (4.37 dBA). These values were well below the noise standard of 70 dB. Figure 5-4 - Figure 5-6 below shows the ambient noise level for three communities within the regional sphere of the quarry outside blasting events.

The kiln will be designed to meet current international standards for the following maximum noise levels at the nearest noise sensitive property; 55 db from 6 a.m. to 7 p.m. and 42 db from 7 p.m. to 6 a.m.

Over the period 2000 – 2006, the quarry had only six (6) recorded incidences when the recommended noise standard (129 dBA) was exceeded during blasting episodes, the last being June 10, 2004 (132.4 dBA). Noise recorded during the period ranged from 88.8 dB to a high of 141 dB (Figure 5-7).

All plant and equipment specified for the new kiln operation will be expected to meet this requirement. The primary source of noise nuisance from the kiln operation will result from the transfer of limestone, particularly at the top of the kiln. These areas will be enclosed in structures fitted with sound deadening cladding to attenuate noise. Air blowers used for kiln operation will be enclosed within a soundproof and dustproof building requiring hearing protection for personnel entry. The intakes for the blowers will also be fitted with silencers.

The kiln is being designed to meet the European Union best technology guidelines as it relates to the Lime and Cement Industries.

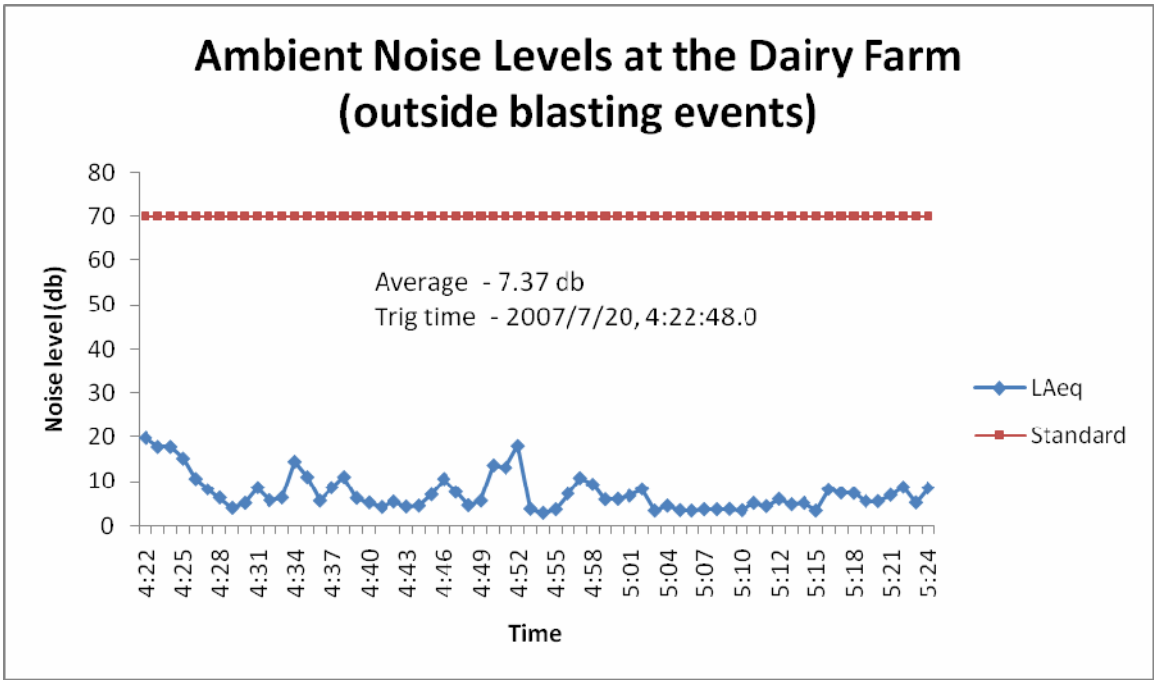


Figure 5-4: Ambient Noise for Dairy Farm, Shooters Hill

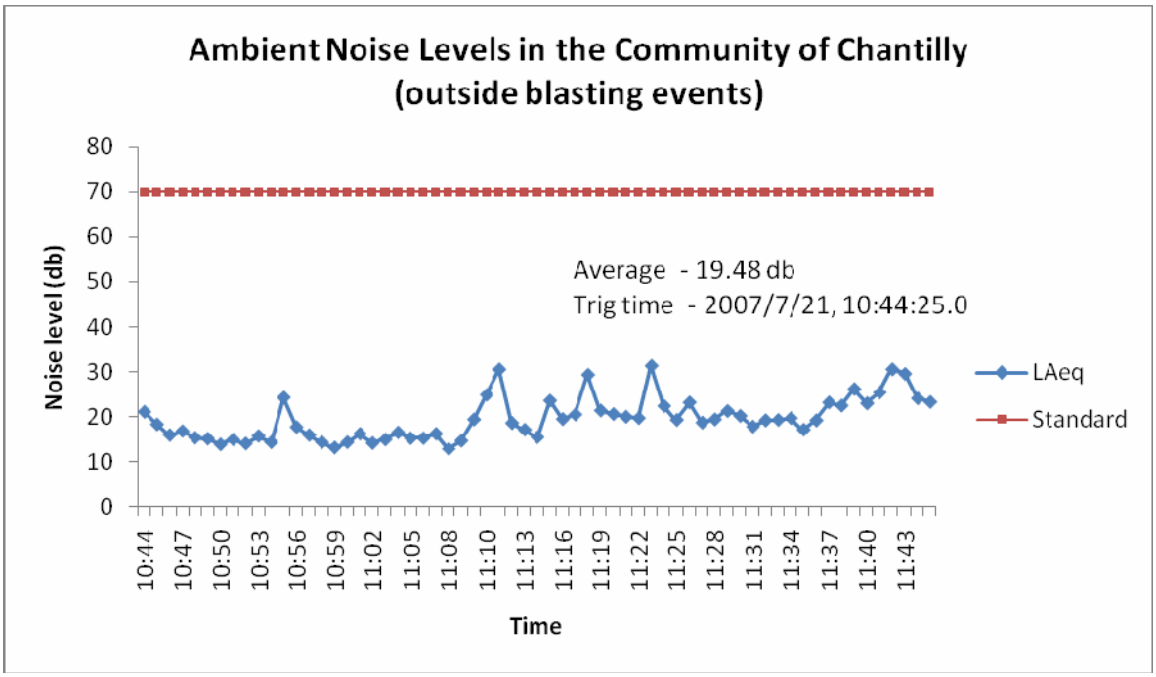


Figure 5-5: Ambient Noise for Chantilly

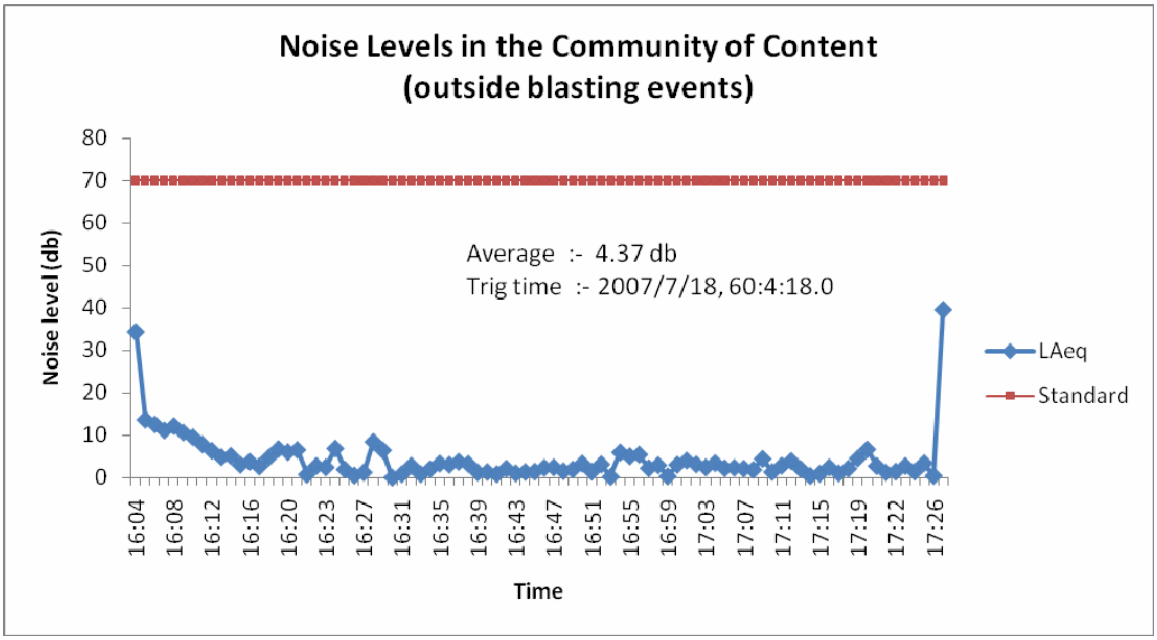


Figure 5-6: Ambient Noise for Content

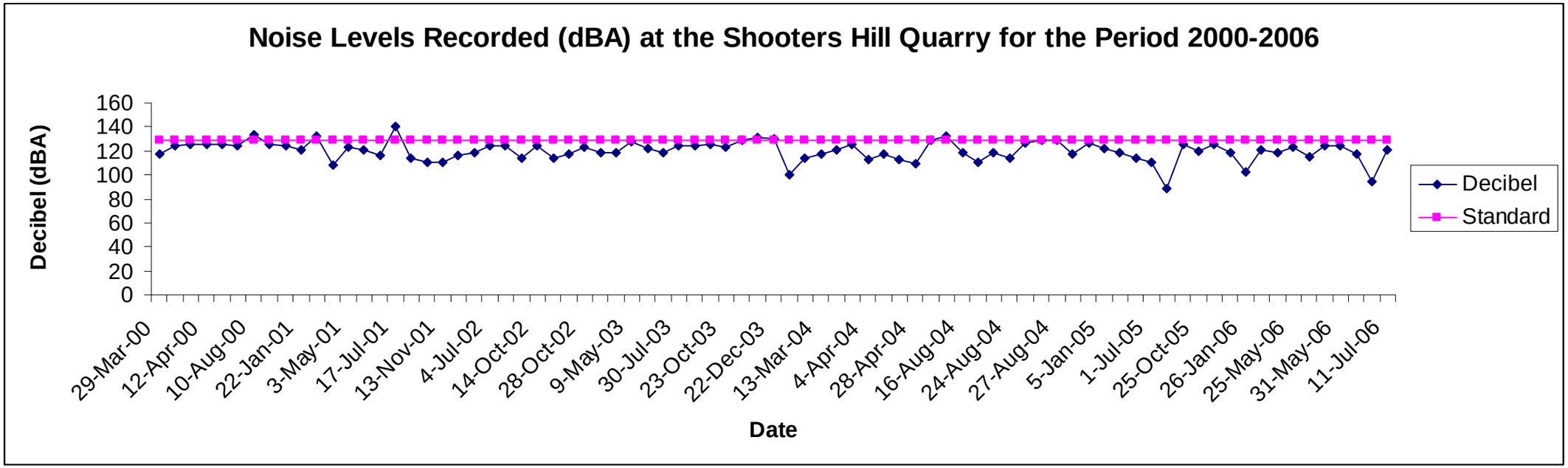


Figure 5-7: Noise Levels Recorded during Blasting at the Shooters Hill Quarry (2000-2006)

5.2.1.4.1 Blasting & Vibration

Over the period 2000-2007, there were no incidences of the peak particle velocity exceeding the stipulated 25.4 mm/sec (1 in/sec)[6] for ground vibration. Figure 5-8 below shows the peak particle velocity during blasting events.

Blasting within the quarry to mine limestone will result in particulate matter emissions and ground induced vibrations. Particulate emissions will primarily be in the form of dust, TSP and PM10. This release is transient and disperses rapidly. Blasting activities can potentially generate cracks in structures.

Modern blast techniques will be used by WINDALCO or their contractors. Blasting and drilling within the quarry will be dictated by the guidelines put forward by the Ministry of Mining and Energy through the Mines and Geology Division (Appendix VII), and WINDALCO's Standard Practice Instructions. Pre- and post-blast surveys will be carried out as currently practiced. Training of workers in site specific activities, as practiced by WINDALCO, will also mitigate against bad practices. Mitigation measures are covered under WINDALCO's existing ISO 14001 EMS.

Currently restrictions are placed on the quarry plant operations, effectively confining quarrying activities to daylight hours only. The new quarrying regime has been designed to operate within these hours. The frequency of blasting at the quarry will increase over time for the existing operation. Blasting techniques to be employed at the site will be reviewed and updated periodically to ensure it meets international practice.

Modern blasting techniques to be incorporated at the site include:

- Laser profiling and computerised modelling
- Down the hole initiation systems
- The use of decking and delays to assist in reducing noise and vibration generation

[6] Ministry of Mining and Energy, Mines and Geology Division

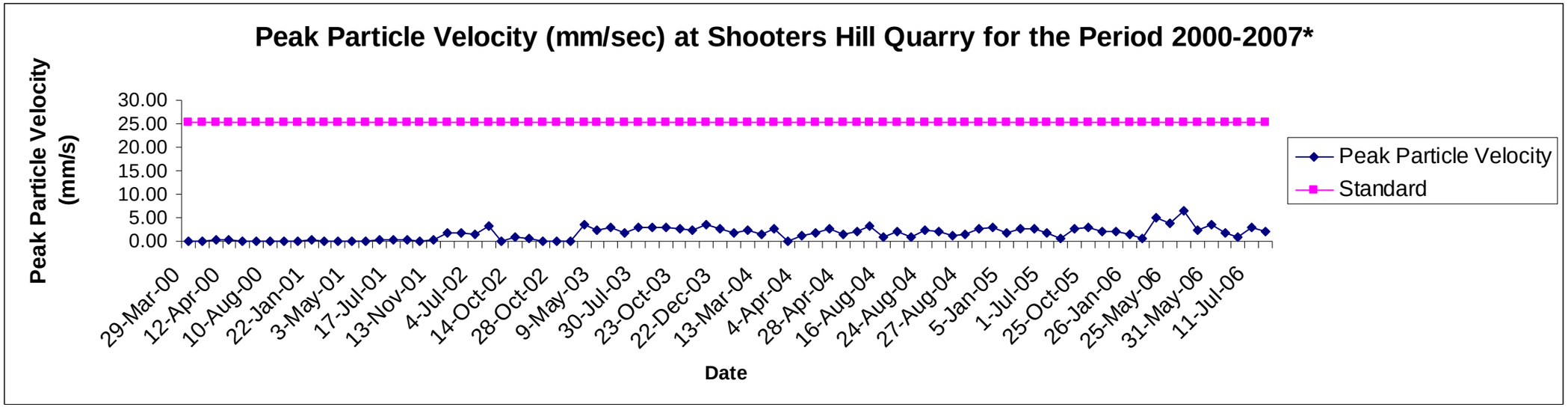


Figure 5-8: Peak Particle Velocity Experienced during Blasting at the Shooters Hill Quarry (2000-2007)

5.2.1.5 Temperature and Relative Humidity

Apart from rapid fluctuations associated with afternoon showers and/or the passage of frontal systems, the island's temperatures remain fairly constant throughout the year under the moderating influence of the warm waters of the Caribbean Sea.

The warmest months are June to August and the coolest December to February. Night-time values range from 18.9 ºC to 25.6 ºC (66 to 78.1 ºF) in coastal areas with inland temperatures cooler. The diurnal range of temperature is much greater than the annual range and exceeds 11.0 ºC or 20 ºF in mountainous areas of the interior.

At elevations above 610 metres (2000 feet), minimum temperature of the order of 10 ºC (50 ºF) have been reported occasionally when active cold fronts reach the island. The project location is at an approximate elevation of 430 m.

Variations of sunshine from month to month in any area are usually small, approximately one hour. Differences, however, are much greater between coastal and inland stations. Maximum day-length occurs in June when 13.2 hours of sunshine are possible and the minimum day-length occurs in December when 11.0 hours of sunshine are possible. However, the mean sunshine in mountainous areas is less than 6 hours per day, while in coastal areas it is near 8 hours per day. The shorter duration in the hilly areas is caused mainly by the persistence of clouds.

Relative humidity is a term used to describe the amount of water vapor that exists in a gaseous mixture of air and water, expressed as a percentage of the maximum amount of water vapor that could be present if the vapor were at its saturation conditions. Afternoon showers are the major cause of most daily variations in relative humidity. Highest values recorded during the cooler morning hours near dawn, followed by a decrease until the early afternoon when temperatures are highest.

The average annual % relative humidity per month ranged from 89 to 93 (Figure 5-9). This value is however, tempered by the usual afternoon showers experienced in the hilly interiors. The average annual temperature for the same period was 24 ºC.

Temperature and relative humidity are not expected to have any meaningful impact on the storage of fuel or lime and/or kiln operation. The lime produced will be stored in enclosed steel silos. The solid fuel will be stored and periodically wetted to reduce the risk of spontaneous combustion.

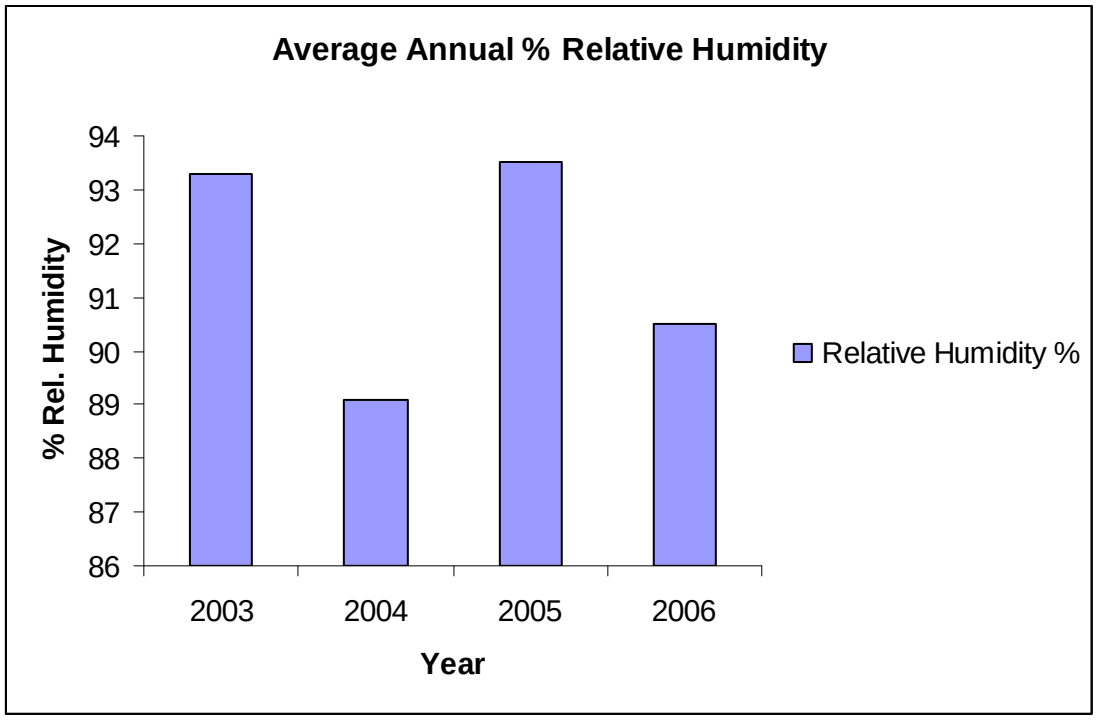


Figure 5-9: Average Annual % Relative Humidity for the Period 2003-2006

5.2.1.6 Ambient Air Quality

The primary emissions anticipated from the quarrying and lime kiln operations will come from equipment and machinery operating and blasting within the quarry. While not being deemed insignificant, it is not anticipated that any of these operations will generate significant amounts of air emissions that should be cause for alarm or concern to the citizens of the area. Air emission monitoring will be conducted at the project site by WINDALCO.

Emissions for nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) are monitored in the Kendal area of Manchester, one of the closest monitoring sites (Figure 5-10 and Figure 5-11) below. Both parameters were significantly below the 24 hour and annual targets.

The proposed lime kiln is very efficient, it will result in lower PM_{10}, TSP, SO_x, NO_x, CO and CO_2 emissions per tonne of lime produced when compared with the existing kilns at Kirkvine Works and ALPART. It will be fitted with pulse jet bags filter unit to reduce dust emissions. The filters operate between 70 °C and 140 °C, and are fitted with high performance bags treated to release dust. The exhaust stacks will be fitted with electrodynamic particulate sensors to monitor actual dust emissions providing a continuous readout displayed on the plant control system. This system is capable of providing an early warning of bag failure.

All conveyor transfers and hoppers will be fitted with covers, dampers, housings and stone boxes.

Within the quarry; all haul roads and other dusty areas will be periodically wetted to reduce dust formation as currently practiced.

Dust generated from the loading and transportation of lime will be reduced through the use of telescopic loading chutes fitted with a dust extraction mechanism. Additionally, trucks will be enclosed or covered with tarpaulin.

Additional dust monitoring stations will be sited north and/or north-east of the quarry in communities most likely to be affected. This will cover areas not currently covered by existing dust monitoring stations

Table 5-1 and Table 5-2 below outline the assumptions and calculations as they relate to the proposed kilns.

Table 5-1: Lime Kiln Assumptions

Assumptions:		
Fuel (poor quality hypothetical petcoke)		
Higher Heating Value	30	MJ/kg
Lower Heating Value (LHV)	27	MJ/kg
Sulphur	6	%w/w
Kiln (per kiln)		
Output of lime	400	t/d
Fuel Consumption (LHV)	3730	kJ/kg CaO
or	890	kcal/kg CaO
Max. Waste Gas Flow	68000	m3/hr
at Temperature of	140	Deg C
Equivalent to	45000	Nm3/hr
Sulphur retention in lime min.	85	%
Sulphur retention in lime max.	90	%
Sulphur	32	Mwt
Sulphur Dioxide	64	Mwt
PFR Kiln Emissions Data [EU data on lime and cement industry]		
PFR kiln emissions NOx	>400	ppm
PFR kiln emissions NOx less than	1.4	kg/t CaO
PFR kiln emissions SO_2	>300	ppm
PFR kiln emissions SO_2 less than	1	kg/t CaO

Table 5-2: Lime Kiln Calculations

Calculations		
Fuel consumption	138.15	kg/t CaO
Sulphur into kiln	8.29	kg/t CaO
Sulphur in lime min.	7.05	kg/t CaO
Sulphur in lime max.	7.46	kg/t CaO
Sulphur in waste gas min.	0.83	kg/t CaO
Sulphur in waste gas max.	1.24	kg/t CaO

Calculations		
Waste gas Flow	2700.00	Nm3/t CaO
Max Volume SO_2	0.87	Nm3/t CaO
Max Volume SO_2	322.35	ppm
Pet-coke consumption	110.52	t/d
	773.63	t/week
Grinding rate (40hr week)	19.34	t/hr
Annual Figures for 2 kilns		
Lime Production	264000	t/a
NOx emissions less than	369.60	t/a
SOx emissions less than	264.00	t/a

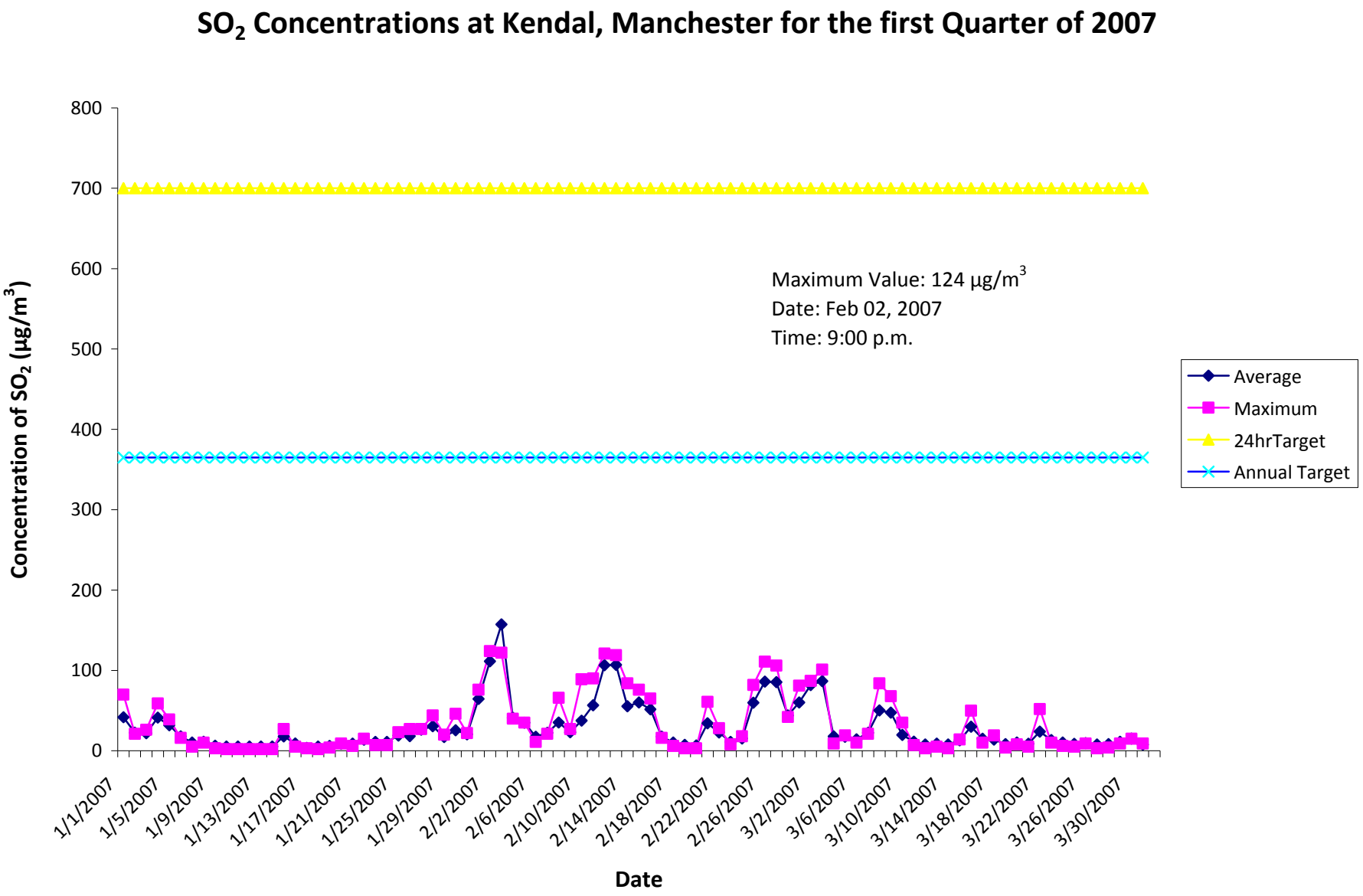


Figure 5-10: SO_2 Concentrations at Kendal, Manchester for the First Quarter of 2007

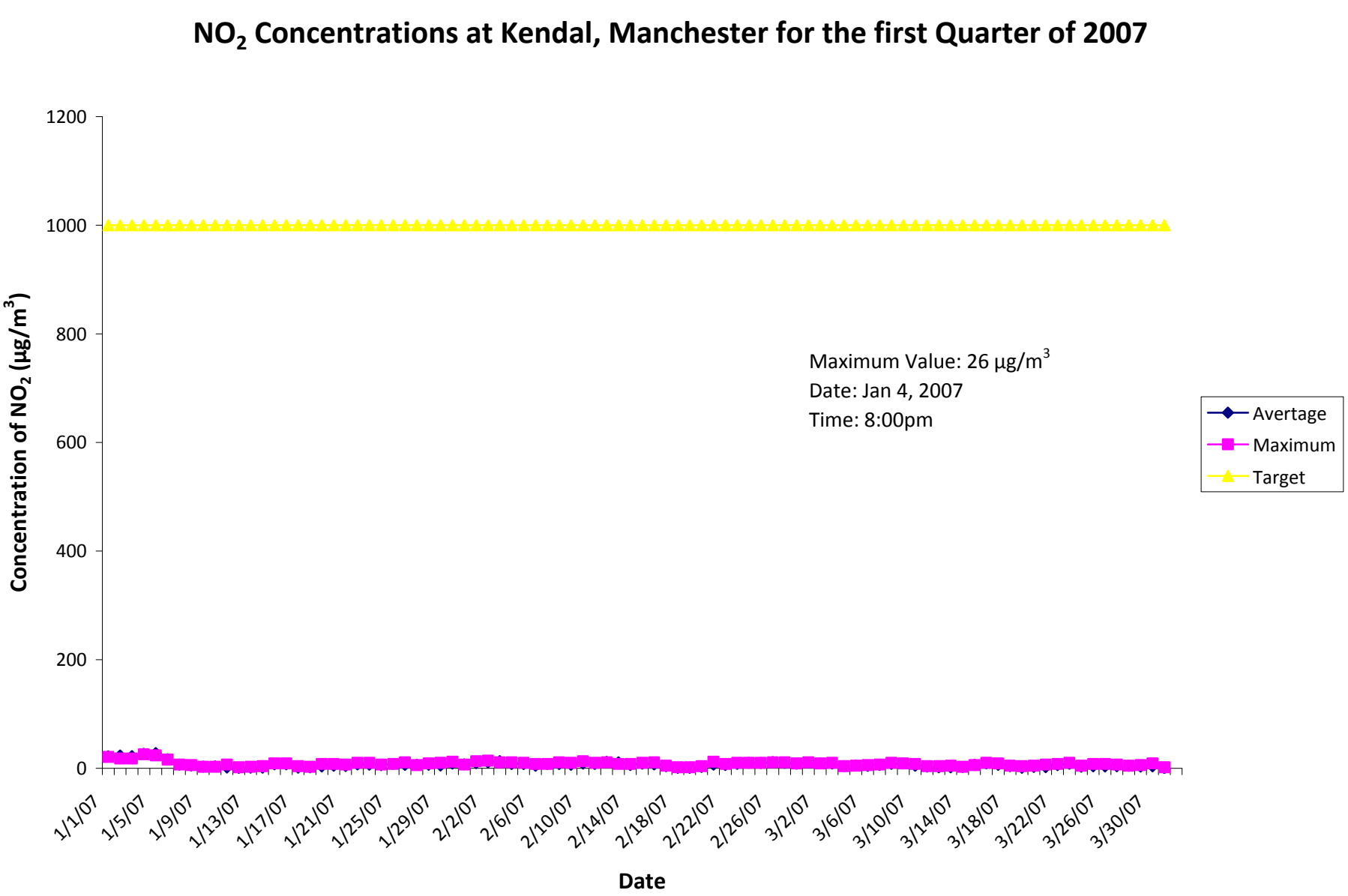


Figure 5-11: NO_2 Concentrations at Kendal, Manchester for the First Quarter of 2007

5.2.1.6.1 Particulate Matter

Emissions of particulates are intermittently released as a result of quarrying activities, windblown dust associated with bulk material handling, transportation and stockpiling of material.

Proven particulate control and dust suppression strategies have been employed at WINDALCO facilities, which have significantly minimized particulate and fugitive dust emissions. These include but are not limited to the use of hooded conveyors, sprinkler systems, cyclones, and ESPs.

The major source of fugitive dust at this operation will be from open areas and stacks (quarry, access roads, and bare areas).

The implementation of dust minimising protocols and procedures will allow WINDALCO to effectively measure and report the impacts that the operations will have in terms of particulate air quality. WINDALCO currently has a Community Complaints Register which is used to track complaints from communities to specific problems, this program will be continued.

WINDALCO will implement a number of fugitive emission control measures (all proven methods adopted at their operating facilities) inclusive of the following:

- Controlling fugitive particulate emissions from storage piles through enclosures, covers or stabilization, minimizing the slope of the upwind face of piles where practicable. Confining as much stockpile activity as possible to the lee side of the operations.
- Limiting the size of quarried loads to minimize loss of material to wind and spillage.
- Planting special wind breaks at critical points.
- Scraping and compaction of unpaved roads to stabilize the road surface as often as necessary to minimize re-entrainment of fugitive particulate matter from the road surface.
- Vegetating bare areas with grass or other applicable plant material.

- Watering of unpaved roads and other unpaved open spaces as often as necessary to minimize re-entrainment of fugitive particulate matter from these surfaces.
- Maintaining good housekeeping practices to minimize the accumulation of materials, which could become fugitive.
- The exhaust stacks will be fitted with electrodynamic particulate sensors to monitor actual dust emissions providing a continuous readout displayed on the plant control system. This system is capable of providing an early warning of bag failure.
- All conveyor transfers and hoppers will be fitted with covers, dampers, housings and stone boxes.
- Storage of lime produced in enclosed steel silos
- Dust generated from the loading and transportation of lime will be reduced through the use of telescopic loading chutes fitted with a dust extraction mechanism. Additionally, trucks will be enclosed or covered with tarpaulin.

Additional dust monitoring stations will be sited north and north-east of the quarry in communities most likely to be affected Figure 5-12 outlines the project location in respect of dust monitoring sites. The closest dust monitor location is Kendal Ambient Station at ~1.25 km and East Content at ~1.75 km.

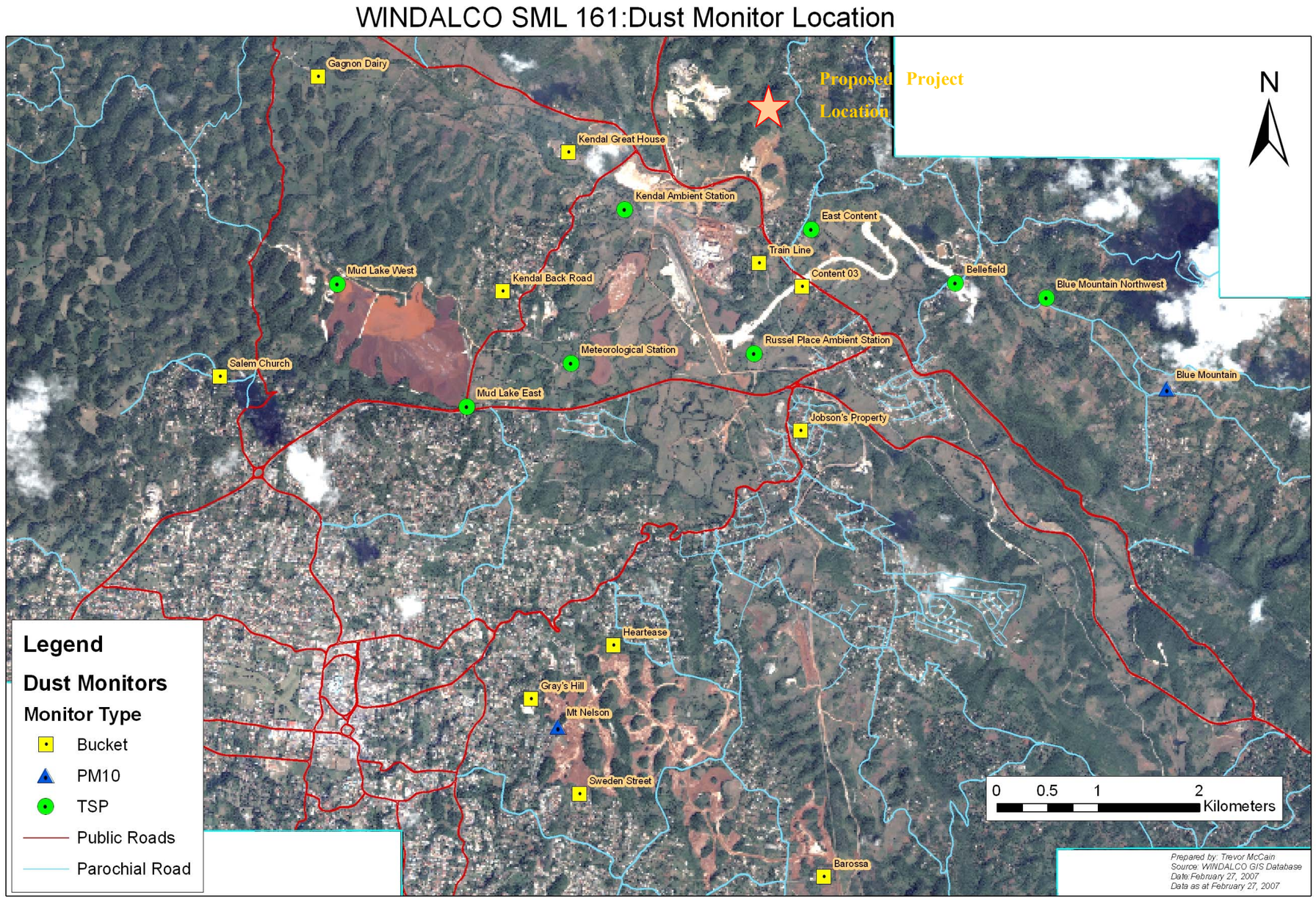


Figure 5-12: WINDALCO Dust Monitoring Locations

5.2.2 *Geology*

The entire area consists of limestone belonging to the White Limestone Group of Tertiary age (40 million to 5 million years old; Geological Sheet 12) with pockets of bauxite overlying the limestone. In the Shooters Hill region it is convenient to separate the limestones of the White Limestone Group into two of the traditional units, the Walderston and Newport members (Figure 5-13; see Zans et al. 1963), Mitchell in recent studies has combined these into a single Moneague Formation (Mitchell, 2004). However, the members as recognised on Geological Sheet 12 appear to characterise regions with somewhat different geomorphological features. The units are described in turn.

Superficial Deposits (bauxite)	Post-Lower Miocene
Newport Limestone	Lower Miocene
Walderston Limestone	Oligocene
Older Limestones	Eocene

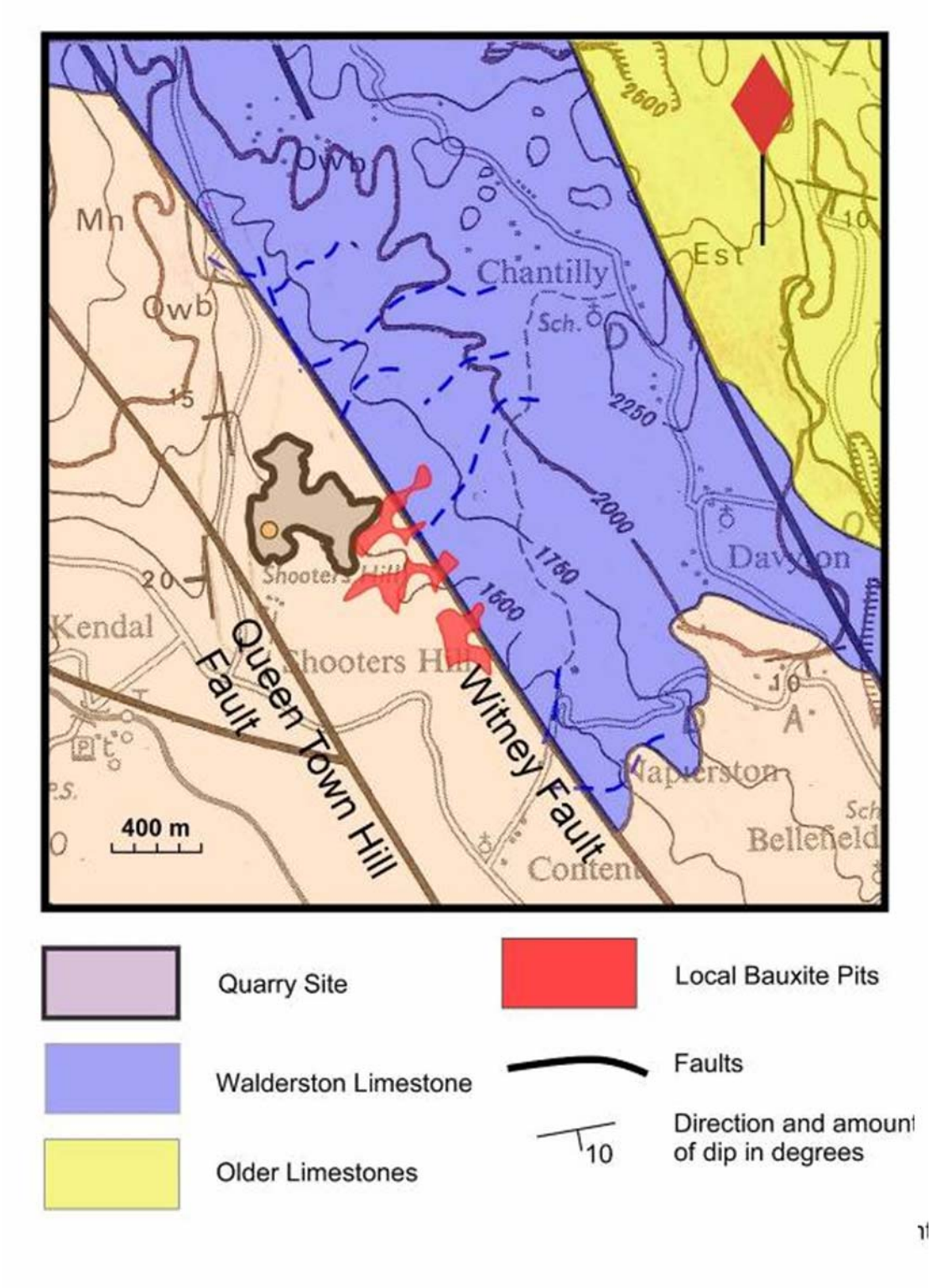


Figure 5-13: Geological Map of the Region (Modified from Geological Sheet 12)

5.2.2.1 The Older Limestones

The older limestones are not further considered here. They include the Somerset and Troy Formations of Mitchell (2004) and others, Middle to Upper Eocene.

5.2.2.2 Walderston 'member'

The Walderston member consists of hard, thickly bedded miliolid grainstones and packstones, and frequently includes "rubbly" layers (Robinson & Mitchell, 1999). The type section for the Walderston limestone extends for 1.5 km north of the community of Walderston, which is 4-5 km north of the quarry site. The member is well exposed along the road to Chantilly (Plate 5-1). A section through the Moneague Formation (equivalent to the Newport limestone as used in this report) was measured by Mitchell (2004) at Williamsfield. The future expansion of WINDALCO's quarry may include extension into the Walderston limestone. On the basis of the fossil evidence and a few Strontium isotope measurements, the Walderston limestones are of Oligocene age (~30 million years).

Plate 5-1: Walderston Limestone (exposed on road to Chantilly, north of quarry site, note – rubbly nature)

5.2.2.3 Newport 'member'

The Newport limestone is fine-grained, white to pink in colour, locally with beds of nodular aspect and with patchy dolomitisation. It is well-exposed along the southern part of the main road from Shooters Hill to Christiana. The existing mined area of the quarry lies entirely within the Newport limestone as mapped (Geological Sheet 12) (Plate 5-2). Mitchell (2004) quoting Hose and Versey (1957) gives a thickness of some 400 m for the Moneague Formation (which includes the Newport of this report). However a thickness of 1,400 m of Newport, overlying 340 m of Walderston limestone was recorded from the Santa Cruz well, suggesting a dramatic increase in thickness southwards (discussion in Robinson, 1990, p. 16). The Newport limestone is Early Miocene age in the Mandeville area but probably includes younger strata towards the south coast of the island.

Plate 5-2: Newport limestone exposed on the road to Christiana. Photo shows massive bedding overlain by a brecciated layer.

5.2.2.4 Superficial deposits (bauxite)

Three mined-out bauxite pits are located immediately east of the presently worked quarry. Quarry expansion will extend into these areas at a future date.

5.2.2.5 Structure

The White Limestone rocks are inclined gently southwards. The main structural feature is the fault that extends across the map (Figure 5-13) the Witney Fault (WRA 2005). It separates the Walderston limestone from the Newport limestone (Figure 5-13). The fault also separates the area into two morphologically distinct physiographic units. It is one of two major faults (the other being the Queen Town Hill Fault) that control the direction of flow of groundwater.

5.2.3 *Geomorphology and Hydrology*

5.2.3.1 Topography

The topography of the area is that of karst limestone, with no surface drainage. The prominent feature of Mile Gully Mountain lies to the west of the valley in which the kiln is to be built. Its shape and the direction of its long axis is controlled by a system of northwest trending faults which extend across the site. To the east the karst topography rises again to form the highlands around Davyton and Chantilly. The Witney Fault which traverses the quarry site also separates the topography into two contrasting areas. To the west the rocks of the Newport limestone form a mountain (Mile Gully Mountain) with few obvious gully courses, probably due to the extensive fault controls. To the east the slopes descending from Chantilly contain several gullies that drain to the line of the Witney Fault and appear to be truncated at the fault (Figure 5-14, see also Figure 5-13).

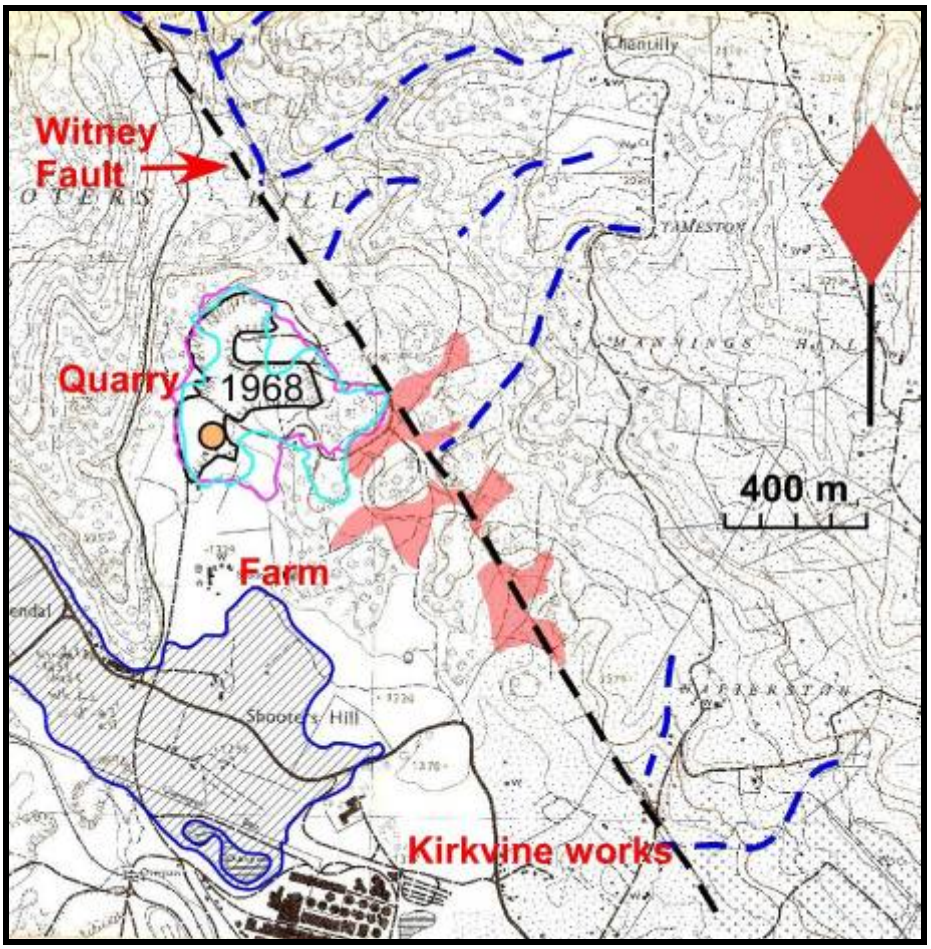


Figure 5-14 Location of Shooters Hill quarry and proposed lime kiln. Gullies blue dashes; bauxite pits, pale red; region of internal drainage diagonal ornament. Quarry outlines are for 1968 (black), 1980 (pink), 2006 (pale blue); kiln site orange circle. Base map is from 1:12,500 topographic sheet 65A, with old line of main road.

5.2.3.2 Drainage

The low-lying area south of the quarry and farm is an area of internal drainage as indicated by the closed contours on the topographic maps. It encloses the Shooters Hill Sports Club and extends to immediately north of the Kirkvine works. Thus the initial impression is one of the local drainage (blue dashed lines on Figure 5-14) converging on the central region of internal drainage. However, although the dry gullies on the eastern side of the Witney fault do trend in that direction, they appear to be truncated against the Witney Fault. No records of flow in the gullies exist, although, being gullies, they must have been carved over time by rare, extreme rainfall events. Perhaps permeability in the Witney Fault plane allows runoff

from normal high rainfall to infiltrate along the fault, and be diverted along the fault plane to the southeast, past Williamsfield towards Porus and the well-field there.

In the quarry itself there are two areas that might be termed waste ponds, the first being the washed clay dump pond (Plate 5-3). The second pond is used to collect the water from the crushing plant (Plate 5-4).

Plate 5-3: Pond with Waste Fines from the Crushing Plant

Plate 5-4: Pond with Wastewater from the crusher (wastewater re-circulated)

5.2.3.3 Groundwater

Regional groundwater flow is to the southeast, parallel to the Whitney Fault and the main trend of the Williamsfield Trough (Figure 5-15; WRA, 2005; the Williamsfield-Porus Trough of WRA, 2002). WRA 2002 and 2005 indicate the nature of the geometry of the water table in the Kendal-Porus Trough. There is no surface flow in the Kendal and Shooters Hill area, except briefly in times of intense rainfall. The WRA (2007) has indicated that the depth to groundwater is approximately 300 m. This was measured in the community of Content close to the entrance of Kirkvine Works.

The footprints of the kiln will not exceed 50 m. The kiln site is also at a higher elevation than the location in which the WRA conducted their investigation.

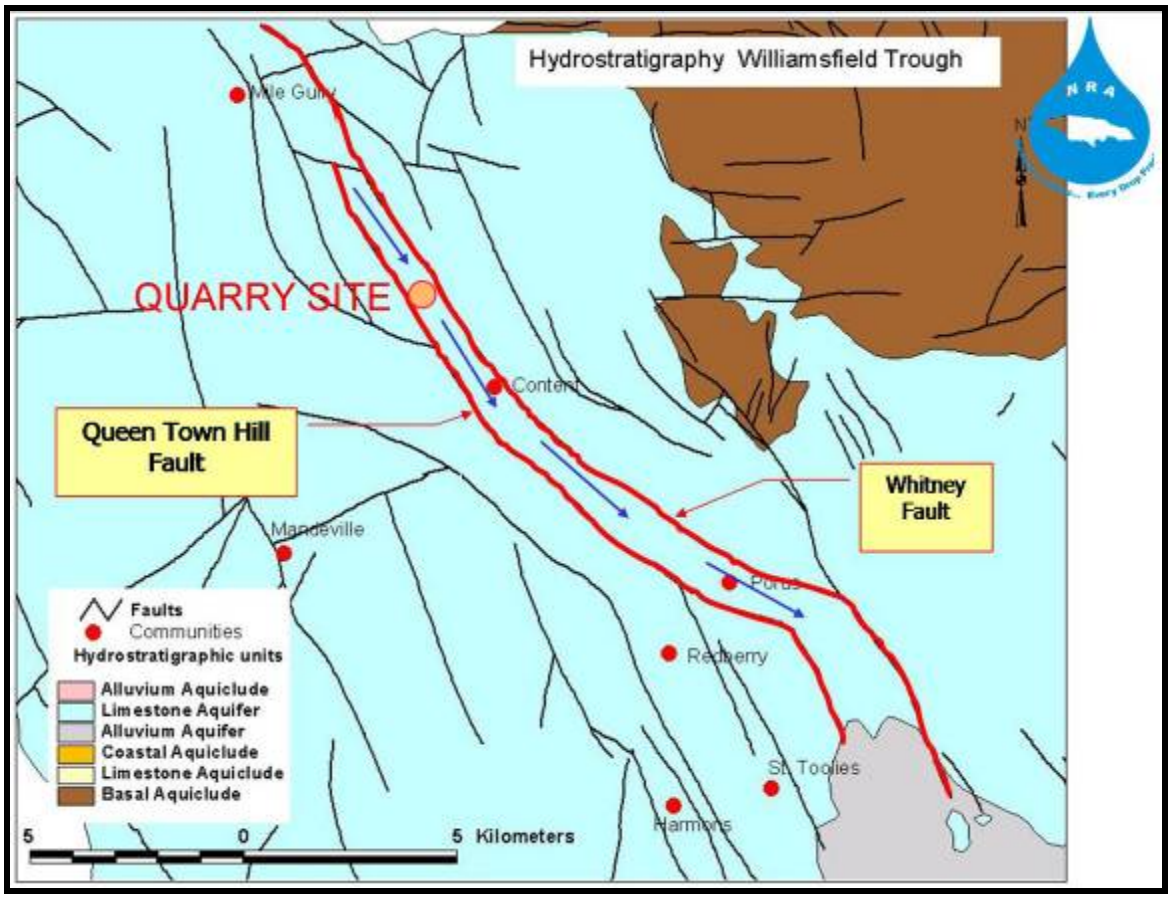


Figure 5-15 Location of quarry site in relation to the structure and groundwater flow directions (WRA 2005; quarry location added)

5.2.3.3.1 Springs

No springs occur in the immediate area.

5.2.4 *Land-Use*

The primary focus of this EIA report centres on the establishment of the new lime kiln facility and related aspects such as quarrying in the Shooters Hill area of North Manchester, and transportation of lime to WINDALCO Kirkvine Works, Ewarton Works, and ALPART. In this section historical data is utilised and the resulting information ground-truthed based on expert knowledge of the area.

These establishments are recognised as requiring access to and the use of significant amounts of space. No residential, commercial, farming or other land-use areas will be affected in the region of the quarry site. The quarry lands are owned by WINDALCO. No acquisition of property is required for this project. The existing quarry faces are expected to serve the purposes of the operation for at least another 10 years before expansion into new areas of the quarry lands.

5.2.4.1 Historical

Manchester was demarcated in 1814 from a sub-division of Clarendon and St. Elizabeth hence its location between both parishes. Its name is derived from the then Governor of Jamaica, the Duke of Manchester.

Mandeville, its main town and now a regional centre since 1970, was selected in 1816 as the "parish capital" deriving its name from the eldest son of the then Governor.

The pattern of urban settlement is scattered in small communities and isolated dwellings except for the urban centres such as Williamsfield, the closest recognised urban centre to the quarry site.

5.2.4.2 Topography

The topography of Manchester is undulating with escarpments and highlands of which the most prominent are the Carpenters Mountains, Mile Gully Mountains, May Day and Don Figuerero Mountains.

5.2.4.3 Area and Land Cover

The parish of Manchester occupies an area of 791.6 km^2, while the proposed lime kiln location and associated quarry area occupies an area of 90 ha (0.9 km^2).

Manchester accommodates a scattering of villages and other urban settlements. Mixed cultivation is confined to the northern regions. Bauxite deposits have impacted on the levels of mixed cultivation. Large areas in the valleys are now used as pasture lands, some areas are in woodland and ruinate providing poor grazing for small herds of cattle and goats. This can be seen around the quarry area with some small farming, leased from WINDALCO, mainly to the north and a dairy farm to the south. Residential communities are located mainly to the east and north, such as the communities of Content and Chantilly.

Citrus is cultivated in some areas as are mixed crops such as corn, coffee, Irish potatoes, and pimento. Upland areas are cultivated in ackee, breadfruit, mango, cocoa, etc. The Northern area comprises forests and forest reserves, within conservation areas. However, the extent of the quarry lands does not fall within any forest reserve or other conservation areas.

5.2.4.4 Land Capability

Agricultural land capability in Manchester varies between classes I, II, III and V. The Shooters Hill area falls within Class II (Plate 5-5 below) of the agricultural land capability for Jamaica and is suitable for crops with moderate limitations such as limited permeability. The quarry area has been a quarry area for about 50 years and the license is held by WINDALCO.

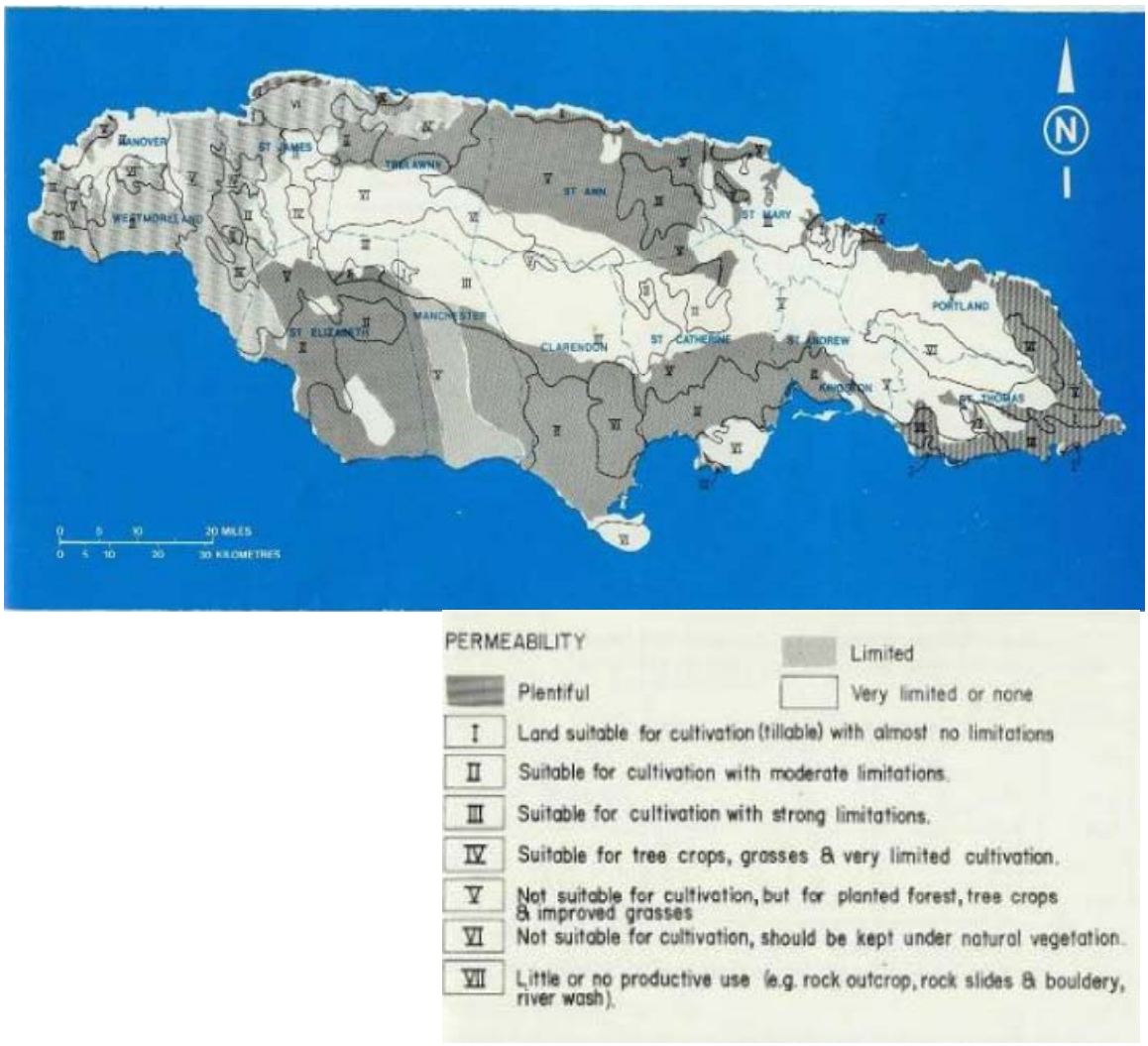


Plate 5-5: Agricultural Land Capability for Jamaica

5.2.4.5 Development Strategy

The long term land management and development strategy is to allow for available resources to be used in a manner that ensures maximum economic benefits without contravening the general principles of conservation. In this regard there are definitions of growth centres for urbanization and conservation. Land uses within the Shooters Hill area include agriculture, national parks, watershed areas, bauxite deposits (Plate 5-6).

Plate 5-6: Jamaica Development Strategy

Physical, social and economic growth and development over the last 30 years have been influenced by the bauxite/alumina industry, through Alcoa, ALPART, and other foreign interests largely enhanced by Alcan of Canada (now WINDALCO). Mandeville, the parish capital, has become a strong financial and commercial location and also an important administrative centre which continues to experience growth.

There are scatterings of linear and star shaped villages along roadways and road intersections in the vicinity of the proposed site location, the largest of which is Williamsfield. These growth points have continued to sprawl, leap frog and become conurbations.

5.2.4.6 Industrial

Light industrial land use is confined to the hierarchy of rural/urban settlements and linear occupancy along district, sub-arterial and arterial roads. Heavy and special industrial plants include the bauxite processing plant at Kirkvine (WINDALCO).

Transportation and access routes, e.g. all classes of roads and railway lines link all urban centres and also penetrate agricultural areas, national parks and conservation areas (Plate 5-7).

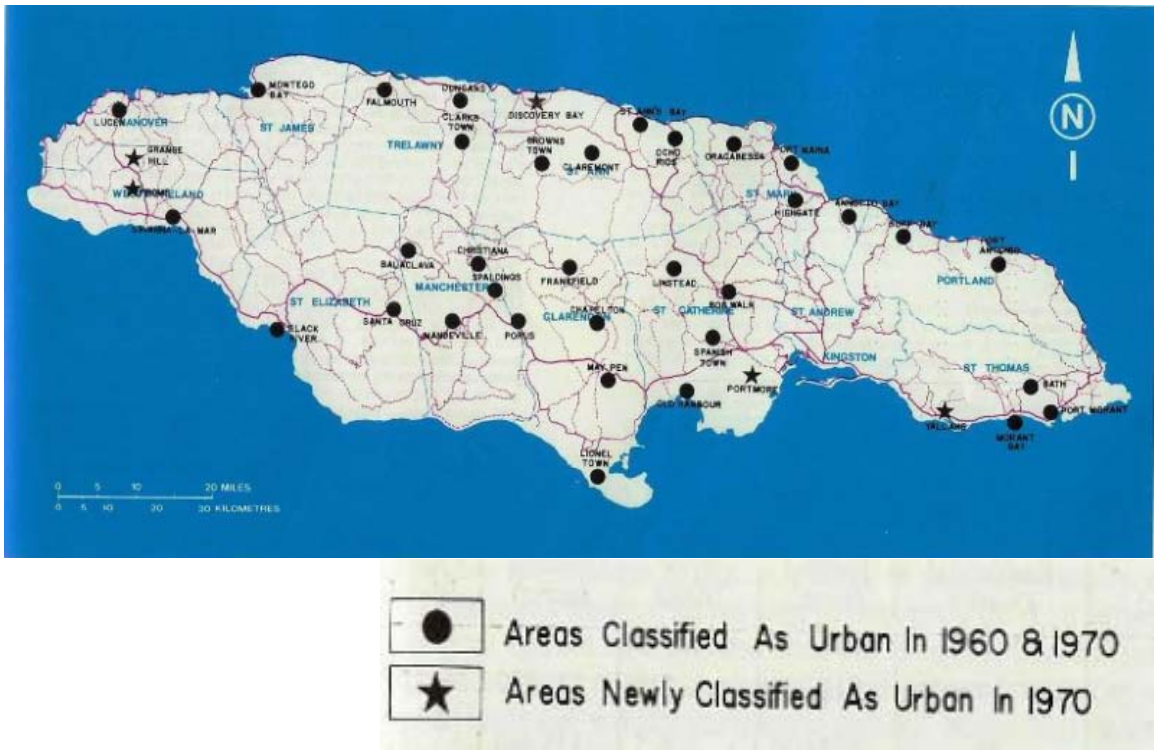


Plate 5-7: Areas Classified as Urban

5.2.5 *Urban Settlement Development*

Table 5-3: Urban Settlement Development

Manchester – Hierarchy Of Major Growth Centres		
District Centres	**Sub-Regional Centres**	**Regional Centres**
Mile Gully	Christiana/Spaldings	Mandeville
Williamsfield		
Medina		
Ballynure		

5.2.5.1 Parish Council/Land Use Zoning

The Parish of Manchester is covered by Development Orders and subsequently falls under the aegis of the Town and Country Planning Act. Thus any form of development requires an application to the relevant Local Planning Authority (Parish Council) for permission to carry out building, engineering and mining operations or change in the use of land or buildings.

There are no specific demarcated zones for land use, but there are general statements of intended uses, supporting requirements and standards. WINDALCO intends to apply for the necessary permission to undertake this project.

5.2.5.2 Aesthetics

There are several areas of outstanding natural beauty, visual and recreational amenity, and therapy. There are also areas which are aesthetically appealing and spiritually inspiring. There are remarkable 360° scenic views from the North Manchester Highlands in the vicinity of Shooters Hill.

A wide variety of microclimates exits throughout the parish, ranging from cool climatic conditions in Northern Manchester to warmer, drier conditions towards the south coast of the Parish. The area under study is adequately provided with transportation infrastructure – roads, railway; power transmission; and social infrastructure – hospitals (Mandeville, Spaldings), police stations, post offices, some government offices, schools, etc.

5.2.5.3 Potential Uses

The Parish of Manchester is a designated watershed area. Some areas are designated as national parks and protected areas. Some are likely to be zoned for specific classification of industrial uses and buffer zones to avoid conflict and potential nuisances between industrial and residential users.

The proposed project includes the establishment of a new lime kiln at an existing and operational limestone quarry at Shooters Hill, along with the associated transportation corridors connecting the quarry to the refinery in Kirkvine. Manchester has been extensively zoned and leased for bauxite mining operations.

5.3 Hazard and Risk Assessment

5.3.1 *Seismic Vulnerability*

Jamaica lies within the fault complex associated with the boundary between the Caribbean Plate and the North American Plate. As such the island, and its vicinity experiences frequent earthquakes. The major faults extending through the Shooters Hill region were active after early Miocene times (20 million years ago), but it is not possible to identify recent activity on these faults. Nevertheless felt earthquakes are frequent. The Earthquake Unit's website lists those felt over the past four years. Figure 5-16 indicates the average number of felt earthquakes of MMVI or over per century. Figure 5-17 provides a probabilistic model for horizontal ground acceleration exceedance.

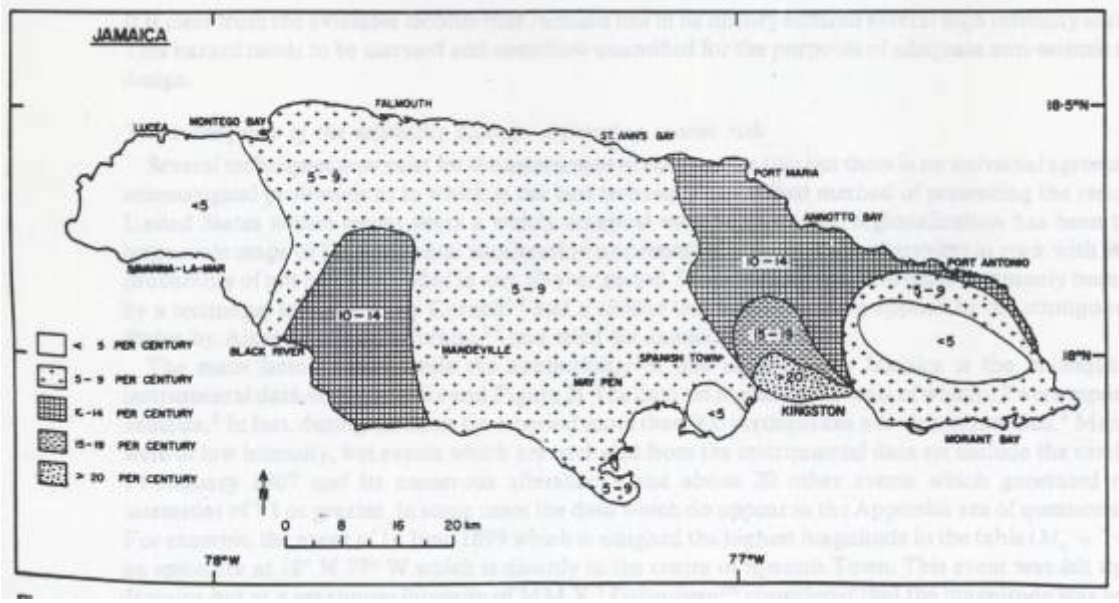


Figure 5-16: Map showing number of times per century that intensities of MM VI or greater have been reported, 1880-1960 (from Shepherd & Aspinall, 1980).

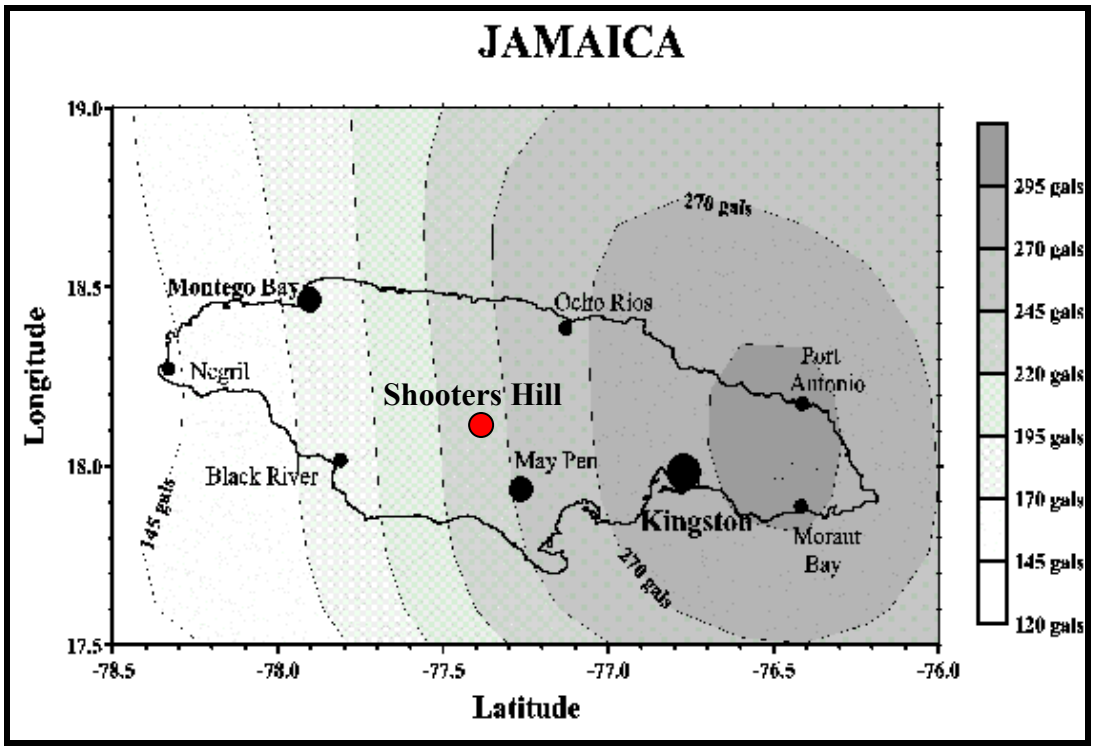


Figure 5-17: Horizontal Ground Acceleration with 10% Probability of Exceedance in Fifty Years [Contour Intervals - 25 gals (2.5%g)][7]

Throughout the quarry and vicinity the limestone bedrock is at or very near the surface, except where there are deposits of bauxite. No liquefaction problems are likely to occur at the plant, except possibly in the waste pond and the crushing plant retention pond. It must be ensured that these two containments, if being retained for the project, have containment walls/dikes that are resistant to ground shaking.

The design specifications for the kilns and silos will prevent a collapse due to improperly stacked materials and/or hurricane winds. Hurricane force winds may come from any direction and usually change direction during passage. Tall kilns can potentially sway during these events.

[7] Shepherd et al. 1999 in CDMP 2001

5.3.2 *Hurricane Vulnerability*

Hurricanes are a serious seasonal threat from June to November; since 1886, 21 hurricanes have made landfall in Jamaica, while over 100 have passed within 240 km (150 miles) of the island. Tsunamis are also a major risk.

Considerations have been given to issues related to storm water and potential for erosion during the construction and operational phases of the development. As such, a storm water management system, involving the use of drains and absorption pits (French drains) has been recommended.

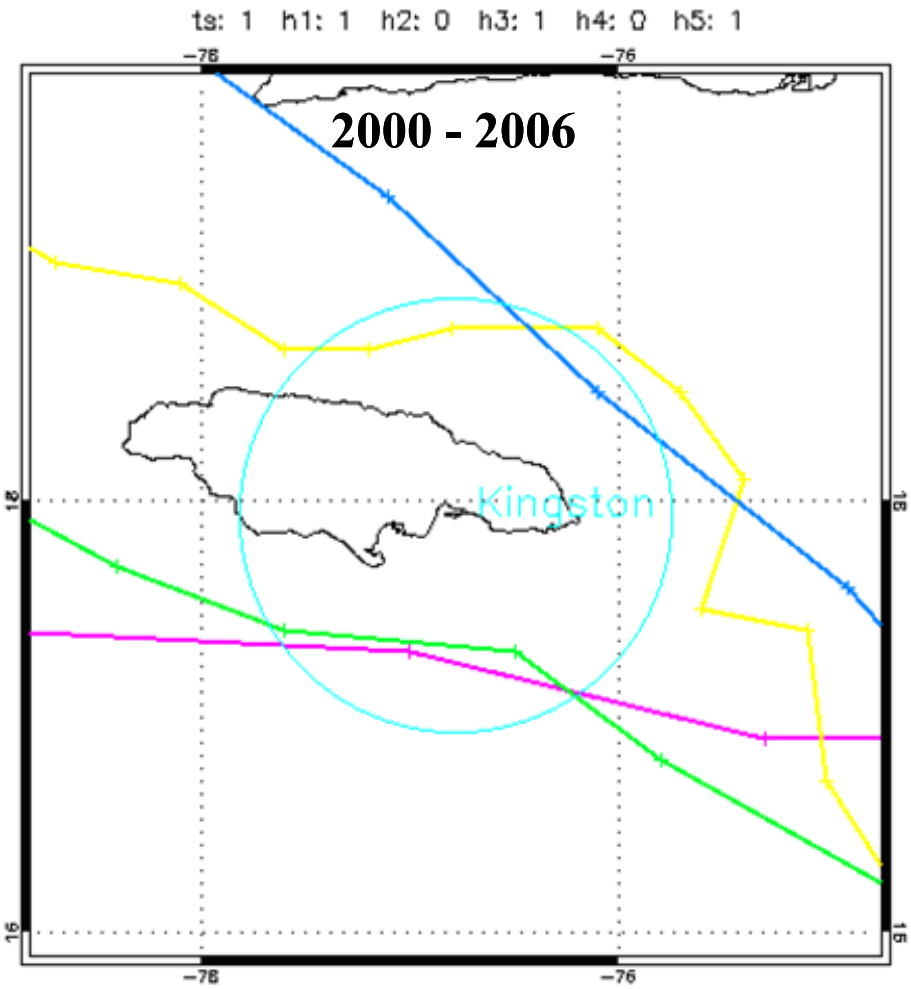
Using Sangster International Airport in Montego Bay as a reference point location: 18.50N 77.92W, all recorded tropical storm and hurricane activity over a period of 100 years are considered to estimate any trends related to the hurricane activity and the return period of such activities to the island[8]. This can be done confidently as Jamaica is a small island and is likely to be affected wholly regardless of the point of approach of a tropical depression or storm system.

So far this year, no hurricanes have affected the island. However, the island was last affected during the 2005 cycle by two storms, both considered big hurricanes (Category 3 and above) passing on either side of the island. No significant damage was recorded in the vicinity of the proposed project location at Shooters Hill.

Analyses of tropical systems passing within 60nm (= 60mi.) of the island is shown below. Latitude/longitude coordinates (18.50N, 77.92W) used is for Sangster International Airport, one of the island weather stations. Figure 5-18 below shows the storm track for tropical systems passing by for the period 2000-2006. Figure 5-19 shows whether there are more storms lately or which 5-year period in the last 60+ years was most active.

Based on the design specifications, the kiln will be able to withstand winds up to 60 m/s which equates to a category 4 wind gust.

[8] StormCarib – Caribbean Hurricane Network http://stormcarib.com/climatology/



Date	Wind	Cat.	cpoa	Name
07 Oct 2001	86	**h1**	46	IRIS
29 Sep 2002	58	**ts**	58	LILI
11 Sep 2004	155	**h5**	41	IVAN
07 Jul 2005	115	**h3**	59	DENNIS

Figure 5-18: Hurricane Storm track for the Period 2000-2006[9]

[9] StormCarib – Caribbean Hurricane Network http://stormcarib.com/climatology/MKJP_dec_isl.htm

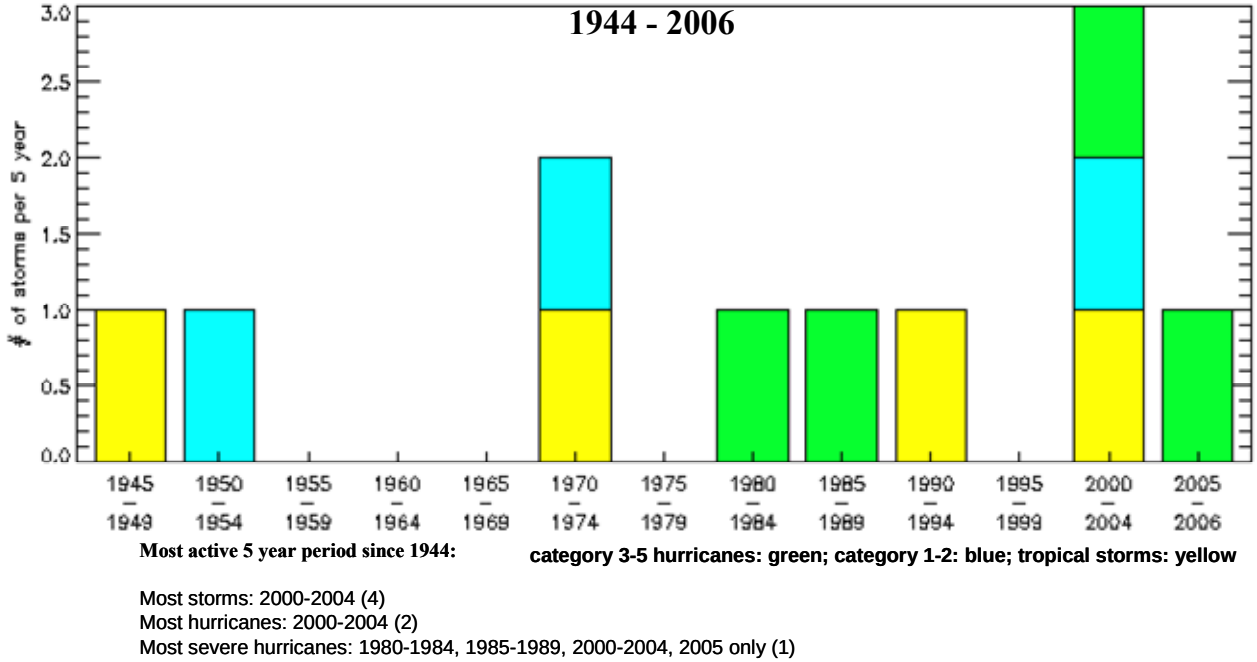


Figure 5-19: Hurricane Activity for the Period 1944 – 2006[10]

5.3.3 *Riverine and Flash-Flood Potential*

There is normally no surface flow in the areas adjacent to the quarry, except briefly, in times of extreme rainfall events. Based on discussions with staff at the Dairy Farm, flash-flood flow after heavy rainfall used to occur through the low-lying land to the east of the farm, south of the quarry, but drainage modifications had led to a cessation of these occurrences in recent times. Now, following heavy rainfall, flow is along the access road to the quarry. This water is then carried out past the sports field, under the main road to the pond (south of main road) next to Kirkvine Works. WINDALCO and their design engineers are also preparing to undertake a comprehensive appraisal of drainage conditions around the quarry area and modify the drainage as necessary in light of this project.

The karst drainage is evidently adequate to transmit flood water underground to points downhill from the site. The well at Content (Figure 5-15) showed a 51 m rise in water level during the 2002 and 2005 flood events at Porus and Harmond Valley, but surface flooding

[10] StormCarib – Caribbean Hurricane Network http://stormcarib.com/climatology/MKJP_dec_isl.htm

did not occur there although it occurred lower down the Williamsfield-Porus Trough (WRA, 2005).

5.3.4 *Traffic Analysis*

5.3.4.1 Methodology

Raw data from traffic surveys conducted over a 13 day period (July 26 – August 7, 2007), a continuous 14 hour assessment in August 2005, and over a continuous period of 7 weeks (March 04, 2002 to April 14, 2002) was used to make an assessment of the impact on the road network along distribution routes. Data was in part obtained from the National Works Agency (NWA).

The surveys were done in the following areas:

- Williamsfield main road (before roundabout)
- Porus Main Road (in the vicinity of Trinity)
- Clarendon Park Main Road (Between train line and Juicy Patties)
- Spur Tree Hill (before the turn-off to Nain)
- Old Harbour Bypass

Classification was based on the type of vehicles that were counted. The vehicle classes that were used for the surveys were:

- Car
- Light Commercial Vehicle
- Bus
- Truck
- Minibus

5.3.4.2 Findings

5.3.4.2.1 Williamsfield Main Road

Based on the surveys, cars were consistently higher in frequency from Shooters Hill Road (North) and from Williamsfield Roundabout (South) than any other vehicle. The period during which there was the most vehicular traffic on the route irrespective of direction travelling was between 7 a.m. – 8 a.m. The least traffic period was 10 a.m. – 11 a.m. Shooters Hill traffic was highest during the period 7 a.m. – 8 a.m. Based on numbers of vehicles observed, the number of cars going in either direction during survey times was almost equal (90% - north vs. 91% - south). Trucks accounted for less than 10% of traffic for the times surveyed (9% - north vs. 8.8% - south).

Trucks were also consistently higher in frequency from Shooters Hill than buses for the observed time periods. This is explained by the fact that most buses use the Kendal to Mandeville route. The collective traffic from trucks traveling in opposite directions shows a bimodal distribution, peaking between 1 a.m. and 3 a.m. and the second peak from 5 a.m. to 12 p.m.

It can therefore be assumed that any significant impact would occur between the morning hours. The addition of 10 – 20 additional truck trips through this location is not expected to have a significant impact on traffic in terms of congestion. As such, WINDALCO will use this route during periods when traffic is least for other vehicles such as 12 a.m. to 5 a.m., especially during week days. As with all other routes, a follow-up traffic analysis will be conducted once trucking commences.

5.3.4.2.2 Porus Main Road

Similar to Williamsfield, cars were consistently higher in frequency from Porus (East) and from Trinity (West) than any other vehicle. The period during which there was the most vehicular traffic on the route irrespective of direction travelled was between 5 a.m. – 6 a.m. The least traffic period was 1 a.m. – 3 a.m. The most vehicular traffic from Trinity (West) was between 5 a.m. – 6 a.m. Similarly, for the opposite direction Porus (east) was between 5 a.m. and 7 a.m. Based on numbers of vehicles observed, the number of cars going in either direction during survey times was significantly higher than other vehicles. Trucks accounted for approximately 11% of traffic for the times surveyed in both directions.

Trucks were also consistently higher in frequency than buses for the observed time periods. The most trucks traveling from Porus (east) was between 7 a.m. – 8 a.m. and from the Trinity (west) was 12 p.m – 1 p.m. It should be noted that the truck volumes was approximately the same, 38 trucks per hour, from either direction for the same time period.

5.3.4.2.3 Winston Jones Highway (West of the intersection with Kendal Main Road)

Cars were consistently higher in frequency from than any other vehicle. The most vehicular traffic westbound was between 8 a.m. – 9 a.m. in the morning hours, and 4 p.m. – 6 p.m. in the afternoon. Based on numbers of vehicles observed, the number of cars going in either direction during survey times was significantly higher than other vehicles. Trucks accounted for approximately 11% of traffic for the times surveyed in both directions.

Trucks were also consistently higher in frequency than buses for the observed time periods. The most trucks traveling eastbound were during the periods 7 a.m. – 8 a.m. in the morning hours, and 5 p.m. – 6 p.m. in the afternoon hours.

5.3.4.2.4 Clarendon Park Main Road

As expected, cars were consistently higher in frequency from Porus (East) and from Toll Gate (West) than any other vehicle. The period during which there was the most vehicular traffic on the route irrespective of direction travelled was between 5 p.m. – 6 p.m. The least

traffic period was 12 a.m. – 5 a.m. The most vehicular traffic from Toll Gate (westbound) was between 8 a.m. – 9 a.m. in the morning hours, and between 5 p.m. and 7 p.m. in the afternoon. For the opposite direction Porus (eastbound) the most traffic was between 7 a.m. and 10 a.m. in the morning hours, and between 4 p.m. and 7 p.m. in the afternoon hours. Based on numbers of vehicles observed, the number of cars going in either direction during survey times was significantly higher than other vehicles. Trucks accounted for approximately 13% of traffic for the times surveyed in both directions.

Trucks were also consistently higher in frequency than buses for the observed time periods. The most trucks traveling from Porus was between 12 p.m. – 1 a.m. and from the Toll Gate was 7 a.m. – 8 a.m.

5.3.4.2.5 Spur Tree Hill

Peak traffic in the morning (on average) occurs between 6 a.m. and 9 a.m. It should be noted, however, that although there is a decrease in the traffic (in terms of quantity of vehicles), the traffic does not fluctuate much after this time. Hence, the peak traffic hour in the morning period should not be seen as absolutely significant in comparison to the traffic hours after 9 a.m. and those which approach the peak hours in the afternoon in either direction. Trucks were observed in higher volumes to buses.

Peak traffic occurs in the afternoon between 4 p.m. and 7 p.m. The significance of the amount vehicles quoted for the time period is only realized between 5 p.m. and 7 p.m. However, the decrease in traffic is more significant after this period until the next observed peak in the morning hours.

5.3.4.2.6 Old Harbour Bypass

Peak traffic in the morning (on average) occurs between 8 a.m. and 9a.m. It should be noted, however, that although there is a decrease in the traffic (in terms of quantity of vehicles), the traffic does not fluctuate much after this time. Hence, the peak traffic hour in the morning period should not be seen as absolutely significant in comparison to the traffic hours after 9 a.m. and those which approach the peak hours in the afternoon in either direction.

Peak traffic occurs in the afternoon between 5 p.m. and 6 p.m. The significance of the amount of vehicles quoted for the time period is only realized between 7 p.m. and 8 p.m. However, the decrease in traffic is more significant after this period until the next observed peak in the morning hours.

The data set for 2007 is attached as Appendix V.

5.3.4.3 Conclusions

WINDALCO proposes to utilise:

- A maximum of 5 trucks in total to move solid fuels from Port Esquivel to the Quarry at Shooters Hill on a daily basis, and
- A maximum of 20 truck movements for lime from Shooters Hill to WINDALCO-Kirkvine Works and ALPART in Nain, St. Elizabeth on a daily basis.

WINDALCO does not intend to dispatch any trucks during peak hours and will modify truck travel times, as necessary, to limit congestion and bottlenecks along the respective routes.

Based on the survey, it does not appear that the addition of these trucks to the existing numbers on the road will pose a difficulty, or create a significant additional hardship on the motorists using the surveyed roadways. The pattern of traffic has not changed significantly since. All three (3) survey periods reflect similar patterns for comparable areas.

It should also be noted that the current truck volumes of lime from Rugby Jamaica Lime and Minerals Limited, and limestone from Somerset Quarry will be discontinued once the facility is operational and supplying the necessary volumes. This will mitigate the trucks to be used for transporting through this project.

5.3.5 *Other Perceived Environmental Hazards*

These problems have much to do with the wind transport of noxious or unsightly dust and aerosols from the plant producing such materials to the complainant. Quicklime is a potentially corrosive agent, and proper containment is essential. Figure 5-20 shows the

distribution of the localities of dust related complaints received for 2006 and January to April 2007. Meteorological data for the period January to March 2007 show the primary wind direction being from the south-east (see Section 5.2.1.3). This information is provided in the expectation that the direction the emissions will take will be controlled by the wind. It should be noted that location of complaints does not correspond to the primary wind directions in all cases.

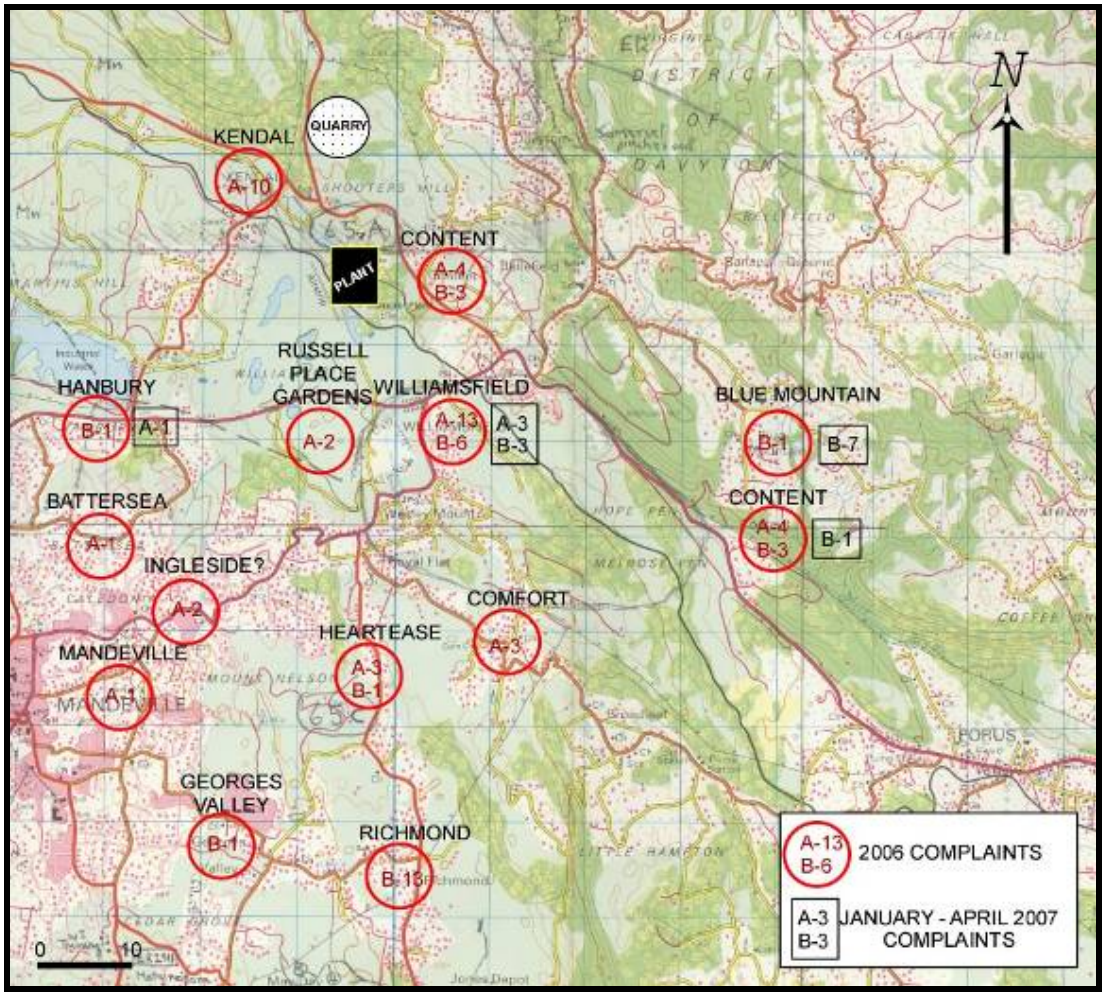


Figure 5-20: Geographic distribution of dust related complaints received by WINDALCO for 2006 and January to April 2007 [A – Alumina dust, B – Bauxite dust]

5.3.6 *Overall Assessment of Natural Hazard Vulnerability of Sites*

The main conclusions evident are:

1. There would appear to be adequate reserves for the foreseeable future for limestone. There is an expected 79 years of useable limestone resources in the quarry.
2. The impact of hurricane winds and storm wind gusts on the lime kiln is expected to be minimal. The kiln is designed to withstand winds up to 60 m/s. This translates to a category 4 hurricane. Similarly, the impact from earthquakes is also designed against. The kiln will be designed to an earthquake factor of 0.18.
3. The ambient air quality in the area is fairly good. WINDALCO will take all necessary precautions to protect its workers and the surrounding communities from impacts to health by ensuring that best technologies are utilised in the materials and construction and operation of the proposed facility. As such, all technological advances such as baghouse filters, telescopic chutes etc, and additional dust monitoring stations will be installed.
4. The hydrological characteristics of karst limestone as well as anecdotal reports suggest there is little likelihood of flooding in the vicinity of the quarry.

   Drainage works to be carried out are planned to minimize any possible flooding in the future. The karst system appears capable of easily carrying away excess water from all points above (northwest) of Content, although this water does impact on communities downslope, such as Porus and Harmond in cases of extreme and prolonged rainfall.

5.4 Biological Environment

5.4.1 *Introduction*

The survey entailed ground-truthing using GPS and an assessment of the flora and fauna of the general area. Avifauna was recorded by sight and sound. Aerial photography (video and still) and satellite imagery were also used in the analysis. A literature review of the flora and fauna of the area was also conducted

5.4.2 *Floral Resources*

5.4.2.1 Methodology

A "walk-through" survey was conducted throughout the entire property. All macroscopic plant species were recorded and, where possible, identified in the field. Unidentified species were collected and compared with a Herbarium collection for classification. Each species was then checked against known Jamaican plant taxonomy literature for endemism and rarity.

5.4.2.2 Findings

The area can be characterized as a "brownsite" environment. The area is largely disturbed owing to incidences of mining, quarrying, dairy farming, and other small-scale agricultural practices. A small intact, mostly undisturbed area was also found and surveyed. The proposed site for the lime kiln is the foothills of the quarry which houses the existing sizing and washing of limestone aggregates operations and office building. The majority of the lot is on limestone bedrock and lies to the east of the southern foothills of the Mile Gully Mountain.

The closest region of ecological importance is Mile Gully (Figure 5-21). Earlier studies revealed a high level of endemicity of species in this area. The area speaks to the potential for high biodiversity levels in the general area but indicate more exceptional habitats rather than representative ones. Mile Gully is considered outside the scope of this project area.

The region can be classified as a combination of Wet and Dry Limestone Forest and grassland. The proposed site is not located within any of the recognised special conservation areas for Central Jamaica.

Three zones were identified during the assessment and are expanded on below:

1. The Patches of Dry and Wet Limestone Forest
2. The Peripheral Wet Limestone Forest
3. The Grassland areas

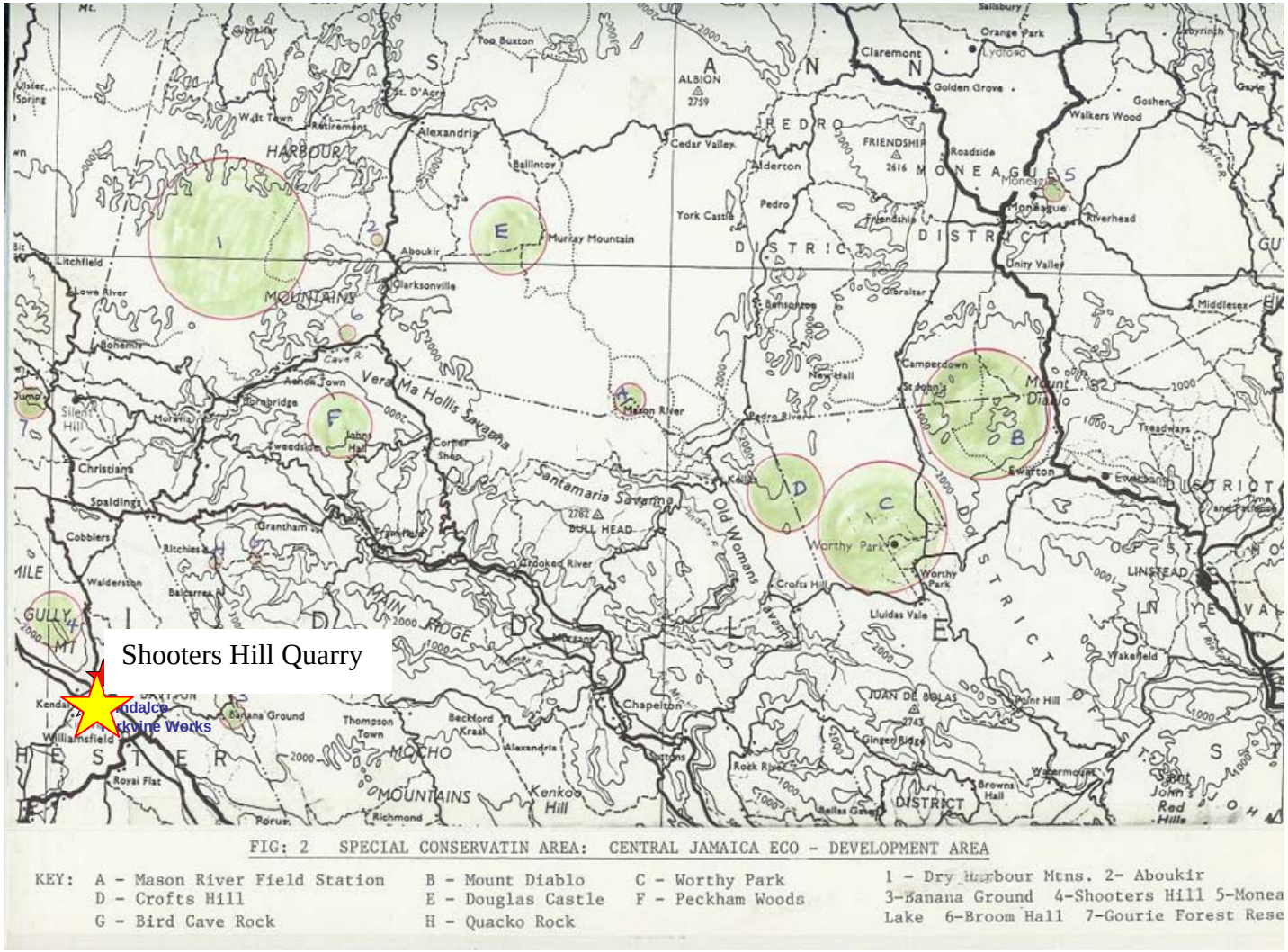


FIG: 2 SPECIAL CONSERVATIN AREA: CENTRAL JAMAICA ECO - DEVELOPMENT AREA

KEY: A - Mason River Field Station B - Mount Diablo C - Worthy Park 1 - Dry Harbour Mtns. 2- Aboukir
D - Crofts Hill E - Douglas Castle F - Peckham Woods 3-Banana Ground 4-Shooters Hill 5-Monea
G - Bird Cave Rock H - Quacko Rock Lake 6-Broom Hall 7-Gourie Forest Rese

Figure 5-21: Special Conservation Area - Central Jamaica Eco-Development Area

5.4.2.2.1 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 (0.30.6m) with wide spreading crowns. Naturalized species included Red Birch (*Bursera simaruba*), made conspicuous by its red, flaky bark and the Trumpet tree (*Cecropia peltata*). Other species dominant were *Ficus sp.* and the Silk Cotton tree (C*eiba pentandra*).

The sub-canopy 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 sp.* Only the latter was observed but the hanging roots of the former added to the thickness of the sub canopy layer. Increasing altitude (cooler conditions), and increasing distance west on the Manchester Plateau (higher rainfall), result in an increase in species which prefer wetter environments such as mosses and bromeliads, the latter was observed throughout, particularly on the northern periphery of the quarry and forest fragments to the east.

Topographic variations exert a major influence on physiognomy 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.

5.4.2.2.2 Dry limestone Forest

This type was obvious within the quarry site, resembling that which is seen on the windward face of the south-east portion of Mile Gully Mountain. 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 of the open quarry. Leaf litter was minimal. Termite mounds were also noted in a few locations. 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 due to the character of the quarry. The trumpet tree was the dominant emergent tree in this zone. Its prevalence is probably due to its unsuitability for lumber or charcoal. Other frequent types were logwood (*Haematoxylon campechianum*) and lead tree (*Leucaena leucocephala*); the latter considered an invasive plant, both used for charcoal but no coal kilns were discovered.

Climbing, scrambling and epiphytic plants were represented primarily by *Tillandsia* sp., no orchid or cacti were observed. No rare or endemic species were identified.

5.4.2.2.3 Grassland

The vegetation here is generally spanned from the quarrying sizing, washing, sorting and storage areas through the entire length or pathway of the access roadway.

At the proposed lime kiln and storage area species diversity showed more invasive species due to the anthropogenic influences of the quarrying operations. The area was dominated by stoloniferous grasses and herbs. The grass and herbs provided 100% coverage, leaving bare areas only in places with obvious disturbances such as the temporary parking area for vehicles used at the site.

Other conspicuous tree species included Poinciana (*Delonix regia*) and Guango (*Samanea saman*). An area to the west of the main operations has been used for small scale operations. Callaloo (*Amaranthus spinosus*) and potato (*Solanum tuberosum*) were observed in mixed vegetation. However, the area shows little upkeep with many herbaceous species interspersed and may be remnants of a previous small scale farmer. To the south of the general operations is a WINDALCO's dairy farm. This area is predominantly grassland with occasional trees, particularly Guango).

Historically introduced pasture grasses are found in the area. These include Guinea grass *(Panicum maximum)* and species from the genus *Andropogon.* It should also be noted that WINDALCO leases land to small farmers from the neighbouring communities. These farmers are referred to as *tenant farmers*, they utilise the land until WINDALCO is ready for it. The farm lands to the south of the quarry are not included in the quarry lease. Only two (2) endemic species were observed, both are found throughout the country and are not endemic to the Shooters Hill area. No endangered or rare species to the region were observed.

A total of 67 species of plants were identified (Table 5-4). A photo-inventory is included (Appendix IX).

Table 5-4: Flora Observed At Site of the Proposed New Lime Kiln

Family	Scientific Name	Common Name
Amaranthaceae	*Achyranthes indica*	Devil's horsewhip
Anacardiaceae	*Mangifera indica*	Mango
Anacardiaceae	*Metopium brownie*	Burnwood
Anacardiaceae	*Comocladiapinnatifolia**	Maiden plum
Apocynaceae	*Urechites lutea*	Nightshade
Aracaceae	*Philodendron sp.*	
Asclepiadaceae	Asclepias curassavica	Red top
Asteraceae	*Bidens pilosa*	Spanish needle
Asteraceae	*Eupatorium odorata*	Christmas bush
Asteraceae	*Mikania micrantha*	Guaco
Asteraceae	*Prthenium hysterophorus*	
Bignoniaceae	*Enallagma latifolia*	Gourd tree
Bignoniaceae	*Spathodea campanulata*	Flame-of-Forest
Bignoniaceae	*Tecoma stans*	
Bombacaceae	*Ceiba pentandra*	Silk Cotton tree
Boraginaceae	*Borreria sp.*	
Bromeliaceae	*Tillandsia sp.*	Old mans beard
Bromeliaceae	.	Bromeliads
Burseraceae	*Bursera simaruba*	Red birch
Capparaceae	*Cleome viscose*	Wild caia

Family	Scientific Name	Common Name
Clusiaceae	*Clusia flava*	
Commelinaceae	*Commelina diffusa*	
Convolvulaceae	*Merremia aegyptia*	
Cucurbitaceae	*Momordica charantia*	Cerasse
Cyperacea	*Cyperus sp.*	
Dennstaedtiaceae	*Pteridium aquilinum*	Fern
Euphorbiaceae	*Ricinus communis*	Castor Oil Plant
Euphorbiaceae	*Croton sp.*	
Euphorbiaceae	*Ricinus cummunis*	Castor oil plant
Euphorbiaceae	*Euphorbia hirta*	
Fabaceae	*Delonix regia*	Poinciana
Fabaceae	*Moghania strobilifera*	Wild hops
Fabaceae	*Aeschynomene americana*	
Fabaceae	*Abrus precatorius*	
Fabaceae	*Haemotoxylum campechianum*	Logwood
Fabaceae	*Mimosa pudica*	Shame weed
Fabaceae	*Leucaena leucocephala*	Lead tree
Fabaceae	*Zornia reticulate*	
Fabaceae	*Centrosema pubescens*	Wist vine flower
Fabaceae	*Mucuna puriens*	Cowitch
Fabaceae	*Dalbergia sp.*	
Fabaceae	*Macroptilium lathyroides*	
Gramineae	*Bambusa vulgaris*	Bamboo
Lamiaceae	*Leonotis nepetifolia*	Christmas candlestick
Lauraceae	*Persea Americana*	Pear, Avocado
Malvaceae	*Sida acuta*	Broomweed
Malvaceae	*Sida cordiflia*	
Melastomataceae	*Miconia pachyphylla*	
Mimosaceae	*Albizia lebbeck*	Woman's tongue
Myrtaceae	*Psidium guajava*	Guava
Nyctaginaceae	*Pisonia aculeate*	Cockspur
Piperaceae	*Piper amalago*	
Plumbaginaceae	*Plumbago sp.*	

Family	Scientific Name	Common Name
Poaceae	*Paicum maximum*	Guinea grass
Poaceae	*Chloris barbata*	
Poaceae	*Andropogon pertusus*	Seymour grass
Polygonaceae	Cocoloba diversifolia	Pigeon plum
Polygonaceae	Antigonon leptopus	Coralita
Polypodaceae	*Polypodium phyllitidis*	
Sapindaceae	*Melicoccus bijugatus*	Guinep
Solanaceae	*Solanum torvum*	Susumber
Solanaceae	*Browallia Americana*	Jamaican forget-me-not
Urticaceae	*Pilea microphylla*	
Verbenaceae	*Lantana camara*	White Sage
Verbenaceae	*Stachytarpheta jamaicensis*	Vervine

Endemics-2

5.4.3 *Faunal Resources*

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 within the quarry and its periphery.

5.4.3.1 Avifauna

At least 33 bird species were observed with 8 identified as being endemic. Of this number, the majority were residents, with only one listed as a migrant (Table 5-5 and Table 5-6)

The number of sightings also indicated that many of the identified birds were common in the area. 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.

Table 5-5: Bird Species List (Residents and Endemics)

Proper Name	Code	Scientific Name	Status	DAFOR
American Kestrel	MAKE	*Falco sparverius*	Resident	F
Bananaquit	BANA	*Coereba flaveola*	Resident	F
Black-faced Grassquit	BFGR	*Tiaris bicolor*	Resident	R
Black-whiskered Vireo	BWVI	*Vireo altiloquus*	Migrant	R
Caribbean Dove	CADO	*Leptotila jamaicensis*	Resident	R
Cattle Egret	CAEG	*Bubulcus ibis*	Resident	R
Cave Swallow	CASW	*Hirundo fulva*	Resident	D
Common Ground Dove	COGD	*Columbina passerina*	Resident	O
Gray Kingbird	GRKI	*Tyrannus dominicensis*	Resident	F
Great Antillean Grackle	GRAG	*Quiscalus niger*	Resident	D
Jamaican Euphonia	**JAEU**	***Euphonia jamaica***	**Endemic**	O
Jamaican Oriole	**JAOR**	***Icterus leucopteryx***	**Endemic**	F
Jamaican Vireo	**JAVI**	***Vireo modestus***	**Endemic**	O
Jamaican Woodpecker	**JAWO**	***Melanerpes radiolatus***	**Endemic**	O
Kildeer	KIER	*Charadrius vociferus*	Resident	R
Loggerhead Kingbird	LOKI	*Tyrannus caudifasciatus*	Resident	R
Northern Mockingbird	NOMO	*Mimus polyglottos*	Resident	A
Olive-throated Parakeet	OTPA	*Aratinga nana*	Resident	F
Red-billed Streamertail	**RBST**	***Trochilus polytmus***	**Endemic**	**O**
Sad Flycatcher	**SAFL**	***Myiarchus barbirostris***	**Endemic**	**R**
Smooth-billed Ani	SMBA	*Crotophaga ani*	Resident	F
Turkey Vulture	TUVU	*Carthartes aura*	Resident	O
Vervain Hummingbird	VEHU	*Mellisuga minima*	Resident	O
White-crowned Pigeon	WCPI	*Columba leucocephala*	Resident	F
White-winged Dove	WWDO	*Zenaida asiatica*	Resident	D
Yellow-faced Grassquit	YEFC	*Tiaris olivacea*	Resident	F
Zenaida Dove	ZEDO	*Zenaida asiatica*	Resident	O
Jamaica Mango Hummingbird	**JMHU**	***Anthracothorax mango***	**Endemic**	**R**
White-chinned Thrush	**WCTH**	***Turdus aurantius***	**Endemic**	**O**
Great Antillean Bullfinch	GABU	*Loxigilla violacea*	Resident	O
Antillean Nighthawk	ANNI	*Chordeiles gundlachii*	Resident	O
Grasshopper Sparrow	GRSP	*Anmodramus savannarum*	Resident	O

Proper Name	Code	Scientific Name	Status	DAFOR
White-Collared Swift	WCSW	*Streptoprocne zonaris*	Resident	R

Note: Endemic species in bold.

Table 5-6: Endemic Bird Species Encountered

Proper Name	Code	Status	DAFOR	Forest Dependent Y/N
Jamaican Euphonia	JAEU	Endemic	O	N
Jamaican Oriole	JAOR	Endemic	F	N
Jamaican Vireo	JAVI	Endemic	O	N
Jamaican Woodpecker	JAWO	Endemic	O	N
Red-Billed Streamertail	RBST	Endemic	O	N
Sad Flycatcher	SAFL	Endemic	R	Y
Jamaica Mango Hummingbird	JMHU	Endemic	R	N
White-chinned Thrush	WCTH	Endemic	O	Y

Note: Two of the endemics observed are forest dependent species. Only 8 of the 29 endemic birds on the island were observed on the property.

5.4.3.1.1 Site Description

The property has large mined out depressions (limestone and bauxite mines), small forest fragments (hills with patches of the quarry's original vegetation before it was removed) and grasslands. In addition there are also four small depressions, at least one filled with industrial waste water (water which was used to wash the aggregate produced).

The surrounding areas of the limestone quarry consist of a highly disturbed midlevel limestone forest. The forest patches in the quarry has vegetation which is typical of a wet limestone forest.

5.4.3.1.2 Method

Due to the extensive patchiness of the fragmented vegetation as a result of the quarry, point counts were selected to conduct the avifaunal assessment (Plate 5-8 below).

The point count census method was the ideal method to use, since it was unlikely to find birds in the open mined out caverns and also in active mining areas. It should be noted that birds are likely to be found in areas with vegetation and low disturbance from mining.

Approximately 16 points were selected throughout the property. In addition special emphasis was placed on the forest fragments, where the birds are likely to be found.

Point Count Census Method

This Point Count method is based on the principle of counting birds at a defined point or spot and determining the distance of each bird censured. A point is selected and then all bird contacts (seen and heard) are recorded, with a determination of distance given (< 25m or >25m) for each contact. This is done for a predetermined time, usually 10 minutes, before moving to another point at a specified distance away (this can be either 100m – 200m) (Bibby et al. 1998). Points for this survey were 200m apart (Plate 5-8 below). It should be noted that any avifaunal species observed between point counts were recorded.

Advantages of this method include:

- Greater concentration on the birds and habitats without having to watch where you walk (Bibby et. al. 1998).
- More time available to identify contacts (Bibby et. al. 1998)
- Greater opportunity to identify cryptic and skulking species (Bibby et. al. 1998)
- Easier to relate bird occurrence to habitat features (Bibby et. al.1998).

Technique Weaknesses

As with all survey techniques, there are weaknesses, which influence overall results. Below are given factors which affect both census techniques used.

- Time of Day – the best time for conducting a census is in the morning from sunrise until about 10am in the lowlands. It is recognized that as the day continues it gets hotter and the ability to detect birds decreases due to lack of movement. (Wunderle 1994).

- Time of Year – the change in behaviour of birds during the breeding and non-breeding seasons affect detection. However for this report, the assessment was done in the non-breeding season, when birds are less vocal. (Wunderle 1994).
- Weather – things such as wind, rain, fog or if the day is too hot, affect conducting a census (Wunderle 1994).

Plate 5-8: Point Count Locations

5.4.3.1.3 Findings

Most of the birds observed during the survey are typical of disturbed woodlands. In addition most of the birds observed during the bird survey were seen in the fragmented vegetation patches. Only a few birds, including the Great Antillean Night Hawk, Grasshopper Sparrow and the Grass Quits were seen in the grassland and the mined areas. The other birds were observed in the forest fragments. Two of the eight endemic birds, the White-chinned thrush

and Sad Flycatcher, observed during the survey are dependent on forest habitats. It should be noted that large patches of vegetation including the forested ravine to the north-west were seen outside of the main limestone quarry. One can therefore assume that most birds including the forest dependent birds use the vegetation corridors alongside the quarry. In addition, it is likely that nocturnal birds are present in the area, however, no night survey was done. No water birds were observed at the quarry. Only one (1) migrant bird was observed during the survey as a result of the time of the year the survey was done.

The open areas, including the areas that were being actively quarried and areas that have been quarried, had low bird activity. The quarrying of limestone is expected to have negative effects on the bird community in the limestone quarry. The quarrying processes including removal of vegetation, blasting, excavating, and transporting of the aggregate will scare a number of the birds away.

The proposed development is not expected to have a major negative effect on the bird community in the area, given wise quarrying practices to be employed by WINDALCO. Few birds were observed in the area proposed for the kilns during the survey. The birds which are going to be displaced during the development will migrate to adjacent vegetation corridors.

The following DAFOR scale was used to categorise the bird population (Table 5-7).

Table 5-7: DAFOR Rating of Birds Observed

Category	Total number of birds observed during the survey (2 days)
D	≥ 20
A	15 – 19
F	10 – 14
O	5- 9
R	< 4

5.4.3.2 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, dragonflies, mosquitoes, wasps and honeybees.

5.4.3.2.1 Amphibians and Reptiles

The reptiles observed were the usual lizards of the genera *Anolis*. No amphibians were noted during surveys however literature reviews indicated the likely occurrence of certain species in the study area. Table 5-8 below is a list of terrestrial invertebrates known to inhabit North Manchester. Note, this does not suggest that these species are located within the quarry. Based on the level of anthropogenic influences, it is highly likely that none will be found in the 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, two were observed, *Anolis grahami and Anolis lineatopus*. 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*[11].

Table 5-8: Terrestrial Invertebrate Fauna Known To Inhabit North Manchester

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*	Jamaican Stippled	-

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

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/RANK
	argus	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		

5.4.3.2.2 Butterflies

As with amphibians, this group was not fully surveyed and unfortunately literature did not yield concrete data on species distribution. Four species were observed of which none are known to be endemic (Table 5-9). 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 (9) are endemic species or subspecies.

Table 5-9: Butterfly Species Observed

Scientific Name	Common Name
Euptoieta hegesia hegesia	The Tropical Fritillary
Danaus sp.	Monarchs
Dryas iulia delila	Julia
Eremia sp.	Barred Yellow

5.4.4 Other Habitats

Other than already mentioned, no other established habitats were observed. The possibility of cave systems, however, is a good possibility though none were observed. The limestone make-up of Central Jamaica highlands (Cockpit Country) makes it laden with cave systems. Based on information from the Jamaican Caves Organisation, no cave system is known from the area.

5.4.4.1 Caves

No significant caves have been reported from the immediate vicinity of the quarry area. The nearest caves and sinkholes are the Bombay sinkholes and Ganja Pot, 3-4 km northeast of the site. These are listed in Table 5-10 below (derived from Fincham, 1997).

Table 5-10: Recorded Caves and Sinkholes nearest to the quarry site.

Eastings	Northings	Name
2012	1621	Bombay sinkholes 2 and 5
2016	1625	Bombay sinkholes 6 to 8
2016	1627	Babylon Cave

Eastings	Northings	Name
2016	1612	Bombay 4
2021	1625	Bombay 3
2036	1606	Ganja Pot

The grid used is that of the 1:50 000 maps metric edition

5.5 Cultural Heritage Environment

The following is a list of heritage sites in Manchester, identified by the Jamaica national Heritage Trust (JNHT)

- St. Mark's Anglican Church
- New Broughton United
- Bloomfield Great House
- Marlborough Great House
- Marshall's Pen Great House
- Greenvale Railway Station
- Williamsfield Railway Station
- Roxborough
- Northern Caribbean University
- Maidstone
- Mandeville Court House

Of the sites identified the closest would be the Williamsfield Railway Station which lies outside the sphere of influence of this project.

SOCIO-CULTURAL ENVIRONMENTAL

6 Socio-Cultural Environmental

6.1 Introduction

WINDALCO has a vested interest in the opinions, attitudes and views of the constituents of the communities in which it does business. As a result, they have been in direct contact with community members, area leaders and even Members of Parliament in several communities that will be impacted during this project. This report presents the findings of a socio-economic survey conducted in July 2007 among residents within the radius of influence of the project and the major issues from community consultations conducted.

While the selection of the areas for interviewing were based on the enumeration districts as defined by Statistical Institute of Jamaica (STATIN), the communities as presented in this report were defined in the field by the interviewer and the respondent. Accordingly it is possible for a number of communities to cross Enumeration Districts (ED) boundaries (Table 6-1).

This section also outlines community complaints generated by communities surrounding Windalco operations from January 2006 to April 2007, as well as details of consultations held with community groups.

Table 6-1: Enumeration Districts Surveyed

Enumeration District Code	Total Households	5 % Sample Value
Mandeville	**504**	**25**
Central 033	286	14
Central 034	218	11
Williamsfield	**1175**	**59**
Central 008	275	14
Central 009	257	13
Central 019	156	8
Central 020	288	14
Central 025	199	10
Rural	**911**	**46**

Enumeration District Code	Total Households	5 % Sample Value
NE 072	164	8
NE 074	179	9
NW 043	249	12
NW 044	101	5
Central 007	218	11
Total	**2590**	**130**

A Total of 139 surveys were conducted. The surveys were conducted in 12 EDs as outlined by the STATIN, which were in relatively close proximity to the project site. The survey population was devised based on a 5% sample of the Total Households in the area. Figure 6-1 outlines the communities surveyed. This represents 29 named communities.

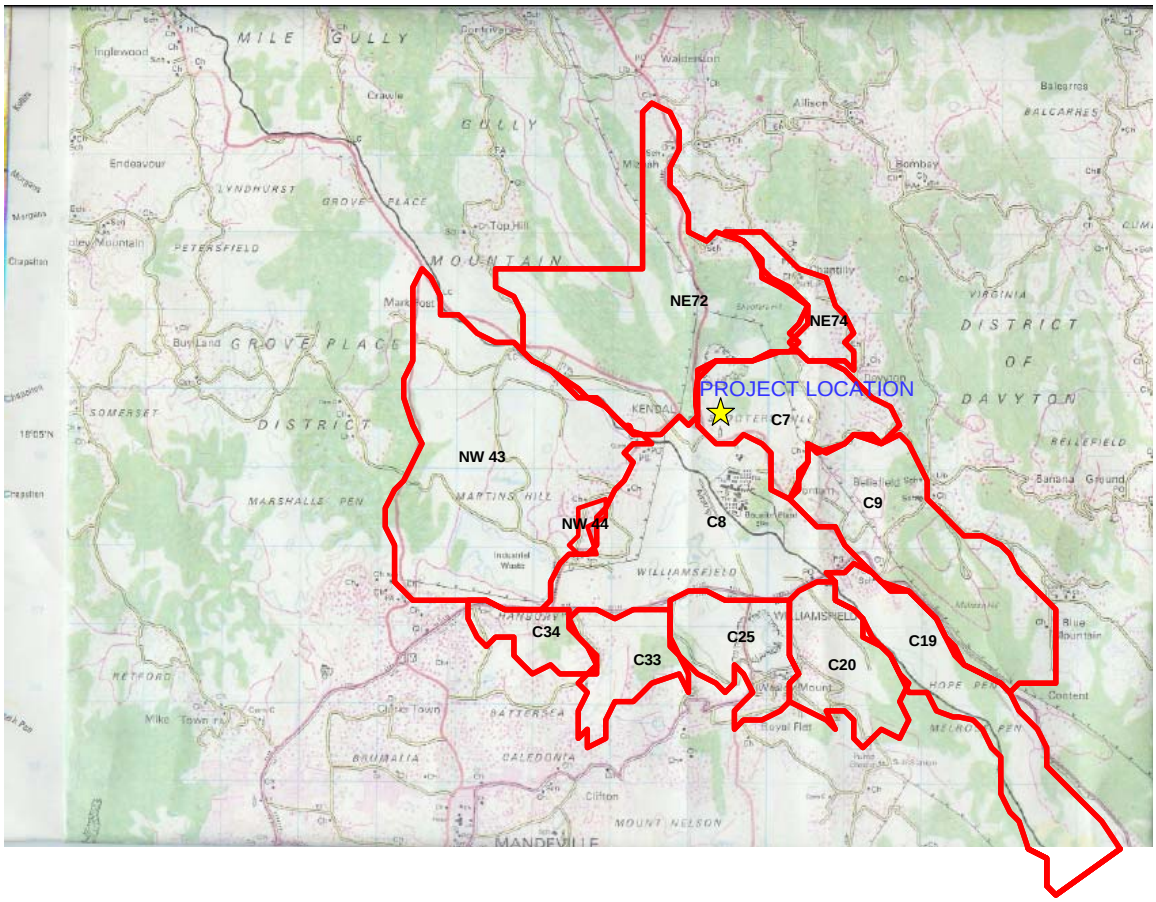


Figure 6-1: Enumeration Districts Surveyed

6.2 Methodology

The survey was based on a 5 per cent sample of households from the enumeration districts in the study area (as defined by the Statistical Institute of Jamaica) for the 2001 Population Census. The households for administration of the questionnaire were selected at random by the interviewer, within the enumeration districts. The respondent in all instances was the household head.

The information collected through the questionnaire included the following:

1. Personal Characteristics
2. Opinions on the community
3. Awareness and Opinions on Existing Bauxite Operations
4. Knowledge of and Views on Upgrade Plans
5. Interest in Areas of the Community
6. Miscellaneous

In most instances the questions allowed for multiple responses. The details of the specific findings related to the communities are presented in the following sections.

The follow-up consultations sought to provide direct answers to direct questions from the people of the communities.

6.3 Survey Findings

6.3.1 *The Survey Population Characteristics*

A total of 139 respondents were covered in the survey, 59 women and 80 men. The majority of the survey population were of the 20-39 years age group. The majority, 69 (49.60%), of the total survey population have lived in the community for twenty years or more. The information on age and numbers of years lived in the community characteristics are presented in the table below.

Table 6-2: Age and Years of Residency within each Community/ED

Community ▶ / Parameter ▼	NW 43*	NE 72*	Williamsfield	Mizpah	Hope View	Top Hill	Bellfield	Content/Chantilly	Comfort Hall	Kendal	Hope Village	Melrose	Royal Flat	Porus	Cool Shade	Old Road	ED C25*	Total
AGE																		
6-10 years	4	1	6	0	1	0	1	1	1	2	1	0	0	1	0	0	2	**21**
11-20 years	1	1	7	1	3	1	0	2	2	2	1	0	2	1	1	2	1	**28**
20+	4	1	8	8	4	1	1	12	3	13	2	6	0	1	3	1	1	**69**
NR	0	0	1	0	0	0	1	0	0	1	0	0	0	1	0	0	0	**4**
NR	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Total	**12**	**5**	**25**	**11**	**10**	**2**	**4**	**16**	**6**	**18**	**5**	**6**	**2**	**4**	**4**	**3**	**6**	**139**
YEARS OF RESIDENCY																		
0-5 years	3	2	3	2	2	0	1	1	0	0	1	0	0	0	0	0	2	**17**
6-10 years	4	1	6	0	1	0	1	1	1	2	1	0	0	1	0	0	2	**21**
11-20 years	1	1	7	1	3	1	0	2	2	2	1	0	2	1	1	2	1	**28**
20+	4	1	8	8	4	1	1	12	3	13	2	6	0	1	3	1	1	**69**
NR	0	0	1	0	0	0	1	0	0	1	0	0	0	1	0	0	0	**4**
Total																		**139**

NR – No Response
***Refers to the small communities grouped together:**

6.3.2 *Demographic and Social Profile*

The total population identified for this area in the 2001 census was 9,525. There were 2,186 housing units. The main material used in the construction of the housing units was concrete which accounted for 88.7% of total housing units (THU). The total number of households reported was 2,590 at an average of 1.18 households per housing unit.

Due to the small size of the community samples, the analysis will be presented on the basis of the absolute numbers and not on percentages.

6.3.3 *Opinions of the Community*

Quietness, friendliness of people and no crime and violence were expressed by the majority as being the traits they liked most about their community (24, 24 and 26 % respectively). The communities of Williamsfield, Content/Chantilly and Kendal found their communities to be largely quiet. A clean environment was most identified in Mizpah, Coolshade and Kendal, while the friendliness of people was high in Williamsfield, Content/Chantilly and Kendal. Availability of farmland was the least loved trait (Figure 6-2).

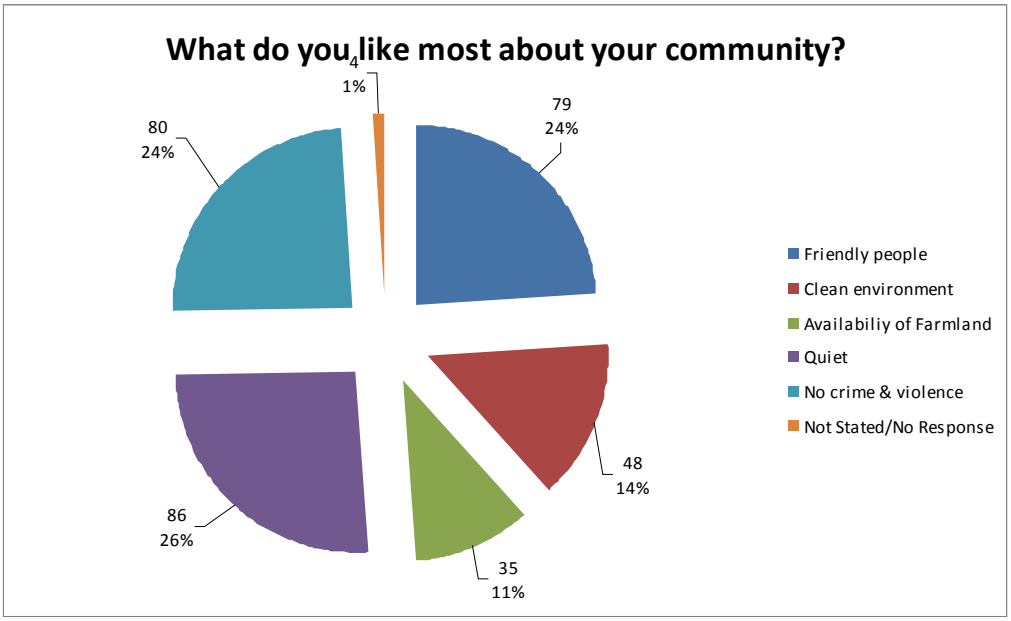


Figure 6-2: What do you like most about your Community?

Unemployment was the major dislike and accounted for 32%, particularly in the communities of Williamsfield, Content/Chantilly, Kendal and Mizpah. This was followed by responses to poor roads (26%), while lack of recreational activities accounted for 1%. Poor roads were a major concern in Content/Chantilly, Coolshade, Kendal and Mizpah. Almost the same number of people in Kendal found their environment dirty vs. clean. Williamsfield, Kendal and Hope Village respondents also found dirty environment as a major dislike (Figure 6-3).

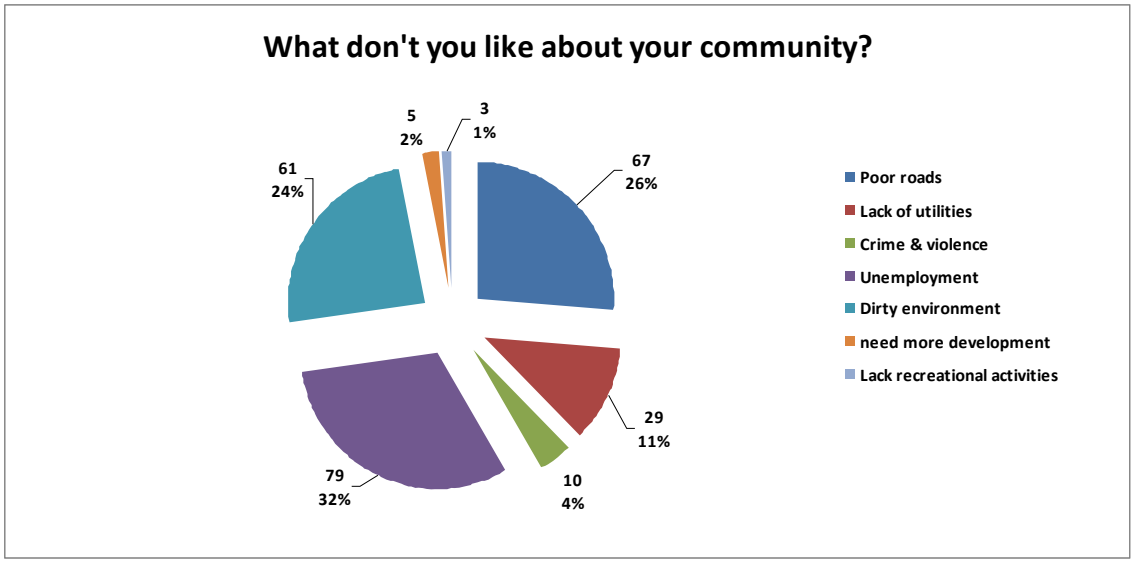


Figure 6-3: What don't you like about the Community?

6.3.3.1.1 Awareness and Opinions on Existing Bauxite Operations

Sixty-six percent (92) of respondents were not aware that WINDALCO intended to replace their existing lime kiln (Figure 6-4). This view was consistent across all communities surveyed.

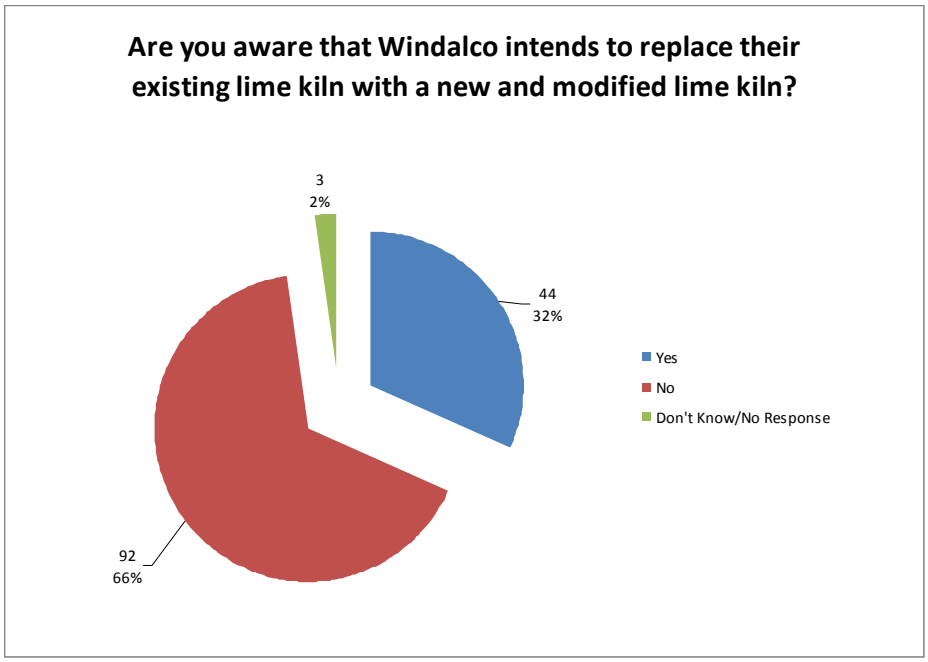


Figure 6-4: Awareness of WINDALCO's Intent to Replace Existing Kilns

Seventy-six percent (105) respondents said they were experiencing some kind of negative impacts from the bauxite operations at WINDALCO in the vicinity of Kirkvine Shooters Hill Quarry (Figure 6-5).

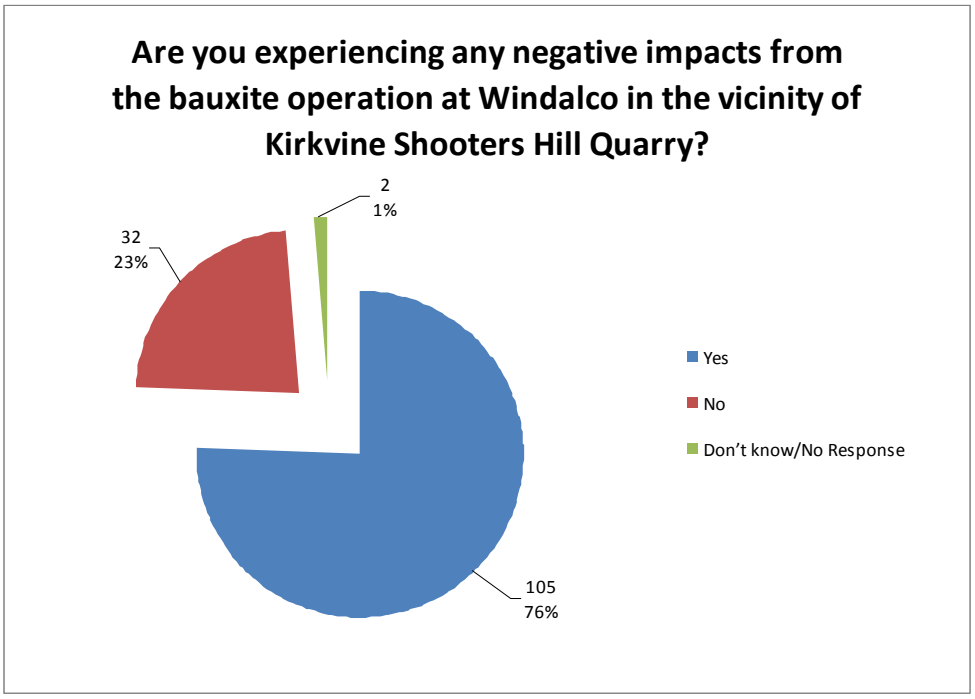


Figure 6-5: Respondents experiencing Negative Impacts from Windalso's Operations at Shooters Hill Quarry

Of the responses identified, 51% identified dust, soot or gaseous emission as the leading negative impacts facing them, particularly in the communities of Williamsfield, Mizpah, Hope View, Content/Chantilly, Kendal and Coolshade (Figure 6-6). This was followed by odour (16%) and noise (14%). Odour was significant in Williamsfield and Kendal, whereas noise was important in Williamsfield, Kendal and Content/Chantilly. No response was given by 14%. Health and unemployment accounted for 1% each.

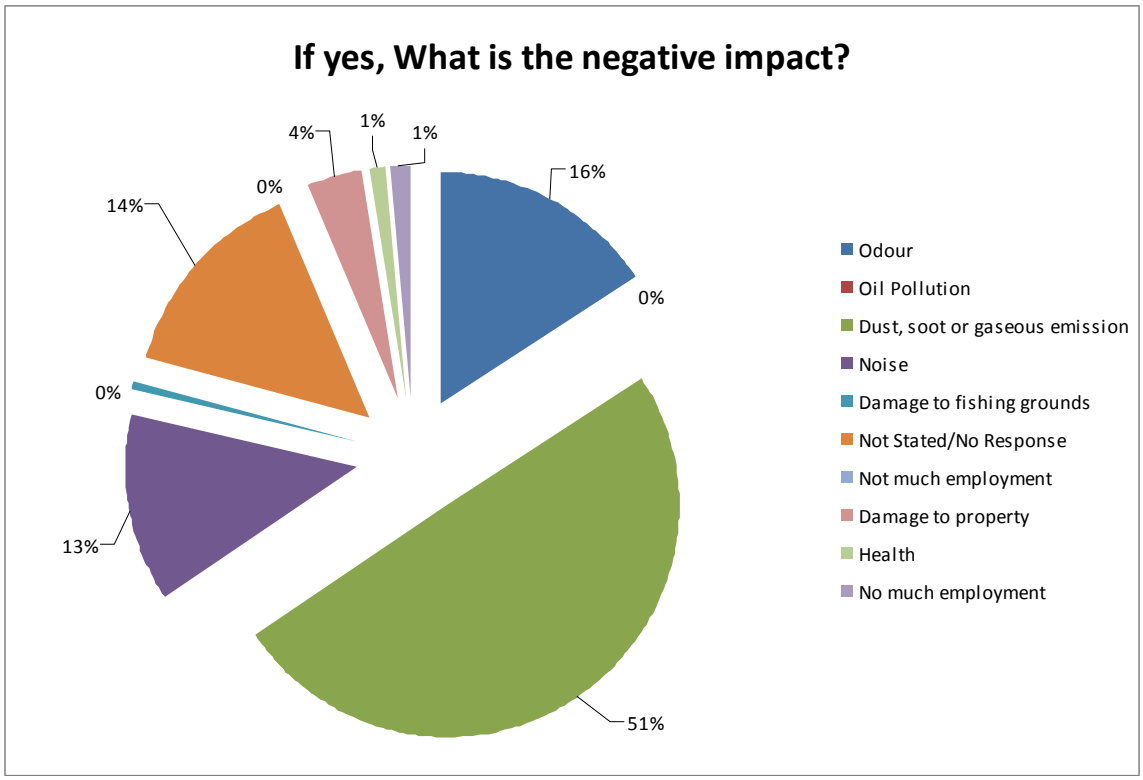


Figure 6-6: What kind of negative impacts are you experiencing from the bauxite operations at WINDALCO?

The existing kiln was viewed as having provided jobs on the positive side and more dust and noise on the negative side. Job opportunities accounted for 22% with the communities of Williamsfield, Mizpah, Content/Chantilly, Kendal and Melrose viewing it as a major impact of the existing kiln. However, 25% thought it contributed to more dust in their communities. This was felt by respondents mainly from Williamsfield, Mizpah, Hope View, Content/Chantilly, and Kendal. More noise accounted for 11% of responses and was felt by respondents mainly from Kendal, Williamsfield and Content/Chantilly. Incidentally, increased traffic only accounted for 9%, primarily from respondents in Kendal.

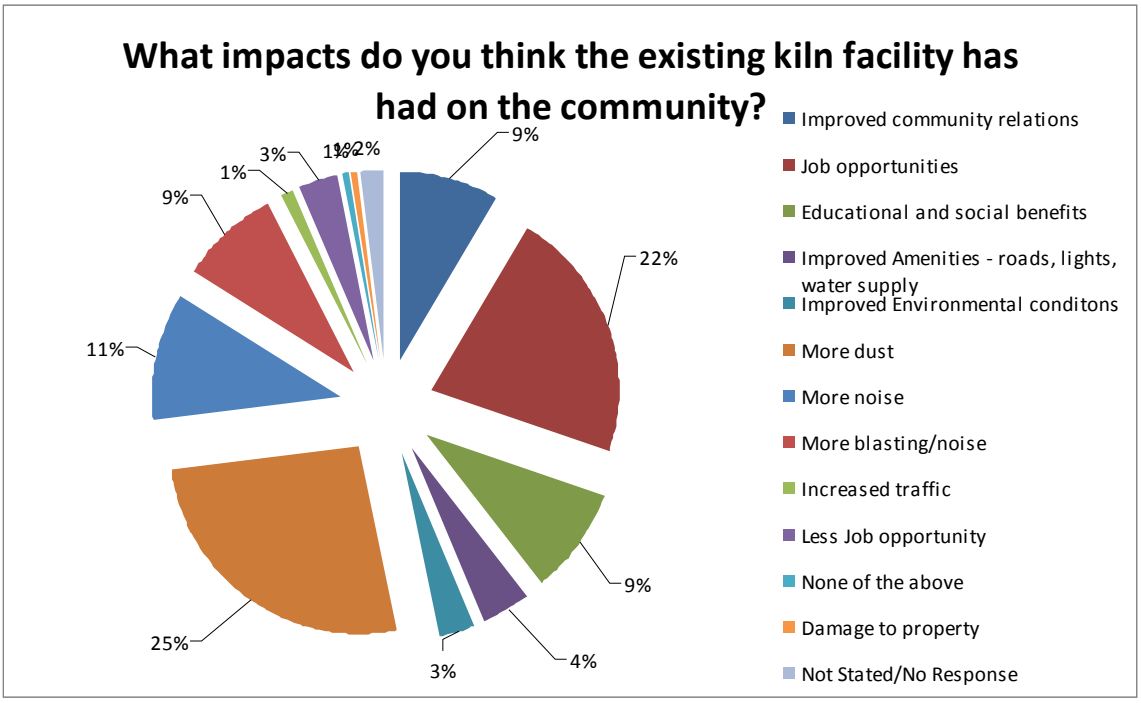


Figure 6-7: Impacts from the Existing Kiln

6.3.3.1.2 Knowledge and Views on Upgrade Plans

Fifty-nine percent (82) of respondents were not aware of the proposed construction of a new lime kiln by WINDALCO compared to 41% (57) that were aware. Of this number approximately equal views were expressed by respondents from Bellefield and Kendal. Those who knew about the proposed new lime kiln were mainly from the communities of Coolshade, Old Road, Melrose, Hope Village and Royal Flat. Respondents from Mizpah, Williamsfield, Content/Chantilly, Hope View and Porus were the least aware. Interestingly, approximately two-thirds of the respondents from Williamsfield, one of the closest communities, were not aware of the proposed plans (Figure 6-8).

It should be noted that the lime kiln project was presented in the electronic and print media since March 2007 (Appendix X).

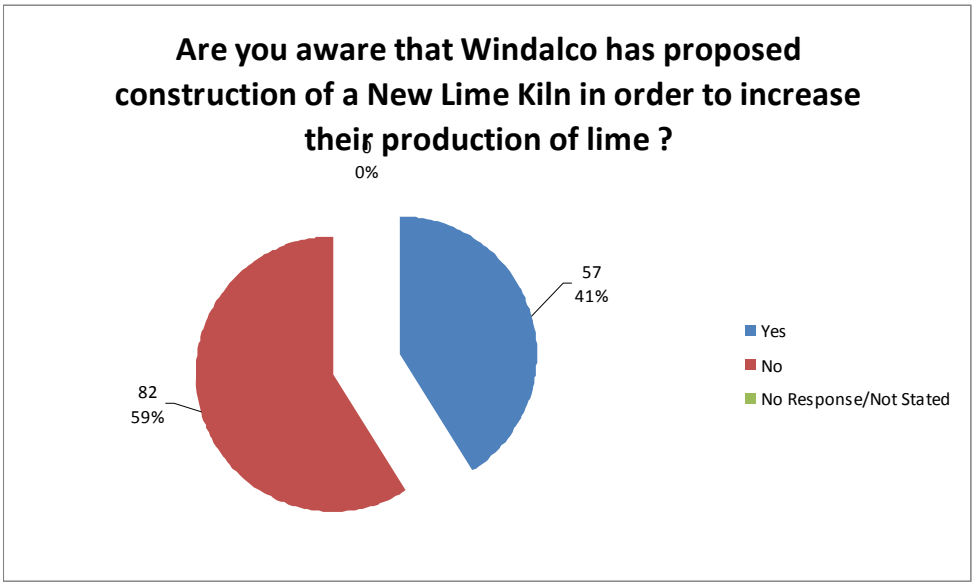


Figure 6-8: Awareness of WINDALCO Upgrade Plans

Respondents who heard of the plans were mainly informed via word of mouth (23%) and WINDALCO representative (16%), and community representation (6%) (Figure 6-9). The communities of Content/Chantilly, Kendal, Hope Village and Coolshade were mainly informed via word of mouth. Respondents in the communities of Content/Chantilly, Comfort Hall and Melrose indicated they were informed by WINDALCO representation. A Community representative was indicated to have informed respondents in Williamsfield, Hope View, Bellefield and Content/Chantilly.

A significant number, 27% indicated they were being informed for the first time at the time of the survey. These respondents were mainly from Williamsfield, Mizpah, Content/Chantilly.

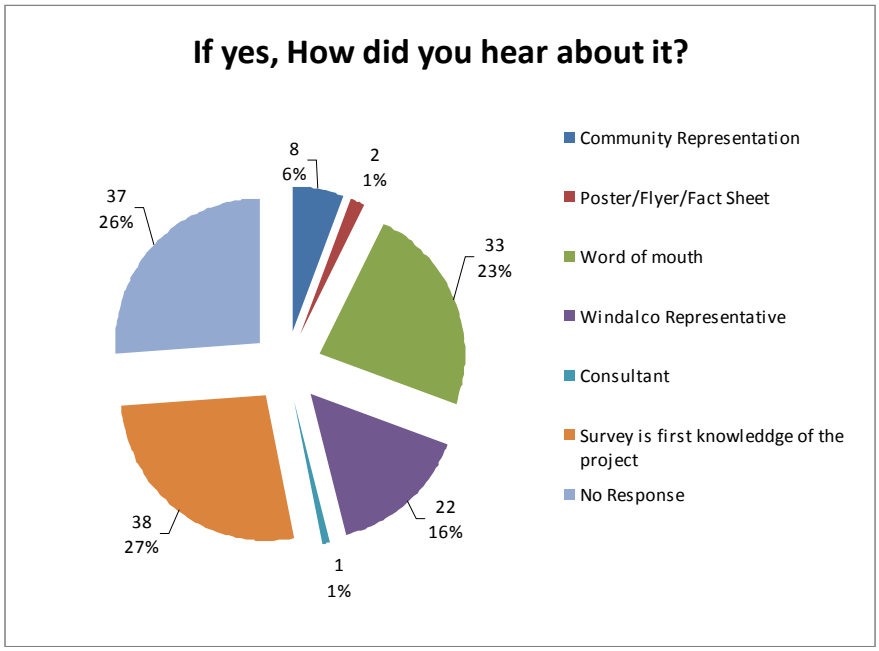


Figure 6-9: Information Channel on New Lime Kiln Project

Responses were also sought on respondents' views on the effect of the proposed construction of WINDALCO's new lime kiln on the following (Figure 6-10 to Figure 6-12):

- Income/economic value on community
- Job opportunities
- Pollution

Fifty-one percent (51%) were of the view that the proposed new lime kiln would affect them personally, while 30% thought it would not.

The view that the proposed construction of a new lime kiln by WINDALCO would have a positive impact on income or the economic value on the community was expressed by 47% of respondents. Twenty-five percent (25%) had a negative view. The positive view was expressed mainly by respondents from Williamsfield, Kendal, Hope View and Coolshade. The negative opinion was expressed mainly from Content/Chantilly.

Sixty-three percent (63%) of respondents thought the proposed construction would provide job opportunities and represented the majority of respondents' views across all communities, while 11% disagreed mainly from the community of Content/Chantilly.

The majority, 38% expressed the view that the proposed construction would impact negatively in terms of pollution on the environment. Respondents from the communities of Williamsfield, Hope View, Content/Chantilly and Kendal mainly expressed this view. Eighteen percent (18%) of respondents had a positive view of the impact to the environment from the proposed construction, mainly from the community of Coolshade.

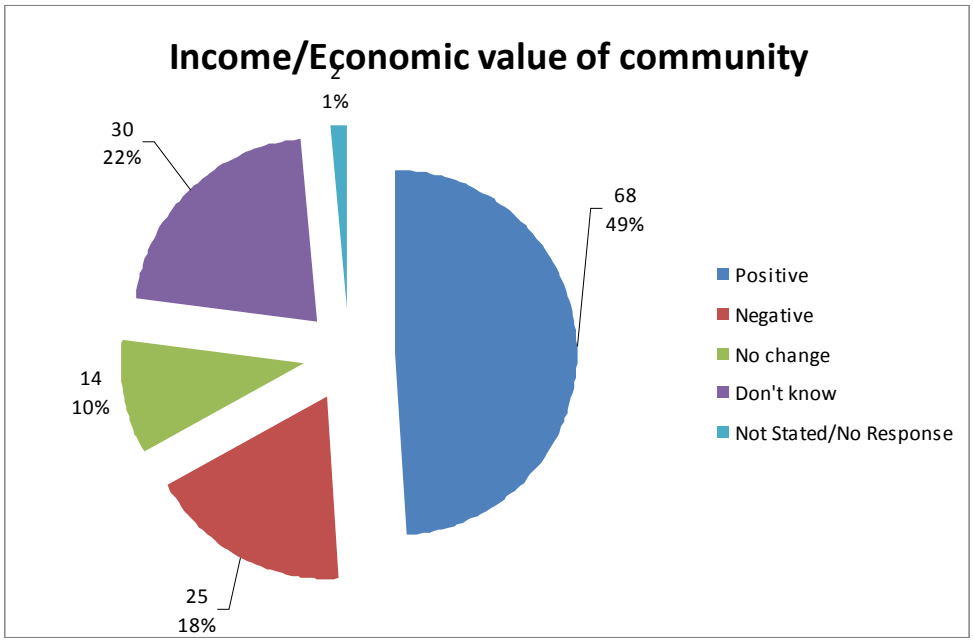


Figure 6-10: Income/Economic value to Community Potential

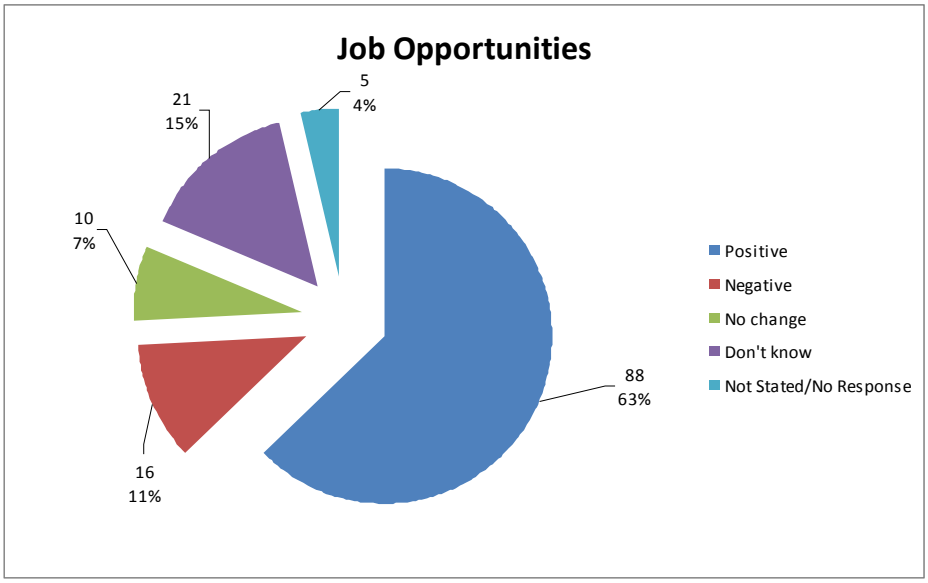


Figure 6-11: Job Opportunity Potential

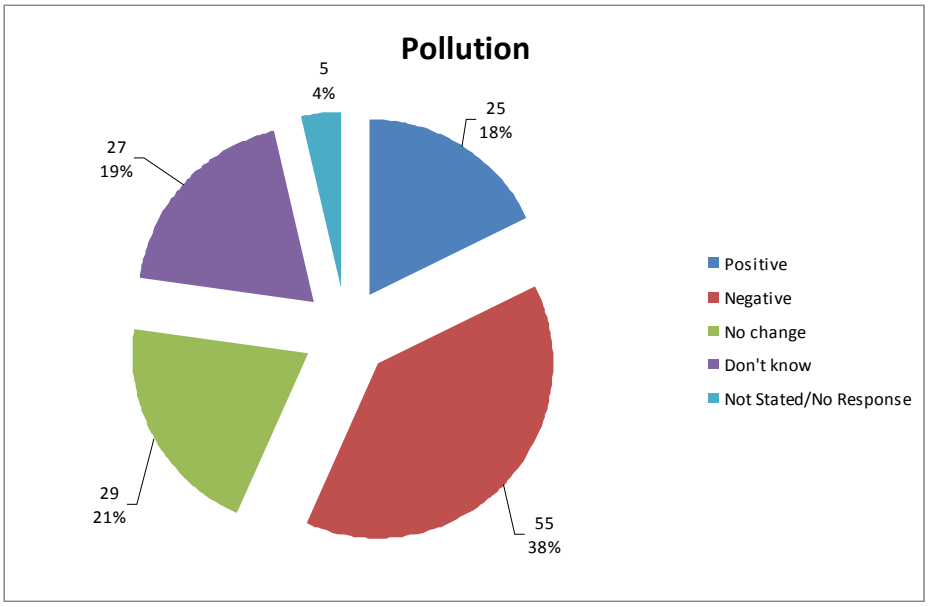


Figure 6-12: Pollution Potential

The main impacts from the proposed new lime kiln were viewed as: more dust (29%), more jobs (21%), more air pollution and noise (20%), and better community relations (9%). The communities of Williamsfield, Mizpah, Content/Chantilly and Kendal viewed the main

impacts as being more dust and more jobs. Better community relations were voiced by respondents from the communities of Content/Chantilly, Melrose, Coolshade and Old Road.

Fifty-seven percent (57%) of respondents stated that they have either worked or have a member of their household worked for a bauxite company or in the bauxite industry. Fifty-one percent (51%) of respondents were aware of programs or activities initiated by bauxite companies in the community.

6.3.3.1.3 Interest in Community Areas

Of the 139 respondents, 42% stated that they rely on the areas close to the quarry for their livelihood. These respondents were mainly from Content/Chantilly and Royal Flat. Twenty percent (20%) used the area for unemployment and 20% for farming. No response was given by 57% of respondents (Figure 6-13).

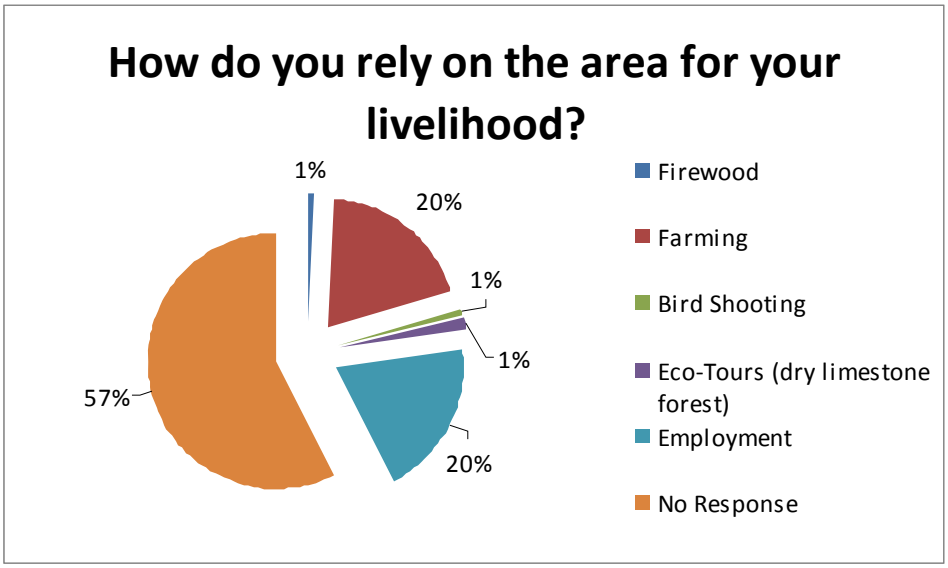


Figure 6-13: How Respondents relied on area for livelihood

Forty-seven percent (47%) of respondents stated the used the areas close to the quarry for recreational purposes. The majority of the respondents that stated they used the area did so on weekends (Friday-Sunday).

The areas utilised the most were the sport facilities, which accounted for 27% of respondents that used the area. Farming was second with 7% followed by use of the clubs/community centres. Thirty-eight percent (38%) did not state what they used the area for. Sporting facilities were used primarily by respondents from Williamsfield, Kendal, Melrose and Coolshade. Farming was done by respondents mainly from Content/Chantilly, and clubs and community centres were utilised mainly by respondents from Kendal and Old Road (Figure 6-14).

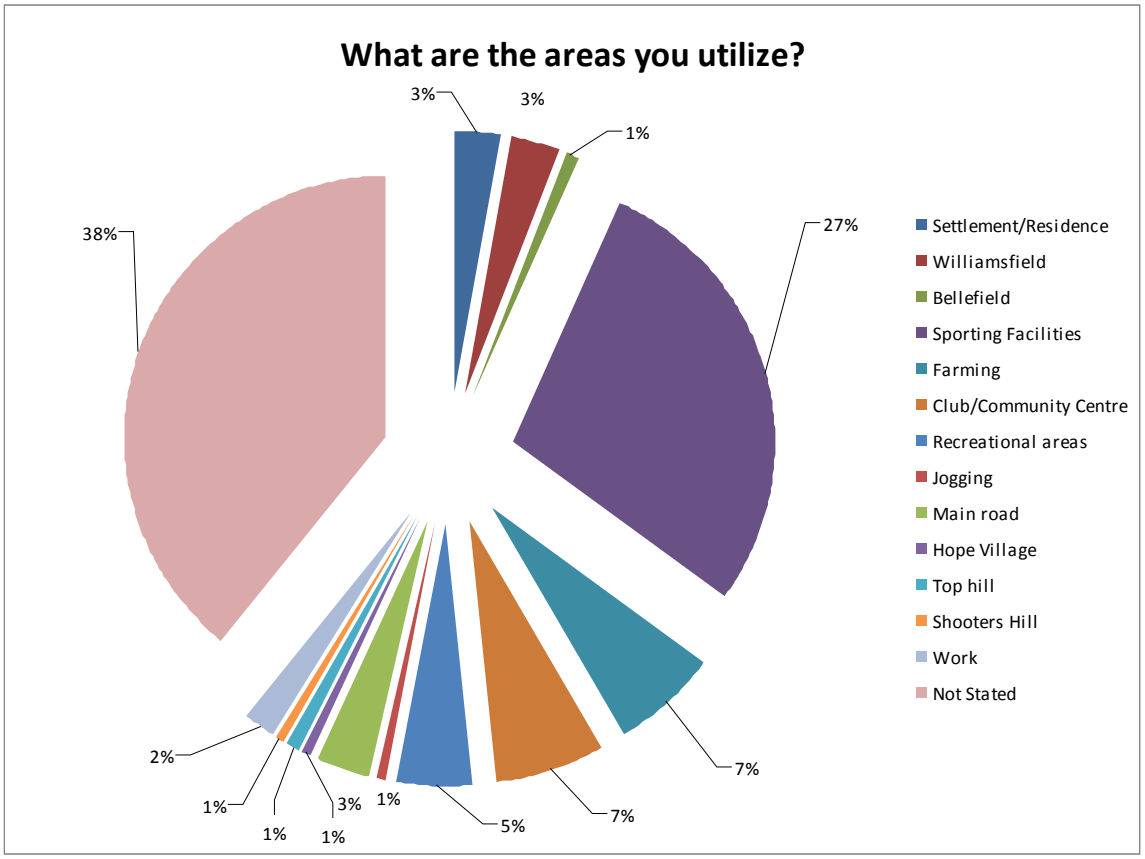


Figure 6-14: Areas Utilised

6.4 WINDALCO Kirkvine Works Community Complaints Registry

Windalco maintains a community complaints registry to track and deal with claims made against their operations. A total of 106 complaints were received through this forum for the calendar year 2006. Of this number, a total of 23 were for other dust and health related incidences. This represents less than 22% of all complaints generated. Within this number, health related incidences would be a combination of all complaint type that would generate health impacts and as such will not give a true representation of health impacts as they relate to individual parameters (Figure 6-15 below).

No complaint was generated for impacts from blasting. Additionally, of the 106 complaints received, about 42% (44) were found to be unsubstantiated.

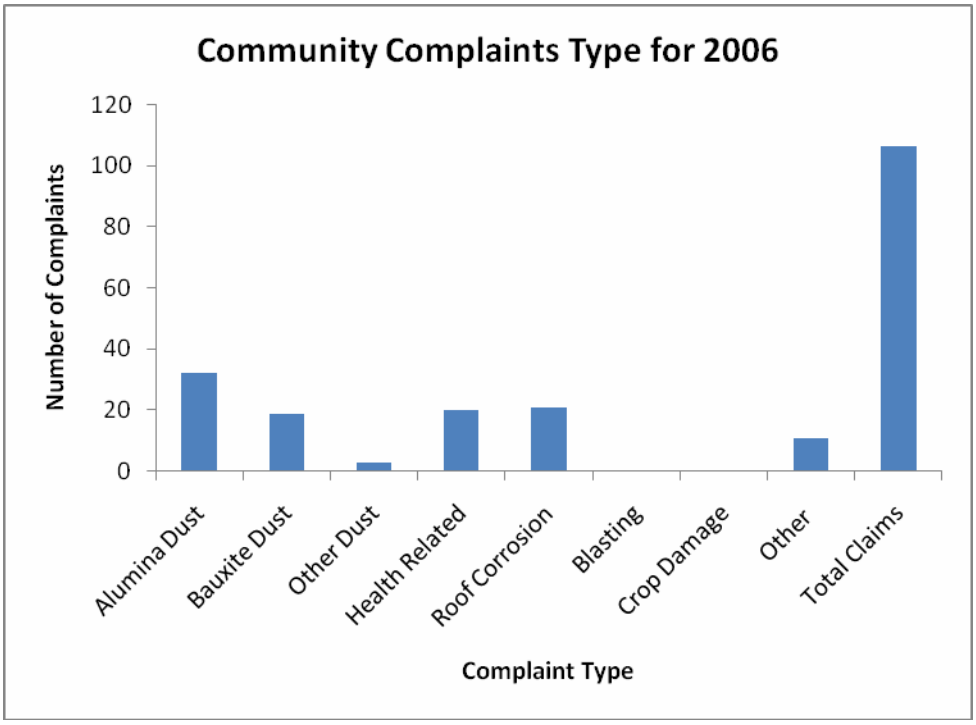


Figure 6-15: Community Complaint Summary for 2006

Communities such as Williamsfield and Kendal who have very active Community Councils would make reports through this medium. This means that more complaints would be generated by way of one person instead of various persons from the community.

Seventy-two complaints have been generated so far for 2007 (January – April). Of this number, 31 were for health related and 2 for blasting, with 6 non-classified claims (Figure 6-16). Blasting claims were made from individuals from Melrose Mews and Long Hill. None have so far been received from communities closest to the quarry such as Chantilly and Content.

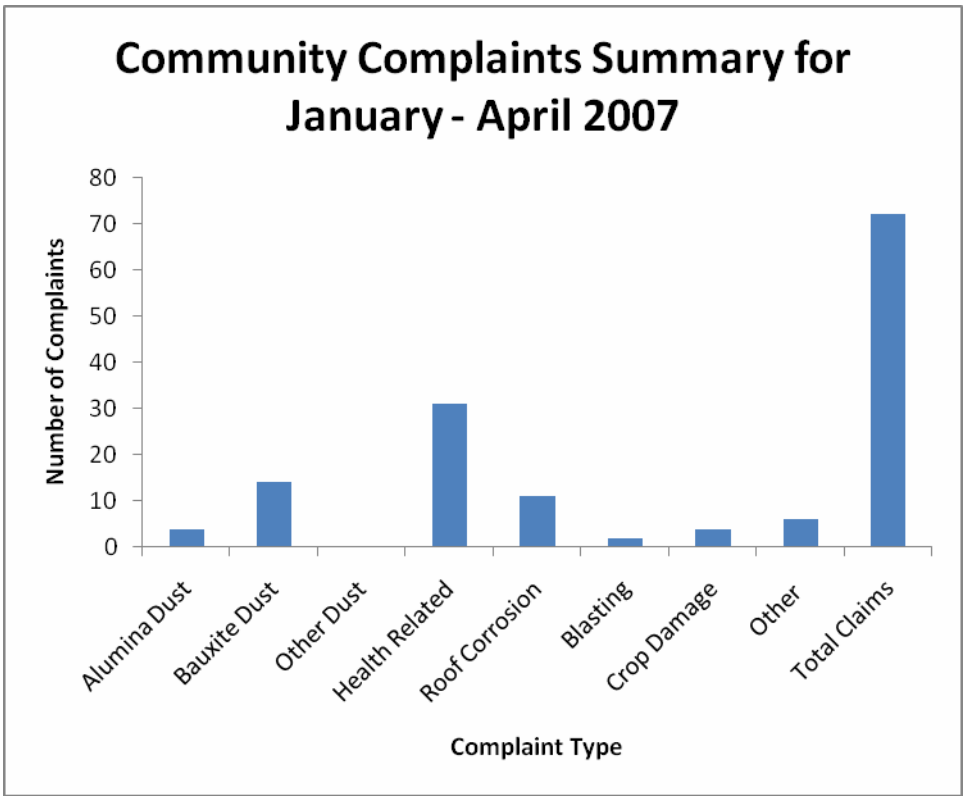


Figure 6-16: Community Complaints Summary for Jan. - Apr. 2007

6.5 Details of Consultations in North Manchester

Issues related to the following have come out as major concerns to those who participated in the consultation:

- Sources of dust and methods to deal with it
- All truck movements will be by main roads
- Communication with the community and authorities

- Economic situations related to repayment for inconveniences caused and access to trucking jobs

WINDALCO has publicised the new kiln project in the print and electronic media. Appendix X shows examples of these releases. These releases have been in major print newspapers such the Jamaica Gleaner, and electronic media such as Go-Local Jamaica (internet). Community sensitisations meetings have also been held with various community groups since the beginning of the year to inform them about the project. The last meeting was held in May 2007. Consultations have also been held with regulatory agencies such as NEPA, the last of which was held in June 2007 (NEPA).

DETERMINATION OF THE POTENTIAL IMPACTS OF THE PROPOSED PROJECT

7 Determination of the Potential Impacts of the Proposed Project

7.1 Introduction

In the process of undertaking this EIA, several potential impacts of the proposed project have been identified for each phase of the development. Impacts are evaluated in terms of the actual risk of occurrence, the extent (spatial) and duration, and severity. Cumulative effects of potential impacts of this project in conjunction with the impacts of existing activities/operations are also considered.

The project incorporates two aspects of the proposed development; each is considered separately with each phase (Pre-Construction, Construction and Operation) being taken into account. The operations are as follows:

- Quarry Development (Operation)
- Operation of Lime Kilns at Quarry
- Transportation of Fuel and Lime

Appropriate mitigation measures are also recommended for the various potential impacts identified.

In assessing the significance of potential impacts, various measures are used. These include the use of checklists/matrices, expert knowledge and a keen assessment of the project plans and details. Each parameter is evaluated according to the following:

- Potential impact - any change to the environment, whether adverse or beneficial, wholly or partially resulting from the proposed activities, products or services
- Activity – phase of development that action takes place in
- Environmental receptor - sensitive component of the ecosystem that reacts to or is influenced by environmental stressors
- Magnitude - A measure of how adverse or beneficial an effect may be

- Duration - the length of time needed to complete an activity
- Significance - A measure of importance of an effect
- Mitigation - Measures taken to reduce adverse impacts on the environment

Also presented are impact matrices (identification and mitigation) that summarise the impacts identified and the mitigations proposed for this project.

The following potential impacts are related to the key aspects of the proposed project; the quarry (operations), the new lime kiln facility (pre-construction, construction and operation), and the transportation of fuel and lime. The parameters analysed are as follows:

- Aesthetics
- Geology and Geo-Technology
- Water Quality/Surface Water Hydrology and Groundwater
- Air Quality
- Noise and Vibration
- Wildlife Resources
- Vegetation Resources
- Employment
- Solid Waste
- Sewage Waste
- Utility Demand
- Occupational Health and Safety
- Fuel & lime Storage

7.2 Project Stages

7.2.1 *Quarry Development (Operation)*

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
7.2.1.1 Aesthetics							
Operation	Humans, Flora & Fauna	Negative	**Item A1** – The clearance and removal of any vegetation from the site will result in a visually negative impact and loss of natural resources. Similarly, there will be the creation of limestone boulders and pits. The site is already a brownsite operation with on-going daily quarrying activities. All activities on the site will be carefully examined to ensure as little impact on the surrounding community as possible	Proper upkeep and maintenance of the site will be done. Vegetation cover will be maintained at the periphery to reduce the visual impact. Where necessary, vegetated areas will not be disturbed until existing quarried areas are exhausted. Quarry waste will also be utilised in the quarry rehabilitation.	Long Term	Major Negative	High
7.2.1.2 Geological and Geotechnical							
Operation	Humans, Flora and Fauna	Positive	**Item GG1** – Quarrying by nature changes the topography of any area. The existing quarry faces are expected to produce limestone for another 10 years. This will mitigate the need to open new quarry faces in vegetated areas. The existing faces have already been surveyed, and as such all geological and geotechnical surveys have been completed.	Modern blasting techniques will be utilised. Drilling and blasting techniques to be employed at the site will be revised and updated periodically to meet accepted international standards and practice. Quarrying within the site is and will be directed by geological and geotechnical surveys, as currently practiced. Pre- and post-blast surveys will be done. These surveys are already an implemented aspect of WINDALCO's Standard Practice Instructions (11/49 E&K – blasting; 11/16 K - operation) and will be continued. The continued quarrying activities will be directed by the regulations set forth within the licence as granted by the Ministry of Mining and Energy, Mines and Geology Division. Quarry Rehabilitation Plan will be implemented throughout the life of mine operations. Additional mitigation measures are included in the existing procedures under the ISO 14001 EMS. Existing programme of community consultations will be continued. The following is a list of communities near to the facility and the primary community issues addressed, as it relates to this project: • Providence – Pre- and Post-Blasting survey • Shooters Hill – Pre- and Post-Blasting survey, Dust compensation programme • Napierston – Pre- and Post-Blasting survey • Tameston – Pre- and Post-Blasting survey • Kendal – Dust compensation programme	Long Term	Major Positive	High

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
				• Mannings Hill – Dust compensation programme			
7.2.1.3 Water Quality/Surface Water Hydrology and Groundwater							
Operation	Humans, Flora and Fauna	Negative and Positive	**Item WQ1** – The potential impacts on water quality are confined to groundwater. The impacts on groundwater from quarrying will be negligible. Quarrying activities will not extend to the groundwater table which is at a minimum depth of 300 m in the Content area which is at a lower elevation than the quarry. The quarry operations entail the washing of stone for use in the kiln. The design for the new crusher screening and limestone storage plant allows for the use of water to wash the product for use in the kiln. Current operations employ stone washing and wash water, with fines, are drained into settling ponds. This water is settled and reused for further washing. Settled fines/calcite are periodically removed and placed in a designated area of the quarry. This calcite is periodically used in the front end of the Kirkvine Works alumina process.	The adoption of pre-screening (scalping) prior to the first stage of crushing coupled with the use of washing only for the kiln feed stone will reduce the overall water demand per tonne of quarried stone. It is anticipated that the washing process will only be required when severe contamination of limestone is encountered. This can occur in the upper levels of limestone where downward contamination by bauxite can occur. If washing is required, the present source of water (WINDALCO) will be used and techniques of recycling and reusing will be employed. No impact to groundwater is expected.	Long Term	Minor Negative	Low
7.2.1.4 Air Quality							
Operation	Humans, Flora and Fauna	Negative	**Item AQ1** – Quarrying activities have the potential to generate fugitive dust through blasting, crushing, and transportation of limestone aggregates. This is transient and disperses rapidly. The frequency of blasting will increase over the life of the existing operation, particularly during the initial development of the quarry plan.	Strict working procedures will be implemented to ensure that acceptable best practices are carried out by WINDALCO and/or their contractors, especially as it relates to the use of personal protective equipment to protect against dust. SPI 11/16 K will be effected. Dust suppression systems are already in place at the quarry and these measures and their frequencies will be increased to meet the increase in activity. This includes the treatment of all haul roads and working areas with water bowsers equipped with sprays. The new mobile crushing screens and limestone storage plant will be designed to minimise the release of dust. All tipping hoppers will be fitted with hoods, conveyors and conveyor transfers with wind covers, stone boxes and dust suppression water systems. Transportation within quarry will be restricted to daylight hours.	Short Term	Minor Negative	Medium
			Item AQ2 – Various mechanical equipment and vehicles are used within the quarry, such as crushers and trucks. The heavy duty vehicles will primarily be diesel fuel vehicles. When properly maintained heavy duty vehicles can operate without causing significant decrease in air quality. However, if maintenance is poor, excessive fugitive emissions may result.	Heavy duty equipment and vehicles using diesel fuel will be properly maintained and inspected at regular intervals. All vehicular maintenance will be done at an approved off-site maintenance location. Vehicle causing excessive fugitive emissions will be removed from service.	Short Term	Minor Negative	Low

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
7.2.1.5 Noise & Vibration							
Operation	Humans and Fauna	Negative	**Item N1 –** Various mechanical equipment, vehicles and site activities such as blasting can generate noise that may exceed acceptable levels. These activities are currently permitted and WINDALCO has an on-going policy to manage such.	Manufacturer approved silencers or mufflers will be fitted on quarry operation equipment and maintained as specified. Quarry operations are already restricted to daylight hours. Continuous monitoring of quarrying operations as currently practiced will be continued, and will abide by the regulations in place by NEPA and the Mines and Geology Division. Modern blast techniques such as the careful selection of stemming materials complete with time delayed blasting will result in significantly less noise and vibration.	Long Term	Minor Negative	Medium
7.2.1.6 Wildlife Resources							
Operation	Fauna	Negative	**Item WR1** – There exists a potential loss of wildlife resources within the immediate area. However this is confined to the extent of the quarry for which a licence exists. No region-specific wildlife resource occupies the area that will be critically endangered should this project go ahead.	No mitigation required. Wildlife is mobile in nature and will more than likely relocate to other areas in the vicinity where they are less likely to be in danger. Also, the existing quarried areas will provide limestone aggregates for at least another 5-10 years.	Long Term	Minor Negative	Low
7.2.1.7 Vegetation Resources							
Operation	Flora	Negative	**Item VR1 –** Any expansion into new quarry areas will result in minimal vegetation clearance. This will present a loss of biodiversity within the immediate area. No established ecosystems will be lost. No region-specific endemic plant species were found in the area. The proposed site is degraded with anthropogenic impacts primarily through the movement of heavy duty vehicles and the stockpiling of aggregates.	No Mitigation required. Also, the existing quarried areas will provide limestone aggregates for at least another 5-10 years	Long Term	Minor Negative	Low
7.2.1.8 Employment							
Operation	Humans	Positive	**Item E1 –** The quarry currently employs approximately twenty (20) contract workers. WINDALCO will utilise its existing contractors and engineers who may seek to employ residents of the surrounding communities due to their proximity to the project site, and their knowledge of the area and skill-set on an *as needed* basis.	No mitigation required.	Long Term	Major Positive	High

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
7.2.1.9 Solid Waste							
Operation	Humans	Negative	**Item SW1** – Quarrying operations produce waste stream in the form of boulders, fine limestone and clays etc. A properly implemented and executed solid waste management plan will remove this negative potential. WINDALCO has existing policies to handle this impact such as the WINDALCO Quarry Working Plan, and the Quarry Rehabilitation Plan.	Solid waste in the form of overburden will be removed during quarrying operations and stored in designated areas before being incorporated into the restoration of the worked-out quarry. Waste rock not required for the production lime will either be converted into saleable product for use in other markets including road stone or will be incorporated into the quarry restoration programmes. Fine limestone and clays removed during pre-screening and washing of quarried stone will be incorporated into the quarry restoration programme. This material will be stored in designated storage areas prior to re-use. The quarry working plan dictates the way in which the quarry will operate including the removal of overburden, the "winning of limestone", the disposal of waste products and the final restoration of the quarry.	Short term	Minor Negative	Medium
7.2.1.10 Occupational Health and Safety							
Operation	Humans	Negative	**Item OHS1** – This activity is confined to employees on the site. WINDALCO's existing occupational health and safety policies will be applied to this operation. WINDALCO is committed to the goal of zero accidents and will employ best practices to achieve worker health and safety compliance.	Adherence to the existing WINDALCO occupational health and safety standards and policies such as dust abatement technologies.	Long term	Minor Negative	Low
7.2.1.11 Transportation of Limestone to Kiln							
Operation	Humans	Negative	**Item T1** – Noise from heavy duty equipment can potentially be a nuisance activity is confined to employees on the site. WINDALCO's existing occupational health and safety policies will be applied to this operation. WINDALCO is committed to the goal of zero accidents and will employ best practices to achieve worker health and safety compliance.	Adherence to the existing WINDALCO occupational health and safety standards and policies such as dust abatement technologies.	Long term	Minor Negative	Low

7.2.2 *Lime Kiln & Associated Facilities (Pre-Construction, Construction & Operation)*

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
7.2.2.1 Aesthetics							
Pre-Construction, Construction, Operation	Humans, Flora & Fauna	Negative	**Item A1** – The clearance and removal of any vegetation from the site will not result in a visually negative impact. The site is already a brownsite operation with on-going daily quarrying activities. All activities on the site will be carefully examined to ensure as little impact on the surrounding community as possible	Proper upkeep and maintenance of the site will be done. Vegetation cover will be maintained at the periphery to reduce the visual impact. Where necessary, hoarding of not less than 2.4 m above ground level will be provided along the entire length of that portion of the site boundary except for any site entrances or exits.	Long Term	Major Negative	High
7.2.2.2 Geological and Geotechnical							
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	Positive	**Item GG1** – The inclusion of any existing drains at the site location for the kilns (which will be upgraded) into the project's drainage design will allow for better control and management of stormwater. This is a long term, beneficial impact. Significance Level: major positive. Change in topography is also expected with site grading and levelling exercises.	Engineered drainage and floodwater control system. The inclusion of any existing drainage features (which will be upgraded) into the projects' drainage design will allow for better control and management of stormwater which will reduce or eliminate erosion. The magnitude of site grading and levelling will be dependent on the design, which is being finalised.	Long Term	Major Positive	High
7.2.2.3 Water Quality/Surface Water Hydrology and Groundwater							
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	Negative and Positive	**Item WQ1** – The potential impacts on water quality are confined to groundwater. The impacts on groundwater of this project will be negligible as there are no chemicals, waste streams or disposal activities associated with the development that stands to affect groundwater.	WINDALCO's works are zero discharge operations. All water collected in the plants are ultimately impounded and reused in the process. This technique is practiced in the quarry. Within the quarry there are five settling ponds which are used to collect residue water from quarry operations and store rainfall runoff during rainy season. The installation of the kilns will not effect a change in the topography of the Shooters Hill Quarry. There will be zero sloping of land to accommodate the foundations of the structures. Therefore, no deviation from current drainage, storm water collection is expected. Part of the site will be covered with coarse aggregate to allow natural drainage to the subsoil. Concrete and tarmac surfaces will be drained into existing water pathways and diverted to the settling ponds using 6 inch HDPVC pipes routed underground.	Long Term	Minor Negative	Low

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
7.2.2.4 Air Quality							
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	Negative	**Item AQ1** – During site clearance and construction activities, there is a possibility that stockpiles of various materials associated with the proposed project may have to be maintained in the project area. These stockpiles, without proper management and monitoring can dry out and result in fugitive dust formation which can be dispersed in the wind affecting air quality. This is a short term, reversible and mitigable impact.	All stockpiles of construction material will be kept onsite for a minimum amount of time. This will limit the potential for stockpiles drying out and becoming airborne. If unavoidable, the stockpiles will be sprinkled or in the worst case covered to limit dispersion of dust particles.	Short Term	Minor Negative	Medium
			Item AQ2 – Various mechanical equipment and vehicles will be used at the project site. The heavy duty vehicles will primarily be diesel fuel vehicles. When properly maintained heavy duty vehicles can operate without causing a significant change in air quality.	Heavy duty equipment and vehicles using diesel fuel will be properly maintained and inspected at regular intervals. All vehicular maintenance will be done at an approved off-site maintenance location such as a garage. Vehicle causing excessive fugitive emissions will be removed from service.	Short Term	Minor Negative	Low
			During the operation of the lime kilns it is likely that gaseous emissions will occur. This may affect the ambient air quality within the area and are generated by intermediate and final materials handling and storage, and by the operation of kiln systems, clinker coolers and mills. Along with other trace gases, carbon dioxide contributes to greenhouse effect (global warming). Greenhouse gas emissions are mainly associated with fuel combustion and with the decarbonation of limestone, which in its pure form is 44% CO_2 by weight. The impacts of carbon dioxide production are global and cannot be quantified or mitigated on a local level by an individual company. International and national programmes are now in place, e.g. Montreal Protocol, to reduce or eliminate the usage of other elements of greenhouse effect. NO_X emissions are associated with the high temperature combustion process for operation of the kiln. SO_x emissions are dependent on the sulphur content of the fuel and limestone. Typical dry volumetric analysis of the exhaust gas is: CO_2 – 22-25%; O_2 – 5-8%; and N_2 – residual. The throughput and type of solid fuel will directly affect the quantity of CO in the exhaust gas. The new PFR kiln is more efficient than the existing rotary kiln.	Best technology will be utilised in this operation. The kiln will be fitted with a pulse jet bag filter unit designed to reduce dust emissions to less than 20 mg/m^3. The filter operates at 70-140 °C and is fitted with high performance bags treated to release dust. The lower temperature is close to the dew point of the gas and care will be taken in the operation and selection of material to ensure adequate release and removal of solids. Several different types of filter material have been found to be effective for this job, such as: PPS, Nomex and DralonT. Nomex is the specified filter material for WINDALCO's filters. The kiln exhaust stacks will be fitted with electrodynamic particulate sensors to monitor actual dust emissions. This device gives a continuous readout which is displayed on the plant control system. It is a predictive tool which can be used to give early warning of bag failure allowing planned replacement of the bags. Typical published NO_x values from PFR kilns fired with solid fuel is 300 and 400 mg/Nm^3. This equates to less than 200 tpa from an annual production of 300,000 tonnes of lime. NO_x production is generally low in lime manufacturing and will be controlled using low NO_x burners. Kiln operators indicate that approximately 90% of the sulphur will be absorbed by the limestone. Coal with a sulphur content of 2.2% is expected to give emissions of less than 200 tpa of SO_x from production of 300,000 tpa lime. Typical CO gas values may be between 250 and 500 mg/l. Fuel selected will be of low sulphur content. Installing the new PFR kiln will introduce a more efficient plant. The existing	Long Term	Minor Negative	Low

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
				rotary kiln at the WINDALCO and ALPART facilities will be mothballed and ultimately decommissioned.			
			Item AQ4 – Dust emissions are generated from kiln systems. The main sources of dust from the operation of a kiln plant are associated with the intermediate and final materials, handling and storage.	A simple linear layout will be employed as much as possible to reduce the need for multiple transfer points. Crushed and pre-blended raw materials will be covered as necessary. Pulverised coal and petcoke will be stored in enclosed steel structured silos. Fuel for the kiln will be stored in areas protected from the wind at the lee side. The lime produced will also be stored in steel structured silos. Routine plant maintenance and good housekeeping practices will be employed at the site to keep small air leaks and spills to a minimum. Conduct material handling will undertaken in enclosed systems maintained under negative pressure by exhaust fans, collecting ventilation air and removing dust by cyclones and bag filters, as needed. The kiln is also designed to capture kiln dust and recycle the recovered particulates into the kiln feed. Fabric filter systems (baghouses) will be incorporated to collect and control fine particulate emissions in kiln gases.	Short Term	Minor Negative	Low
7.2.2.5 Noise & Vibration							
Pre-Construction, Construction, Operation	Humans and Fauna	Negative	**Item N1** – Various mechanical equipment, vehicles and site activities associated with the kiln will generate noise that may exceed acceptable levels. The siting of the lime kilns and their operations will not affect the baseline noise and vibration of normal operations appreciably. Current international guidelines allow for the following maximum noise levels at the nearest noise sensitive property: o 55 db from 6 a.m. – 7 p.m. o 42 db from 7 p.m. – 6 a.m. All plant and equipment to be specified for the new kiln operation will be expected to meet this requirement. The main source of noise within the lime kiln operation will be from the transfer of stone particularly at the top of the kiln.	At the transfer points for stone at the top of the kiln the structures will be fitted with sound deadening cladding to attenuate noise. Air blowers used for kiln operations will be enclosed within a soundproof and dustproof building requiring hearing protection for personnel entry. The intakes for the blowers will also be fitted with silencers. The kiln is designed to meet the EU best technologies guidelines for the lime and cement industries. All plant and equipment is designed to meet NRCA limit of less than 70db.	Long Term	Minor Negative	Medium

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
7.2.2.6 Wildlife Resources							
Pre-Construction, Construction, Operation	Fauna	Negative	**Item WR1** – There exists a potential loss of wildlife resources within the immediate area. Based on the proposed location for the lime kilns, no resident wildlife will be affected. No region-specific wildlife resource occupies the area that will be critically endangered should this project go ahead.	No mitigation required. Wildlife is mobile in nature and will more than likely relocate to other areas in the vicinity where they are less likely to be in danger.	Long Term	Minor Negative	Low
7.2.2.7 Vegetation Resources							
Pre-Construction, Construction, Operation	Flora	Negative	**Item VR1** – In order to set up the lime kilns minimal vegetation clearance may be necessary. This presents a loss of biodiversity within the immediate area of less than one (1%) percent of the total acreage. No established ecosystems will be lost. No region-specific endemic plant species were found in the area in which the kiln is to be sited. The proposed site is degraded with anthropogenic impacts primarily through the movement of heavy duty vehicles and the stockpiling of aggregates.	No Mitigation required.	Long Term	Minor Negative	Low
7.2.2.8 Employment							
Pre-Construction, Construction, Operation	Humans	Positive	**Item E1** – The quarry currently employs approximately twenty (20) contract workers. WINDALCO will utilise its existing contractors and engineers who may seek to employ residents of the surrounding communities due to their proximity to the project site, and their knowledge of the area and skill-set on an *as needed* basis.	No mitigation required.	Long Term	Major Positive	High
7.2.2.9 Solid Waste							
Pre-Construction, Construction, Operation	Humans	Negative	**Item SW1** – Site clearance activities during the pre-construction phase and other waste from packaging materials in the other phases will generate solid waste. If these waste streams are not properly managed then the potential exist for a negative impact. A properly implemented and executed solid waste management plan can remove this negative potential.	The majority of the construction elements will be structural steel to be welded and fitted onsite. The remnants of the metal construction will be removed and ultimately sold to external contractors. All solid waste generated during all phases will be collected, handled and disposed of appropriately. Centralised storage areas (dumpsters, compacters etc.) will be located within the development for proper solid waste handling and storage. Solid waste in the form of paper and plastic conduits will be removed to WINDALCO's industrial dump.	Short term	Minor Negative	Medium

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
7.2.2.10 Sewage Waste							
Pre-Construction, Construction, Operation	Humans and Fauna	Positive	**Item SeW1** – The potential for sewage waste pollution during site clearance and construction activities exist though remote. The use of regularly serviced portable chemical toilets will negate this potential negative impact. Sewage handling and disposal will be effectively and carefully managed as part of the project management and monitoring plans. This will follow the same policy practiced at other WINDALCO operations. The existing amenity block includes toilet and shower facilities and serves approximately 20 people working in and around the quarry.	No mitigation required. The additional kiln operating staff will be four (4) individuals. This in itself will not significantly increase the loading on the system. As such, there will be no upgrade of existing system required. The existing septic tank/absorption pit system will be continued because it can accommodate the small increase in number of workers at the site.	Short term	Major Positive	High
7.2.2.11 Utilities Demand							
Operation	Humans	Negative	**Item UD1** – WINDALCO will be supplying the required fuel needed to run the kilns. As such there is no major need for working with NWC and JPSCo to develop independent/reliable source of each utility for the project. The quarry already has the basic energy and water demands met from existing infrastructure which is expected to be suitable for similar site operations. WINDALCO will also initiate water and energy conservation and minimisation strategies.	No mitigation required.	Long term	Minor Negative	Low
7.2.2.12 Occupational Health and Safety							
Pre-Construction, Construction, Operation	Humans	Negative	**Item OHS1** – This activity is confined to employees on the site. WINDALCO's existing occupational health and safety policies will be applied to this operation. WINDALCO is committed to the goal of zero accidents and will employ best practices to achieve worker health and safety compliance.	Adherence to the existing WINDALCO occupational health and safety standards and policies such as dust abatement technologies and the use of personal protective equipment	Long term	Minor Negative	Low
7.2.2.13 Lime & Fuel Storage							
Operation	Humans, Flora and Fauna	Negative	**Item LFS1** – Storage of diesel fuel will be done in the form of an above ground fuel storage tank. Diesel oil is required for cold start-up of the kilns. As a result of producing lime, storage facilities will be required prior to the transportation to the various destinations (Kirkvine	Once the kiln is running, diesel oil will only be used after a prolonged period of kiln shutdown. The unloading and diesel oil storage facility will be designed in line with current international practice for the bunding and containment of spillages. These spill containment bunds will be designed to hold a capacity of	Long term	Minor Negative	Low

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
			Works etc.). WINDALCO's existing occupational health and safety policies will be applied to this operation. WINDALCO is committed to the goal of zero accidents and will employ best practices to achieve worker health and safety compliance, in this case as it relates to spills.	1.5 times the capacity of the tank. The lime will be housed in steel enclosed silos of capacity 150 m^3. Loading of silos will be done within an all-enclosed design to prevent the lime coming in contact with moisture. The silos will also be equipped with pneumatic loading chutes fitted with filters to reduce loss of lime during filling of trucks.			

7.2.3 *Transportation and Storage of Fuel and Lime*

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
7.2.3.1 Transportation along Public Main Roads							
Operation	Humans	Negative	**Item T1** – This activity will generate noise and possible be a nuisance with regards to possible congestion caused by slow-moving vehicles, and wear and tear of roads. The average decibel level is not expected to exceed 95 dB (35 dB above conversational level). Intensity will be affected by distance (sound energy is inversely proportional to the square of the distance[12]). Lime from the facility will be transported to Kirkvine Works and ALPART by trucks. Delivery to Ewarton Works will be via rail. Approximately 20 truck movements will be required per day between the kiln and Kirkvine Works. At a consumption of 400 tpd there will be an increase of 20 truck movements between Kirkvine Works and ALPART. All proposed truck movements will be via main roads.	Muffling and maintenance of vehicles will be undertaken and the use of vehicles during hours of low traffic flows. The increased production of lime will replace imported lime and hydrated lime resulting in reduced truck movements. The transportation corridor between the proposed kiln location and Kirkvine Works will be approximately 100 m on public roads, significantly less than the distance currently covered between Port Esquivel and Kirkvine Works. A reduction of 6 lime hydrate truck movements will be realised between Port Esquivel and Kirkvine Works per day, this will mitigate the movements between the kiln and the plant. There will be a reduction in truck movements between Port Kaiser and ALPART to mitigate against the truck movements between the kiln and ALPART. Additionally, reduction in truck movements will be realised between Rugby Lime and ALPART.	Long Term	Minor Negative	Low
7.2.3.2 Air Quality							
Operation	Humans	Negative	**Item AQ1** – The formation of dust and increased gaseous emissions is also a possibility. This will be of direct nuisance. This impact may be realised from the filling and movement of trucks.	The loading of lime into trucks will be done via a telescopic loading chute fitted with dust extractors. The trucks will be enclosed either by steel cover or tarpaulin when travelling on public roads to reduce or eliminate the possibility of air-borne particles. Trucks transporting solid fuel will be covered with tarpaulin during transfers. The fuel will be transported damp to avoid spontaneous combustion. Trucks will be equipped with fire extinguishers. Proper vehicle maintenance will reduce the levels of air emissions.	Long Term	Minor Negative	High

[12] Morris & Thrievel, 1995. Methods of Environmental Impact Assessment p54

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
7.2.3.3 Occupation Health and Safety							
Operation	Humans	Negative	**Item OHS1** – Oil spill and other pollution of the environment. This event is extremely unlikely, and could be considered as rare, accidental occurrence. In the event that an accident of this nature occurs, the response would be instantaneous. This may be realised during loading and transportation of lime and fuel. Solid fuel will be transported via ships to Port Esquivel and then via trucks from Port Esquivel to Kirkvine Shooters Hill Quarry where a solid fuel stockpile will be maintained. Coal will be preferentially stockpiled against a quarry face which will act as a wind cover.	The development and institution on an emergency response plan specifically for the solid fuels and lime material being transported, and response mechanism that would enable effective clean-up measures. The transportation of lime will be via steel covered or tarpaulin covered trucks. Tarpaulin covered trucks will not be filled to capacity to prevent contact between the lime and the tarpaulin. Ingress of water will also be prevented since this can result in sufficient heat generation to set fire to the tarpaulin. As such, the loading of trucks will be closely managed to reduce contact of lime and cover. In addition, securing of the truck covers will enable the driver to cover the load without the risk of falling as per existing safety standards. All fuel stockpiles will be equipped with sprinklers to allow for periodic wetting, and compacted to prevent spontaneous combustion. Solid fuel will be offloaded at Port Esquivel from ships equipped with grabs and cranes onto trucks for temporary storage in an area downwind of the pier. Solid fuel will be transported damp to prevent spontaneous combustion. Trucks will be outfitted with fire extinguishers and drivers and/or operators trained in Emergency Preparedness and Response. SPI will be developed for solid fuel handling. WINDALCO Offloading SPI will be modified to effect the use of solid fuel. Training will be developed to allow for safe operation.	Long Term	Minor Negative	Low
7.2.3.4 Storage of Lime and Fuel							
Operation	Humans	Negative	**Item SLF1** – The storage of lime and fuel has the potential for impacts to groundwater, air quality and fire hazard. The production of lime necessitates storage. A stockpile of the kiln feed (fuel) will be necessary onsite because the kiln site is not closely located to Port Esquivel. An above ground fuel storage tank will also be maintained at the kiln site. This will provide fuel for the kiln start-up. Once the kiln is running it will only be used after a prolonged period of kiln shutdown. This storage facility will be designed in accordance with current international practice for the bunding and containment of spillages.	Lime produced will be stored in two (2) steel covered silos with individual capacity of 1,250 m^3. Coal will stored preferentially against a quarry face which will act as a wind cover. Coal will be crushed in a fully enclosed pulverising mill equipped with air dryer, bag filter and/or cyclone. The pulverised fuel will be blown into two (2) 150 m^3 fully enclosed pressurised silos. Inertization systems will be installed on solid fuel bins. All solid fuel stockpiles will be stored in areas underlain with a protective liner to mitigate against groundwater intrusion. The solid fuel storage area at Port Esquivel will be bunded and lined. The fuel will also be covered with tarpaulin. The diesel fuel stored at the quarry site will be housed in a 4500 L above ground fuel storage tank. The tank will be housed in a bunded area capable of holding 1.5 times the capacity of the tank.	Long Term	Minor Negative	Medium

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
7.2.3.5 Water Quality/Surface Water Hydrology and Groundwater							
Operation	Humans, Flora, and Fauna	Negative	**Item WQ1** – The potential impacts on water quality are confined to groundwater. Stormwater flowing through petcoke and coal stockpiles in open air may become contaminated.	Stormwater will be prevented from contaminating stockpiles by covering stockpiles and installing run-on controls around them. The base of stockpiles will also be lined. The run-on control systems will collect the stormwater into the existing settling ponds to allow particulate matter to settle before separation, control and recycling. WINDALCO's works are zero discharge operations. All water collected in the plants are ultimately impounded and reused in the process. This technique is practiced in the quarry. Part of the site will be covered with coarse aggregate to allow natural drainage to the subsoil. Concrete and tarmac surfaces will be drained into existing water pathways and diverted to the settling ponds using 6 inch HDPVC pipes routed underground.	Long Term	Minor Negative	Medium

7.3 Impact Matrices (Identification and Mitigation)

Table 7-1: Impact Identification Matrix

	EIA Activities																		
	Site Preparation				Construction									Operation					
	Site Surveying	Site Clearance	Site Access	Solid Waste Disposal	Materials Sourcing	Materials Transport	Materials Storage	Construction Works	Solid Waste Disposal	Sewage Treatment		Surfacing/Paving	Landscaping	Traffic	Solid Waste Disposal	Rail Line	Water Supply	Electricity Generation	Increased Migration
TOPOGRAPHY																			
GEOLOGY																			
AMBIENT NOISE & VIBRATION																			
WINDS																			
RAINFALL																			
NOISE AND DUST																			
DRAINAGE																			
TEMPERATURE																			
NATURAL HAZARD VULNERABILITY																			
Ecological Parameters:-																			
TERRESTRIAL ECOSYSTEMS																			
VEGETATION																			
BIRDS																			
OTHER FAUNA																			
VEGETATION																			
SENSITIVE HABITATS																			
Socio-Economic Parameters:-																			
AESTHETICS																			

	EIA Activities																		
	Site Preparation				Construction									Operation					
	Site Surveying	Site Clearance	Site Access	Solid Waste Disposal	Materials Sourcing	Materials Transport	Materials Storage	Construction Works	Solid Waste Disposal	Sewage Treatment		Surfacing/Paving	Landscaping	Traffic	Solid Waste Disposal	Rail Line	Water Supply	Electricity Generation	Increased Migration
LAND USE COMPATIBILITY																			
EMPLOYMENT																			
FOREIGN EXCHANGE EARNINGS																			
STRUCTURES/ROADS																			
WASTE MANAGEMENT																			
TRAFFIC ON THE ACCESS ROAD																			
HAZARD VULNERABILITY																			
SOLID WASTE DISPOSAL																			
SEWAGE DISPOSAL																			
OCCUPATIONAL HEALTH & SAFETY																			

Key

	Potential major positive impact
	Potential minor positive impact
	No potential impact
	Potential minor negative impact
	Potential major negative impact

The following are mitigative actions proposed for the project. Provided below is a key explaining the type, magnitude of each impact identified.

Table 7-2: Impact Mitigation Matrix (Pre-Construction Phase)

	Proposed Mitigative Measures																				
	Detailed Topographic Surveys	Effective Site Management	Scheduling of Construction Activities	Waste Management Plan	Placing of Solid waste Receptacles	Regular Solid waste collection	Road Paving and Surfacing	Dust Monitoring & Management Techniques	Proper Vehicle Maintenance	Installation of Sediment Traps/Silt screens	Security & Fencing	Positive Impact No Mitigation	Community Relations	Flora & Fauna Relocation/Landscaping	Portable Chemical Toilets	Disposal in approved landfill	Regulate & supervise Train Operation	Noise Monitoring & Management	Regular Servicing of Chemical Toilets	Limit Amount of Area Disturbed	Transport by Road
Levelling of Site	■	■	■					■		■											
Transportation of Construction Material		■	■	■			■	■	■												■
Increase in Noise & Vibration		■	■						■				■				■	■			
Increase in Dust		■	■				■	■					■								
Disturbance of flora and fauna		■	■											■						■	
Aesthetics		■	■	■	■			■		■	■		■								
Increased Traffic		■	■														■				■
Increased Employment												■	■				■				■
Road Wear		■	■				■		■				■								■
Increased Sedimentation of Coastal Waters		■								■											
Change in the Natural Drainage Patterns	■	■															■			■	
Solid Waste Generation & Disposal		■		■	■	■										■					
Increased Earning Potential for Community												■	■								
Traffic Inconveniences		■	■				■										■				■
Sewage Management		■	■				■								■				■		
Transportation of Large Equipment		■	■				■										■				■
Transportation of Solid Waste to Landfill		■	■				■									■					

Table 7-3: Impact Mitigation Matrix (Construction Phase)

	Proposed Mitigative Measures																			
	Detailed Topographic Surveys	Scheduling of Construction Activities	Waste Management Plan	Placing of Solid waste Receptacles	Regular Solid waste collection	Road Paving and Surfacing	Dust Management Techniques	Proper Vehicle Maintenance	Landscaping Measures	Effective Site Management	Security & Fencing	Installation of Sediment Traps	Scheduling of Heavy Vehicles	Positive Impact No Mitigation	Continue with Community Relations	Portable Chemical Toilets	Disposal in approved landfill	Noise Monitoring & Management	Regular Servicing of Chemical Toilets	Limit Amount of area Disturbed	Transport by Road
Impacts - Construction Phase																					
Increased Employment																					
Levelling of Site																					
Transportation of Construction Material																					
Increase in Noise																					
Increase in Dust																					
Occupational Health & Safety Concerns																					
Aesthetics																					
Increased Earning Potential for Community																					
Increased Traffic																					
Road Wear																					
Change in the Natural Drainage Patterns																					
Solid Waste Generation																					
Sewage Disposal																					

Key

	Minor mitigable impact
	Major mitigable impact
	No impact

Table 7-4: Impact Mitigation Matrix (Operational Phase)

	Proposed Mitigative Measures									
	Community Wide Plan	Operation & Maintenance Plan	Regulatory Monitoring	Waste Management Plan	Placing of Solid waste Receptacles	Regular Solid waste collection	Security & Fencing	Landscaping Measures	Positive Impact No Mitigation	Transport by Rail
Impacts - Occupational Phase										
Transportation of Lime										
Sewage Treatment Management										
Drainage Patterns										
Solid Waste Management										
Water Conservation										
Energy Conservation										
Aesthetics										
Regulatory Compliance										
Fugitive Dust										
Increased Earning Potential for Community										
Transport of Equipment to Refineries (Kirkvine and ALPART										

Key

	Minor mitigable impact
	Major mitigable impact
	No impact

ENVIRONMENTAL MONITORING AND MANAGEMENT PLAN

8 Environmental Monitoring and Management Plan

8.1 Introduction

8.2 Monitoring Plan

In keeping with its Environmental Health and Safety policies as well as the legislation and regulations of the Government of Jamaica, WINDALCO has an extensive Environmental Monitoring Programme which is carried out on all aspects of its operations.

In respect of Section 17 of the NRCA Act of 1991 the company is required to and submits the results of its Monitoring Programme to NEPA on a scheduled basis.

Among the parameters reported to NEPA, and ideal for this project are:

- raw materials used
- water quality
- effluent quality
- hazardous materials use and storage
- water consumption
- fuel specifications
- materials and chemicals consumption
- effectiveness of dust abatement practices
- effectiveness of nuisance noise abatement practices (audiometric surveys)
- occupational health and safety practices and proper usage of safety equipment
- traffic management practices (signing, use of wardens, gates, flags, notifications etc.)
- solid waste management

WINDALCO will implement a monitoring programme during this brownsite lime kiln project, which will cover the pre-construction, construction and operations phases. These will be based on the potential impacts identified in the impact identification and impact mitigation actions documented in those sections of this report.

The objective is to ensure that all potential impacts and the appropriate mitigation actions are taken.

Monitoring will be done at regular intervals as follows:

1. The conditions of the sites and transportation corridors will again be inspected and recorded two weeks before construction start-up
2. At start-up of construction all activities will be monitored every two weeks for the first three months.
3. From the fourth month and up to the end of the sixth month, monitoring will be done on a monthly basis.
4. Monitoring will take place quarterly until completion of construction.
5. Monitoring will be on a monthly basis for three months during commissioning and start-up.

Monitoring reports will be prepared and submitted to NEPA for each monitoring interval for 1 to 5 above.

8.3 Management Plan

WINDALCO is an ISO 14001 certified facility, with certification issued by Quality Management Institute on July 5, 2006 and is valid until July 10, 2009 (originally registered in August 2000). The associated Environmental Management System (EMS) is accredited by ANAB and IQNET.

WINDALCO is committed to being environmentally compliant through its Environmental Policy (Appendix VIII).

WINDALCO has a highly qualified technical, administrative and support staff within its Environmental Management Department, many trained to the tertiary level. All employees within the Department report to the Manager, Environmental, Health & Safety, a senior manager in the company who in turn reports directly to the Managing Director.

All aspects of WINDALCO's operations have an environmental management, health and safety component. Environmental Standard Operating Procedures, guidelines and instruction exist to govern operations in all areas of operation. As a result, all technical and support staff have a responsibility to ensure that they operate in a safe and responsible manner regardless of the task being undertaken.

Many aspects of environmental management at the facilities are monitored through the use of checklists, periodic reporting and internal audits. These provide timely indications as to the effectiveness of the procedures and provide indications as to the need for changes where applicable. The monitoring and checks also inform process operations and controls.

8.3.1.1 Training

WINDALCO has a commitment to the improvement and advancement of all its employees. A major component of this commitment is the provision and facilitation of training for employees at all levels.

Specific to environmental management, WINDALCO provides training in the following areas, which are designed to keep relevant employees and contractors informed and ensures competence in performing their duties.

8.3.2 *Proposed Rehabilitation Methods and Standards*

Shooter's Hill Quarry is underlain by a total accessible limestone reserve of 114,000,000 tonnes. This total is split between proven and probable reserves. Assuming a prudent 50% recovery rate this equates to 66 years of reserves suitable for use in the new lime kilns.

A prudent figure has been adopted for "wastage" that can and will be refined as the operation of the deposit proceeds and in the light of operational experience.

Educated assumptions have been utilised to produce a final indicative quarry form on which a successful progressive restoration programme can be based.

The principles of conceptual restoration will be agreed with the relevant authorities and applied to the final landform which will become clear as extraction proceeds.

This report, "Shooter's Hill Quarry - Geology, Reserves and Quarry Development[13]", addresses three (3) major aspects of developing the limestone reserves at Shooter's Hill Quarry.

- Part A deals with the geology of the site based on the exploratory drilling.
- Part B deals with the limestone reserves calculations and the approach in qualitative subdivision.
- Part C uses both previous parts in outlining the proposed quarry development. This part deals in more detail with the development in the first five years and the indicated quarry development for year 10. It also discusses major principles in developing the quarry to maximise the kiln feed stone recovery.
- Additionally, sections are dedicated to handling of waste and quarry restoration.

All of these three sections will be reviewed, revised and refined as operational knowledge and experience of the geology, raw materials and site conditions is accumulated over time through the life of the development.

8.3.3 *Operational Hazard Management & Safety Plan*

WINDALCO has a well-defined emergency response and preparedness program and policy. Effective response is seen as the direct outcome of quality environmental management, comprehensive training and awareness of safety procedures. The principal objective of their emergency preparedness is to localise accidents, contain and minimise them.

8.3.3.1 Response Plan

[13] Brossler, E. O., 2007, Shooter's Hill Quarry - Geology, Reserves and Quarry Development, July 2007, Geological, Planning and Environmental Consultants, Derbyshire, UK

Considering that all the details surrounding the construction of the plant are not yet completed, this report can only provide systems and general procedures necessary to effectively respond to emergencies.

The facility will have an Emergency Response Plan, which will provide guidelines to allow for flexible response to a range of potential circumstances. The plan would include:

- Chain of command and coordination procedures
- Lines of communication
- Means of obtaining needed information and assistance

Copies of the Plan or relevant sections will be strategically located at vantage points across the property to allow for immediate access. All employees will receive safety and emergency response training as part of the institution process.

8.3.3.2 Oil Spill Contingency and Recovery Plan

Fuel oil tanks will be encircled by an impoundment at a distance sufficient to contain 1.5 times the volume of liquid contained. In the unlikely event of failure of the impoundment, the spilled liquids will be pumped to a holding tank. In the event of minor spills, uncontaminated fuel will be returned to the storage tank (after completion of necessary repairs).

WINDALCO will prepare a Solid fuel handling contingency and recovery plan.

8.3.3.3 Fire Safety

Potable water, currently supplied by Kirkvine Works to the quarry, will be piped into a fire response system. This will involve connections to fire hydrants and fire hoses, which will be distributed at the site to assist in the event of a fire emergency. In addition, specialised fire fighting equipment will be provided as necessary.

REFERENCES

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APPENDIX

APPENDIX I: APPROVED TERMS OF REFERENCE

Appendix I: Approved Terms of Reference

DRAFT TERMS OF REFERENCE

ENVIRONMENTAL IMPACT ASSESSMENT

FOR

THE CONSTRUCTION OF A NEW LIME KILN AT WINDALCO'S

KIRKVINE WORKS, KIRKVINE, MANCHESTER

Conrad Douglas & Associates Limited (**CD&A**) has been contracted to conduct the Environmental Impact Assessment for the implementation of the proposed Lime Kiln at WINDALCO, Kirkvine, Manchester. In keeping with the requirements of the National Environment and Planning Agency (NEPA), CD&A provides this Draft Terms of Reference document for the captioned project.

Background

WINDALCO is proposing to replace its existing 55 years old Rotary Kiln with a new Parallel Flow Regenerative (PFR) Lime Kiln at its Kirkvine Shooter's Hill Quarry. The PFR Kiln will be able to produce 280,000 tonnes of lime per year and will allow WINDALCO the opportunity to decommission their rotary kiln which is known to be inefficient and possibly an environmental liability. Additionally, the construction of this new, more efficient kiln will eliminate the need for third party purchasing of lime by the company.

The existing Rotary Kiln cannot produce the required amount of lime to supply the plant, as a result, WINDALCO has to purchase lime from local and international third party suppliers to meet their demand. In 2005, 14,041 tonnes of lime were purchased from local while 28,583 tonnes were purchased from international suppliers to meet the demand for lime.

The scope of WINDALCO's Lime Kiln Project will include, but is not limited to:

- Site clearance and preparation to locate the kiln foundation
- Construction of the kiln foundation
- Installation of the kiln and associated infrastructure, which may include, fuel storage, lime storage, equipment maintenance area
- Lime Kiln operation
- Transport and handling of lime from kiln to Kirkvine plant and other locations
- Transport and handling of fuel
- Additional limestone mining and processing
- Emissions control and dust suppression at the kiln and quarry
- Quarry Preparation

DETAILS OF THE DRAFT TERMS OF REFERENCE

Conrad Douglas & Associates Limited will conduct an Environmental Impact Assessment (EIA) and prepare an EIA report, which will detail the pre-construction, construction and operational aspects of the proposed Lime Kiln project, in accordance with the requirements, standards and regulations of the National Environment and Planning Agency (NEPA) and WINDALCO's Environmental, Health and Safety Policy and Procedures. WINDALCO will also engage professionals to conduct a Health Impact Assessment (HIA) to satisfy the Terms of Reference of the Ministry of Health.

In the EIA, **CD&A** will:

1. Provide a comprehensive description of the existing site proposed for the construction of the Lime Kiln. The EIA report will detail the elements of the project, highlighting areas to be reserved for construction, the boundaries of the quarry, and the areas which are to be preserved in their existing state.

   The physical and chemical processes involved in the conversion of limestone (calcium carbonate) to lime (calcium oxide) will be presented and schematics used to illustrate

the same. Detailed design descriptions and drawings for the facility, including foundation, embankments and the actual kiln, will be presented.

2. Identify the major environmental issues of concern through analysis of the project designs and details, baseline data, social and cultural considerations. An assessment of the public perception of the proposed development will also be done, utilizing information gathered from a series of consultations with the local community and the use of a socio-economic survey instrument.
3. Outline the Regulatory Framework, Legislations and Regulations relevant to the project.
4. Predict the likely impacts of the proposed project on the described environment, and on health including, direct, indirect and cumulative.
5. Identify mitigation actions to be taken to minimize any adverse impacts that may be realized and provide associated costs where applicable (or practical).
6. Provide the basis for an Environmental and Health Monitoring Plan, which should guide the production of a detailed Plan that can be implemented during the project implementation. The proper implementation of the detailed Plan will ensure that the mitigation measures identified will be adhered to.
7. Conduct a Health Impact Assessment to determine impact of the activity on public health and satisfy the Terms of Reference of the Ministry of Health (MOH EHU).
8. Describe the alternatives to the proposed project.

CD&A will also provide full and detailed accounts in the following areas, prior to construction, during construction and the operational phases of the project:

1. **Description of the Project**:
    - Description of the area proposed to put up the lime kiln in detail.
    - Description of detailed element of the project – highlighting areas to be reserved for construction as well as areas to be preserved in their existing state and, activities and features which will introduce risks or generate impact (negative and positive) on the environment.

- Detailed design calculations and drawings for the facility, including base and embankments.
- Seismic vulnerability assessment.
- Use of maps, site plans and other graphic aids as appropriate.
- Information on location, general layout and size of the project area.
- Description of pre-construction, construction and post construction plans.

2. Description of the Environment

Presentation of baseline data, which is to be used to describe the study area in respect of the following:

i. Physical environment inclusive of geology, hydrology (include impact of the modification of the topography on the hydrology of the area of the influence of the project).
   a. Determination of storm water run-off, drainage patterns and effect of the project on ground water.
   b. Slope stability issues.
   c. Water quality and quantity issues, leachate management.
   d. Climatic conditions and air quality in the area in the area of influence, including particulate emissions from stationary and mobile sources, NO_x, SO_x, wind speed and direction, precipitation, relative humidity and ambient temperatures.
   e. Noise levels at the undeveloped site and ambient noise in the area of influence.
   f. Obvious sources of pollution existing and the extent of contamination, including identification of any additional services that may arise from this project.

ii. Biological environment
   a. Description of any flora or fauna in the sphere of influence of the proposed project with special emphasis on rare, endemic or endangered species.

b. Species dependence, niche specificity, community structure, population dynamics, carrying capacity, species richness and evenness (measure of diversity).

iii. Socio-economic and cultural constraints

a. Present and projected population
b. Present and projected land use
c. Planned development activities
d. Community structure
e. Employment
f. Distribution of income, goods and services
g. Recreation
h. Public health and safety
i. Cultural peculiarities
j. Aspirations and attitudes
k. Historical importance of the area
l. Public perception.

3. Policy, Legislations and Regulations:

- An outline of all pertinent policies, regulations and standards in keeping with the nature of the project will be provided. The examination of the legislation should include at a minimum, legislation such as the NRCA Act, Public Health Act, Clean Air Act, legislation from the Solid Waste Management Authority (SWMA), Mining Act and as appropriate, international conventions, protocols, treaties, etc.

4. Determination of Potential Impacts:

- An identification of any major environmental and health issues of concern, and an indication of their relative importance to the design of the project with the intended activities.
- Determination of potential impacts related, but not limited to, the following:
  a) Change in the drainage pattern and storm water management;
  b) Flooding potential;

c) Landscape impacts of mining, excavation and construction;
d) Loss of any natural features by construction activities;
e) Pollution of surface and ground water;
f) Solid waste disposal;
g) Air pollution;
h) Socio-economic and cultural impacts;
i) Risk assessment/Natural Hazard Vulnerability;
j) Noise;
k) Change in soil pH;
l) Waste disposal via recycling;
m) Accidental discharges into drainage features and water bodies;
n) Distinguish between positive and negative impacts.
o) Avoidable as well as irreversible impacts.

- Cumulative impacts.

5. Mitigation

- Preparation of guidelines for avoiding, as far as possible or eliminating, any adverse impacts due to proposed activity at the site while utilizing existing environmental attributes for optimum development. Where possible, quantification and the assignment of financial and economic values to impacts and mitigating methods will be done.

6. Monitoring

- Suggestion of a plan to monitor implementation of mitigation or compensatory measures and project impacts during construction and operation.
- Preparation of an Environmental Management Plan for the long-term operations of the site.

An outline of the monitoring program will be included in the EIA report and a detailed version will be submitted to NEPA after the granting of the permit and prior to the

commencement of the proposed development. The monitoring program will include the following, at a minimum:

- Introduction outlining the need for a monitoring program and the relevant specific provisions of the permit license granted;
- The activity being monitored and the parameters chosen to effectively carry out the exercise.
- The methodology to be employed and the frequency of monitoring.
- The sites being monitored, stating any outer boundary where no impact from the development is expected if stated by NEPA or other local agencies;
- A summary of data collected. Tables and graphs are to be used where appropriate;
- Discussion of results with respect to the development in progress, highlighting any parameter(s), which exceed(s) the standard(s).
- Frequency of reporting to NEPA.
- Recommendations;
- Appendices of data and photographs.

7. Project Alternatives

- Examination of alternatives to the project including the no-action alternative, alternative sites and an evaluation of alternative fuels. (Project alternatives should incorporate the use history of the overall area in which the site is located and previous use of the site itself.)
- Technological alternatives will be assessed and where possible comparisons made.

CD&A will present all findings in the Environmental Impact Assessment, reflecting the headings in the body of the approved Terms of Reference, as well as other references. Fourteen (14) hard copies and one electronic copy of the report will be submitted to NEPA. It will include an appendix with items such as maps, site plans, the study team, photographs and other relevant information.

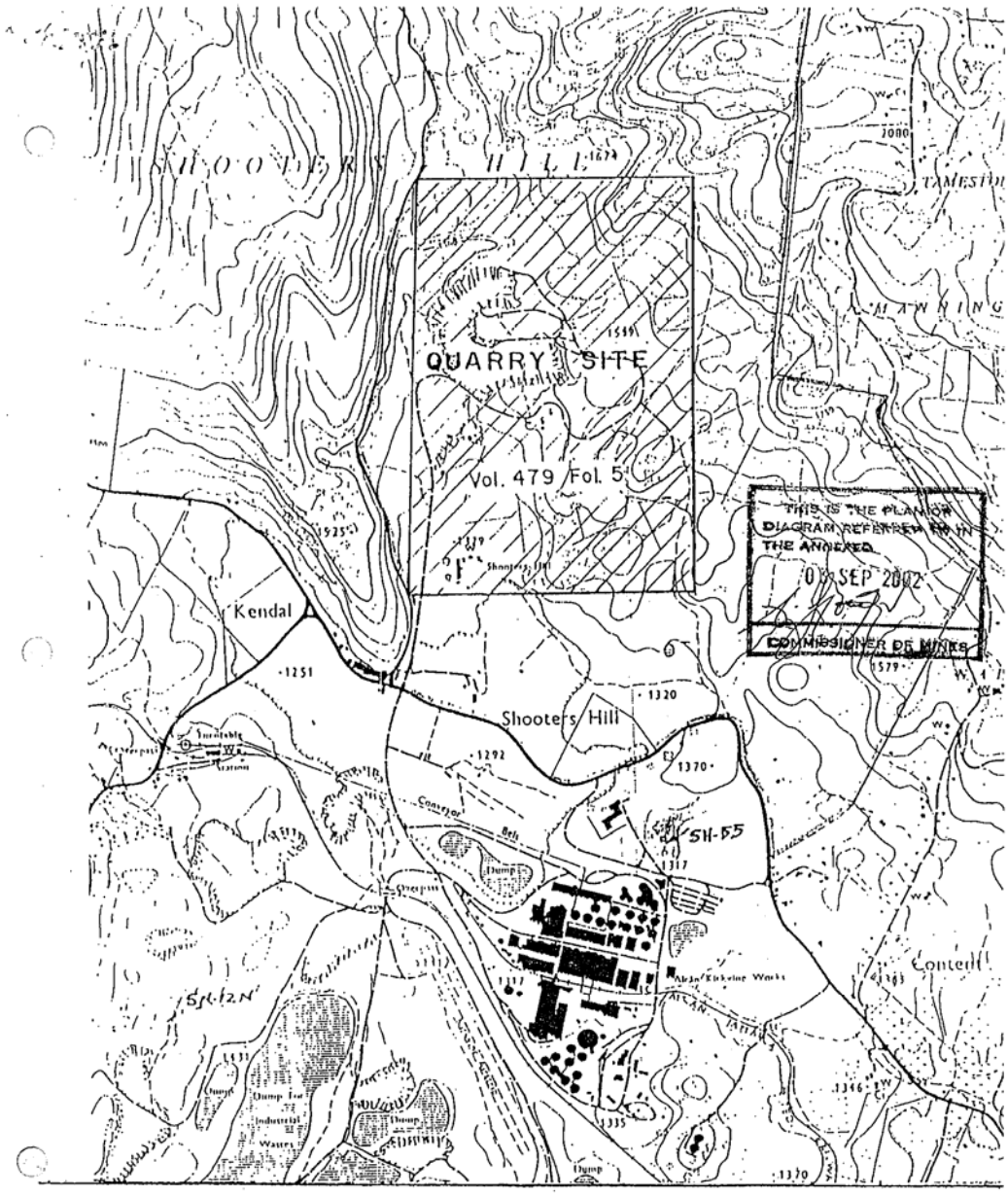
APPENDIX II: WINDALCO QUARRY LICENCE/PERMIT

Appendix II: WINDALCO Quarry Licence/Permit

THE QUARRIES CONTROL ACT

QUARRY LICENCE No. 1644

WINDALCO



LOCATION MAP

QUARRY SITE – KIRKVINE WORKS.

Scale 1:12,500 – Ref. Sheet 65A of the 12,500 Map Series.

E-1920-JA.

APPENDIX III: PROJECT TEAM

Appendix III: Project Team

Dr. Conrad Douglas

Professor Ted Robinson

Mr. Paul Thompson

Mr. Orville Grey

Mr. Wayne Morris

Mr. Burklyn Rhoden

Mr. Vance Johnson

Mr. Marco Campbell

Mr. Damion Whyte

APPENDIX IV: SURVEY INSTRUMENT

Appendix IV: Survey Instrument

Socio-Economic Survey for WINDALCO's Proposed Lime Kiln at Kirkvine Shooter's Hill Quarry, Manchester.

Community Name _____ Community Code | | | | | |

SECTION 1

PERSONAL CHARACTERISTICS

1) Gender
    1. Male
    2. Female
2) Age Range
    1. Under 20
    2. 20 – 39
    3. 40 – 49
    4. 50 – 59
    5. 60 – over
    6. Not Stated/No Response
3) How many years have you been living in the community?
    1. 0 – 5 Years
    2. 6 – 10 Years
    3. 11 – 20 Years
    4. more than 20 Years
    5. Not Stated/No Response

SECTION 2

OPINIONS ON THE COMMUNITY

4) What do you like most about the community? **(*ASK & WAIT FOR RESPONSE)***

1. Friendly people
2. Clean environment:
3. Availability of farmland
4. Quiet
5. No crime & violence
6. Other, (specify)_____
7. Not Stated/No Response

5. What don't you like about the community? (***ASK & WAIT FOR RESPONSE)***

1. Poor roads
2. Lack of Utilities
3. Crime & violence
4. Unemployment
5. Dirty environment
6. Other, (specify)_____
7. Not Stated/No Response

SECTION 3

AWARENESS OF EXISTING OPERATIONS

6. Are you aware that WINDALCO has been given a permit to **replace** their existing Lime Kiln with a new and modified Lime Kiln?

1. Yes
2. No
3. Not Stated/No Response

7. Are you experiencing any **negative** impacts from the bauxite operation at WINDALCO in the vicinity of Kirkvine Shooter's Hill Quarry?

    1. Yes (Go To Question 8 below)
    2. No
    3. Not Stated/No Response

8. If **YES ASK**: What is this negative impact?

    1. Odour
    2. Oil Pollution
    3. Dust, soot or gaseous emission
    4. Noise
    5. Damage to fishing grounds
    6. Not Stated/No Response
    7. Other, (specify)_____

9. What impacts do you think the **existing** kiln facility has had on the community? (***ASK & WAIT FOR RESPONSE)***

    1. Improved community relations
    2. Job opportunities
    3. Educational and social benefits
    4. Improved Amenities – roads, lights, water supply
    5. Improved Environmental conditions
    6. More dust
    7. More noise
    8. More blasting/noise
    9. Increased traffic
    10. Less Job opportunity
    11. None of the above
    12. Other (specify)_____
    13. Not Stated/No Response

SECTION 4

KNOWLEDGE AND VIEWS ON UPGRADE PLANS

10. Are you aware that WINDALCO has proposed **construction** of a Lime Kiln in order to increase their production of lime for their bauxite operation?

i. Yes
ii. No

10a. How did you hear about it?

i. Community Representation
ii. Poster/Flyer/Fact Sheet
iii. Word of mouth
iv. WINDALCO Representative
v. Consultant
vi. This Survey is first knowledge of the project

11. What effect do you think the proposed construction of WINDALCO's new Lime Kiln will have on the following: (**Answer in terms of positive, negative, no change, don't know. ASK AND WAIT)**

i) Income/ Economic value of the community

1. Positive
2. Negative
3. No Change
4. Don't Know
5. Not Stated/No Response

ii) Job Opportunities

1. Positive
2. Negative
3. No Change
4. Don't Know
5. Not Stated/No Response

iii) Pollution

1. Positive
2. Negative
3. No Change
4. Don't Know
5. Not Stated/No Response

12. Do you think the proposed construction will affect you personally?

1. Yes
2. No
3. Don't Know/Not Sure
4. Not Stated/No Response

13. What do you think are the **main** impacts that the new Lime Kiln and its environs would have on the local environment?

1. More jobs
2. Loss of income
3. More dust circulating in the area
4. Less air pollution and noise
5. More air pollution and noise
6. Contamination of fishing grounds
7. Better community relations
8. Improved environmental protection and other amenities
9. More crime in the community

10. Increased population
11. Don't know/Not Sure
12. Other (specify)
13. Not Stated/No Response

14. Why do you think so?

1. The present activities at the Bauxite Plant / Quarry have caused this already. So it can only get worse.
2. The upgrade will add new equipment that will be cleaner to operate
3. More jobs will be available
4. This is something common to all bauxite operations
5. The upgrade will cause more people to pass through the community. So it gives more opportunity for crime
6. This is something that someone told me
7. Don't Know/Not Sure
8. Other (specify)
9. Not Stated/No Response

SECTION 5

15. Have you or any member of your household ever worked for a bauxite company or in the bauxite industry?

1. Yes
2. No
3. Don't Know/Unsure
4. Not Stated/No Response

16. Are you aware of any programs or activities initiated by bauxite companies in your community?

1. Yes
2. No
3. Don't Know/Unsure
4. Not Stated/No Response

17. Do you rely on the areas close to the quarry for your livelihood?

    1. Yes (Go To Next Question)
    2. No (Skip To Question 21)

18. How do you rely on the area for your livelihood?

    1. Firewood
    2. Farming
    3. Bird shooting
    4. Eco-Tours (dry limestone forest)
    5. Other _____

19. Do you use the area for recreational purposes?

    1. Yes
    2. No

20. How many days per week do you use the area?

    1. One
    2. Two - Three
    3. Four or more

21. When do you use the area?

    1. Weekends only (Fri, Sat, Sun)
    2. Sun-Sat (all week)
    3. Mon – Fri

22. What are the areas you utilize? (Name them).

_____

_____

THANK YOU

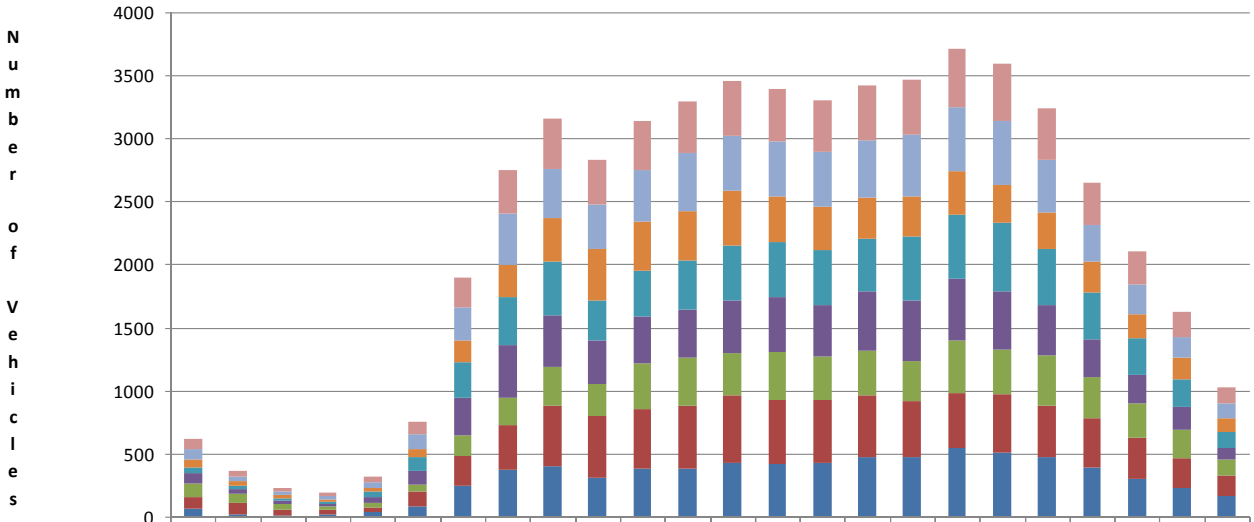
Name of interviewer:

Signature of interviewer:

Date of interview:

APPENDIX V: TRAFFIC COUNT DATA

Appendix V: Traffic Count DATA – 2007 Data Set

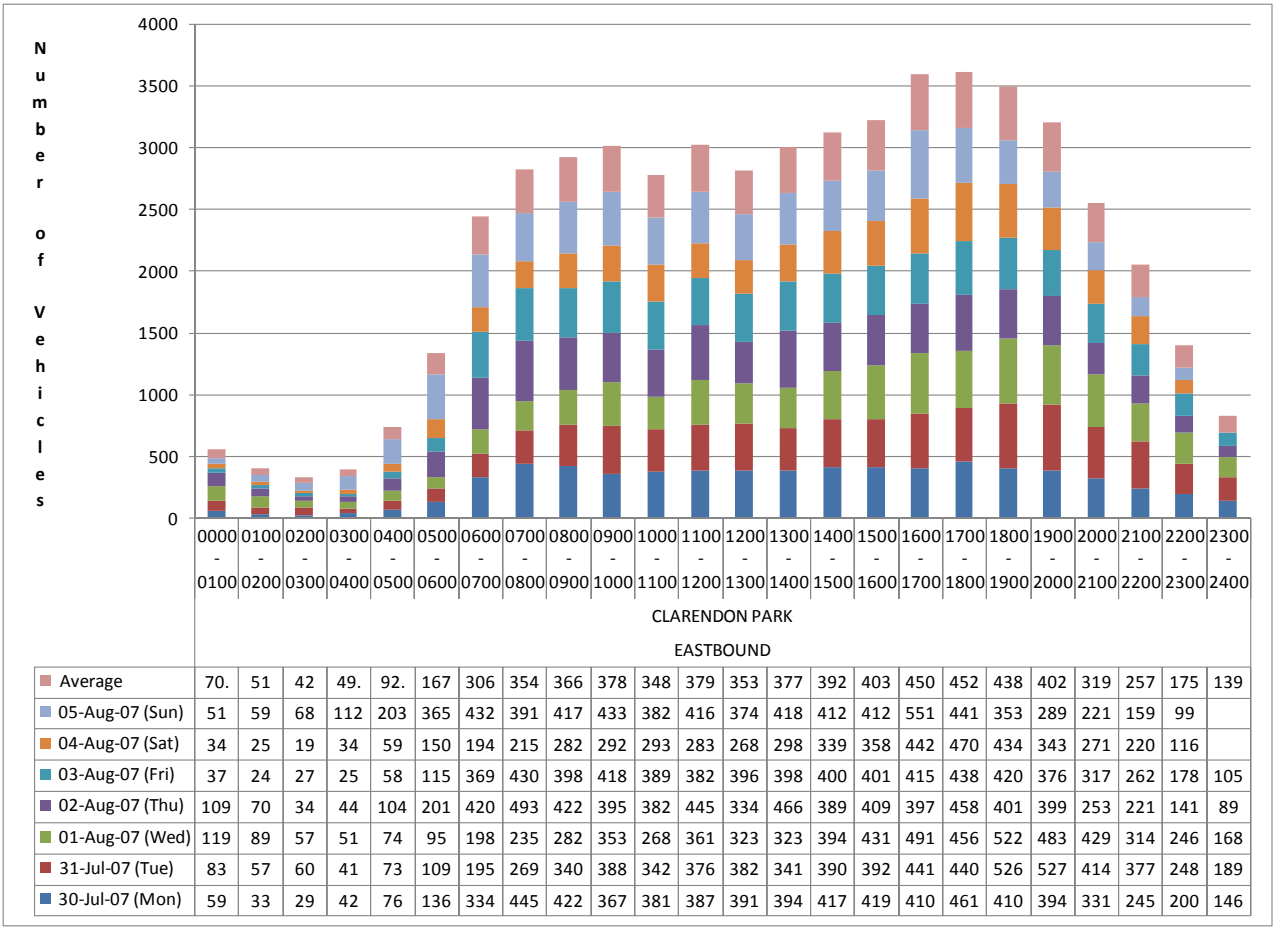


CLARENDON PARK

WESTBOUND

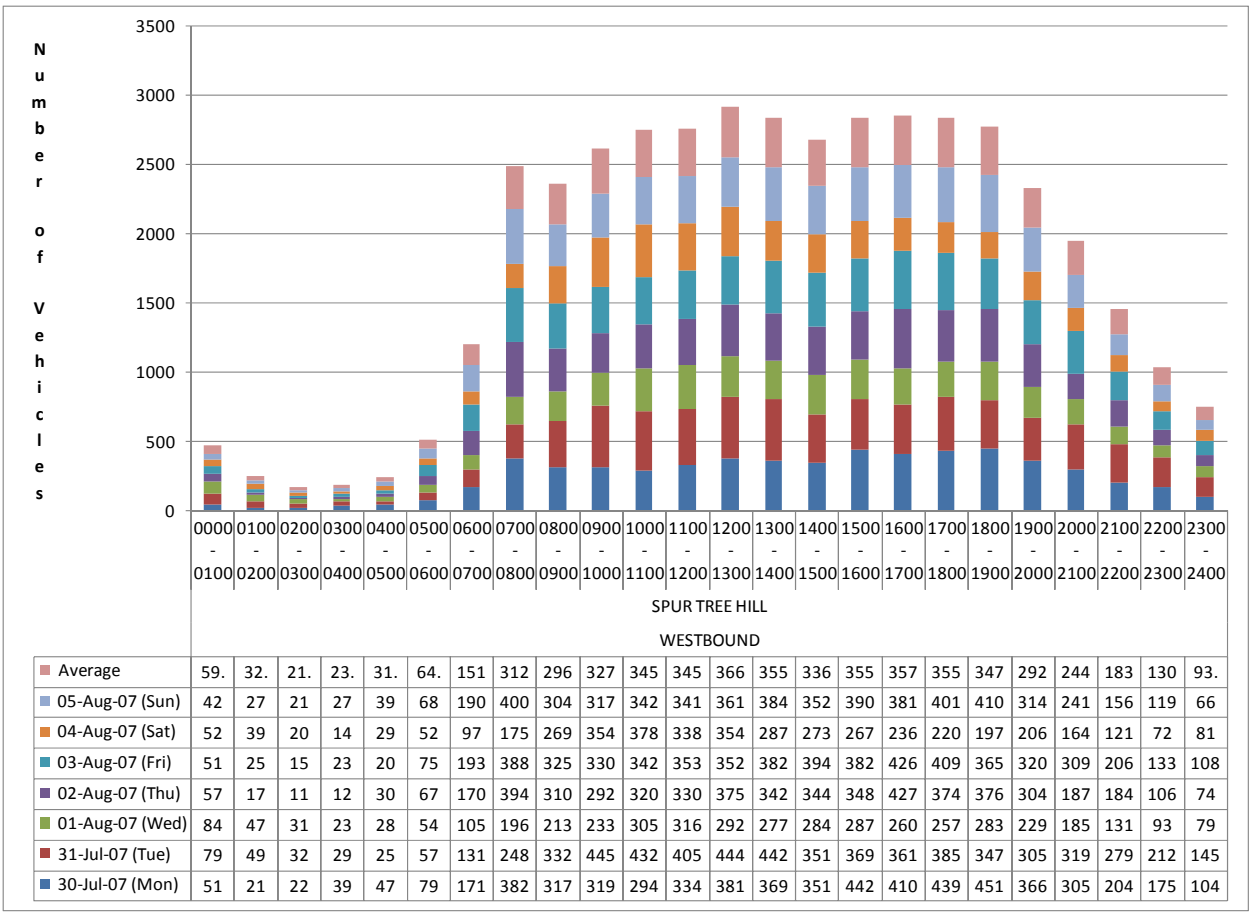
	0000 - 0100	0100 - 0200	0200 - 0300	0300 - 0400	0400 - 0500	0500 - 0600	0600 - 0700	0700 - 0800	0800 - 0900	0900 - 1000	1000 - 1100	1100 - 1200	1200 - 1300	1300 - 1400	1400 - 1500	1500 - 1600	1600 - 1700	1700 - 1800	1800 - 1900	1900 - 2000	2000 - 2100	2100 - 2200	2200 - 2300	2300 - 2400
Average	77.	46.	29.	24.	40.	94.	238	344	395	354	394	413	433	426	414	428	434	465	450	406	332	264	204	130
05-Aug-07 (Sun)	84	37	27	27	48	118	264	403	392	354	405	460	437	432	431	456	486	506	510	421	293	228	159	114
04-Aug-07 (Sat)	61	35	24	14	29	67	170	256	343	406	393	392	430	361	345	327	326	346	301	288	241	198	173	117
03-Aug-07 (Fri)	50	31	20	22	42	108	283	385	423	318	358	392	439	435	432	417	500	505	540	441	374	289	217	126
02-Aug-07 (Thu)	77	37	25	19	47	104	294	415	408	345	380	379	420	436	407	473	484	491	465	407	301	226	183	89
01-Aug-07 (Wed)	114	68	46	30	34	60	167	217	314	251	357	382	332	380	349	354	319	416	355	395	328	266	228	129
31-Jul-07 (Tue)	89	90	46	31	38	111	231	358	475	491	475	501	538	506	503	486	439	437	460	408	386	332	231	157
30-Jul-07 (Mon)	70	29	18	28	44	95	257	377	412	316	388	386	432	430	431	484	485	556	518	481	401	307	240	175

Figure 9-1: Clarendon Park – Westbound



	0000 - 0100	0100 - 0200	0200 - 0300	0300 - 0400	0400 - 0500	0500 - 0600	0600 - 0700	0700 - 0800	0800 - 0900	0900 - 1000	1000 - 1100	1100 - 1200	1200 - 1300	1300 - 1400	1400 - 1500	1500 - 1600	1600 - 1700	1700 - 1800	1800 - 1900	1900 - 2000	2000 - 2100	2100 - 2200	2200 - 2300	2300 - 2400
Average	70.	51	42	49.	92.	167	306	354	366	378	348	379	353	377	392	403	450	452	438	402	319	257	175	139
05-Aug-07 (Sun)	51	59	68	112	203	365	432	391	417	433	382	416	374	418	412	412	551	441	353	289	221	159	99	
04-Aug-07 (Sat)	34	25	19	34	59	150	194	215	282	292	293	283	268	298	339	358	442	470	434	343	271	220	116	
03-Aug-07 (Fri)	37	24	27	25	58	115	369	430	398	418	389	382	396	398	400	401	415	438	420	376	317	262	178	105
02-Aug-07 (Thu)	109	70	34	44	104	201	420	493	422	395	382	445	334	466	389	409	397	458	401	399	253	221	141	89
01-Aug-07 (Wed)	119	89	57	51	74	95	198	235	282	353	268	361	323	323	394	431	491	456	522	483	429	314	246	168
31-Jul-07 (Tue)	83	57	60	41	73	109	195	269	340	388	342	376	382	341	390	392	441	440	526	527	414	377	248	189
30-Jul-07 (Mon)	59	33	29	42	76	136	334	445	422	367	381	387	391	394	417	419	410	461	410	394	331	245	200	146

Figure 9-2: Clarendon Park – Eastbound



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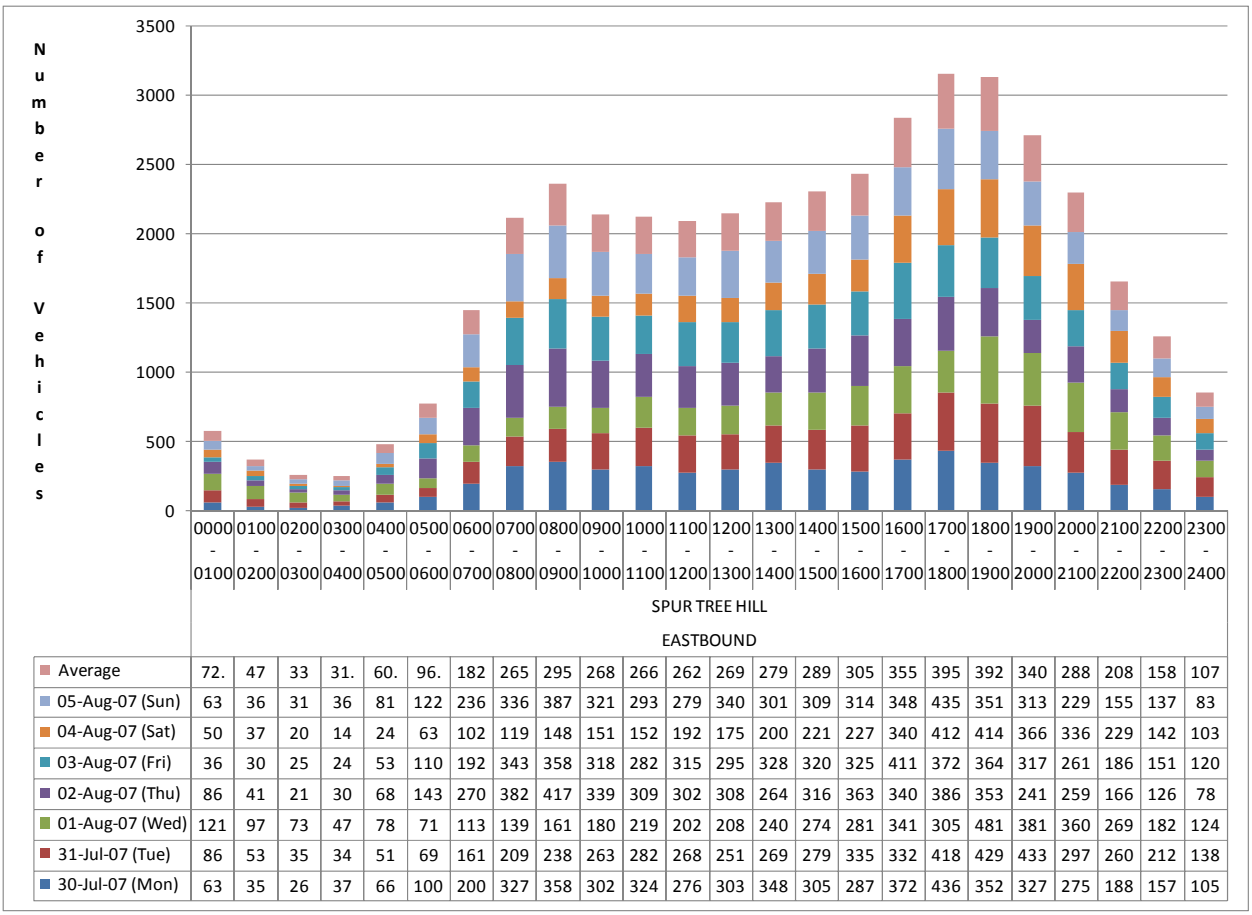
Average	59.	32.	21.	23.	31.	64.	151	312	296	327	345	345	366	355	336	355	357	355	347	292	244	183	130	93.
05-Aug-07 (Sun)	42	27	21	27	39	68	190	400	304	317	342	341	361	384	352	390	381	401	410	314	241	156	119	66
04-Aug-07 (Sat)	52	39	20	14	29	52	97	175	269	354	378	338	354	287	273	267	236	220	197	206	164	121	72	81
03-Aug-07 (Fri)	51	25	15	23	20	75	193	388	325	330	342	353	352	382	394	382	426	409	365	320	309	206	133	108
02-Aug-07 (Thu)	57	17	11	12	30	67	170	394	310	292	320	330	375	342	344	348	427	374	376	304	187	184	106	74
01-Aug-07 (Wed)	84	47	31	23	28	54	105	196	213	233	305	316	292	277	284	287	260	257	283	229	185	131	93	79
31-Jul-07 (Tue)	79	49	32	29	25	57	131	248	332	445	432	405	444	442	351	369	361	385	347	305	319	279	212	145
30-Jul-07 (Mon)	51	21	22	39	47	79	171	382	317	319	294	334	381	369	351	442	410	439	451	366	305	204	175	104

Figure 9-3: Spur Tree Hill – Westbound



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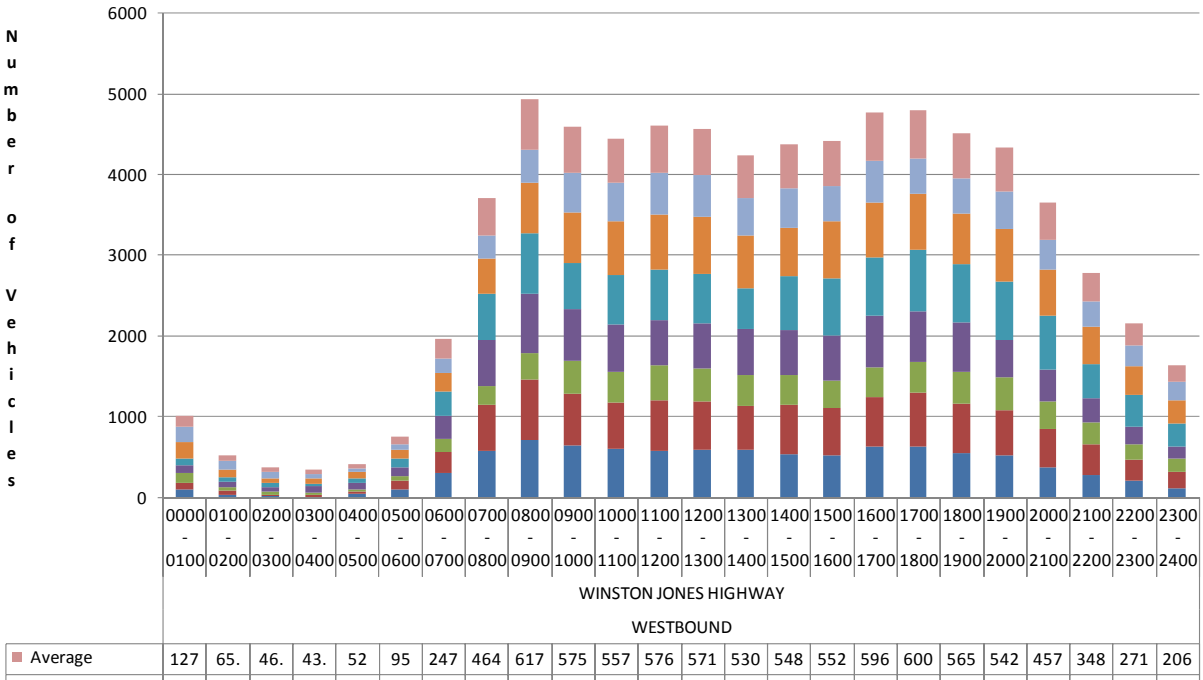
Average	72.	47	33	31.	60.	96.	182	265	295	268	266	262	269	279	289	305	355	395	392	340	288	208	158	107
05-Aug-07 (Sun)	63	36	31	36	81	122	236	336	387	321	293	279	340	301	309	314	348	435	351	313	229	155	137	83
04-Aug-07 (Sat)	50	37	20	14	24	63	102	119	148	151	152	192	175	200	221	227	340	412	414	366	336	229	142	103
03-Aug-07 (Fri)	36	30	25	24	53	110	192	343	358	318	282	315	295	328	320	325	411	372	364	317	261	186	151	120
02-Aug-07 (Thu)	86	41	21	30	68	143	270	382	417	339	309	302	308	264	316	363	340	386	353	241	259	166	126	78
01-Aug-07 (Wed)	121	97	73	47	78	71	113	139	161	180	219	202	208	240	274	281	341	305	481	381	360	269	182	124
31-Jul-07 (Tue)	86	53	35	34	51	69	161	209	238	263	282	268	251	269	279	335	332	418	429	433	297	260	212	138
30-Jul-07 (Mon)	63	35	26	37	66	100	200	327	358	302	324	276	303	348	305	287	372	436	352	327	275	188	157	105

Figure 9-4: Spur Tree Hill – Eastbound



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Average	127	65.	46.	43.	52	95	247	464	617	575	557	576	571	530	548	552	596	600	565	542	457	348	271	206
05-Aug-07 (Sun)	197	107	83	61	40	63	180	280	410	492	476	517	513	462	489	434	510	437	436	464	371	318	261	236
04-Aug-07 (Sat)	203	95	60	61	83	113	231	438	626	624	665	680	705	650	596	706	679	691	625	650	574	461	362	279
03-Aug-07 (Fri)	86	49	46	40	51	113	297	564	748	569	608	628	619	511	669	705	731	761	721	720	660	422	389	288
02-Aug-07 (Thu)	97	68	59	79	77	109	289	575	739	636	585	568	556	564	562	559	636	631	609	466	391	300	211	156
01-Aug-07 (Wed)	124	51	36	23	26	53	155	233	330	409	378	430	407	376	364	351	365	375	397	401	344	272	197	162
31-Jul-07 (Tue)	79	50	18	21	35	108	263	566	741	638	567	624	598	553	604	577	612	666	603	563	477	374	261	197
30-Jul-07 (Mon)	105	41	26	20	52	106	315	590	723	655	619	586	599	596	550	532	642	642	563	528	382	291	215	127

Figure 9-5: Winston Jones Highway - Westbound

APPENDIX VI: WINDALCO STANDARD PRACTICE INSTRUCTIONS ON BLASTING

Appendix VI: WINDALCO Standard Practice Instructions on Blasting

WINDALCO

Rev: Revision 1
Date: 4 October 2005
Document ID: SPI 11/49E&K

WEST INDIES ALUMINA COMPANY
ENVIRONMENTAL MANAGEMENT SYSTEM
STANDARD PRACTICE INSTRUCTIONS
Mining Department

Element: **Blasting Operations**

1 SCOPE

This SPI describes the procedures to follow to minimise vibrations due to blasting operations in mine development and limestone quarrying. Vibrations might cause damage to property. Blasting operations are contracted out, however the Mines Department is responsible for their overall management.

2 ENVIRONMENTAL ASPECT& IMPACT

Aspect: Vibration and air blast
Impact: Property damage and noise nuisance

3 OPERATIONAL CONTROL PARAMETER

Vibration and air blast analyses are done at each blast as a means of monitoring. Ground vibration readings should not exceed 25.4 mm per second or 1 inch per second and air blast readings should be equal to or less than 129 decibels. Readings are taken at a distance from the blast site that is less than or equal to that of the nearest building.

4 PROCEDURE AND RESPONSIBILITY

Blasting emits vibrations that can result in damage to properties within a certain radius of operations. The most effective way of minimising damage caused by vibrations is to ensure that the proper techniques are used to reduce vibrations. This is achieved by contracting the services of licensed Blasters to conduct the blasting exercise.

4.1 COMPANY RESPONSIBILITIES

Contractors shall submit a Blasting Report to the *Team Leader Operations Support/Mines Preparation and Restoration* at the end of each blasting exercise. The *Team Leader Operations Support/Mines Preparation and Restoration* shall make periodic assessments of the Blasting Contractor's performance using the Work Certificate form.

4.2 PRE-BLAST PROCEDURE

Community Relations/Safety Officer:
Inform all persons residing within 800 m ($^1/_2$ mile) radius of the intended blast site(s).

4.3 BLASTING OPERATIONS

Contractor:
It is the responsibility of the contractor to:

Initials of Signatories: Page 1 of 1

- Conduct a survey of the physical state of all structures within a specified radius (800 m or $^1/_2$-mile) of the blast site(s). This survey shall be documented in a pre-blast survey and submitted to the *Team Leader Operations Support*.
- Carry out the blasting exercise.
- Conduct vibration analyses and submit Seismographs as records to *the Team Leader Operations Support*.

4.4 POST-BLAST OPERATIONS

Claims for blasting related damage are addressed in accordance with SPI 08/01.

Contractor:
It is the responsibility of the contractor to conduct a post-blast survey of the physical state of all structures within a specified radius (800 m or $^1/_2$-mile) of the blast site(s). In the case of Kirkvine mines, this survey shall be done if the contractor receives a written claim for alleged damage within six (6) months after the blast and the affected structure lies within the specified radius. While at Ewarton mines, a preblast survey is carried out once blasting is carried out within a half mile of structures. This survey shall be documented and submitted to the *Team Leader Operations Support*.

5 REFERENCES

The following document can be referred to for supplementary information:

- SPI 08/01 – Procedure for Third Party Claims/Complaints

6 RECORDS

- Blasting Report
- Seismograph reports
- Blasting Contract
- Work certificate
- Pre and Post blasting surveys

7 SIGNATURES

Title: Mines Manager Ewarton Works	**Title:** Team Leader Operations Support Ewarton Mines
Name:	**Name:**
Signature:	**Signature:**
Initials:	**Initials:**
Date:	**Date:**

APPENDIX VII: MINES AND GEOLOGY DRILLING AND BLASTING REQUIREMENTS

Appendix VII: Mines and Geology Drilling and Mining Requirements

Jan 23 2007 11:45AM HP LASERJET 3330 p.1

APR 23 2001 903 5922

MINISTRY OF MINING AND ENERGY
MINES AND GEOLOGY DIVISION

ANY REPLY OR SUBSEQUENT REFERENCE TO THIS COMMUNICATION SHOULD BE ADDRESSED TO THE COMMISSIONER OF MINES AND GEOLOGY NOT TO ANY OFFICER BY NAME AND THE FOLLOWING REFERENCE QUOTED:-

HOPE GARDENS
P.O. BOX 141, 189, 191
KINGSTON 6, JAMAICA ,W.I.
PHONE # (876) 927-1936-40
FAX # (876) 927-0350/977-1204
E-MAIL MGD@wtjam.net
Website: www.minesandgeologyjamaica.com

The Safety Manager
Alcan Jamaica Limited
Kirkvine Works
Kirkvine P.O.,
Manchester.

Dear Sir:

Please ensure that the procedures on the attached list are adhered to when conducting drilling and blasting operations at your quarry.

Yours faithfully

Laurence N. Neufville
for Commissioner, Mines and Geology

Encl.

Copies made LGL/KAL:4/5/01 for:

JPR/RER/HAG/CWM/GFR/PJH/RGC/DAV

Jan 23 2007 11:45AM HP LASERJET 3330 p.2

1. Ensure that blasting contractors carry out pre-blast surveys to all buildings within 0.8 kilometres of the blast site.

2. Seismographs must be used to measure ground vibrations in at least two directions away from the blast site.

3. A blasting log must be completed and submitted to the Commissioner of Mines and Geology within 10 working days of the blast event.

4. Blasters must design blast to comply with limits for ground vibration and all blast. For ground vibration (peak particles velocity) should not exceed 1.00 inch per second at the nearest structure from the blast site.

5. Conduct post-blast surveys immediately after a complaint is received.

6. Respond to the complaints in writing expeditiously.

Additionally, please ensure that the following safety procedures are enforced.

- Persons who assist the blaster must be trained in the safety aspects of materials and methods being used.
- Blast site must be cleared prior to start of loading.
- Blast area beyond blast site must be cleared of people and equipment prior to detonation.
- Blast site must be free of safety hazards.
- Boreholes must be free of obstructions prior to start of loading.
- Weather conditions must not pose a hazard to loading crew.
- Detonators and high explosives must be kept separated until they are ready to be placed in a borehole.
- Smoking is prohibited within 50 feet of loading area.

APPENDIX VIII: WINDALCO ENVIRONMENTAL POLICY STATEMENT

Appendix VIII: WINDALCO Environmental Policy Statement

WINDALCO

WEST INDIES ALUMINA COMPANY

ENVIRONMENTAL POLICY STATEMENT

West Indies Alumina Company is a bauxite mining and processing company, whose policy is to achieve compatibility between the environment and its processes and products.

We strive to be the leader in our industry and protection of the environment is a high priority for every employee.

We take practical steps to prevent environmental pollution, which may result from our operations and products. Appropriate actions are taken to ensure local, legal and other requirements are met.

We minimize waste, expeditiously restore mined-out land and seek to achieve the most efficient use of energy and raw materials. Significant impacts are the basis for setting & reviewing environmental objectives and targets, to ensure continual improvement.

QMI REGISTERED

Signed: Gabriel Henn
Gabriel Henn
Managing Director

Rev: Revision 5
Date: August 2006

APPENDIX IX: PHOTO-INVENTORY

Appendix IX: Photo-Inventory

GRASSLANDS [North of Working Quarry Face]

Plate 9-1: Open Grassland to the north [Note: Vehicle tracks]

Plate 9-3: Small farming to the north [Note Banana plants]

Plate 9-2: Open grassland

Plate 9-4: Grassland bordering edge of current mined area and wet limestone forest [Note: high tension wires just beyond]

STOCKPILE AREA

Figure 9-6: Stockpile Area [Main area for placement of new lime kiln]

Figure 9-8: Stockpiles and associated conveyor system and crusher in background

Figure 9-7: Stockpile area for sized aggregates

CURRENT QUARRY FACE

Figure 9-9: Blasted material to be collected

Figure 9-10: Quarry material

Figure 9-11: Trucks collecting quarried material

Figure 9-12: Current quarry face to the northeast of main operational area

BAUXITE MINED AREAS [North and East of Main Quarry]

Plate 9-5

Plate 9-7

Plate 9-6

GRASSLAND [West of Main Entrance and Stockpile Area]

Plate 9-8: Unkempt Small Farming Area [Calalloo and Potato Plants mainly]

Plate 9-10: Earthen drain area north of Dairy Farm grassland

Plate 9-9: Wet Limestone Forest boundary to the west [Road just beyond tree line]

Plate 9-11: Earthen drain south of main settling/wash pond

Equipment/Operational Area

Plate 9-12: Crusher [View from eastern ponds/depressions]

Plate 9-14: Sand Material recovered from aggregate wash wastewater

Plate 9-13: Aggregate wash material wastewater pipe near crusher

Plate 9-15: Crusher and associated equipment

Plate 9-16: Truck delivering material to crusher

Plate 9-17: Drain behind restroom/canteen area [Encircles main wastewater pond]

DEPRESSIONS/PONDS [Close to Operational Areas]

Plate 9-18: Depression #3 – Semi-dry

Plate 9-20: Pond 5 - Sand material at entrance collected and stockpiled

Plate 9-19: Main Wastewater Pond [Pond #5]

Plate 9-21: Depression/Pond #4 [South of Pond 3]

Plate 9-22: Pond #2 [East of Crusher]

Plate 9-24: Depression/Pond #3 - Dry [East of Pond 5 and south of Sand stockpile]

Plate 9-23: Depression/Pond #1 - Dry [East of Pond #2]

VEGETATION FRAGMENTS [WITHIN QUARRY]

Plate 9-25

Plate 9-27

Plate 9-26

Plate 9-28

Plate 9-29

Plate 9-30

Plate 9-31

TYPICAL WET LIMESTONE FOREST [North, East and West of Quarry]

Plate 9-32

Plate 9-34: Northeast of Quarry [Ravine between quarry and main road to Christiana]

Plate 9-33

SMALL FARMING [North of Quarry]

Plate 9-35

PREVIOUS QUARRIED AREAS

Plate 9-36

Plate 9-37

Plate 9-38

Plate 9-39

APPENDIX X:

Appendix X: Information on the Lime Kiln Project in the Press

Windalco investing $3b in lime plant at Kirkvine

published: Wednesday | January 10, 2007

Aerial view of the Windalco Kirkvine plant in Manchester, in photo taken September 15, 2004. - file

Windalco, the owners of two alumina plants in Jamaica, announced yesterday that it will build a new chemical lime facility here to meet the refineries' requirement of 10,000 tonnes a year.

Windalco said that it will spend an estimated US$45 million (J$3 billion) on the project, which will be completed within two years.

"We have been importing lime, but once the project is completed, we will be able to adequately supply both our plants," said Windalco's director for business development, Michael Douglas.

Windalco's two refineries, which it purchased from the Aluminium Company of Canada (Alcan) early in the decade, have a combined capacity of approximately 1.2 million tonnes of alumina annually.

Lime (calcium oxide) is a critical ingredient in the process of refining bauxite to alumina, helping to remove phosphorous and other impurities from the product.

300,000 tonnes of lime used

However, the island, with alumina production of over four million tonnes a year, used approximately 300,000 tonnes of lime last year, a substantial proportion of which was imported despite installed lime production capacity of between 310,000-320,000 tonnes a year.

"I would say that there is a production shortfall of between 80,000 and 90,000 tonnes a year and most of that would be for Windalco," said a senior mining industry executive. "How the industry developed is that lime plants were attached to the alumina companies, but most of these facilities are long past their best, having been installed nearly half a century ago."

The industry's requirement for lime would rise dramatically if major expansion plans, including the doubling of the capacity of the 1.3 million-tonne Jamalco refinery takes place, officials say.

Windalco's Douglas described the plant at the company's Kirkvine refinery as "a very old and unreliable rotary kiln" with "very poor thermal efficiency" and an

inefficient dust suppression system.

"The situation is expected to be significantly alleviated with the construction of the new kilns," Douglas said. He expects to plant to help bring down operating costs.

The existing Windalco facility has a rated capacity of just under 70,000 tonnes of lime but last year produced an estimated 48,000 tonnes of the 88,000 tonnes consumed by its two refineries.

Industry sources say that Windalco' decision to establish the new lime facility came after the company failed to entice new, independent investors in the sector. Lime production was not its core business and should be undertaken by others, Windalco argued.

"The point they were making is that 75 per cent of Jamaica is comprised as high quality limestone and that it is provides a good business opportunity, both for the alumina sector and for downstream products and exports," said the Wednesday Business source. "They took the decision to go ahead with the investment earlier this year when there were no takers."

There is one significant independent manufacturer of chemical line in Jamaica, the 120,000 tonne capacity Rugby Lime, all of whose output is sold to Jamalco, the refinery owned by Alcoa and the Jamaican government.

Initially a joint venture between the British building material company Rugby and Jamaican investors, Rugby Lime is now fully-owned by Cemex of Mexico.

business@gleanerjm.com

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WINDALCO to Construct New Lime Plant at Kirkvine

(Jan-17-2007)

WINDALCO is set to commence the construction of a new state-of-the-art lime plant at its quarry facility near Kirkvine Works. The plant is expected to cost approximately US$45 million and should be completed within two (2) years.

According to Michael Douglas, Director – Business Development, the decision to construct a new lime kiln at Kirkvine was a sound and strategic decision based on the needs and operating costs of the Company as well as the commitment to continually improve the business.

"WINDALCO currently uses 100,000 tonnes of lime (calcium oxide) per annum in its plants at Ewarton and Kirkvine. Some of the lime is manufactured at Kirkvine plant in a very old and unreliable rotary kiln. This kiln also has very poor thermal efficiency and its exhaust dust suppression system is very inefficient. This situation is expected to be significantly alleviated with the construction of the new kilns," he said.

He further disclosed that the current lime needs of the Company were not being met by the Kirkvine plant and so the balance of WINDALCO's lime comes from a number of local suppliers, both small and large. Mr. Douglas explained that although the Company was purchasing the lime from various local suppliers, the quantity available was still inadequate to supply the needs of the plants.

"We have been importing lime, but once the project is completed, we will be able to adequately supply both our plants. This means that that we will not be faced with the increasing oil and sea freight charges associated with the importation and based on this we expect to immediately see some significant savings to the Company," stated Mr. Douglas.

Raquel James, Senior Design Engineer and WINDALCO's Project Manager, in her overview of the project said, "This plant will consist of two Parallel Flow Regenerative kilns with associated handling, storage and quarrying equipment. The kilns will be fitted with a waste gas cleaning system and dust suppression system to ensure full compliance with environmental regulations."

Mobile Crusher

She also stated that the project also includes the

supply of a mobile crushing plant, which will be located at the quarry face to facilitate the production of kiln stone of the correct size and quality for the optimisation of the kiln performance. The project will also encompass all the necessary equipment for washing, storing and feeding limestone to the kiln and for crushing, screening and storing the burnt lime product. "Once these are in place, it means that WINDALCO can not only shut down the rotary kiln that it currently operates, but the Company will also eliminate third party purchases of the product," she said.

Mr. Douglas further added, "Now that we have gotten the approval from our owners, a full environmental impact assessment will be done before the project starts and we will have to await those results and the necessary approvals from the relevant government agencies before construction starts. We hope the project will be approved because not only will the lime plant be more efficient, it will also be more environmentally friendly."

The lime will be delivered by truck from the new plant to Kirkvine plant for use by Kirkvine and for onward transportation to Ewarton by train.

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