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Quicklime (Slaked and Hydraulic)

Limestone Investment Package

Jamaica's Limestone Industry Value Chain Development Project

Prepared by PricewaterhouseCoopers

pwc

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Table of Contents

1.0 Executive Summary 3

2.0 Introduction and Overview 6

3.0 Product Overview – Quicklime, Slaked Lime and Hydraulic Lime 16

4.0 Potential Markets for Jamaican Quicklime, Slaked Lime and Hydraulic Lime and Competitive Profile 26

5.0 Financial Highlights 44

6.0 Appendices 51

6.1. Appendix 1: Financial Model 51

6.2. Appendix 2: Excerpts from Mordor Intelligence Report 55

1.0 Executive Summary

Overview

Limestone is the largest mineral resource possessed by Jamaica and is an essential raw material for multiple industries such as steel, cement, agriculture, pharmaceutical and construction. It is estimated that there are over 150 billion metric tonnes in limestone reserves in Jamaica of which 50 billion metric tonnes are deemed recoverable. A significant portion of these reserves are of high purity limestone, which is defined by a high concentration (i.e. 95% to 98%) of calcium carbonate.

In Jamaica, the production of limestone is supported by one hundred and forty-six licenced mining and quarry operators situated in all parishes across the island. Over the past four years, the country's production has been increasing. Approximately 10% of extracted limestone is exported, while the remaining 90% is consumed domestically and the total value of limestone exports from Jamaica is just above 1% of the total value of limestone imported in the nearby regions. Although Jamaican limestone is used primarily as construction material and road base, limestone can be utilised in a wide range of sectors. The high value of import in prominent markets in North America, South America and the CARICOM region presents an opportunity for Jamaica to enter the value-added market of limestone which is significant in terms of value.

Why Jamaica?

The Government of Jamaica (GoJ), in its 'Vision 2030 Jamaica' document, has identified Mining and Quarrying as one of the key and strategic sectors to achieve its vision to make Jamaica a developed nation by 2030. The GoJ has secured funding from the World Bank to finance a project entitled Foundations for Competitiveness and Growth Project (FCGP) that is designed to enable private sector-led growth in the Jamaican economy, in an inclusive and sustainable way.

The limestone industry in regions near to Jamaica, namely CARICOM, North and South America has been primarily driven by the growth in construction activities in the residential and commercial building sectors and other infrastructure developments. In addition, low, stable economic growth, infrastructure development, increasing populations and rising disposable incomes have further increased the demand for value-added limestone products across sectors. The central location of Jamaica provides a strategic advantage where it is closer to the import destinations as compared to the countries from which limestone is currently imported. Other important indicators of the need for the development of Jamaica's value-added limestone industry and other key success factors are highlighted in the table below.

Table 1 Jamaica's limestone value-added success factors

The Value-Added Opportunity	Sustainable Growth Factors
• Jamaica has large quantities of limestone reserves and high-purity limestone. • The export market for limestone as well as value-added products has been growing and there is opportunity for the development of higher products for export globally.	• Increasing stability in the region • Increasing transparency both in governments and local authorities • Inflation stability • Decreasing unemployment levels

The Value-Added Opportunity	Sustainable Growth Factors
• Increased growth in limestone consumption in the Americas region presents an opportunity for Jamaica. • The cost of labour in Jamaica represent one of the lowest in the Americas for accounting to the IDB Labour market division. • Various trade agreements exist between Jamaica and the Caribbean and developed nations with growing demand such as the USA, Canada and the European Union (EU).	• Strong relationship with international development partners • Increasing access to regional and world markets • Jamaica's geographic location makes it is strategically placed to become a regional player in transhipment. Kingston Port has been predicted to become region's biggest transhipment hub. • Growth is being driven by a more stable and increasing income and lower debt levels

Product Overview

Limestone has many industrial uses and can be processed into a variety of products. It is used as a filler in a variety of products, including paper, plastic and paint. The highest purity limestone is used in food and medicines such as breakfast cereals and calcium pills. Value-added limestone products such as Calcium Carbonate (i.e. Ground Calcum Carbonate (GCC) and Precipitated Calcium Carbonate (PCC)), Lime (Quicklime, Slaked Lime and Hydraulic Lime), Dimension Stones (i.e. stones, tiles, blocks.) and Cultured Marble are used across industries.

This Information package focuses on Quicklime, Slaked Lime and Hydraulic Lime[1]. Quicklime and Slaked Lime can be a profitable venture on a standalone basis, however, for Hydraulic Lime another value-added product in the value chain, it is required to be produced in conjunction with Quicklime and Slaked Lime in order to achieve economic viability as there does not currently exist a large demand market to allow for standalone production of only Hydraulic Lime.

The idea of setting up of common operations unit which encompasses Quicklime, Slaked Lime and Hydraulic Lime is feasible not only from the demand point of view but also due to the similarity in the production process of Hydraulic Lime and Slaked Lime.

Table 2 Summary of Quicklime, Slaked Lime and Hydraulic Lime

Product	Description	Applications/Industries
Quicklime	Quicklime is the common name for burnt limestone and is a white caustic alkaline substance consisting of calcium oxide, which is obtained by heating limestone and then combining with water.	• Iron and steel (as a flux) • Paper and Pulp (for generating Slaked Lime in Kraft pulping) • Wastewater treatment (pH neutralisation, water softening)

1 Quicklime, produced after calcination of limestone, can be hydrated to form Slaked Lime. Therefore, generation of Quicklime is a prerequisite for Slaked Lime production. In case of Hydraulic Lime, the production process and equipment are similar with the difference being in raw material used and kiln / calcination temperature. Hence, these lime products may be produced in the same facility. It is noted that Hydraulic Lime is normally produced along with other limestone-based products due to limited usage and low commercial quantities.

Product	Description	Applications/Industries
		• Building and construction (Bricks and mortars, cement-based mixes, soil stabilisation and modifications) • Agriculture (for nutrients/fertility, pH balance of soil)
Slaked Lime	Slaked Lime is a colourless crystal or white powder and is formed through a chemical reaction between Quicklime and water. Depending on how much water is added during the process, slaked lime is either formed as a dry powder or a paste.	• Paper and Pulp (in the generation of Caustic soda) • Wastewater treatment (sludge treatment, pH adjustment, removal of heavy metals) • Buildings and Construction (Mortars, plasters, replacement of cement in concrete, road surfacing) • Agriculture (for nutrients/fertility, pH balance of soil) • Environment (Flue gas desulphurization) • Food (pH modifier, pasteurisation, storage of fruits and vegetables)
Hydraulic Lime	Hydraulic Lime is a general term for varieties of quicklime, or slaked lime, used to make lime mortar which is set through a hydration process. The presence of silica is important during the burning process in the production of Hydraulic Lime.	• Construction (Mortars and plasters)[2]

Financial Highlight

An assessment of the valued-added production for Quicklime, Slaked Lime and Hydraulic Lime in Jamaica indicates that for a total production of 29,285 tonnes per annum, an investment in this product could be financially feasible. The analysis was conducted under two scenarios,

I. On a standalone (start-up)
II. An incremental basis (existing operation)

On an indicative basis, the internal rate of return (IRR) could range from 24.0% to 34.0% and net present value (NPV) range from US$7.8M to US$8.9M on a standalone and incremental basis respectively.

[2] The primary difference in construction usage for quicklime and hydraulic lime is that quicklime is often mixed with cement, sand, water and aluminium powder and used in constructional block production while hydraulic lime is mainly used in mortars and plasters. Hydraulic lime mortars may be used in place of cement-sand and cement-lime-sand for bricks and block masonry.

2.0 Introduction and Overview

The Jamaican Context

It is estimated that Jamaica has over 150 billion metric tonnes in limestone resources of which 50 billion metric tonnes are deemed recoverable. Over the past four years, the country's production has been increasing. Limestone is the largest mineral resource possessed by Jamaica and is an essential raw material for other industries such as steel, building and cement, agriculture and paper and pulp. It is usually extracted in open pits and predominantly used as a construction material and road base. The production of limestone is supported by one hundred and forty-six licenced mining and quarry operators situated in all parishes across the island.

As of 2019, Jamaica is exporting limestone valued at US$4.0m per annum. The total existing export market in the region (Americas and CARICOM) stands at US$300 million and is expected to grow by at least US$7 million every year. The annual increase in limestone import in the nearby region is itself double the value of the existing export market of Jamaica.

The Limestone Value-Added Opportunity

Despite the vast quantity of limestone reserves and the large number of quarries operating in the island, the industry remains largely underdeveloped as many of the quarries operate under capacity, and the sector lacks financing. Approximately 10% of extracted limestone is exported while the remaining 90% of the production is used to meet local demand. Exports are directed to the USA, South America, Canada, and CARICOM. More importantly, the value of limestone exported from Jamaica is slightly above 1% of the total value of limestone import in the nearby regions.

A large proportion of Jamaica's limestone is considered to be "high purity" due to its concentration of calcium carbonate (<95%-98%). Geographical studies conducted on limestone deposits in Jamaica reveal large deposits of reserves in the parishes of Portland, St. Elizabeth and Trelawny, with high to very high purity limestone, as shown in Table 3 below, suitable for end use in multiple industries from construction to pharmaceuticals.

Table 3: Quality of limestone in Jamaica

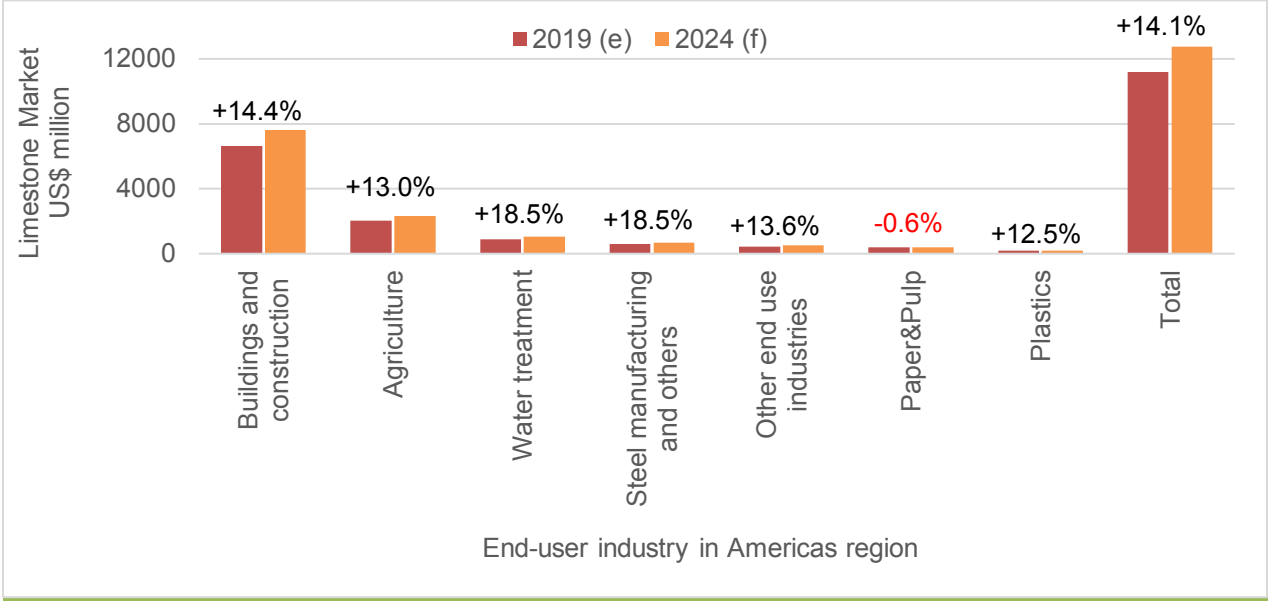
	Portland (Average)	Trelawny (Average)	St. Elizabeth (Average)
Calcium Carbonate, $CaCO_3$ (%)	>99	>99	>98
Magnesia, MgO (%)	~0.60	~0.2	~0.3
Silica, SiO_2 (%)	<0.20	0.50	<0.20
Iron oxide, Fe_2O_3 (%)	<0.10	0.05	0.20
Aluminium Oxide Al_2O_3 (%)	<0.10	<0.15	0.35

Source: PwC Research, MGD reports

Limestone is used in a wide variety of applications depending on whether it is crushed, ground or is converted to lime. These include construction materials, water treatment, food & beverage, pharmaceuticals, iron & steel, agriculture, plastics and paper. In the Americas region, all the end use sectors

are set to grow with a Compound Annual Growth Rate (CAGR) in double digit value terms with an exception of the paper and pulp industry which is expected to see a reduction in demand. The key end-use industries of limestone are collectively set to grow by 14.1% between 2019 and 2024.

Figure 1: Limestone end-use industry consumption in the Americas region



Source: Mordor Intelligence; e: estimated, f: forecasted

Global Trends

The global limestone market exceeded US$5.7 billion in 2017 and is estimated to surpass US$9 billion while growing at a CAGR of 6.5% over the period of 2019 to 2024. This growth is primarily due to an increase in consumption in iron & steel processing, building & construction and agricultural industries. As per International Trade Centre (ITC) Trademap statistics, the total quantity of limestone exported across the world in 2018 increased by 10 million tonnes from 47 million tonnes to 57 million tonnes.

Top Exporters and Importers of Limestone in 2018

As shown in Table 4, the five largest limestone exporters in 2018 were United Arab Emirates, Japan, India, Oman and Turkey. These countries represent 72% of world production.

Table 4: Top Limestone Exporters

Rank	Exporters	Quantity Exported in 2018 (Million Tonnes)	Percentage of Global Export by Quantity	Export Value in 2018 Million US$
1	United Arab Emirates	24.53	44.3%	229.90
2	Japan	5.15	9.3%	52.28
3	India	3.30	6%	61.55
4	Oman	2.95	5.3%	66.86
5	Turkey	2.60	4.7%	6.72

Source: ITC calculations based on UN COMTRADE and ITC statistics (accessed on March 24, 2020)

As shown in Table 5, the five largest limestone importers in 2018 were India, Germany, Bangladesh, Taiwan and Kuwait.

Table 5: Top Limestone Importers

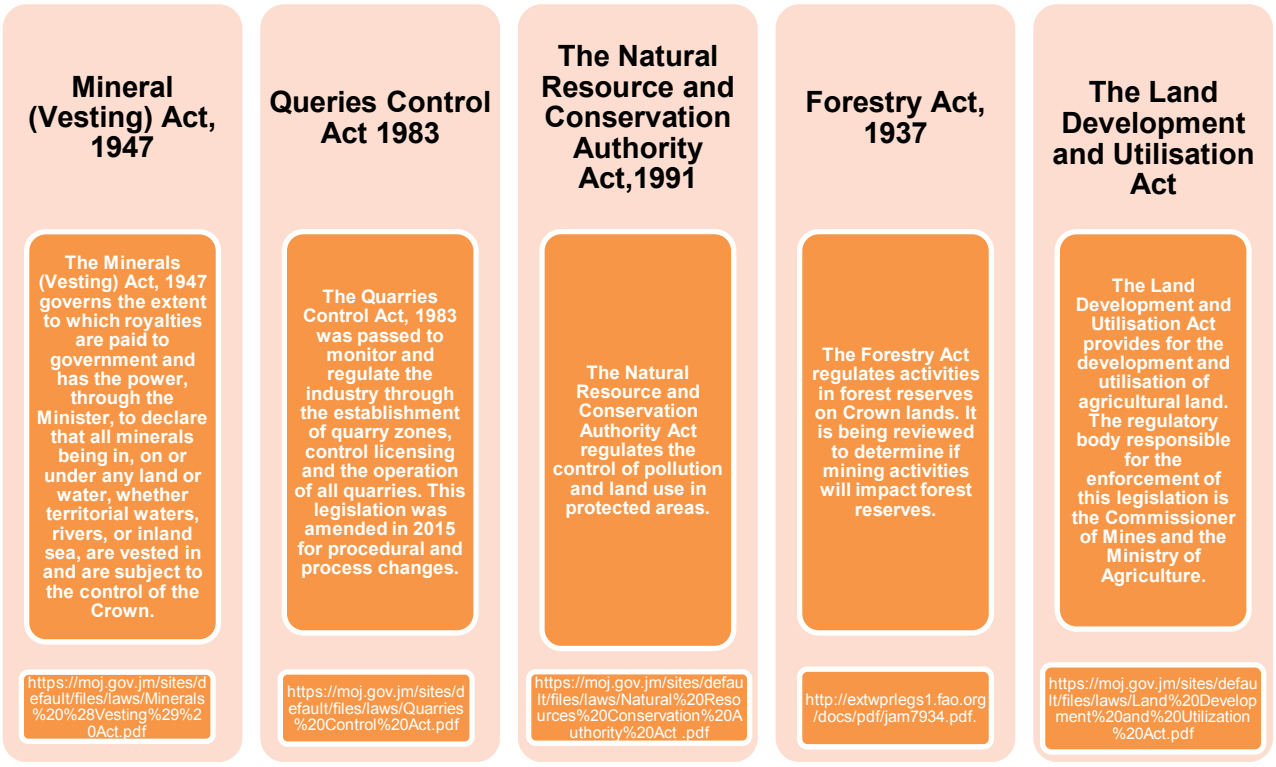
Rank	Importers	Quantity Imported in 2018 (Million Tonnes)	Percentage of Global Import by quantity	Import Value in 2018 Million US$
1	India	22.85	39.6%	453.63
2	Germany	3.65	6.3%	43.11
3	Bangladesh	3.61	6.3%	43.23
4	Taiwan	3.21	5.6%	64.38
5	Kuwait	2.94	5.1%	31.74

Source: ITC calculations based on UN COMTRADE and ITC statistics (accessed on March 24, 2020)

Regulatory Environment

The main legislation / regulations that impact the mining and quarrying industry in Jamaica include:

Figure 2 Jamaica regulations for Mining & Quarrying



According to the Minerals Policy, the GoJ has separated its regulatory role through the Ministry of Transport and Mining (MTM) and its ownership in the mining industry and its operations through the Jamaica Bauxite Mining Limited (JBM) and Clarendon Alumina Production Limited (CAP). The Ministry's main responsibilities are the overall policy responsibility and development of the industry. The MGD has statutory authority under the Mining Act and the Quarries Control Act to exercise general supervision over all

prospecting, mining and quarrying operations throughout the island. The MGD also manages the investigation, characterisation, documentation and release of information on all aspects on the geology of Jamaica.

Investing in Jamaica

As an emerging market Jamaica relies on foreign direct investment (FDI) to spur its growth and international competitiveness. Jamaica has welcomed FDI as a major part of the development of several industries. In 2018 the inflow of FDI to Jamaica valued approximately USD$ 775 million. The ability to conduct business efficiently has been improving over the past 10 years. Jamaica's ease of doing business current ranking improved to 71 in 2019 from 75 in 2018, according to the latest World Bank annual ratings, Jamaica is ranked 71 among 190 economies

The Jamaican economy provides many benefits to foreign investors such as stable and positive economic growth and improved competitiveness in the region. Jamaica also boasts a strategic geographic location, stable democracy, a relatively large English-speaking market and access to major shipping paths such as the Panama Canal.

The limestone industry in the region is driven by construction in the residential and commercial building sectors and other infrastructural development. As the region continues to grow with the increased population, rising disposable incomes and continued infrastructural development the demand for value-added products across sectors is expected to rise.

With billions of limestone reserves and the strategic advantage of being closer than most import destinations such as India and Japan, Jamaica's value-added limestone industry is uniquely positioned to tap into the growing market. Table 6 below highlights the position of the market and other key success factors of limestone value-added production.

Table 6: Investing in Jamaica Limestone - The Opportunity

The Value-Added Opportunity	Sustainable Growth Factors
• Jamaica has large quantities of limestone reserves and high-purity limestone. • The export market for limestone as well as value-added products has been growing and there is opportunity for the development of higher products for export globally. • Increased growth in limestone consumption in the Americas region presents an opportunity for Jamaica. • The cost of labour in Jamaica represent one of the lowest in the Americas for accounting to the IDB Labour market division. • Various trade agreements exist between Jamaica and the Caribbean and developed nations with growing demand such as the USA, Canada and the European Union (EU).	• Increasing stability in the region • Increasing transparency both in governments and local authorities • Inflation stability • Decreasing unemployment levels • Strong relationship with international development partners • Increasing access to regional and world markets • Jamaica's geographic location makes it is strategically placed to become a regional player in transhipment. Kingston Port has been predicted to become region's biggest transhipment hub. • Growth is being driven by a more stable and increasing income and lower debt levels

Economic Profile

Jamaica has a mixed economy that is heavily reliant on services. Approximately 70% of the country's Gross Domestic Product (GDP) is derived from services, and most of its foreign exchange comes from tourism, remittances, and bauxite/alumina exports. Over the last decade, Jamaica's GDP (at market price) has grown by 88%. The country's GDP for FY2019 stood at JM$ 2,053 bn, representing an increase of about 6.5% over FY 2018.

High public service debt obligation and vulnerability to frequent natural disasters are the key concerns to the macroeconomic stability of the island. In terms of the public service debt obligation to GDP, Jamaica was previously at 147% of GDP. In 2019 Jamaica successfully completed its economic reform programme supported by the International Monetary Fund (IMF) and through the programme the debt obligation to GDP ratio fell to 94%. This indicates strong political will and a strong future of economic growth and development.

Table 7: Key economic indicators for Jamaica

Indicator	FY 2016	FY 2017	FY 2018	FY 2019
Total Gross Domestic Product at Market Prices (JM$ million)	1,688,754	1,787,954	1,927,202	2,053,185
Mining & Quarrying sector contribution to the GDP (JM$ million)	32,845	35,246	46,852	60,573
Central government gross debt (JM$ million)	2,068,760	2,158,846	2,028,154	1,998,668
Gross Debt to gross GDP (%)	123%	121%	105%	94%
Interest rates (Domestic currency, %)	3.51%	3.75%	2.85%	2.51%
Interest rates (Foreign currency, %)	1.65%	2.07%	1.90%	1.83%
Exchange rate (US$ to JM$)	118.75	127.13	127.99	130.60

Source: Statin, Bank of Jamaica

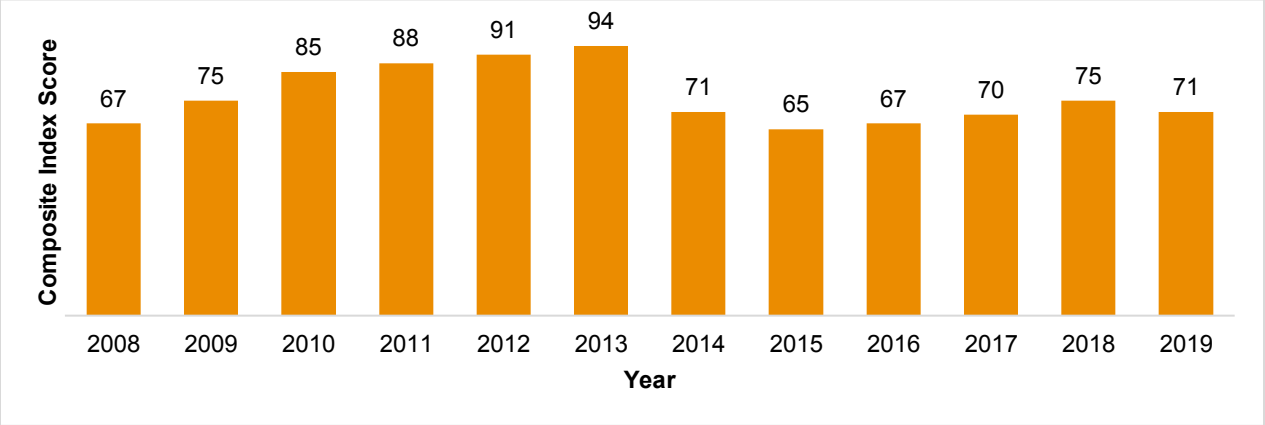
Table 8: Jamaica's credit rating by leading Credit Rating Agencies (CRA)

No.	CRA	Rating	Outlook	Date (as of)	Remarks on CRAs' ratings
1	Fitch	B+	Positive	January 29, 2020	For Fitch, a bond is considered investment grade if its credit rating is BBB- or higher. Bonds rated BB+ and below are speculative grade, sometimes also referred to as "junk" bonds.
2	Moody's	B2	Stable	December 11, 2019	For Moody's, a bond is considered investment grade if its credit rating is Baa3 or higher. Bonds rated Ba1 and below are speculative grade, sometimes also referred to as "junk" bonds.
3	Standard and Poor's (S&P)	B+	Stable	September 27, 2019	For S&P, a bond is considered investment grade if its credit rating is BBB- or higher. Bonds rated BB+ and below are speculative grade, sometimes also referred to as "junk" bonds.

Investor Friendly Reforms

Jamaica has been trying to attract investors to the island through business-friendly reforms. Since 2013, Jamaica's Parliament passed numerous pieces of legislation to improve the business environment and support economic growth through a simplified tax system and broadened tax base. This has allowed improvement in Jamaica's Doing Business Ranking as depicted in the figure below.

Figure 3: Jamaica's historical Ease of Doing Business ranking

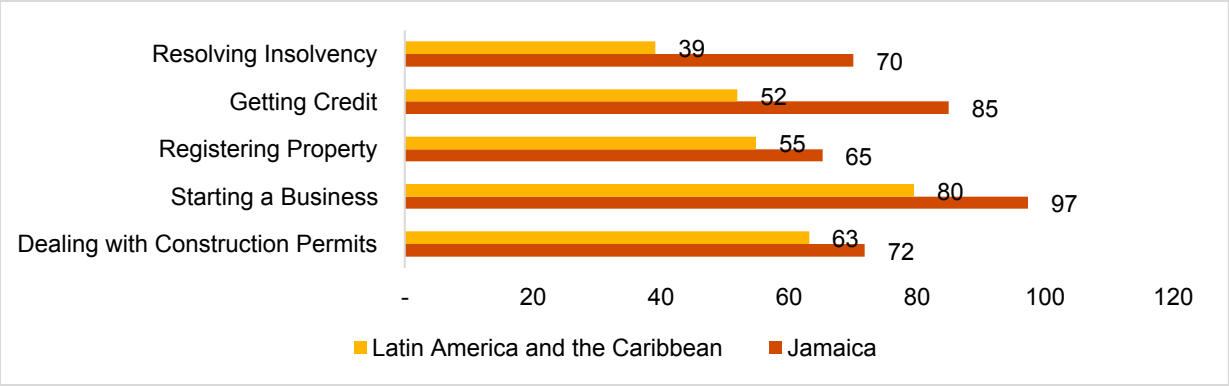


Source: The World Bank

The establishment of credit bureaus and a Collateral Registry under the Secured Interest in Personal Property (SIPP) legislation are improving access to credit. Jamaica made starting a business more streamlined by consolidating forms and made electricity less expensive by reducing the cost of external connection works. The GoJ is also open to foreign investment in all sectors of its economy and is currently in the process of developing a National Investment Policy to guide future FDI reform.

The graph below compares Jamaica's ranking in key doing business ranking factors within the region. Compared to the region, it is clear Jamaica has made significant gains in absolute terms, and there are further reforms currently in the works including process re-engineering for construction permits, as well as reforms around decreasing the length of time it takes to gain an electrical connection. Taken together, this demonstrates a focus on creating a further business-friendly environment in Jamaica.

Figure 4: Doing Business 2020 Indicators – Jamaica in comparison to Latin America and the Caribbean Region



Source: The World Bank Group – Doing Business 2020

Enabling Environment

The Government of Jamaica provides vast support for the development and expansion of the sector, including:

- Incentives to investors including income tax relief, duty concessions on production- related imports
- Introduction of online registration for importers and exporters that allows access to all trade related agencies
- Provision of information on commerce and industry such as information on product marketing, trade statistics and government incentives
- Large scale improvements to the transport infrastructure and services

Taxation Environment

The incentive regime came into effect in Jamaica on January 1, 2014 and provides for varying levels of relief, via the following legislation:

	Key Legislation	Summary
1	The Fiscal Incentives (Miscellaneous Provisions) Act, 2013	The standard tax rate is 25% for non-regulated entities. This Act provides for: • the reduction of the effective corporate income tax rate by applying an Employment Tax Credit (ETC) at a maximum value of 30%, which reduces income tax from standard rate 25% for unincorporated company to an effective tax rate of 17.5% • Capital Allowances that cover, among other things, a broadened definition of 'industrial buildings' to include Duty-free Importation of Equipment and Machinery, as well as revised tariff rates ranging from 0% to no higher than 20% (with some exceptions). If designated as SEZ Reduced income tax from standard rate 12.5% for unincorporated company to an effective tax rate of 7.5% or 0%
2	The Income Tax Relief (Large Scale Projects and Pioneer Industries) Act, 2013	This provides for an improved and more attractive rate of income tax for projects that are considered to be large scale or of a pioneer nature. As of the date of this investment package the related regulations regarding how this benefit will be administered have not yet been promulgated.
3	The Customs Tariff (Revisions) (Amendment) Resolution, 2013	This Act provides for the duty-free importation of capital equipment and raw material.
4	The Stamp Duty (Amendment of Schedule) Order 2013	Provides stamp duty exemption on raw materials and non-consumer goods.

The above acts provide relief through tax credits, duty-free importation, stamp duty exemptions and capital allowances as it relates to specific industrial buildings. With the development of new manufacturing plants to process the limestone into value added products, the limestone industry can draw on these acts to mitigate the costs associated with manufacturing. Particularly, the income tax relief will improve profits and the customs tariff resolution will significantly reduce the heavy charges that are accompanied with importation of capital equipment.

Special Economic Zones

The Jamaica Special Economic Zone Authority (JSEZA) was created to implement and manage special economic zones within Jamaica. These zones are areas in which the regulations of the country do not apply or are modified to allow for increased investment, employment and job creation.

Under the SEZ Act, many reforms were introduced. Under the previous free zone regime, manufacturing entities were only allowed to supply up to 15% of production locally. Entities under the SEZ are now able to sell goods both locally and for export with no restrictions. It can be noted however that the JSEZA highly prefers exportation of locally produced goods. The SEZ also provides a number of additional tax benefits and incentives which includes a 12.5% reduction in income tax, no General Consumption Tax (GCT) on electricity and telephone services and stamp duty relief.

Implications for the Limestone Industry

Although an SEZ cannot be applied to mining and quarrying operations they can be applied to manufacturing and other related industries which would provide support for value-added products. JSEZA highly recommends Single or Multi-Occupancy for this purpose; however, there must be a clear separation of business from mining. The limestone industry can seize the opportunity offered by SEZ legislation to become Multi-Occupancy by setting up a Special Purpose Vehicle (SPV) for value-added products that they plan to market or export.

JSEZA has also introduced a business centre to facilitate quick application processing for prospective SEZs. Provided that the required regulations and licences are approved by the respective authorities the timeline for an application review is at least forty-five (45) days, with a pre-approval timeline of approximately thirty (30) days.

Trade Agreements

Jamaica has negotiated trade agreements with the world's major trading powers such as the European Union, Canada, and the United States, as well as in our important domestic CARICOM markets. These trade pacts provide a range of opportunities for Jamaican exporters. The main trade agreements that Jamaica is party to include:

Figure 5: Summary of Key Trade Agreements

The European Partnership Agreement

- The accords immediate duty-free/quota-free market access for CARIFORUM goods into the EU except sugar.

Caribbean Basin Initiative (CBI)

- The CBI comprises the Caribbean Basin Economic Recovery Act of 1983 (CBERA) and the Caribbean Basin Trade Partnership Act of 2000 (CBPTA). The CBI Act was established by the US in 1984 to provide economic aid to Jamaica (and 23 other countries in the Caribbean and Central America) through the waiver of tariff benefits. Most products manufactured or grown in CBI beneficiary countries are eligible for duty-free entry into the United States.

Caribbean-Canada Trade Agreement (CARIBCAN)

- CARIBCAN is a preferential arrangement guaranteeing duty free access to Canada for a wide range of products excluding textiles and apparel, footwear, luggage and handbags, leather garments, lubricating oils and methanol.

Caribbean Single Market Economy (CSME)

- Established by CARICOM to create economies of scale in the region. It offers Jamaicans the right to establish a business in another territory in the CSME without restriction. Jamaican goods that have already entered a CSME country will also be eligible for export/import into another CSME territory without duty. Capital from Jamaica can also 11 circulate freely in other CSME countries. Jamaica has also negotiated and signed Free Trade Agreements (FTA) with Argentina, Colombia and the Dominican Republic.

Potential risks and constraints

Jamaica has a world class quality and abundant quantities of limestone. The limestone in Jamaica is readily accessible but there is a need for evaluation of reserves along with improved mining techniques, upgraded state-of-the-art machinery and equipment and modernization process. The industry also faces several risks to the limestone market such as:

- Inadequate record keeping
- High cost of energy
- Lack of bulk shipping of products
- Lack of security of the precious material

The Jamaican government is willing to provide an enabling environment to reduce these risks and have started the process through active engagement with stakeholders, implementing the Draft Minerals Policy and improving access to finance. JAMPRO has a specialist to assist investors and market players with entering the value-added industry.

The table below highlights common issues associated with limestone and respective factors used to mitigate them.

Table 9: Common issues associated with limestone

Problems associated with Limestone		Constraint Mitigating Factors
Weathering	Limestone is more prone to chemical weathering than other stones, such as graphite, owing to the presence of calcium carbonate which readily reacts with rainwater. Rainwater gets acidic when it combines with carbonic acid and causes weathering in limestone walls.	After extraction mined limestone can be stored to prevent weathering by rain and other atmospheric elements.
Erosion	Limestone walls when exposed to continuous air or water, is prone to erosion. The airborne abrasives floated by wind cause erosion on limestone.	Erosion can be mitigated by planting in areas surrounding limestone walls.
Staining	Staining is also known as discolouring of limestone. Different types of organic and inorganic oils that limestone absorbs, organic matters, such as leaves, flowers or tea and coffee, animal droppings, and metals, like copper or iron, which causes rust, are the major reasons of staining on the limestone.	Limestone surfaces can be cleaned to prevent long-term stain.
Crumbling	The most critical problem of limestone and limestone materials is crumbling. Limestone has a brittle structure and inherent weakness of the stone along with external factors and gradual breakdown of the binders used in the building affects the durability and strength of the stone, thus causing crumbling in the limestone walls.	Potential sources of crumbling can be repaired if detected early.

3.0 Product Overview – Quicklime, Slaked Lime and Hydraulic Lime

Overview

Quicklime and Slaked Lime can be a profitable venture on a standalone basis; however, for Hydraulic Lime another value-added product in the value chain, it is required to be produced in conjunction with Quicklime and Slaked Lime in order to achieve economic viability as there does not currently exist a large demand market to allow for standalone production of only Hydraulic Lime.

The idea of establishing a common operations unit which encompasses Quicklime, Slaked Lime and Hydraulic Lime is feasible not only from the demand point of view but also due to the similarity in the production process of Hydraulic Lime and Slaked Lime.

Quicklime and Slaked Lime

Quicklime is a white to grey, caustic alkaline substance. It is also known as calcium oxide (CaO). It is obtained by heating or calcining limestone in kilns. The calcination process decomposes calcium carbonate in the limestone and releases carbon dioxide resulting in calcium oxide or Quicklime.

When quicklime is treated with water, it results in conversion of oxides to hydroxides, a crystalline, white soft powder, which is known as Slaked Lime or Hydrated Lime ($Ca(OH)_2$). Slaked Lime is either formed as a dry powder or as a paste depending on how much water is added during the process and the needs for end use.

Quicklime and Slaked Lime are widely used raw material in industries such as iron and steel, paper and pulp, construction, environmental protection, food and agriculture.

Figure 6: A typical representation of Quicklime and Slaked Lime

Key Applications of Quicklime and Slaked Lime

The end-uses for Quicklime and Slaked Lime are described in the table below.

Table 10: Key Applications of Quicklime and Slaked Lime

Product		Uses
Iron and Steel		Quicklime is used as a flux in steel manufacturing in order to remove impurities from iron ore in the blast oxygen furnace and electric arc furnace.
Paper and Pulp		Quicklime and Slaked Lime are used in the pulping process. Quicklime is used to neutralise acidic water and for the generation of Slaked Lime in Kraft process; while, Slaked Lime is used in causticisation.
Buildings and Construction		Quicklime and Slaked Lime are used as construction material in buildings and roads. It is used in cement mixes or mortars, soil stabilisation and modification and in construction blocks. Slaked Lime is also used in road surfacing.
Environment		Quicklime and Slaked Lime are used in sewage and water treatment to adjust the pH of water. They are also used in flue gas scrubbing and neutralising acid in soil.
Food		Slaked Lime is used in dairy industry, storage of fruits and vegetables, and production of gelatin. It is also used in sugar and corn refining.
Agriculture		Quicklime and Slaked Lime assist in agriculture by ensuring necessary nutrients in soil via pH stabilisation.

In addition to the applications mentioned above, Quicklime and Slaked Lime have various other chemical industry applications such use in the production of calcium carbide and cyanimide, citric acid and polyvalent alcohols and in industrial applications like metal refining, glass, plastic, and bleaching powder production.

Hydraulic Lime

Hydraulic Lime is made from argillaceous limestone which contains calcium carbonate together with a proportion of clay. The clay content provides the source of silica and alumina which imparts the lime with setting and hardening under water properties. Hydraulic lime can also be produced from natural limestone by infusing clay (amorphous silica) during the calcination process artificially. Presence of silica is important in the production of hydraulic lime as it combines with quicklime during calcination to form a cementitious compound (calcium silicates, or clinker). The lime produced through calcination consists of a mixture of quicklime, cementitious material and inert material such as silica or uncombined clay. The calcination products are, then, slaked with enough water to convert the quicklime to calcium hydroxide, but not so much to initiate a chemical setting of the compound.

Figure 7: Typical representations of Hydraulic Lime

Key Applications of Hydraulic Lime

Hydraulic lime is used in the following industries as described in the table below.

Table 11: Key applications of Hydraulic Lime

Product		Uses
Construction		Hydraulic Lime is used as mortar. It is also used as plaster, in floors and ceilings, as a cement in making blocks and in unreinforced lime concrete.

Production Process

The production process of both Hydraulic Lime and Slaked Lime contains common steps such as crushing, calcination, cooling, slaking of lime and finally packaging & dispatch. The difference between the production process of these products is the calcination temperatures and the raw material used in each.

The calcination temperature for Hydraulic Lime is around 100-200$_{o}$ C higher than that of Slaked Lime. However, the requirement of a higher temperature can be easily resolved by procuring a kiln that can cater to both products.

Slaked Lime is produced from high purity limestone (>98%) whereas Hydraulic Lime production requires argillaceous limestone as the raw material. Therefore, the two products can be produced from a single plant set up with the use of different raw material inputs.

The switch over from Slaked Lime production to Hydraulic Lime production or vice-versa should be made post the scheduled maintenance period to ensure that there is no contamination of the output post switch over. Kiln maintenance for this type of joint operation majorly consists of:

- Rotary kiln alignment study

- Carrying and thrust roller adjustment
- Check on the warping condition of the kiln
- Inspection of condition of kiln drives both main and auxiliary, its lubrication, etc.
- Inspection of kiln vibration
- Inspection of kiln's gear & pinion alignment
- Check on the refractory lining
- Check on the kiln insulation
- Inspection and removal of scaling, etc.

The kiln maintenance period for the rotary kiln varies from 1 week to 2 weeks depending upon the kiln dimensions and operating conditions.

Apart from kiln maintenance, maintenance of the other equipment such as the crusher, pre-heaters, burner, cooler, slaking tank, material handling and conveying system should also be planned as part of the kiln maintenance period following industry standard practices.

It is advisable to make a switch over from one process (Slaked Lime) to the other (Hydraulic Lime) during the scheduled maintenance period. The same should be planned a maximum of 2-3 times in a year per lime industry maintenance practices.

Based on the demand for Hydraulic Lime, it is suggested to maintain a single quarter in a calendar year for maintenance as well as production solely of Hydraulic Lime while the other three quarters of the year are reserved for the production of Slaked Lime.

The production process for Quicklime, Slaked Lime and Hydraulic Lime is detailed in the table below.

Table 12: Production Process of Slaked Lime and Hydraulic Lime

Process	Quicklime and Slaked Lime	Hydraulic Lime
Transportation and storage of raw material (feed)	High purity limestone is transported to the Quicklime and Slaked Lime plant location after primary crushing and stored in a storage yard inside the plant boundary. General sorting may be done to ensure that the maximum feed size of the limestone does not exceed rated intake capacity of the Jaw crusher (~340mm).	Limestone with high clay content from mines is used in the production of Hydraulic Lime. The raw material from mines is stored in a storage yard inside the plant boundary. General sorting may be done to ensure that the maximum feed size of the limestone does not exceed the rated intake size capacity of the jaw crusher (~340mm).
Two Stage Crushing	A two-stage crushing system is used to reduce the size of feed suitable for input to the lime kiln system. The output size of the two-stage crushing process is determined according to the specification of the end-use product and the kiln system being used. The raw material from the storage yard is fed into the hopper with the help of a wheel loader. The hopper discharges the limestone feed to a vibrating feeder which is capable of continuously and evenly sending materials to the jaw crusher and roughly screening them. The jaw crusher crushes the limestone feed to about 40mm to 80mm size. The output of the jaw crusher is fed to the hammer crusher with the help of a belt conveyor. The hammer crusher further reduces the size of the particles to approximately 6.4mm to 20mm which is then fed into the lime kiln system for calcination.	
Calcination	After the two-stage crushing, the crushed limestone is transported to the lime kiln system via a conveyor belt. The conveyor	After the two-stage crushing, the crushed limestone is transported to the lime kiln system via a conveyor belt. The conveyor

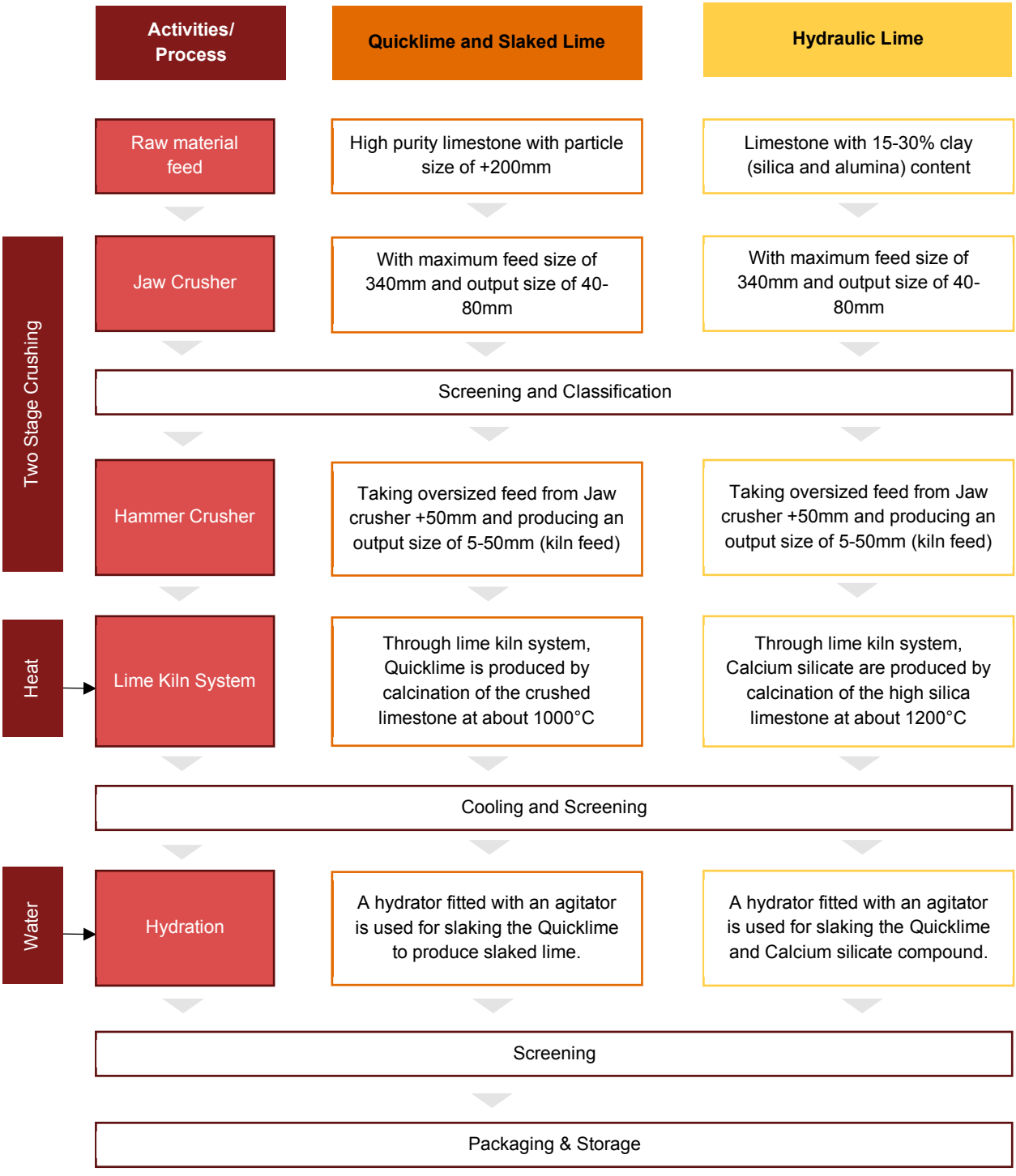
Process	Quicklime and Slaked Lime	Hydraulic Lime
	belt discharges the crushed and screened limestone through a bucket elevator up to the kiln top. From there it is fed into a multi-stage pre-heater, where it meets the hot gases rising from the kiln. Preheating is done to save the amount of energy required during the kiln stage Heat is generated from burning low volatile coal, natural gas or fuel oil. The usage of natural gas is preferred for calcination to ensure the purity of the product as well as lower emissions. Limestone particles from the preheater are discharged into a lime kiln which uses heat, air flow and motion for the calcination process. In order to complete the thermal decomposition of limestone into lime (Quicklime), limestone is heated to a temperature of approximately 1000°C. The chemical reaction that takes place in calcination is: $CaCO_3$ + Heat = CaO (quicklime) + CO_2 Lime produced in the kiln through the calcination process is known as Quicklime. The Quicklime produced is cooled and inspected.	belt discharges the crushed and screened limestone through a bucket elevator up to the kiln top. From there it is fed into a multi-stage pre-heater, where it meets the hot gases rising from the kiln. Preheating is done to save the amount of energy required during the kiln stage Heat is generated from burning low volatile coal, natural gas or fuel oil. The usage of natural gas is preferred for calcination to ensure the purity of the product as well as lower emissions. Limestone particles from the preheater are discharged into a lime kiln which uses heat, air flow and motion for the calcination process. The calcination temperature used in the lime kiln for Hydraulic lime is typically 100-200°C higher than the temperature used during preparation of Quicklime or Slaked Lime. The calcination temperature in the kiln can go up to 1200°C to ensure a chemical reaction between the Quicklime and minerals in the clay to form calcium silicates. The chemical reaction that takes place in calcination is: $CaCO_3$ + Heat = CaO (quicklime) + CO_2 $CaCO_3$ + SiO_2 = CaO.SiO_2 + CO_2 Lime produced in the kiln through the calcination process of argillaceous limestone is a mixture of Quicklime, calcium silicate (cementitious material) and inert material. The output of the kiln is cooled and inspected to remove impurities and ensure consistency.
Slaking/ Hydration	The Quicklime obtained from the calcination process is collected at the discharge end of the kiln and is transported to the slaking plant. Slaked Lime or Hydrated Lime is produced in a vessel called a hydrator by adding a specific amount of water to the Quicklime and stirring the mixture using a turbine style agitator. In this case the hydrate material is a dry powder. If excess water is used for hydration, the process is called	Post the calcination of the argillaceous limestone, a precise amount of water is added to the Quicklime and silicate compound mixture to ensure that the Quicklime is sufficiently hydrated while resisting the setting of the calcium silicate compound. A hydrator is commonly used for industrial scale production. The hydrator unit is equipped with an agitator which results increased consistency in the product. Some proportion of clinker-like

Process	Quicklime and Slaked Lime	Hydraulic Lime
	slaking. The chemical reaction which takes place in the hydration/ slaking process is: $CaO + H_2O = Ca(OH)_2$ The lime slurry produced post slaking is screened to remove impurities and un-burnt material. The resulting hydrated lime is a fluffy, dry white powder, which is conveyed to an air separator for storage/ packaging. The lime slurry after screening is standardised per the product requirement and envisaged end-use application.	lumps may be present after the slaking process. These lumps are screened-out. The powder-like Hydraulic Lime is transported through a conveyor belt for packaging.
Storage and packing	The lime products are taken to storage silos or to a semi-mechanised packaging system for packaging. Storage facilities, or bags used, are watertight to avoid product deterioration. The product bag is then either stored in a storage shed or dispatched to end-use customers.	

Process Flow

The key steps involved in the production of Quicklime, Slaked Lime (hydrated) and Hydraulic Lime are reflected in the figure below:

Figure 8: Typical production flow process of Slaked lime and Hydraulic lime



Waste Generation and Pollutants in a Quicklime and/or Slaked Lime Production Line

Quicklime, produced after calcination of limestone, can be slaked or hydrated to form Slaked Lime. The production of Quicklime, Slaked Lime and Hydraulic lime includes steps such as raw material handling, crushing & grinding, calcination, cooling of calcined product, slaking/hydration of quicklime along with

screening, filtration, drying and packaging. The conversion of limestone to lime may lead to pollutions in the form of air emissions, wastewater generation, solid waste generation and noise pollution. Although, such pollution may not be significant or hazardous at national or global scale; however, they can be a source of pollution within communities in which the operation resides. Therefore, best industry practices should be followed during the plant operation to minimise or control pollution within permissible limits as regulated by the National Environment and Planning Agency (NEPA).

Some of the key areas leading to the generation of unwanted wastes and pollutants in the production line of quicklime, slaked lime and hydraulic lime are stated below: –

- Particulate Matter or Fugitive dust emission – raw material handling & storage, crushing, screening, grinding, conveyors & transfer points, product storage in silos, packaging & dispatch
- Gaseous pollutants – exhaust gases of Kiln containing SOx, NOx, CO_2, CO, etc.
- Metals – kiln refractories, metals present in raw material, etc.
- Solid waste – unburnt particles during calcination in Kiln, bag filter dust
- Wastewater – drainage water, hydration system
- Noise – Crushing and milling system, Heavy machineries

General Industry Best Practices for Minimising Environmental Footprint of Quicklime, Slaked and Hydraulic Lime Operations

Focus area (Emissions)	Best Industrial Practices (Control Measures)
Particulate Matter (associated with crushing & grinding of raw material, material handling and material storage)	• Use a simple and linear layout design to reduce number of transfer points. • Store raw material, intermediate and final products in covered silos or enclosures. • Utilise a closed shed for major equipment like crusher, screen, grinding mill and conveyors. • Use dust separators like cyclones or bag filters for removing and collecting dust generated during crushing, grinding and material handling operations. • Store raw material and the waste generated during the process in an environment protected from wind and weather conditions. • Use dust extraction systems in conjunction with hoods and enclosures covering transfer points and conveyors. • Minimise material drop distances by the use of adjustable conveyors. • Automate the cleaning of material handling systems such as conveyor belts and bucket elevators while on their return path. • Use bag filters for collecting dust generated from product silos. • Utilise a semi-automatic or fully automatic system for packaging finished products. • Suppress fugitive dust emissions by using a vertical tube air filters or Dry Fog Dust Suppression System. The dust recovered from it can be re-circulated in the process. • Curb dust on roads and pavements by using a vacuum type or brush type sweepers.

Focus area (Emissions)	Best Industrial Practices (Control Measures)
	• Use proper personal protective equipment (PPE) such as safety goggles and respiratory masks. • Install air quality detectors at strategic locations of the plant to keep a regular check on the air quality and take preventive measures accordingly.
Particulate Matter (associated with the operation of kiln systems and coolers)	• Use an electrostatic precipitator and bag house for capturing fine particulate dust generated during kiln operation and to prevent its removal along with exhaust gases. The collected dust can be recycled back to the kiln along with its feed. • Use a dust extraction system along with bag filters to capture and separate particulates from cooler and rotary dryer operation. The collected particulates can be mixed with final product or can be used for construction work at the site along with aggregates.
Sulphur Oxide	• Use low Sulphur fuels (preferably natural gas). • Use low Sulphur limestone as a raw material input. • Design the kiln and selection of combustion conditions to ensure that most of the emitted SOx is retained in the kiln along with Quicklime.
Nitrogen Oxide	• Use low NOx burners which operate by avoiding localised hot spots. • Use finely pulverised coal so that complete combustion can be achieved with low excess air or usage of natural gas for fuel in the calcination process. • Control kiln temperatures and stabilize the temperature to below 1400$_{o}$C to minimize the generation of NOx.
Greenhouse Gases	• Deploy energy efficiency measures to reduce combustion emissions. • Use high-quality processing material where applicable to lessen the amount of emissions generated. • Recycle carbon dioxide produced during calcination to be used in the carbonation process • Utilise a fuel with a lower ratio of carbon content to calorific value (preferably natural gas, fuel oil, etc.) to emit less greenhouse gases.
Metals	• Select raw materials with a low content of metals. • Stabilise the kiln conditions including temperature, heating zones, mixing of materials to minimise removal of metals along with gases and maximise capturing along with burnt lime.
Industrial Wastewater	• Investigate the landscape, geology and groundwater in the area. • Utilise surveillance and continuous monitoring of ground water quality. • Use techniques such as sedimentation using thickeners or clarifiers to remove suspended solid particles. • Use neutralisation methods (Effluent Treatment Tank) for pH adjustment before water recirculation into the process. • Design a proper drainage system for the collection and processing of rainwater.

Focus area (Emissions)	Best Industrial Practices (Control Measures)
	• Monitor plant drainage and disposal measuring the pH level, conductivity, solid dissolution, hardness, calcium and sulfide content.
Noise	• Design appropriate acoustics to limit the amount of noise which reaches nearby communities. • Install vibration-dampening mounts and concrete foundations for the installation of heavy equipment such as crushers and mills. • Use a muffler in the grinding mill to arrest noise pollution. • Select machines which generate less noise (if practically feasible). • Use silencers for fans, room enclosures for mill operators and noise barriers. • Use of PPE like noise cancelling ear headphones. • Select a site away from communities (if possible) otherwise install outdoor silencers at site to prevent noise from affecting local people. • Install noise level sensors for continuous monitoring.
Other waste (Solid wastes) or by-product	• Plan disposal route and standard operating procedures (SOP) based on environmental regulations and dispose of waste by identifying disposal areas (wherever permissible). • Maintain systems to keep the record of quantity, origin, nature and frequency of waste being disposed. • Use dust generated or screened out material during the process for construction work at site along with aggregates or for soil stabilisation work. • Segregate and recycle waste back into the process for the reduction of environmental footprint. • Develop storage areas away from watercourses and sensitive boundaries. • Designate appropriate storage facilities for substances which require special treatment such as for substances that are flammable, sensitive to heat or light. • Inspect storage containers and dumps regularly for compliance.

Equipment Required for Quicklime, Slaked Lime and/or Hydraulic Lime Production

The type of equipment required for production of Quicklime and Slaked lime includes:

- Crushing Unit - Charging Hopper, Primary Crusher (Jaw Crusher), Vibrating Chute, Secondary Crusher
- Lime Kiln System, Lime Slaking or Hydration System – Hydrator unit equipped with an agitator
- Packaging Unit – Product Silos and Packaging system
- Other units – Blower, Elevator, Feeder, Discharge Screen Conveyor, Pulse Dust Collector, Air Compressor

4.0 Potential Markets for Jamaican Quicklime, Slaked Lime and Hydraulic Lime and Competitive Profile

Limestone trade in the Americas

The core markets for limestone exports from Jamaica are CARICOM, North America and South America. The import trend in prominent markets in North America, South America and CARICOM region presents an opportunity to Jamaica to enter the value-added market of limestone which is significant in terms of value.

Table 13: Limestone import in Americas and CARICOM

Markets	Total Limestone Import (in Million US$)	Import of Aggregates and Stones (in Million US$)
USA	99.9	13.0
Canada	79.2	11.5
Mexico	4.6	0.0
Brazil	29.5	6.9
Chile	81.3	0.0
CARICOM excluding Jamaica	5.2	0.6
Total imports in the region	**300**	**32**
Jamaica's exports	**3.8**	**3.78**

Source: ITC Trademap (accessed March 24, 2020)

The total value of imports of the studied markets in Americas was estimated at more than US$300 million while Jamaica is currently exporting approximately US$3.8 million (approximately 1% of the regional value).

Potential Market for Quicklime

Quicklime Market from a Global Perspective

For the analysis of potential markets of Quicklime, Harmonised System (HS) code of 252210: Product name: Quicklime is used. Per ITC Trade map data, global imports of Quicklime were estimated at 7 million tonnes, a decrease of 8% from quantity imported in 2018. In terms of value, the global imports were estimated at US$ 819 million in 2019. The imports are mainly driven by countries in Europe. The key global importers of Quicklime are presented in the table below:

Table 14: Global import statistics of Quicklime

Country	2017		2018		2019	
	Quantity, thousand tonnes	Value, US$ Million	Quantity, thousand tonnes	Value, US$ Million	Quantity, thousand tonnes	Value, US$ Million
World	7,038	819	7,671	905	7,069	819
Netherlands	647	83	670	90	628	84
Finland	408	53	472	69	404	61
Chile	412	61	429	64	402	58
India	567	52	626	59	601	57
Democratic Republic of Congo	157	27	257	39	251	43

Source: ITC Trade map accessed on 26th April 2020

Global imports are led by European countries with Netherlands and Finland accounting for 18% of the total global imports by value. In terms of regional imports in 2019, the European market accounted for 43% of the total global imports followed by Asia which contributed 21% and the Americas with 20% of the global imports. The major import destination in these regions are shown in the table below:

Table 15: Major importing markets in for Quicklime in 2019 by value

Geography	Imports, US$ million	Geography	Imports, US$ million	Geography	Imports, US$ million
Europe	356	**Asia**	168	**Americas**	160
Netherlands	84	**India**	57	**Chile**	58
Finland	61	**Taiwan**	38	**USA**	40
Germany	37	**Indonesia**	10	**Canada**	38
France	31	**Kazakhstan**	10	**Brazil**	16

Source: ITC Trade map accessed on 26th April 2020

According to global trade statistics, Quicklime's regional imports are summarised as follows:

- Europe led the globe in Quicklime imports. In 2019, European countries imported Quicklime worth US$ 356 million. Key Quicklime importing countries in the region includes the Netherlands, Finland, Germany and France which together imported US$ 213 million worth of products, accounting for 60% of the total regional imports.
- Asian Quicklime imports were estimated at US$ 168 million in 2019. The imports in the region is dominated by India and Taiwan, together, accounting for 56% of the total regional imports. Other key Quicklime importing countries in the region includes Indonesia, Kazakhstan, Bahrain and South Korea.
- In 2019 the Americas region imported US$ 160 million worth of Quicklime accounting for 20% of the total global imports. The key importers in the region include Chile, the USA, Canada and Brazil, together accounting for 95% of the region's total Quicklime imports.
- Africa accounted for 12% of the total Quicklime imports in 2019. The Democratic Republic of Congo led the imports in the region, accounting for 43% of the total imports into the region.

France, Germany, Belgium and Spain lead in terms of Quicklime exports. Together, these countries account for 32% of total global Quicklime exports, valued at approximately US$ 257 million. Other key global exporters include Vietnam, Zambia, the USA, Canada and Malaysia.

Quicklime Market from a Regional Perspective

The Americas region has been selected for the assessment of a potential market for Quicklime for Jamaican exports. Per ITC Trade map data, the Americas import of Quicklime grew at a compound annual growth rate (CAGR) of 1.05% between 2015 and 2019. In terms of value, imports were estimated at US$ 160 million in 2019, accounting for 21% of total global imports. The leading importers in the Americas region and their import statistics are presented in the table below:

Table 16: America's import statistics of Quicklime

Country	2017		2018		2019	
	Quantity, thousand tonnes	Value, US$ million	Quantity, thousand tonnes	Value, US$ million	Quantity, thousand tonnes	Value, US$ million
Americas Aggregation	1,135	169	1,168	173	1,088	160
Chile	412	61	429	64	402	58
USA	271	41	265	43	243	40
Canada	293	42	363	47	283	38
Brazil	81	15	89	15	103	16
Dominican Republic	-	0.01	-	0.07	30	4

Source: ITC Trade map accessed on 26th April 2020

Chile leads the import of Quicklime in the Americas mainly due to the demand arising from its metal refining industry. Chile is one of the world's leading producers of copper. Quicklime is used in the processing of copper ore wherein it maintains alkalinity and acts as a depressant in flotation process. USA, Canada and Brazil are other key markets in the region, together, accounting for 59% of imports in 2019. The major suppliers of Quicklime to the Americas region are segmented in the table below:

Table 17: Major suppliers of Quicklime to the Americas

S.N.	Supplier by geography	Value in 2019 (in US$ million)
Suppliers within the Americas region		
1	Argentina	52
2	USA	36
3	Canada	36
4	Uruguay	16
5	Mexico	3
6	Others within the Americas region	5
	Total	**148**
Suppliers outside the Americas region		
1	Spain	3
2	Italy	3
3	Turkey	2
4	Portugal	2
5	United Kingdom	1
6	Others outside the Americas region	1
	Total	**12**

Source: ITC Trade map accessed on 26th April 2020

Approximately 92% of imports of Quicklime in the region is supplied by countries within the Americas; while, 8% is supplied by countries outside the region, mostly from Europe. In 2019, US$ 12 million worth of

Quicklime was imported from geographically distant countries like Spain, Italy, Turkey, Portugal and the UK. Jamaica's imports are currently confined to relatively low value calcareous stones which are used for lime and cement manufacturing. Jamaica's central location and proximity, coupled with availability of high purity raw material (limestone) may enable it to penetrate the US$ 160 million regional import market and assist it in increasing its share of exports, provided it can scale up and be cost competitive with other export competitors within as well as outside the region.

Potential Markets in Caribbean Community (CARICOM)

CARICOM accounts for less than 1% of the total Quicklime import value in the Americas region. Albeit, low in import share, CARICOM's import was estimated at US$ 310,000 in 2019[3]; while, historically the total import value in CARICOM region has been higher at US$ 2 million in 2018 and US$ 8 million in 2017. Historically, Jamaica has been an importer of Quicklime. The country imported US$ 22,000 worth of Quicklime in 2019. Other key markets in the region include Guyana, Suriname and the Bahamas, together accounting for 93% of the CARICOM imports in 2019.

Table 18: CARICOM's import statistics of Quicklime

Country	2017		2018		2019*	
	Quantity, thousand tonnes	Value, thousand US$	Quantity, thousand tonnes	Value, thousand US$	Quantity, thousand tonnes	Value, thousand US$
CARICOM Aggregation	58	7,773	5	1,915	3	310
Guyana	23	2,061	3	1,660	1	161
Suriname	29	4,360	-	-	0.8	72
Bahamas	1	274	1	255	0.2	54
Jamaica	4	1,053	-	-	0.3	22

Source: ITC Trade map accessed on 26th April 2020

The import dependency of Jamaica in Quicklime gives an opportunity for local producers to capture the local market. In addition, easier access (trade partnership) to the CARICOM markets can allow Jamaica to capture the entire nearby market which has an estimated total import value of US$ 310,000 (in 2019) while imports have been much higher in 2017 and 2018.

Potential Market for Slaked Lime

Slaked Lime Market in Global Perspective

For the analysis of potential markets of Slaked Lime, Harmonised System (HS) code of 252220: Product name: Slaked Lime is used. Per ITC Trade map data, global imports of Slaked Lime were estimated at 1.18 million tonnes, a decrease of 3% from quantity imported in 2018. In terms of value, the global imports were estimated at US$ 186 million in 2019. The imports are driven mainly by countries in Europe which accounted for more than 43% of total global imports of Slaked Lime in 2019. The leading global importers of slaked lime are presented in the table below:

[3] Based on mirror data available on ITC Trade map accessed on 26th April 2020

Table 19: Global import statistics of Slaked Lime

Country	2017		2018		2019	
	Quantity, thousand tonnes	Value, US$ Million	Quantity, thousand tonnes	Value, US$ Million	Quantity, thousand tonnes	Value, US$ Million
World	1,126	209	1,218	209	1,179	186
France	111	17	92	17	86	15
USA	52	14	51	14	54	15
Netherlands	37	6	74	14	101	14
Singapore	44	8	50	11	55	13
Democratic Republic of Congo	57	8	131	17	87	11

Source: ITC Trade map accessed on 26th April 2020

Global imports are led by European countries with France, Netherlands and Germany accounting for 20% of the total global imports by value and 46% of total European imports of the product in 2019. In terms of regional imports in 2019, the European market accounted for 43% of the total global imports followed by Asia which contributed 22% and Americas with 16% of the global imports. The major import destination in these regions are shown in the table below:

Table 20: Major importing markets for Slaked Lime in 2019, by value

Geography	Imports, US$ million	Geography	Imports, US$ million	Geography	Imports, US$ million
Europe	80	**Asia**	42	**Americas**	30
France	15	**Singapore**	13	**USA**	15
Netherlands	14	**Philippines**	4	**Canada**	5
Germany	8	**India**	4	**Chile**	2
Sweden	5	**Hong Kong**	3	**El Salvador**	2
Poland	4	**China**	2	**Costa Rica**	1

Source: ITC Trade map accessed on 26th April 2020

Per global trade statistics, Slakes Lime's regional imports are summarised as follows:

- Like Quicklime, Europe led the global Slaked Lime imports. In 2019, European countries imported Slaked Lime worth US$ 80 million. Key Slaked Lime importing countries in the region include France, Netherlands, Germany, Sweden and Poland which together imported US$ 46 million worth of products, accounting for 57% of the total regional imports.
- Asian Slaked Lime imports were estimated at US$ 42 million in 2019. The imports in the region are dominated by Singapore accounting for 31% of the total regional imports. Other key Slaked Lime importing countries in the region include the Philippines, India, Hong Kong and China, together accounting for more than 30% of regional imports in 2019.
- The Americas region imported US$ 30 million worth of Slaked Lime in 2019, hereby, accounting for 16% of the total global imports. The key importers in the region include the USA followed by Canada, Chile, El Salvador and Costa Rica, together accounting for 87% of the region's total Slaked Lime imports.
- Africa accounted for 17% of the total global Slaked Lime imports in 2019. The Democratic Republic of Congo led the imports in the region, accounting for 35% of the total imports, followed by Burkina Faso which accounted for 19% of African imports.
- Europe with countries such as the UK, Germany, Belgium and France lead in terms of Slaked Lime exports. Together, these countries account for 30% of total global Slaked Lime exports, valued at

approximately US$ 57 million. Other key global exporters include Zambia, Malaysia, China and Canada.

Slaked Lime Market from a Regional Perspective

The Americas region has been selected for the assessment of a potential market for Slaked Lime for Jamaican exports. Per ITC Trade map data, the Americas imports of Slaked Lime are estimated at 136,228 tonnes valued at US$ 30 million in 2019. The region accounts for a substantial 16% of total global imports which in value terms is much higher than Jamaica's current exports. The leading importers of slaked lime in the Americas region and their import statistics are presented in the table below:

Table 21: America's import statistics of Slaked Lime

Country	2017		2018		2019	
	Quantity, thousand tonnes	Value, US$ million	Quantity, thousand tonnes	Value, US$ million	Quantity, thousand tonnes	Value, US$ million
Americas Aggregation	158	41	146	38	136	30
USA	52	14	51	14	54	15
Canada	19	5	21	5	25	5
Chile	38	13	30	10	12	2
El Salvador	15	2	15	2	16	2
Costa Rica	8	2	7	1	7	1

Source: ITC Trade map accessed on 26th April 2020

While the import of Slaked Lime by Chile has decreased between 2017 to 2019, imports by the USA and Canada have remained stable. In 2019 the USA and Canada accounted for 67% of the total imports in the Americas. The major suppliers of Slaked Lime to the Americas region are segmented in the table below:

Table 22: Major suppliers of Slaked lime to the Americas

S.N.	Supplier by geography	Value in 2019 (in US$ million)
Suppliers within the Americas region		
1	Canada	7.18
2	USA	5.57
3	Guatemala	4.39
4	Mexico	4.13
5	Dominican Republic	1.48
6	Others within the Americas region	2.67
	Total	**25.42**
Suppliers outside the Americas region		
1	Belgium	1.35
2	United Kingdom	0.77
3	Germany	0.44
4	Netherlands	0.40
5	Spain	0.35
6	Others outside the Americas region	0.95
	Total	**4.25**

Source: ITC Trade map accessed on 26th April 2020

Approximately 86% of imports of slaked lime in the region is supplied by countries within the Americas; while, 14% is supplied by countries outside the region, mostly from Europe. In 2019, US$ 4.25 million worth of quicklime was imported from far-flung countries like Belgium, United Kingdom, Germany, Netherlands and Spain. As stated, Jamaica's imports are confined to relatively low value calcareous stones which are used for lime and cement manufacturing. Jamaica's central location and proximity, coupled with availability of high purity raw material (limestone) may enable it to penetrate the US$ 30 million regional import market and assist it in increasing its share of exports, provided it can scale-up and be cost competitive with other export competitors within as well as outside the region.

Potential Markets in Caribbean Community (CARICOM)

CARICOM accounts for approximately 2% of the total import value of slaked lime in the Americas region. Albeit, low in import share, CARICOM's import was estimated at US$ 587,000 in 2019[4]; an increase of more than 50% from the import value in 2018. The growth in imports was led by Barbados and Suriname, which together accounted for more than 80% of CARICOM's import in 2019. Other key importers of Slaked Lime in the nearby market are Guyana, Trinidad and Tobago, and the Bahamas. Trinidad and Tobago currently the only exporter in CARICOM of Slaked Lime and account for 99% of exports from the region.

Table 23: CARICOM's import statistics of Slaked Lime

Country	2017		2018		2019	
	Quantity, thousand tonnes	Value, thousand US$	Quantity, thousand tonnes	Value, thousand US$	Quantity, thousand tonnes	Value, thousand US$
CARICOM Aggregation	0.96	510	1.01	387	1.29	587
Barbados	0.54	398	0.32	212	0.42	371
Suriname	-	-	-	-	0.41	108
Guyana	0.21	28	0.37	79	0.23	45
Trinidad and Tobago	0.10	46	0.13	21	0.16	34
Bahamas	0.05	24	0.19	75	0.05	20

Source: ITC Trade map accessed on 26th April 2020

Potential Market for Hydraulic Lime

Hydraulic Lime Market in Global Perspective

For the analysis of potential markets of Hydraulic Lime, Harmonised System (HS) code of 252230: Product name: Hydraulic Lime is used. Per ITC[5] Trade map data, global imports of Hydraulic Lime were estimated at 240 thousand tonnes, an approximate decrease of 32% from 353 thousand tonnes imported in 2018. In terms of value, the global imports were estimated at US$ 32.71 million in 2019, a decrease of 36% from imports valued at US$ 51.40 million in 2018. The imports mainly are driven by countries in Europe and Africa. The leading global importers of Hydraulic Lime are presented in the table below:

[4] Based on mirror data available on ITC Trade map accessed on 26th April 2020
[5] International Trade Centre

Table 24: Global import statistics of Hydraulic lime

Country	2017		2018		2019	
	Quantity, thousand tonnes	Value, thousand US$	Quantity, thousand tonnes	Value, thousand US$	Quantity, thousand tonnes	Value, thousand US$
World	281	42,706	353	51,400	240	32,708
Netherlands	82	7,450	91	9,193	88	9,119
United Kingdom	8	1,966	6	1,454	7	2,081
Malawi	9	2,720	10	3,049	10	1,773
Namibia	11	2,974	12	2,400	8	1,721
France	6	393	8	774	15	1,532

Source: ITC Trade map accessed on 24th April 2020

The Netherlands leads the import of Hydraulic Lime globally, accounting for about 28% of total global import in value terms in 2019 followed by United Kingdom which accounts for 6% of the global imports. Altogether, Europe accounted for 60% of the total global imports of Hydraulic Lime, making it the largest market followed by Sub-Saharan Africa which accounted for 24% of the global import share in 2019. Imports to Africa is led by countries including Malawi, Namibia, Zimbabwe and the Democratic Republic of Congo which together accounted for 79% of the total imports into the continent in 2019.

The major exporters of Hydraulic Lime in Europe are France, Germany and Portugal which supplies to the European market along with USA, the largest importer in the Americas region. While, for Sub-Saharan Africa, the largest exporters are Zambia and South Africa which supplies mainly to the African market. With the vast resources of limestone, Jamaica may be able to scale up and capture some of the demand in these markets provided they develop a niche marketing strategy to serve specific needs in the market while maintaining cost competitiveness.

Hydraulic Lime Market in Regional Perspective

The Americas region has been selected for the assessment of potential regional market for Hydraulic Lime for Jamaica. The region accounted for around 5% of the global imports share in 2019. Per ITC Trade map data, the region imported 9.95 thousand tonnes of Hydraulic Lime in 2019 with an estimated value of US$ 1.54 million. The region has net negative trade balance of US$ 0.73 million. The leading importers of Hydraulic Lime in the Americas region are presented in the table below:

Table 25: Americas' import statistics of Hydraulic Lime

Country	2017		2018		2019	
	Quantity, thousand tonnes	Value, thousand US$	Quantity, thousand tonnes	Value, thousand US$	Quantity, thousand tonnes	Value, thousand US$
America Aggregation	9.42	1,966	16.98	3,218	9.95	1,539
USA	1.04	471	1.15	852	0.97	740
Canada	4.67	800	11.27	1,206	6.66	437
Belize	1.87	260	1.73	234	1.93	248
Panama	0.15	42	0.03	5	0.12	26
Chile	-	-	-	2	0.03	25
Trinidad and Tobago	0.17	44	0.17	124	0.03	15
Uruguay	0.06	7	0.15	18	0.11	13

Source: ITC Trade map accessed on 24th April 2020

Major markets in the Americas per imports are the USA and Canada which together accounted for 76% of the Americas imports. CARICOM aggregation accounts for approximately 18% of the imports share in the region.

The major suppliers of Hydraulic lime to the America region are segmented in the table below:

Table 26: Major suppliers of Hydraulic Lime to the Americas

S.N.	Supplier by geography	Value in 2019 (in US$ thousand)
Suppliers within the Americas region		
1	USA	429
2	Guatemala	188
3	Honduras	67
4	Brazil	20
5	Mexico	19
6	Others within the Americas region	9
	Total	**732**
Suppliers outside the Americas region		
1	France	646
2	Germany	50
3	United Kingdom	46
4	Belgium	42
5	Italy	12
6	Others outside the Americas region	12
	Total	**808**

Source: ITC Trade map accessed on 24th April 2020

As assessed through global trade analysis, trade is mainly done in proximity with leading suppliers in Europe serving the European market and likewise in Africa, as well. In the case of Americas region, 52% of imports in the region are supplied by countries outside of the Americas region. Some of the major suppliers to the region are far-flung countries such as France, Germany, the United Kingdom, Belgium and Italy. For example, the major Hydraulic Lime importer in the region, the USAs imports most of its Hydraulic Lime from France.

Potential Markets in CARICOM

CARICOM accounts for 18% of the total import value in the Americas region. Albeit, low in import volume, CARICOM's import was estimated at US$ 277 thousand[6] in 2019 and US$ 894 thousand in 2018. The major importing countries driving demand in the region are Belize and Trinidad & Tobago.

6 Data on Bahamas and Guyana are not available on Trade map as on date

Table 27: CARICOM's import statistics of Hydraulic Lime

Country	2017		2018		2019	
	Quantity, thousand tonnes	Value, thousand US$	Quantity, thousand tonnes	Value, thousand US$	Quantity, thousand tonnes	Value, thousand US$
CARICOM Aggregation	2.92	516	3.30	894	1.98	277
Belize	1.87	260	1.73	234	1.93	248
Trinidad and Tobago	0.17	44	0.18	124	0.03	15
Barbados	0.02	8	0.02	8	0.02	8
Suriname	-	-	-	-	NA	4
Antigua and Barbuda	0.001	1	0.001	1	0.003	2
Rest of countries in CARICOM	0.85	203	1.37	527	-	-

Source: ITC Trade map accessed on 24th April 2020

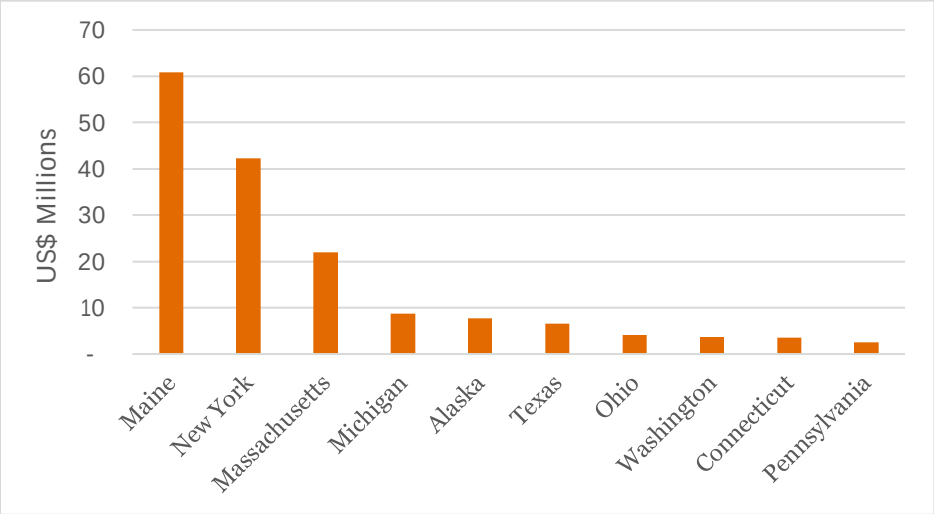
Belize accounted for almost 90% of CARICOM's total imports in 2019. In Jamaica's context, Belize as a member of CARICOM is an accessible potential market with consistent imports of more than US$ 200 thousand of Hydraulic Lime. Currently, it imports product mainly from Guatemala, Honduras and Mexico. Other important markets in CARICOM include Trinidad & Tobago, Bahamas, Guyana and Barbados. Due to proximity to CARICOM and easier accessibility, Jamaica can substitute some of these imports provided it serves the quality needs of the various markets and remain cost competitive with respect to other suppliers within the region.

Potential Markets in the United States

Quicklime

The chart below represents the top ten (10) states that import quicklime, these states represent 94.1% of total demand/importation within the US. Quicklime is used in industries such; paper and pulp, water treatment, iron and steel, buildings and construction. Quicklime is mainly imported from Canada, Mexico, United Kingdom and China. According to the University of Maine lime is mainly used for soil and agricultural products because the soil is highly acidic (low pH) and agricultural lime increases the soil pH improving the fertility of the soil.

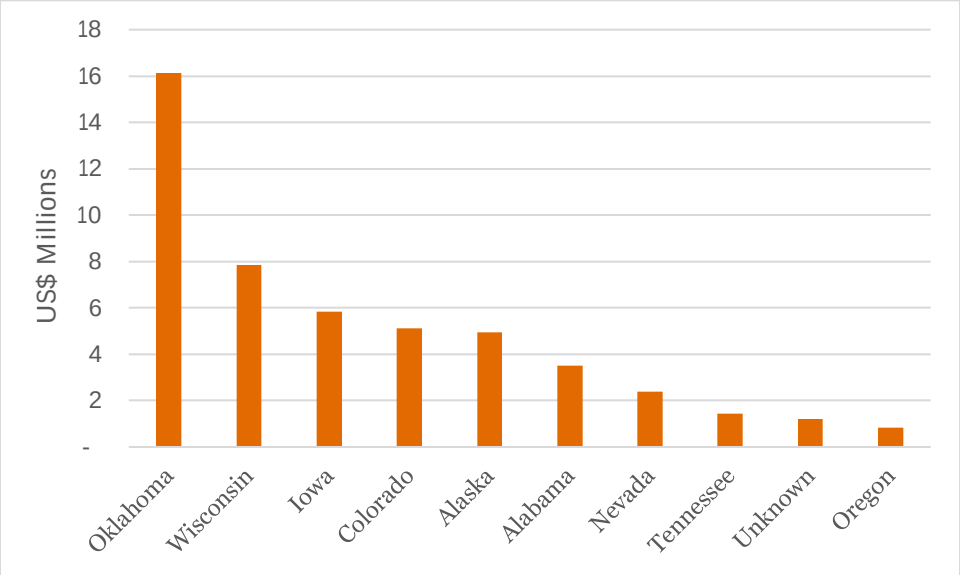
Figure 9: Top 10 Importers of Quicklime



Slaked Lime

The chart below represents the top ten (10) states that import Slaked Lime, these states represent 94.3% of total demand/importation within the US. Quicklime is used in industries such; paper and pulp, wastewater treatment, agriculture, Food (storage, pasteurization), buildings and construction. Imports of Slaked Lime come from Canada, Mexico, Dominican Republic and the Netherlands.

Figure 10: Top 10 Importers of Slaked Lime



Hydraulic Lime

The chart below represents the top ten (10) states that import Hydraulic Lime, these states represent 90.3% of total demand/importation within the US. Quicklime is used in buildings and construction as mortar and concrete. Imports primarily come from France, Germany, Belgium and Italy.

Figure 11: Top 10 Importers of Hydraulic Lime

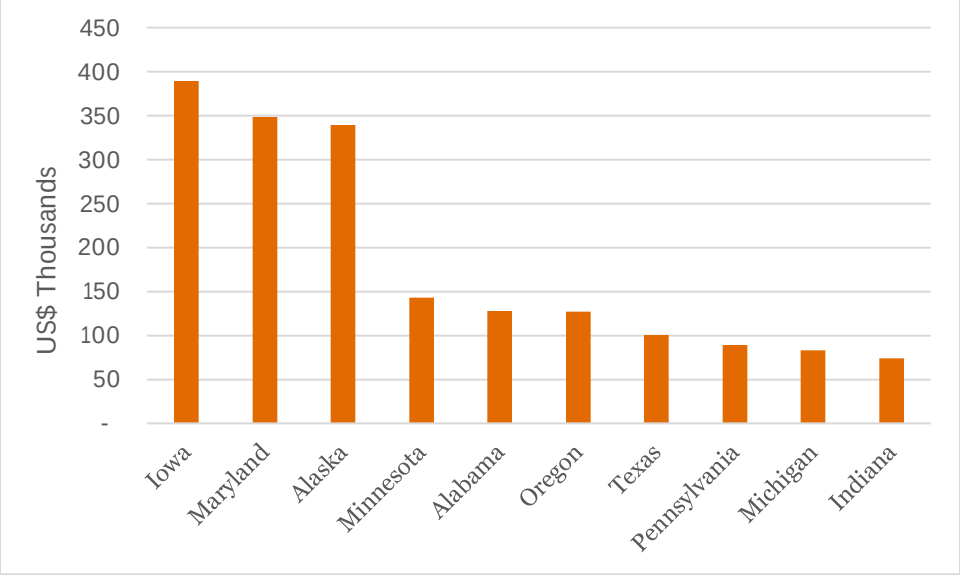


Table 28: Key Importers of Lime

S.N.	Competitor	Location
1	Graymont LLC	Superior, Wisconsin
2	Lhoist North America Inc.	Lhoist North America Ariz Inc: Fort Worth, Texas Lhoist North America Tenn Inc: Brentwood, Tennessee (Multiple operations across USA, Canada)
3	Lime Holdings Inc.	Fort Worth, Texas
4	Austin White Lime Company	Austin, Texas
5	Mercer Lime Company	Bridgeville, Pennsylvania
6	Texas Lime Company	Dallas, Texas
7	Neville Pulverised Lime Company	Pittsburgh, Pennsylvania
8	Carmeuse Lime Inc	Pittsburgh, Pennsylvania
9	United States Lime and Minerals	Dallas, Texas (Operations in Arkansas, Colorado, Louisiana, Oklahoma and Texas)
10	Mississippi Lime	St. Louis, Missouri (Operations in Missouri, Alabama, Kentucky, Mississippi, West Virginia, South Carolina, Illinois, Pennsylvania)
11	Total Lime LLC	Houston, Texas

Summary of Potential Markets of Quicklime, Slaked and Hydraulic Lime

- The total combined global import value of Quicklime, Slaked and Hydraulic Lime was valued at US$ 1,005 million in 2019. Quicklime imports accounted for about 80% of the total combined import value. In the global trade, both imports and exports, are dominated by Europe followed by Asia.
- The Americas combined import value of Quicklime, Slaked and Hydraulic Lime was valued at US$ 190 million in 2019. Quicklime imports accounted for about 84% of the total combined import value. Chile and the USA are major import markets in the region accounting for about 60% of the regional imports. Chile led the import of Quicklime; while, USA led the import of Slaked Lime (in 2019).
- The combined value of imports coming into the Americas region from countries outside was estimated at US$ 16 million. This represents a sizeable market that Jamaica can try to substitute provided it is cost competitive against the current exporters.
- The CARICOM region represents less than 1% of the Americas total imports by value. The combined import of Quicklime, Slaked Lime and Hydraulic Lime in the region was valued at approximately US$ 1.175 million. About 50% of the combined imports was for Slaked Lime; while, 26% was of Quicklime imports, with the balance of 24% for Hydraulic lime. Guyana led the imports of Quicklime in CARICOM; while, Barbados and Belize led the import of Slaked Lime and Hydraulic lime respectively. Also, Jamaica was observed to be a net importer of Quicklime in 2019. This presents an opportunity for the local market and import substitution.

End Use Industries and Market Forecasts

Quicklime is mainly used in industries as a catalytic agent. It is used in steelmaking to help separate impurities from the molten steel. It reacts readily with water liberating heat in the process. Quicklime's chemical affinity for water absorption makes it a useful drying agent in various industrial processes. Quicklime is also used to make paper, refine metals and make fiberglass. It also helps separate Sulphur from industrial smoke emissions.

Slaked Lime (Hydrated Lime) is used in environmental purification, agriculture and construction but can be used in some of the same industrial applications as Quicklime. Slaked Lime is used to purify wastewater

and industrial wastes and control odours. It reduces soil acidity in farms, lawns and gardens. In construction, Slaked Lime is an essential ingredient in mortar, plaster, whitewash and stucco. It is also used to stabilise soil for construction projects.

Hydraulic Lime is mainly used in buildings and the construction industry. Additionally, in some construction applications, Hydraulic Lime's performance is superior to Portland cement in workability and elasticity.

The key differences between Quicklime and Slaked Lime (hydrated lime) are their reactivity & their chemical composition. The higher density of Quicklime reduces the storage and transportation cost which makes it preferred in some bulk quantity applications. In terms of Hydraulic Lime, while production process remains similar to Slaked Lime, change in raw material used (limestone with high clay content in place of high CaCO3 content) imparts a cementitious property to the product making it suitable for use mainly in building and construction industry.

Key End Use Industries of Quicklime, Slaked Lime and Hydraulic and Quality Requirements

Iron and Steel

Quicklime can be used as an additive into steel blast furnaces when iron is being extracted from iron ore. The calcium oxide (CaO) reacts with the silicon dioxide (SiO_2) in sand to form calcium silicate ($CaSiO_3$), which is called 'slag'. The slag separates and floats on the surface of the molten iron and can be easily removed, leaving only molten iron clean of impurities. Without the lime additive, iron silicate would be formed, and metallic iron would be lost. Adding lime, also, has the advantage of reducing the temperature required to melt the iron, resulting in energy savings. Although, slag is considered a waste product, it can be turned into 'slag cement' and can be used in road construction.

The USA and Brazil are the major steel producers in the nearby region and the production of crude steel in both the countries has increased in recent years. In 2018, the USA raised import duties on all steel imports into the country to 25%. Such increase in import duty on steel products is expected to drive the domestic steel production in the country while restricting import. Further, the duty-free imports of lime and limestone products – key raw material for steel production, is expected to improve the limestone market in the USA due to expected rise in domestic steel production.

In 2019, steel manufacturing and related industries contributed an estimated US$580 million, accounting for approximately 5.2% of the Americas total limestone market by value. The value is further estimated to increase at a compound annual growth rate (CAGR) of 3.4% to US$687 million by 2024.

Table 29: Quality parameters for limestone to be used in the Iron and Steel Industry

Quality parameters	Acceptable Value (%)
Lime, as CaO	53
Silica, as SiO_2	2.5
Iron oxide, as Fe_2O_3	0.10
Total lime and magnesia (as CaO + MgO)	54.50

Paper and Pulp

Kraft pulping is the most widely used pulp process; wherein, Slaked Lime is utilised in the recovery of sodium hydroxide or caustic soda (NaOH) through a process called causticisation which involves a chemical reaction between Slaked Lime ($Ca(OH)_2$) and sodium carbonate (Na_2CO_3). Further, Quicklime (CaO) is used in generation of Slaked Lime for the causticisation.

The aim of the paper and pulp production process is to dissolve the lignin that holds the wood fibers together. Caustic soda is used to attack lignin and the process generates sodium carbonate (Na_2CO_3). This sodium carbonate is pumped to a large container with Slaked Lime ($Ca(OH)_2$). The reaction between the two in the vessel produces sodium hydroxide and calcium carbonate ($CaCO_3$). The calcium carbonate thus formed can be calcined to produce Quicklime (CaO) which is then hydrated to form Slaked Lime and reused in causticisation. Fresh Quicklime amounting to 250kg/tonne of pulp[7] is added to maintain impurities within an acceptable level.

The Americas have significant paper production capacities and the pulp, paper and paperboard capacities of the USA, Canada and Brazil were estimated at 51.98 million tonnes per annum (MTPA), 9,900 tonnes per annum, 23,530 tonnes per annum[8], respectively. North America has the highest per capita paper consumption in the world. However, the paper consumption has been witnessing a gradual decline in the United States in the recent years owing to the substantial decline in the use of paper for printing and writing as businesses shift to online workflows and automated processes.

In contrast paper consumption is witnessing a growth in Canada and Mexico. The growing need for cardboard packaging and increasing e-commerce activities are the key driving factors for the paper industry in these countries.

In 2019, paper and pulp industries contributed an estimated US$ 408 million, accounting for approximately 3.6% of the Americas total limestone market by value. The value is further estimated to decline slightly at a CAGR of 0.1% to US$ 406 million by 2024. Overall, albeit the slight decline, the volume of paper and pulp industry, proximity to major markets and availability of high purity limestone provides an opportunity for Jamaica to export its Quicklime and Slaked Lime.

Table 30: Quality parameters for limestone to be used in the Paper Industry

Quality parameters	Mean	Range
Calcium Carbonate, $CaCO_3$ (%)	98.46	96 - 99.35
Lime, CaO (%)	55.17	53.79 - 55.67
Magnesia, MgO (%)	0.45	0.15 - 1.2
Silica, SiO_2 (%)	0.11	0.05 - 0.4
Iron oxide, Fe_2O_3 (%)	0.04	0.01 - 0.1
Brightness (%)	96.7	93.5 - 99

Constructional Use

Lime in the form of Quicklime, Slaked Lime (hydrated lime) or lime slurry is utilised in civil works for soil stabilisation and modification; hereby, improving the engineering properties of soil. Quicklime helps in drying wet soil and reducing the downtime in construction activities. It can be used in earthworks such as construction of embankments, compacted cushions or road and railway foundation by assisting in

[7] Source: https://www.carmeuse.com/
[8] Food and Agriculture Organisation of the United Nations

compaction by drying out wet areas, drying up spongy subsoil, providing a working table for further construction, and conditioning the soil for further stabilisation using Portland cement. Slaked Lime or hydrated lime slurry can also be used in place of Quicklime for improving soil stability. Slaked Lime helps in reducing the water holding capacity of soil through chemical changes; therefore, making it easier to work on while decreasing swelling and shrinkage.

In addition to soil modification, Quicklime and Slaked Lime both are used in cement-based mixes. Due to plasticiser properties, Slaked Lime is used in cement-based mortars. Quicklime is often mixed with cement, sand, water and aluminium powder and used in production of constructional blocks with better thermal and sound insulation. In addition, Slaked Lime or limewash is used in painting walls.

Hydraulic Lime is typically used in mortars and plasters. Hydraulic Lime mortars combine the advantages of lime mortars and cement mortars and may be used in place of cement-sand or cement-lime-sand mortars for bricks and blocks masonry. Also, in marine masonry structures, Portland cement is not preferred due to the presence of sulphates in sea water, therefore Hydraulic Lime is more suitable for marine applications.

The construction sector in North America has witnessed a significant growth in the past few years with 8.6% increase in value of new construction in the USA and 7.2% increase in value of new construction in Canada. Although the Latin America construction industry has witnessed a slight downfall in the recent years owing to political and financial uncertainties, it is expected to recover in the coming years. The Latin American construction industry is expected to grow by 1.1% in 2019 and 2.6% during 2020-2023.

The demand for limestone in the building and construction industry in the region is expected to grow however, the growth is expected to be higher in the USA and Canada which should be the primary target market for Jamaica. In 2019, Americas limestone market of buildings and construction industry was estimated at US$ 6,643 million. The market is expected to further grow at a CAGR of 2.73% to reach US$ 7,602 million by 2024.

Water Treatment

Slaked Lime or Quicklime is used as a cost-effective method for pH adjustment of industrial wastewater or potable water by neutralising strong acids. Slaked Lime is also used as a coagulant and stabiliser, used in treating sewage and for removing heavy metals from water.

In Latin America, as of 2018, less than 40% of the region's wastewater was treated. The Development Bank of Latin America (CAF) estimated that during 2010-2030, an investment of US$33 billion is required to carry out the wastewater treatment in the region. The World Bank and CAF have launched a new initiative "Wastewater: From Waste to Resource" to encourage investments in the water treatment industry. This initiative is likely to boost the demand for water treatment chemicals, which, in turn, is likely to drive the demand for Quicklime and Slaked Lime in the region.

In the USA the water treatment market is expected to grow by US$1,441 million in next 5-6 years. The growth of the water treatment market in this region is majorly driven by the mining and power industries.

The demand for limestone in the water treatment industry in the region is expected to grow and can be a potential target segment for Jamaica, importantly as the demand is growing in the Caribbean as well. In 2019 the Americas limestone market in water treatment was estimated at US$ 887 million. The market is expected to further grow at a CAGR of 3.46% to reach US$ 1,051 million by 2024.

Pollution Control in Power Plants: Flue Gas Desulphurisation

Flue gas is a mixture of gases produced during the burning of fossil fuels like coal, oil, natural gas in power plants. The sulphur dioxide produced as a result of burning of fossil may result in acid rain. Rapid climate change and global warming has led to strict environmental emission standards in several countries to limit the amount of sulphur dioxide being emitted to the atmosphere from fossil-based power plants.

A Flue Gas Desulphurisation (FGD) processing unit, commonly referred to as a scrubber, removes acidic gases, particularly sulphur dioxide (SO_2) from the exhaust flue gases in power plants that burn coal. During the combustion process, the sulphur in the coal combines with oxygen (O_2) in the air to form sulphur dioxide. To remove the sulphur dioxide, the flue exhaust from a coal-fired power plant is bubbled through a lime mixture or dry Slaked Lime or limestone and water. The resultant reaction typically captures more than 95% of the SO_2.

The captured SO_2 combined with the Slaked Lime powder or limestone slurry forms a by-product, primarily calcium sulphate ($CaSO_4$) commonly called gypsum. Gypsum is recyclable and marketable product used in many industrial applications such as construction, coatings and polymerisation.

Food Industry

Slaked Lime is widely used in food industry due to its low toxicity and mild basic properties. It is used in sugar and corn processing, pickling, fortifying fruit drinks and as an alternative to baking soda.

Slaked Lime can also be placed in the storage area of fruits and vegetables to absorb the carbon dioxide which is naturally released. The absorption of carbon dioxide by Slaked lime removes the smells during decomposition and helps to maintain the freshness of fruits and vegetables for a longer duration.

Diluted Slaked Lime is also used to reduce the acidity in cream prior to its pasteurisation in the dairy industry. Other products that might be formed as a byproduct in the dairy industry with the help of Slaked Lime includes glue and calcium lactate.

Agriculture Industry

In agriculture, the major application of limestone is in treating acidic soils. The acidity of soils is majorly attributed to soluble aluminum, which harms the root systems of plants. Slaked lime has high neutralising value and can be used for pH or acidic control of soil. Growth and health of crops are limited by the acidity of soil and makes it vulnerable to weather, diseases and pests. The pH level suitable for vegetable growth typically ranges from 6.5 to 7, values outside this range may lead to reduction in micro-nutrients in soil.

Slaked Lime can also be used in fertilized ponds to increase its alkalinity and enhance the water quality for feed-based aquaculture.

According to the Organization for Economic Cooperation and Development (OECD) and the Food and Agriculture Organization of the United Nations (FAO), the agricultural and fisheries production is expected to grow by 17% during 2018-2028 period. Crop production is expected to account for more than half of this growth. Hence, the growing agricultural industry is expected to drive the demand for agrochemicals, which, in turn, is expected to boost the demand for Slaked lime (Agricultural lime products).

Qualitative Assessment of Jamaica's Limestone and Its Suitability for Manufacturing of End Use Products using Quicklime and Slaked Lime

MGD reports reveal large deposit of limestone reserves in the parish of Portland, St. Elizabeth and Trelawny. These deposits are located within the white limestone group, and the research revealed that both the surface and subsurface geology yielded high to very purity limestone suitable for the different end use

applications. The calcium carbonate concentrations (97% and above) with heavy metals within the acceptable limits.

Table 31: Quality of limestone found in Jamaica

Quality parameters	Portland (Average)	Trelawny (Average)	St. Elizabeth (Average)
Calcium Carbonate, $CaCO_3$ (%)	>99	>99	>98
Magnesia, MgO (%)	~0.60	~0.2	~0.3
Silica, SiO_2 (%)	<0.20	0.50	<0.20
Iron oxide, Fe_2O_3 (%)	<0.10	0.05	0.20
Aluminium Oxide Al_2O_3 (%)	<0.10	<0.15	0.35

Source: Mines and Geology Division (MGD) report

From the existing quality data, it is observed that there is presence of high purity, white limestone formations in many areas with very low to trace concentrations of iron (Fe) and other impurities. In addition to data from MGD, Jamaica already has value-added limestone producers across the country, one with calcium carbonate content of 99% used to produce quicklime and slaked lime.

Therefore, comparing the quality requirements of different end use industries and MGD's quality data along with existing value-added producers in the island, it is may be inferred that the limestone found in the island is suitable for production of Quicklime and Slaked Lime.

Investment opportunity: Growth in the key end use industries

Except for the paper and pulp industry, the key end use industry segments of Quicklime and Slaked Lime like such as building and construction, agriculture, wastewater treatment, paper and pulp, food, and plastics are estimated to grow between 2019 to 2024 period.

Table 32: The Americas limestone market by key end-use applications segments of lime, in US$ million

End use Industry	2016	2017	2018	2019 (est.)	2024 (f)	% Growth (2019-2024)
Building and Construction	6,106	6,247	6,465	6,643	7,602	14%
Agriculture	1,822	1,902	1,982	2,046	2,312	13%
Water Treatment	761	806	850	887	1,051	19%
Paper and Pulp	404	407	411	408	406	-1%
Dairy, Food and Beverage, etc.	385	406	426	441	501	14%
Plastics	151	158	164	169	190	13%
Total	9,628	9,925	10,297	10,595	12,063	14%

Source: Mordor Intelligence

Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis

To assess the growth potential of Quicklime, Slaked Lime and Hydraulic Lime in Jamaica, a SWOT analysis was conducted. The high-level results of the analysis are contained in the figure below. Findings and primary source interviews and surveys suggest Jamaica is in a strong position to be able to develop the Quicklime and Slaked Lime industry due to availability of vast high-purity limestone raw material and export potential in nearby region as well as possibility to export to distant markets as well. In addition, there are opportunities in bringing in new types of financing agreements as well as incentivising new entrants with Special Economic Zones (SEZ) for the manufacture of Quicklime, Slaked Lime and Hydraulic Lime.

Figure 12: Summary SWOT Analysis for Jamaica's Quicklime, Slaked Lime and Hydraulic Lime Industry

5.0 Financial Highlights

The following discussion also contains forward-looking statements that involve risks and uncertainties. A potential investor's actual results may differ materially from those discussed in the forward-looking statements as a result of various factors. Although JAMPRO and its independent advisors, believe that in making any such statements its expectations are based on reasonable assumptions, such statements may be influenced by factors that could cause actual outcomes and results to be materially different from those projected. Prospective investors are cautioned not to place undue reliance on these forward-looking statements, which speak only as of the dates on which they have been made and should conduct their own due diligence. Future events or circumstances could cause actual results to differ materially from or anticipated results.

Combination and Phasing of operations

Quicklime and Slaked Lime can be a profitable venture on a standalone basis however, for Hydraulic Lime another value-added product in the value chain, it is required to be produced in conjunction with Quicklime and Slaked Lime in order to achieve economic viability.

- The idea of setting up of common operations unit which encompasses Quicklime, Slaked Lime and Hydraulic Lime is feasible not only from the demand point of view but also due to the similarity in the production process of Hydraulic Lime and Slaked Lime
- Based on the demand for Hydraulic Lime, it is suggested to maintain a single quarter in a calendar year for maintenance as well as production solely of Hydraulic Lime while the other three quarters of the year are reserved for the production of Slaked Lime.

Financial Highlights

A financial assessment of the valued-added production for Quicklime, Slaked Lime and Hydraulic Lime in Jamaica was conducted under two scenarios, that is (i) on a standalone basis (start-up) and (ii) an incremental basis (existing limestone operation). The financial results demonstrate positive trends, and therefore a business will have the liquidity to finance the growth potential and ongoing initiatives. The expected financial performance below reflects the position once the plant has become operational (i.e. Year 1).

Table 33: Scenario 1: Summary Incremental Financial Performance

Projected Incremental Financial Performance					
(In US$M)	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Revenue	2.1	2.2	2.3	2.4	2.6
% Growth	N/A	5.7%	5.7%	5.7%	5.7%
EBITDA	0.8	0.9	1.0	1.1	1.2
% Sales	38.4%	40.5%	42.5%	44.4%	46.3%
Net Income	0.4	0.5	0.5	0.6	0.7
% sales	18.5%	20.8%	23.1%	25.2%	27.3%
Net Debt	1.3	1.1	0.9	0.7	0.5

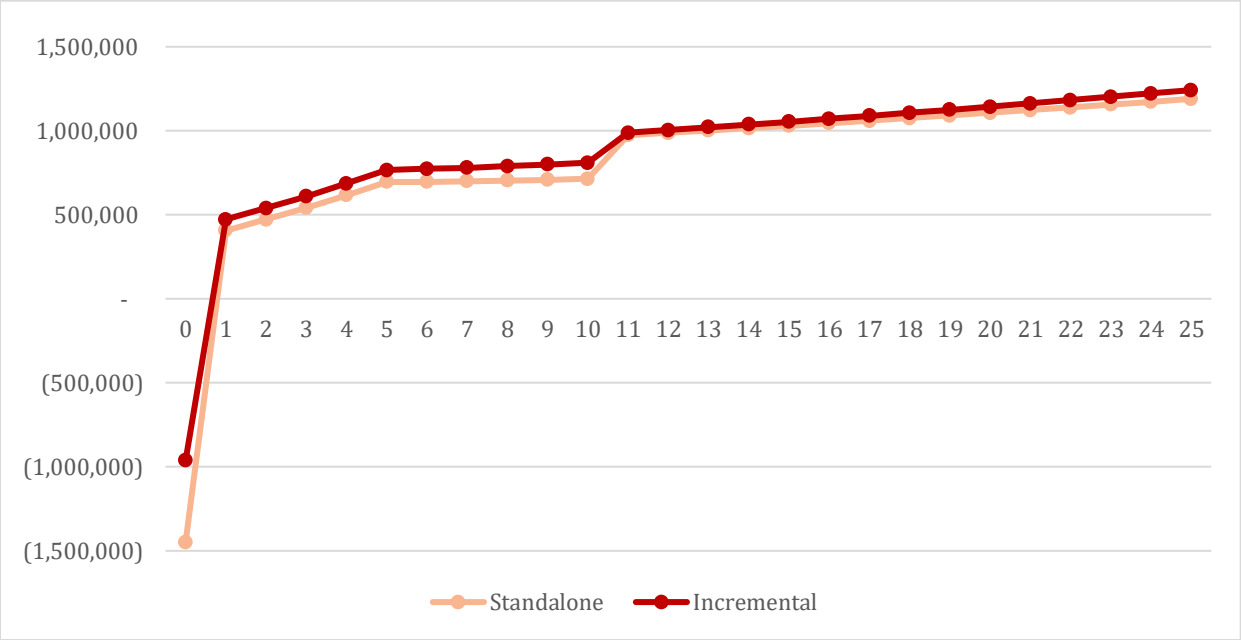
For Quicklime, Slaked Lime and Hydraulic Lime the projected average net income margin generated is expected be in excess of 20% and is expected to be adequate to finance assumed debt.

Table 34: Scenario 2: Summary Standalone Financial Performance

Projected Standalone Financial Performance					
(In US$M)	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Revenue	2.1	2.2	2.3	2.4	2.6
% Growth	N/A	5.7%	5.7%	5.7%	5.7%
EBITDA	0.8	0.9	1.0	1.1	1.2
% Sales	38.1%	40.2%	42.2%	44.2%	46.1%
Net Income	0.3	0.3	0.4	0.5	0.6
% sales	13.1%	15.8%	18.4%	20.9%	23.4%
Net Debt	1.9	1.6	1.3	1.0	0.7

For Quicklime, Slaked and Hydraulic Lime the projected average net income margin generated is expected to be in excess of 15% and is expected to be adequate to finance assumed debt.

Figure 13: Forecasted Cash Flow



Net cashflow in Year 0 of (US$1.0 million) includes investment in incremental setup of US$2.4 million and debt finance US$1.4 million (60%). The average cash position over the projected period will be +US$1.0 million.

Net cashflow in Year 0 of (US$1.5 million) includes investment in standalone setup of US$3.6 million and debt finance US$2.1 million (60%). The average cash position will be +US$0.9 million

Investment Cost

The investment required to produce 29,285 tonnes of Quicklime, Slaked Lime, Hydraulic lime on a standalone (start-up) basis and on an incremental basis is US$ 3.6 million and US$2.4 million respectively. (See Appendix 1 for details).

Revenue Forecast

Quicklime and Slaked Lime is projected to be sold at a price of USD$79.3 per tonne in year one (1), and Hydraulic Lime is projected to be sold at a price $78.9 in year one (1). Growth in sales is expected to remain between 3.5%-4% in line with market CAGR. For consistency, the price of Quicklime and Slaked Lime has been increased in line with the current price inflation within the Americas that produce and sell similar value-added products.

The revenue forecast reflects the production of the various products as follows:

Table 35: Production Profile

Production Profile		
Product	**Period of Production**	**Average Annual tonne**
Quicklime	4 quarters per year	11,861
Slaked lime	3 quarters per year	8,896
Hydraulic lime	1 quarter per year	5,265
Total	N/A	26,022

Projected Profit and Loss

Scenario 1: Stand-Alone Basis (start-up)

Table 36 below shows a five (5) year analysis of a start-up operation. The production of Quicklime, Slaked Lime and Hydraulic Lime on a stand-alone basis is expected to yield a net profit of US$298,998 in year one (1) and this is projected to increase to US$601,850 by year five (5). Gross and net profit margins are forecasted to average 93% and 18% respectively over the 5-year period.

Table 36: Proforma financial performance for Quicklime and Slaked Lime on a stand-alone basis

Amounts in US$	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue:					
Slaked and Quick Lime					
Unit Sales (tonne)	20,757	21,172	21,596	22,028	22,468
Price per (tonne)	79.3	82.2	85.3	88.4	91.7
Hydraulic Lime					
Unit Sales (tonne)	5,265	5,362	5,462	5,563	5,665
Price per (tonne)	78.9	81.8	84.9	88.0	91.3
Total Revenue	2,061,019	2,179,374	2,304,526	2,436,866	2,576,807
Cost of Sale:					
Raw material	84,884	87,704	90,623	93,643	96,768
Variable Labour	66,043	68,487	71,021	73,649	76,374
Total Cost of Sales	150,928	156,192	161,644	167,292	173,141
Gross profit	1,910,092	2,023,183	2,142,882	2,269,575	2,403,666
Total operating Expenses	1,124,300	1,146,786	1,169,722	1,193,116	1,216,978
EBITDA	785,792	876,397	973,161	1,076,459	1,186,687
Net Profit	269,998	343,747	424,637	510,389	601,850

Scenario 2: Incremental Basis (existing limestone operation)

Table 37 below shows a five (5) year analysis on an incremental basis. The production of Quicklime and Slaked Lime on an incremental basis is expected to yield a net profit of US$381,688 in year one (1) and this is projected to increase to US$703,412 by year five (5). Gross and net profit margins are forecasted to average 93% and 23% respectively over the 5-year period.

Table 37: Proforma financial performance for Quick and Slaked Lime on an incremental basis

Amounts in US$	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue:					
Slaked and Quick Lime					
Unit Sales (tonne)	20,757	21,172	21,596	22,028	22,468
Price per (tonne)	79.3	82.2	85.3	88.4	91.7
Hydraulic Lime					
Unit Sales (tonne)	5,265	5,362	5,462	5,563	5,665
Price per (tonne)	78.9	81.8	84.9	88.0	91.3
Total Revenue	2,061,019	2,179,374	2,304,526	2,436,866	2,576,807
Cost of Sale:					
Raw material	84,884	87,704	90,623	93,643	96,768
Variable Labour	66,043	68,487	71,021	73,649	76,374
Total Cost of Sales	150,928	156,192	161,644	167,292	173,141
Gross profit	1,910,092	2,023,183	2,142,882	2,269,575	2,403,666
Total operating Expenses	1,118,545	1,140,916	1,163,734	1,187,009	1,210,749
EBITDA	791,547	882,267	979,148	1,082,566	1,192,917
Net Profit	381,688	453,575	531,757	614,815	703,412

Return on Investment

On an indicative basis over a projected duration of 25 years, the internal rate of return (IRR) could range from 24.0% to 34.0% and net present value (NPV) range from US$7.8M to US$8.9M on a standalone and incremental basis respectively when future cash flows were discounted using a discount rate of 14.3%

Table 38: Investment appraisal results

Scenario	NPV	IRR	Payback Period
Stand-Alone Basis	**US$7.8M**	**24.0%**	**3.3 years**
Incremental basis	**US$8.9M**	**34.0%**	**2.1 years**

Sensitivity Analysis

A sensitivity analysis was conducted to ascertain the variability and vulnerability of the investment to macro or micro environmental factors. The result is presented in Table 38 below.

Table 39: Sensitivity Analysis – Impact of Change in Sales growth

Scenario	NPV	IRR	Payback Period (years)	NPV	IRR	Payback Period (years)
	Stand-Alone Basis			Incremental Basis		
-0.75	-0.9	1.8%	-	0.2	7.5%	18.1
-0.50	-0.1	5.8%	-	1.0	12.2%	6.3
-0.25	2.3	13.7%	6.6	3.4	21.5%	2.5
0.00	7.8	24.0%	3.3	8.9	34.0%	2.1
+0.25	18.6	35.7%	2.6	19.8	47.9%	1.8
+0.50	37.5	48.2%	2.3	38.8	62.3%	1.6
+0.75	67.6	60.9%	2.2	69.1	76.8%	1.5

Key Assumptions

To assess the indicative feasibility of the production of Quicklime, Slaked lime and Hydraulic Lime as a value-added product in Jamaica, the following key assumptions were made:

Input	Inputs/ Assumptions	Source for Information
Production Capacity	Peak production capacity has been considered to be 29,285 tonnes per annum. Quick and slaked lime 22,785 tonnes and Hydraulic lime 6,500 tonnes	The peak production capacity is considered based on typical start-up level plant set-up or an incremental build up to an existing operation.
Sales Volume	Sales volume is estimated at 95% of production level for quick and slaked lime, and 90% for Hydraulic lime. It is assumed that the Jamaica could take 0.1% of the market share of the sales volumes within the Americas for Quick Slaked and Hydraulic lime end user products.	
Revenue	US$79.30 per tonne for Quicklime and Slaked Lime and US$78.9 for Hydraulic Lime. Growth in revenues are expected to remain at 2% plus indexation in line with market CAGR.	This represent average prices derived from primary researched in North America and the Caribbean
Cost of Sales	Raw Material US$2.0 per tonne Variable Labour US$2.0 per tonne	Average cost is determined by market survey of operators for cost to produce limestone within the local market.

Input	Inputs/ Assumptions	Source for Information
Operational Expense	US$ 38.5 to US$38.8 per tonne (includes: Environment Management Cost, Power Cost, Plant Cost, Admin Cost, Logistics and Transfers, Advertising and Corporate Social Responsibility, Other Utilities, Other Expenses)	This represents the average cost derived from primary market research. Operational expense for Quick and Slaked lime is assumed at three quarters (3/4) of the annual cost and for hydraulic lime one quarter of the annual operating cost. The costs are estimated to derive at total annual operating cost.
Financing Option	Debt Vs Equity Mix of 60%/40%. Interest rate 6% Debt tenure- 10 years.	These assumptions represent cost to finance investment both on a start-up and incremental level. Capital Expenditure (CAPEX) replacement is assumed to be financed by working capital thereafter.

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TRADE & INVESTMENT JAMAICA

Role of JAMPRO

JAMPRO is the national trade and investments promotions agency in Jamaica. One of our key functions is the packaging and promotion of investment opportunities and the conversion of investment prospects into viable projects. JAMPRO was first established in 1988 to stimulate, facilitate and promote the development of trade and industry, export and investment activities in all sectors of the island's economy. The agency drives this process through focusing on a number of targeted sectors which include tourism.

JAMPRO works closely with local and global entrepreneurs seeking to tap into the many investment and trade opportunities in Jamaica. In facilitating both local and foreign direct investment, JAMPRO guides investors through the necessary processes and offers support in partnership with key government agencies and ministries, even after their investments are operational.

JAMPRO also provides an array of services to the export community – including export registration and provides export development advice and export promotion (exposure for goods and services entering the export markets).

6.0 Appendices

6.1. Appendix 1: Financial Model

Table 40: Financial Model Assumptions

Input	Inputs/ Assumptions	Source for Information
Land Cost	Land acquisition cost has been arrived at based on cost of each hectare of land as obtained through primary research (US$ 30,000/hectare).	Where the mine/ quarry establishments will already be there plant set-up, one (1) hectare of additional land has been considered for Quick and slaked Lime and Hydraulic lime. The land estimate typically includes area required for plant facility, workshop, storage area, waste dump, worker camps, etc.
Equipment Cost	The vehicles required for transportation within plant premises will be procured. The vehicles considered for capital investment includes truck and wheel loader. Further, it is considered that for in-bound and out-bound logistics, hired vehicles will be used and the associated costs will be covered in operating expenses.	For truck and wheel loader, the landed cost in Jamaica is estimated after considering the equipment cost in the USA with provisioning and contingencies added for transportation cost and duties. No additional cost is considered for these for where facility already exist.
Processing Capital Cost	Crushing, screening, packaging, kiln and hydration processing and systems along with supporting plant equipment has been considered under processing capital cost for Quicklime/Slaked Lime	For these products the processing equipment has been assumed to be procured from China (due to lower procurement cost of the required equipment when compared to the procurement cost from the USA) with provisioning and contingencies added for transportation and duties. In addition, a semi-mechanised packaging facility will be used, due to the very fine mesh size of the grounded limestone which is not suitable for manual packaging.
Power	It is considered that power will be available from grid. However, in case of power cuts, the plant will be operated using a Diesel generator.	It is considered that grid connection will already be in the establishment along with backup generators and hence no incremental cost is taken for power connection/ set-up for financial analysis.
Infrastructure	This will cover the necessary infrastructure required for operations covering shed, laboratory facilities and other relevant infrastructure facilities.	The infrastructure cost is based on typical industry standard costs for additional infrastructure required for setting up of the value-added plants.

Input	Inputs/ Assumptions	Source for Information
Laboratory	A laboratory is considered for testing basic mineral content and size. A capital expenditure of US$ ~0.43 Million would be sufficient for basic grade testing in Jamaica.	Based on industry standard cost for basic laboratory testing equipment.
Contingency	A 5% contingency on total capital cost is applied to cover the budgetary effect of project threats or uncertainties	

Table 41: Estimated capital expenditure for a Quicklime, Slaked and Hydraulic Lime Plant

#	Description	Stand alone Capital Cost (US$ Millions)	Incremental Capital Cost (US$ millions)
1.	Land cost	0.39	0.08
2.	Equipment cost (truck, wheel loader, etc.)	0.64	0.50
3.	Processing set-up cost	1.21	1.21
4.	Power cost	0.68	-
5.	Infrastructure cost	0.10	0.07
6.	Laboratory set-up cost	0.43	0.43
7.	Contingency @5%	0.17	0.11
	Total Estimated Capital Expenditure	**3.62**	**2.40**

Source: PwC Analysis

Table 42: Summary Pro Forma Income Statement Summary – Incremental Basis

Quick, Slaked and Hydraulic Lime					
Income Statement Summary					
Incremental Case					
	Year 1	Year 2	Year 3	Year 4	Year 5
Income	2,061,019	2,179,374	2,304,526	2,436,866	2,576,807
Cost of Sales	150,928	156,192	161,644	167,292	173,141
Gross Margin	**1,910,092**	**2,023,183**	**2,142,882**	**2,269,575**	**2,403,666**
Operating expense					
Staff cost	129,424	132,013	134,653	137,346	140,093
Technical consultancy	14,560	14,851	15,148	15,451	15,760
Maintenance	19,100	19,482	19,872	20,269	20,674
Insurances	14,549	14,840	15,137	15,439	15,748
Logistics and transfers	165,321	168,628	172,000	175,440	178,949
Equipment	69,491	70,881	72,299	73,745	75,220
Plant expenses	216,980	221,319	225,746	230,260	234,866
Power	82,272	83,918	85,596	87,308	89,054

Quick, Slaked and Hydraulic Lime						
Income Statement Summary						
Incremental Case						
			Year 1	Year 2	Year 3	Year 4	Year 5
		Other Utilities	291,161	296,985	302,924	308,983	315,163
		Advertising services	53,406	54,475	55,564	56,675	57,809
		Security services	6,471	6,601	6,733	6,867	7,005
		Other Expenses	53,137	54,200	55,284	56,389	57,517
		Total Operating Expense	**1,115,874**	**1,138,192**	**1,160,956**	**1,184,175**	**1,207,858**
		Environmental	2,670	2,724	2,778	2,834	2,890
		Depreciation	196,732	196,732	196,732	196,732	196,732
		Loan Interest	85,897	80,768	73,408	66,081	58,302
			285,299	**280,224**	**272,918**	**265,646**	**257,924**
		Profit Before Taxes	508,918	604,767	709,009	819,754	937,883
		Taxes	127,229	151,192	177,252	204,938	234,471
	Net Income		**381,688**	**453,575**	**531,757**	**614,815**	**703,412**

Source: PwC Analysis

Table 43: Summary Pro Forma Income Statement Summary – Standalone Basis

Quick, Slaked and Hydraulic Lime					
Income Statement Summary					
Standalone Case					
	Year 1	Year 2	Year 3	Year 4	Year 5
Income	2,061,019	2,179,374	2,304,526	2,436,866	2,576,807
Cost of Sales	150,928	156,192	161,644	167,292	173,141
Gross Margin	**1,910,092**	**2,023,183**	**2,142,882**	**2,269,575**	**2,403,666**
Operating expense					
Staff cost	129,424	132,013	134,653	137,346	140,093
Technical consultancy	14,560	14,851	15,148	15,451	15,760
Insurances	19,100	19,482	19,872	20,269	20,674
Maintenance	20,030	20,431	20,839	21,256	21,681
Logistics and transfers	165,321	168,628	172,000	175,440	178,949
Equipment	69,491	70,881	72,299	73,745	75,220
Plant expenses	216,980	221,319	225,746	230,260	234,866
Power	82,272	83,918	85,596	87,308	89,054
Other Utilities	291,161	296,985	302,924	308,983	315,163
Advertising services	53,406	54,475	55,564	56,675	57,809
Security services	6,471	6,601	6,733	6,867	7,005
Other Expenses	53,411	54,479	55,569	56,680	57,814

Quick, Slaked and Hydraulic Lime					
Income Statement Summary					
Standalone Case					
	Year 1	Year 2	Year 3	Year 4	Year 5
Total Operating Expense	**1,121,630**	**1,144,062**	**1,166,943**	**1,190,282**	**1,214,088**
Environmental	2,670	2,724	2,778	2,834	2,890
Depreciation	296,386	296,386	296,386	296,386	296,386
Loan Interest	129,409	121,682	110,592	99,554	87,834
	428,465	**420,792**	**409,757**	**398,774**	**387,111**
Profit Before Taxes	359,997	458,329	566,182	680,519	802,466
Taxes	89,999	114,582	141,546	170,130	200,617
Net Income	**269,998**	**343,747**	**424,637**	**510,389**	**601,850**

Source: PwC Analysis

6.2. Appendix 2: Excerpts from Mordor Intelligence Report

Americas Limestone Market, By End-user Industry, 2016-2024 (in US$ Million)

End-user Industry	2016	2017	2018	2019 (est.)	2024 (f)	(%) CAGR (2019-2024)
Paper and Pulp	404	407	411	408	406	-0.12%
Water Treatment	761	806	850	887	1,051	3.46%
Agriculture	1,822	1,902	1,982	2,046	2,312	2.47%
Plastics	151	158	164	169	190	2.39%
Building and Construction	6,106	6,247	6,465	6,643	7,602	2.73%
Steel Manufacturing and Other Industries (including Energy)	493	527	558	580	687	3.46%
Others	385	406	426	441	501	2.58%
Total	10,121	10,452	10,855	11,175	12,750	2.67%

Americas Limestone Market, By End-user Industry, 2016-2024 (in kilometric tonnes)

End-user Industry	2016	2017	2018	2019 (est.)	2024 (f)	(%) CAGR (2019-2024)
Paper and Pulp	19,179	18,902	18,595	18,264	17,848	0.46%
Water Treatment	36,610	37,773	38,884	39,960	46,039	2.87%
Agriculture	73,742	74,964	76,211	77,536	85,583	1.99%
Plastics	6,853	6,997	7,127	7,253	7,949	1.85%
Building and Construction	449,940	450,211	456,097	461,807	517,059	2.29%
Steel Manufacturing and Other Industries (including Energy)	25,226	26,404	27,363	27,991	32,277	2.89%
Others	17,488	17,903	18,297	18,693	20,737	2.10%
Total	**629,039**	**633,152**	**642,576**	**651,503**	**727,492**	**2.23%**

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