Background on Vulcan Materials Company and Expected Impacts should White Ridge Farm Karst Hills Become an Aggregate Mine to Supply the U.S. East Coast

3rd Working Draft

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Submitted to: Concerned Citizens of Belize

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Forward

When this document was compiled and first distributed, Vulcan Materials Company, the largest aggregate mining company in the United States, a multi-billion-dollar corporation, has set its sights on purchasing White Ridge Farm in the Stann Creek District of Belize. Their intent is to blast, pulverize, and ship Sugar Hills, a limestone formation, to the southeastern US for use as road fill. Blasting shall disrupt local hydrologic systems in the Southern Lagoon area, threatening the largest concentration of Caribbean manatees, Hawksbill Sea Turtles, Central American River Turtles, American Crocodiles, and other fauna. A conveyer bridge will carry the crushed material over an important Hawks Bill Sea Turtle nesting beach to waiting cargo ships in the dredged-out center of the Inner Channel behind the Mesoamerican Barrier Reef. Spokes persons for the current Belize Government has explicitly stated that no strip mining shall occur in this area.

Now Vulcan has purchased White Ridge Farm and suddenly this threat is becoming a reality. Oven though this Government has blocked strip mining in that area of Belize, Vulcan is intensifying their efforts to get their mining operation up with an increasing urgency. They want to start the EIA process and get approval, if not from this Government administration, then from the next one. Belize has increased in importance to Vulcan because the Mexican Government shut down the Calica Mine on May 5, 2022, due to the extensive amount of environmental damage the mining operation was causing. In response, Vulcan has a lawsuit against the Mexican Government for $1.5 billion USD and the International Center for Investment Disputes shall be issuing a decision. Vulcan Materials has a long history of litigation within many areas of the United States where they operate. If Mexico loses this case in an international court, not only will they lose money, but shall have to contend with Vulcan continuing their destructive operation. This could be the future of Belize.

This web address https://www.whiteridgeproject.com/ takes you to the site where Vulcan Materials describes benefits of having this company within Belize. The attached document tells a vastly different story, reviewing the scientific literature describing ecological and social impacts of limestone mining and taking a close look at the Vulcan site near Playa del Carmen, Mexico. If the Government of Belize had to act against Vulcan for violations of their agreement and failure to protect the environment, as is occurring in other places where Vulcan is operating, we too could face a billion dollar plus lawsuit backed by a powerful and well-funded group of corporate lawyers. If we the citizens of Belize allow this mega corporation to have its way with our small country, our world-renowned ecological resources and cultural/social identity will change forever.

The word needs to get out. The people need to know who we are up against and what the real stakes are, the full cost we and our grandchildren and their grandchildren shall have to pay. If this is of concern to you, please help us spread the word. Forward this document to anyone who may be interested in helping us protect our country from this corporate resource grab. We need all the assistance and support we can muster against this threat that if realized shall impact our ecosystems, water resources, ecotourism, economy, and cultural integrity.

Say No to the Jewel being crushed into US road fill.

Introduction

Visiting Belize on a fact-finding mission, representatives of Vulcan Materials Company (VMC) alerted people within the Stann Creek District coastal area that the company intends to purchase White Ridge Farm. Their goal is to establish a foothold in Belize with a working aggregate mine and ship mined materials from the karst hills of White Ridge Farm to the Eastern Seaboard and other southeastern locations within the United States. Their intention is to strip away the forest and soil, blast the limestone hills to break them apart, and crush the resulting rocks into graded sizes of aggregates required for roadbeds, fill, concrete and asphalt mixes, and other construction uses in the United States (U.S.) where limestone deposits are now less available.

The material is to be transported over land and into the Inner Channel off the coast south of Gales Point Village by a massive conveyer bridge suspended above land and water. The conveyer bridge shall transport crushed and sorted aggregates to Panamax self-loading ships waiting at anchor in the deeper waters of the Inner Channel. Dredging shall be required to accommodate the 228 m or longer vessels with 13.5 to 14 m draft, and the area shall need to be large enough to turn these vessels.

The scale of the project and the removal of karst features/aquifers is not compatible with the sustainable use of this area that conservation NGOs, residents, and the tourism industry have been envisioning and striving toward for three decades. The purpose of this document is to compile and organize information on the company, the export aggregates industry, and environmental, health, and social concerns of this mining facility being established in Belize. The goal is to promote an open and informed discussion about this development plan being presented by a major, heavily financed corporation. Any comments, corrections, additional information, and advice to improve the usefulness of this 3rd draft and incomplete document shall be greatly appreciated.

Brief Profile of Vulcan Materials Company

The VMC website, www.vulcanmaterials.com, posts the Annual Report on Form 10-K, Quarterly Reports on Form 10-Q, and Current Reports on Form 8-K. They also post their Business Conduct Policy that applies to all employees and directors, and their Code of Ethics for the CEO and Senior Financial Officers. Key directors and managers of VMC are listed in Appendix A, while a brief history of highlights in the development of the company, focused specifically on aggregates, is included in Appendix B. Both sets of information are retrieved from the VMC website and updated.

The VMC mission is “to provide quality products and services which consistently meet our customers’ expectations; to be responsible stewards with respect to the safety and environmental impact of our operations and products; and to earn superior returns for our shareholders.” The first guiding principle on the VMC website is integrity, stating “We will work constantly to earn the respect and trust of all parties we interact with by acting fairly and honorably. We will observe high ethical standards and obey all laws and regulations.”

Based on information provided by VMC in their Quarterly Report for the period ending March 31, 2021, submitted to the U.S. Securities and Exchange Commission, the company is chartered by the State of New Jersey and has the head office at 1200 Urban Center Drive, Birmingham, Alabama 35242 (phone number 205-298-3000). VMC common stock is registered with the New York Stock Exchange at $1 per share with 132,665,247 shares outstanding. Assets of the company total $11,332,760,000.

The first quarter of 2021 reported a gross profit of $229,267,000 and net earnings of $160,614,000 for the three-month period. Profit earnings have a seasonal cycle, typically with the third quarter having the highest sales and earnings, and the first quarter having the lowest earnings. Compared to the first quarter of 2020, total revenues increased by 2%, gross profits by 14%, aggregates sales by 3%, shipments by 3%, freight-adjusted sales price by 1.9%, and the Aggregates Segment gross profit by 15%. According to VMC, their four strategic disciplines of 1) Commercial and Operational Excellence, 2) Logistics, 3) Innovation, and 4) Strategic Sourcing, helped increase aggregates cash gross profit by 9% to

$6.56 per ton. The company also sold a southern California reclaimed quarry for an $85,400,000 gain after tax, making this a more lucrative first quarter than that of 2020.

VMC is the largest construction aggregates (primarily crushed stone and sand and gravel) supplier in the U.S. and a major asphalt mix and ready-mixed concrete producer. Their market and most of their mining operations are in the U.S. Aggregates, their primary product, are used in many types of private and public construction projects and are the base components of asphalt mix and ready-mixed concrete production. Their products are sold in twenty states, Washington D.C., and to local markets near their Mexico mines. VMC is concentrated on the U.S. metropolitan markets where the largest population growth is expected. Asphalt mix and/or ready-mixed concrete are sold in Washington D.C., Maryland Alabama, Virginia, Tennessee, Texas, New Mexico, Arizona, and California. VMC once had a chemical business but sold it to Basic Chemicals (subsidiary of Occidental Chemical Corporation) in 2005.

Other than mining sites, real estate leases held by VMC include office buildings, aggregates sales yards, and asphalt and concrete sites. Equipment leases are for railcars, rail track, barges, office equipment, and plant equipment, with total lease costs for the quarter of $ 22,923,000. First quarter of 2021 income tax expense was $60,638,000, up from $12,194,000 in the first quarter of 2020. In the first quarter of 2022, Vulcan's the total revenues increased by 44 percent to $1.541 billion, affected by the acquisition of U.S. Concrete (USCR) and an overall growth in the Company's multiple businesses.

Usually, VMC sells their products to private industry rather than directly to government agencies, although roughly 45% to 55% of aggregates sold are used in publicly funded construction (highways, airports, government buildings schools, prisons, dams, reservoirs, water treatment systems, sewage waste treatment systems, etc.). The Gulf Coast states represent 58.0% of aggregates sales, followed by 27.2% of the sales to the Eastern Seaboard, and 14.8% in western states. Because the weight/value ratio of aggregates is very high, and transportation is a significant part of the cost, typically aggregates are produced near the markets, and therefore VMC operates mines scattered around their twenty market states. However, areas within the Gulf Coast and Eastern Seaboard states have few locally available aggregates resources remaining. These areas are supplied by mines in the Yucatan Peninsula of Mexico, shipped to U.S. ports by the VMC fleet of Panamax-class self-unloading ships, and moved by barge and rail to market locations. Now VMC has set sights on the limestone deposits in Belize, seeking to get a foothold in the country through the purchase of White Ridge Farm, likely with the intention of expanding to other sites within this karst rich country.

Assumptions, risks, and uncertainties listed by the company, other than the usual changes in energy prices, health care, market behavior, COVID-19, etc. that could alter expected results include:

- Company dependency on the construction industry that is pegged to economic cycles,
- Availability of federal, state, and local funding for large infrastructure projects,
- Increasing reliance on information technology and the threat of cyber-attacks,
- High level of competition within the construction industry,
- Impact of future regulatory or legislative actions,
- Outcome of pending legal proceedings (Part I, Item 3 of the VMC Annual Report on Form 10-K for the year ended December 31, 2020, and in Note 8 of the VMC Quarterly Report Form 10-Q for the quarter ending March 31, 2021.)
- Climate change impact and availability of water,
- Long-term debt and interest obligations incurred,
- Environmental restoration costs and other liabilities for existing and divested businesses,
- Ability to secure permitted aggregates reserves in strategic locations [such as Belize].

The web site expounds on the VMC Mission, pledging that the company "will be a good corporate citizen in each community in which we operate. We will support and take an active part in public and charitable projects." The Vulcan Materials Company Foundation was established in 1988 to realize this component of the mission, with contributions being awarded by the Foundation "in a planned and consistent manner that best serves the combined interests of Vulcan and the communities in which we operate."

The Foundation supports local schools in those areas where VMC operates mines, promoting a science, technology, engineering, and mathematics educational focus. The philosophy of the Foundation includes economic development and environmental stewardship promoting goals based on the understanding that "responsible economic growth provides the resources necessary to be a good steward of the environment, while this stewardship helps to sustain growth." VMC recognizes the link between industry and the environment and the importance of technological innovation, maintaining that a society informed about environmental issues can participate more effectively in debates on public policy.

Does this current project proposed for White Ridge Farm, for Belize, represent environmental stewardship or is it a strategy to circumvent environmental laws and people to achieve corporate goals? A search of the internet will turn up many court cases against VMC. A thorough background search of litigation involving VMC is necessary to determine if corporation can be trusted to do as it says, or will it take short-cuts to profits and simply pay the fines for whatever infringements do?

Limestone and Its Importance

Limestone is a sedimentary rock derived largely from marine deposits of mostly nanophytoplankton, which are ultramicroscopic photosynthetic organisms that produce calcium carbonate shells, die, and settle to the sea floor. Eons of sediment compaction forms limestone rock from nanophytoplankton shells and and secondarily shells of many other marine organisms. Sea level fall exposes limestone rock layers to the erosion forces of rainwater collected by and channeled through watersheds. Water infiltrates into cracks and crevices of limestone layers, dissolving passages for water flow. Limestone eroded by water is called karst and typically contains many voids, sink holes, caves, and groundwater drainage systems. Calcium carbonate ($CaCO_3$) and dolomite ($CaMg(CO_3)^2$) are the two principle minerals that make up the bulk of limestone. Other elements such as silicon, magnesium, iron, manganese, zinc, lead, and sometimes gold often occur in very small trace amounts and are considered impurities.

Large karst landscapes occur across the world as limestone outcroppings, sink holes, solution valleys, karst towers, and cave systems, representing roughly 10% of Earth's surface (Drew, 1999). Concern about the collective human impact on karst systems is growing, especially considering the role of karst as water-bearing rock, aquifers that supply water to large numbers of people. The International Union for the Conservation of Nature and Natural Resources (IUCN) World Commission on Protected Areas (WCPA) in 1997 officially established that karst landscapes around the world require protection (Watson et al. 1997). Belize is blessed with large karst areas that support most of our tropical forests, harbor extensive cave systems, and serve as vital aquifers for many communities, villages, and towns. The karst landscapes of Belize harbor a large percentage of our biodiversity, with tropical forests and caves containing many different species, including endemic species many species yet to be described. Caves also harbor artifacts and knowledge about the Ancient Maya.

Limestone has been used for thousands of years, being a principle building material for Ancient Maya structures, for example. It is also an important rock for modern day construction, agriculture, and industries worldwide, serving many different uses. Limestone is the raw material for Portland cement, as well as for other applications, from construction material and roadbed aggregates to food fillers and white paint (Lamare and Singh, 2016). Limestone is also the main ingredient in lime (CaO) manufacturing, lime being used for soil pH adjustment, water purification, copper smelting, and other applications in chemical industries (Bliss et al., 2008).

The U.S. consumes about 1.5 billion tons of crushed stone annually (USGS, 2021), about 65 to 70% being limestone, even though limestone outcroppings represent only about 25 to 35% of exposed surface rock. The U.S. roughly consumes from 5 to 10% of the world's industrial limestone production. Most limestone mined in the U.S., particularly dolomites, have fewer alternative uses than other limestones, and become aggregates for roadbeds, concrete, and asphalt. The largest amount of aggregate mining presently occurs in the southeastern U.S., with Texas producing the most, followed by Florida, Pennsylvania, Georgia, North Carolina, and Virginia. Currently this is a $16.2 billion industry in the U.S. based on 2016 data (www.usgs.gov/news/top-5-us-minerals-production-value). The greatest cost to consumers for aggregates is transportation, with water transport by freighter or barge being less expensive than by train or by truck, the most expensive mode of transportation (Bliss et al., 2008).

The U.S. does not produce enough limestone to satisfy its consumption rate, importing mainly from Canada, Mexico, and China. This explains the strong interest in setting up the first of what could become several mines in Belize. Many limestone sites in the U.S. are off-limits to mining, having been developed into housing complexes, parks, protected areas, important aquifers, or put to other uses. It is also harder now to establish mines in new places within the U.S. because people do not want mines near their residences. Why?

Limestone is an aquifer rock, porous material that is fractured and jointed, divided by bedding panes, and easily eroded to create large conduits for water flow and cavities for water containment. Karst limestone is worth more as an intact ecosystem, a water source, and a scenic view than a source of aggregates (Stanton, 1990). Mining of karst should be avoided, and alternatives found elsewhere. This is especially true today when we are facing the challenges of climate change, with issues of increased dry conditions, droughts and saltwater intrusion predicted for and happening in Belize. It is more sensible to conserve our karst landscape for freshwater storage and biodiversity protection than to have them blasted, crushed, and shipped to the U.S. for use as roadbeds and fill.

Strip-mining Limestone

The most common way to mine limestone is by strip mining, which involves scraping away the vegetation and soil to expose the bedrock material below, a process occurring across Belize in small quarries to acquire marl and aggregates for road work. Two of the largest quarries include the Rockville Quarry along the George Price Highway and the Dolomite mine near Punta Gorda. This quarrying is for use in Belize.

The purpose of crushed stone mining is to create size-graded aggregates within specific size ranges to supply construction and other market areas (Langer, 2001). Once the limestone bedrock is exposed by stripping away the forest and soil, blast holes are drilled at strategic locations in the rock, dynamite inserted into the holes and detonated, a process referred to as blasting. The result is rock broken into chunks small enough to be accommodated by a mechanical crusher. The crushed material is sorted into suitable size grades for market demand. Dry blast material can be gathered and delivered to the crusher with bulldozers, dump trucks, track hoes, and scraper graders. Equipment used at large mines are often much bigger than similar equipment used for conventional road work.

When rock mine pits break into the water table, the water is typically pumped out of the pit, and exposed rock removed just as in a dry pit (Langer, 2001). If water inflow is too large to remove, the mine pit may be allowed to fill up. Rock is drilled and blasted underwater, and the blast rubble removed with draglines and clamshell cranes, being processed as wet material or laid in windrows to drain and dry before being processed.

Environmental Impacts from Limestone Strip-mining

Strip mining imposes many environmental impacts, considering that forest and soil are stripped away to allow access to the bedrock below. Strip mining involves extraction of non-renewable resources. When exploitation has been completed, strip mining leaves a pit or landscape of pits and roads without soil, unless the original soil was properly stockpiled and used to restore the site or soil is brought into the site, which involves mining soil from some other location. Recovery rarely happens, especially not to the state of the environment before the mine was created.

A strip mine is often set in the middle of a forest that, from a drone perspective, appears as a sudden white hole in a green landscape, often with equally white - roads running in and out of the hole. This drastic change in the landscape geomorphology and land use is typically visible for long distances and imposes several major impacts. The most obvious engineering impact of mining is a change in geomorphology and conversion of land use, with associated major impacts including habitat loss, noise, dust, vibrations, chemical spills, erosion, sedimentation, and degradation of the mine site and surrounding area. While some impacts are short term, others become permanent features of the area, now an industrialized landscape.

The extent of these impacts is a factor of the size of the mining operation and the ecological resilience of the ecosystem being mined. Terrestrial areas at the immediate site and areas far beyond the site, including surface waters and subsurface water resources are impacted through the water table drawdown, habitat destruction, diversity loss, waste disposal, river pollution, damage to buildings and infrastructure, and respiratory and psychological effects on people in the area (Lamare and Singh, 2016). These impacts have been studied around the world over the past thirty to forty years (Barksdale, 1991; Kelk, 1992; Smith and Collis, 2001; Luttig, 1994, Bobrowsky, 1998; Primel and Tourenq, 2000; Langer, 2001).

Aggregate mining within karst landscapes can affect sensitive components of the ecosystem that may lead to a cascade of environmental impacts (Langer and Kolm, 2001). Such impacts (changes in water movement and availability, deforestation, habitat and biodiversity loss) are triggered by removal of rock, which permanently alters the structure of the natural system, leading to corresponding long-term impacts, inducing further changes (Langer, 2001). These changes may become obvious after the mining operation has started and can continue long after the operation has shut down. For example, the permanent lowering of the water table may reduce the support of cavern roofs, leading to collapse of the land above and formation of sink holes, a process that may continue for decades into the future.

During each stage, the planning, setup, operation, and decommissioning of a strip mine imposes a wide range of impacts to the land, air, water, wildlife, people, and economies of the areas where they are located, impacts that cannot be fully appreciated through the eye of a drone. The following sections offer bulleted lists of impacts grouped by topic. These impacts have been documented in published scientific articles over the past forty or fifty years. Most referenced documents are available for free on the internet and a library of pdf files is available upon request.

Many impacts listed are ongoing periodically or continuously at an active limestone strip mine throughout the life of the mine. Many of these impacts are interconnected, one leading to the next, and many are synergistic, where one impact increases the severity of other impacts. These impacts are also cumulative, continually adding up, having multiple impacts on the ecosystems around the mine.

Water

Surface waters

Surface waters include streams, rivers, lakes, lagoons, and wetlands. Studies focused on surface and groundwater interactions document long-term, cumulative impacts on stream water quality resulting from aggregate mining (Renken et al. 2008). Following is a list of bulleted impacts to surface water resources caused by limestone strip mining.

- Surface water and groundwater impacted by mining can transport those impacts to wetland, riparian, and aquatic habitats downstream (Langer, 2001), particularly affecting sensitive aquatic organisms.
- Increased erosion due to topsoil loss can creates siltation in local streams and rivers (Rajwar, 1982).
- Mining directly damages karst aquifers, and consequently disrupts base flow, the groundwater input into surface waters that keep streams flowing during the dry season, loss of which can result in drying up of streams, rivers, and shallow wells, contributing to water scarcity within downstream areas (Legard, 1973).
- Location of processing sites, washing facilities, settling ponds, material stockpiles, stormwater ponds, and roads can determine the level of impact on local streams from excess sediments and other pollutant loads carried by stormwater (Green et al., 2005).
- Small streams close to the mining site are frequently covered with rocks, gravel, and fine materials and often have their channels diverted (see Lamare and Singh, 2016), changing downstream structure and aquatic communities.
- Spring water may be diverted to other discharge sites (Green et al., 2005), affecting downstream conditions.

Exposed Water Tables

Mining below the water table can affect the level of the groundwater because the water drains out of the rock material and into the mine pit, filling the opened area and creating a cone of depression around the mine pit, resulting in the lowering of the water table. Mining below the water table can have a range of effects as listed below.

- Springs will dry up as water becomes less available (see Lamare and Singh, 2016).

- Aquatic habitat quality and availability is reduced, affecting local biodiversity (Miller, 1999).
- Water quality is reduced, imposing subsequent effects on aquatic life (Miller, 1999).
- Reduction or increase of sediment transport and consequent changes in sediment deposition within streams and rivers (Miller, 1999) affects stream and river morphology and habitats of aquatic organisms.
- Water available for irrigation, industry, and household use is often reduced (Miller, 1999).

Often mining pits below the water table that are filled with water are pumped out or "dewatered" to expose rock material for blasting and removal of rubble. The pumped water is discharged into streams, rivers, or other sites, creating additional problems for surface water systems. Discharged mine water can have a range of effects as listed below.

- Increased concentrations of calcium, bicarbonates, sodium, and chloride salts occur, not just in flowing water systems, but also the waters they empty into (Iwanoff, 2006).
- Increased stream temperatures by discharged mine water that has sat in the pit long enough to warm up may impose stress on aquatic organisms adapted to colder groundwater discharge (see Green et al., 2005).
- Saline waters lying below fresh groundwaters can leach into the mine pit and be discharged into streams and rivers (Iwanoff, 1998), particularly in those mines near coastal areas.
- Unnatural, unseasonal water flow and stage changes are imposed on streams when discharge of dewatered mines is not timed to accommodate the seasonal patterns of surface streams and rivers (Green et al., 2005).
- Sometimes streams are drained when dewatering of mines and lowering of the water table causes stream water to flow back into its aquifer and seep into the mine pit (Green et al. 2005).
- Mine pit dewatering can change local groundwater hydrology by lowering the water table, similar to a large well (Green et al, 2005).
- Water bodies, springs, and wells within the cone of depression created by a mine pit penetrating the saturated zone can suffer reduced inflow and may go dry due to the changed flow of groundwater (Hobbs and Gunn, 1998).
- Lowering the water table and dewatering mine pits can increase turbidity in ground water (Green et al., 2005).
- When a mine breaks into the saturated zone, typically water seeps slowly from the rock into the mine pit and if the mine breaks into an active conduit, hundreds to thousands of gallons of water can rapidly flow into the mine pit.
- A significant percentage of groundwater flow can be captured and held within the mine pit rather than discharged, being exposed over a longer period to pollutants resulting from mining activities. If discharged much later, this contaminated water can impose a greater impact on natural stream systems.

General Groundwaters

Limestone mining has significant effects on groundwater resources, through the removal of the aquifer deposit or a large part of that deposit. As limestone mining progresses, there is less water storage space available, the intricate structure of the aquifer is destroyed, and eventually the water table is left exposed, becoming a surface water body. Mining may continue beneath the water table, imposing more impacts on groundwaters, and subsequently surface waters.

Mining into the exposed aquifer involves deepening the pit below the level of the water table and pumping out water to expose the rock and work the mine. Of course, more water flows from the rock into the exposed portion of the water table as water is being withdrawn. Given that water seeps slower through the rock than it is removed, a wide depression cone around the open pit, just as occurs around a well head, where the water table is lower the closer it is to the open pit. Dewatering and increasing the size of the depression cone imposes impacts not only on surface waters, as listed above, but on the groundwater resources as well.

- Karst water supplies are vulnerable to unwise land use activities that change the vegetation and geology of an area and can impact water users located at large distances from the water source (Green et al., 2005).

- The first major impact of strip mining is stripping away overlying soil and vegetation, which reduces transpiration (affecting local rainfall) and increases the rate of runoff, in turn reducing the amount of groundwater infiltration and recharge (Gunn and Hobbs, 1999).

- Stripping away forest and soil destroys the filtration layer that removes pollutants form water before it becomes part of the aquifer (Gunn and Hobbs, 1999).

- Unsaturated overlying limestone protects the underlying aquifer. If a pit is dug through this layer, the hole may channel polluted surface water into the groundwater reservoirs, rapidly polluting these water resources (Hobbs and Gunn, 1998; Ekmekçi, 1993).

- The quality of shallow groundwater deteriorates when infiltrated with unfiltered water from mining activities (Naja et al. 2010).

- Enormous quantities of fine materials are produced by the process of rock collection, crushing, washing, and sorting within mines or off-site, particles of this fine material small enough to be washed into karst groundwater networks by rainfall increase turbidity (Green et al., 2005).

- Ground vibrations created by blasting and heavy equipment can loosen small particles within fractured rock and conduits, increasing turbidity within groundwater (Green et al., 2005).

- Karst groundwater is more susceptible to pollution than surface waters because of its reduced ability to eliminate pollutants from this porous rock once contaminated (Kresic et al., 1992).

- Given the larger caverns and conduits within karst aquifers, groundwater moves much faster than occurs in other rock types, and any pollutants and pathogens in contaminated water are transported long distances as compared to other aquifer forming rocks (Assad and Jordan, 1994; Lamare and Singh, 2016).

- Mining can reduce aquifer recharge capacities, causing the degradation of groundwater quality and the quality of streams and rivers into which these groundwaters discharge (Gunn and Hobbs, 1999).

- Rock removal can disrupt the paths of groundwater conduit flow (Green et al., 2005).

- Disruption of a groundwater conduit by mining activities can change the flow path of a large volume of groundwater, causing water to be redirected to discharge outlets in other locations (Green et al., 2003), which can result in changes in stream flow patterns.

- Changes in direction of groundwater flow increases the potential for groundwater to become polluted by opening aquifers to new and polluted recharge sources (Langer, 2001).

- Thick unsaturated karst overlying saturated layers can collect and store rainwater, slowly recharging the saturated zone (Smart and Friederich, 1986; Gunn, 1986), but once removed, recharge to saturated zone groundwaters is reduced.

- Discharging mine water into local streams can contribute to flood conditions (Langer, 2001).

Human-induced sinkholes are associated with aquifer drawdown by many processes, including limestone mining. Dewatering of a mine represents water removed from the groundwater system, lowering the water table, and reducing the support holding up roofs of water-holding karst chambers. Without the support of the groundwater, the ceiling eventually collapses, forming a sinkhole. It is not unusual to see several to many sink holes surrounding a limestone mine within the depression cone.

- Sinkholes caused by human activities often occur within the cone of depression (see Langer, 2001).

- Human-created sinkholes caused by activities that reduce groundwater volumes often occur suddenly (Newton, 1976; LaMoreaux and Newton, 1986; LaMoreaux, 1997) while sink holes created by geological processes do not form as rapidly and frequently (Newton, 1987).

- When the water table is shallow, development of sinkholes resulting from mining occur around the mine area, but as the mine pit is deepened, causing the cone of depression to expand, sink holes form at greater distances from the mine (Newton, 1987).

- Boreholes left unsealed can take in unfiltered and polluted surface water or drain perched soil aquifers, leading to collapse of land around the borehole (LaMoreaux, 1997).

- Sinkholes resulting from disturbance by mining can rapidly form, capturing and funnel polluted surface water directly into groundwater resources (see Green, et al., 2005; Langer, 2001).

- Altering aquifer recharge and drainage is the primary impact that triggers land surface collapse (Williams and Vineyard, 1976; Thorpe and Brook, 1984).

Potential impact of a proposed mine to surface water and groundwater resources depends on many characteristics of the operation and the site (Green et al., 2005). The following information is important in considering the impact to groundwater:

- Size of the mining operation and future expansion being considered
- Depth of mining, considering that the impact of blasting shall extend deeper than the depth at which materials are being removed.
- Amount of overburden on the site and locations where overburden material will be stockpiled
- The size and depth of the karst deposit
- Presence of geological boundaries due to presence of confining units such clay, shale, siltstone, and granite.
- Presence of faults and fractures
- Location and condition of test holes
- Level of the water table within the karst deposit over the seasons
- Direction of water flow through the karst deposit
- Presence of any perched aquifers and the effects of mining activities on their ability to hold water
- Potential wells impacted by any changes in the aquifers and groundwater conduits
- Surface waterbodies at risk if changes in aquifers and groundwater conduits occur
- Off-site and distant areas that may be affected should there be changes in aquifers and conduits
- All caves, joints, fractures, sinkholes, hanging watersheds and springs in the area
- Location of large, active conduits
- Condition of the overall landscape around the mine area

Land

Geomorphology

The geological, hydrological, and topographical character and shape of the landscape are important defining platforms upon which ecosystems cluster, function, and interact. Any significant changes in the geomorphology of the landscape can create cascading changes affecting many ecosystems and organisms within that landscape. The project proposed by VMC is a landscape-scale change, the impacts of which would cross through several ecosystems.

- Degradation of land area and change in landscape topography occurs when overburden, spoils, and lime waste are dumped away from the mine site (Lamare and Singh, 2015).
- Limestone excavation involving stripping away forests and fertile topsoil and dumping of overburden and spoil reduces the aesthetic quality of the local landscape around the mine (Lamare and Singh, 2015), karstic areas considered to hold high scenic value.
- Geological destabilization and displacement of the mined area weakens rocks formations, resulting in slope failure and landslides (see Lamare and Singh, 2016).
- Roadways leading to the mining site, spoil sites, crushing site, and other related areas spread impact throughout the larger area and further reduce aesthetic value and surface water flow.

- In the case of the proposed VMC mine, a conveyer bridge will stretch across the landscape and into the Inner Channel, further impacting the landscape at each support footing and disrupting the aesthetic quality of the landscape further (vibrations, soil compaction, construction, and maintenance access, etc.).

Soils

Soil cover, and the associated root structure, microbial components, fungi, assorted macroinvertebrates (meiofauna to macrofauna), and detritus, is an effective and essential filter system that can absorb, hold, and slowly release rainwater into the aquifer. However, as rainwater passes through this microbial filter system it is changed, some components being stripped out of the water and others added. Soil, together with the organisms within it, is a vital component of a healthy ecosystem without which vital ecological functions are diminished from the landscape.

- Removal of soil is a preliminary step in initiating a mine site, representing a local loss of a large patch of the local terrestrial ecosystem and the ecological services rendered (water infiltration, nutrient storage and cycling, thermal absorption).
- Soil removal represents the elimination of seed bank and root stocks at the local site (Parrotta et al., 1997).
- Soil removal depletes organic matter and nutrients at the local site (Akala and Lal, 2001; Panwar, 1999, Ravichandran et al., 2009).
- Soil texture and structure is modified during removal, storage, and eventual re-use as a landscape restoration ingredient (Grunwald et al., 1988; Norland, 1993; Hanief et al. 2007).
- The quality of removed soil drastically changes, affecting the use of soil in future restoration efforts for the mine site once it is decommissioned (Adewole and Adesina, 2011).
- Vibrations from drilling, explosives, and heavy equipment can destabilize the overburden and trigger landslides into solution openings within the bedrock (Stringfield and Rapp, 1976; Ekmekçi, 1993; LaMoreaux, 1997), leaving landscape scars, areas open to erosion, and degraded aesthetic quality.
- Traffic from heavy mining equipment and vehicles carrying staff and workers can destabilize overburden and trigger landslides (LaMoreaux, 1997).
- The weight of mining and processing equipment can trigger sinkhole formation (Newton, 1976).
- Mining in general imposes an irreversible impact on the quality and quantity of soil, often the loss of fertile topsoil, and changes the quality of surrounding soil relevant to physical, chemical, and microbial characteristics (Ghose, 2004).

Forests

Forest cover is a critical component of our terrestrial ecosystems, with deforestation being a continuous and detrimental process that weakens the resilience of our landscape to the challenges of climate change. Intact forests are key components of the hydrologic cycle.

- Trees and associated plants break the force of falling water, reducing the erosion potential.

- Trees capture rainwater as through fall, dripping from leaf to leaf before reaching the soil, or stemflow, moving down the trunks of trees. Each of these processes enriches rainwater with minerals and nutrients important for soil health.
- The network of tree roots and associated mycorrhizal fungi absorb substantial amounts of soil water and transpire that water back into the atmosphere, contributing to the production of more local rainfall.
- Absorbed soil water leaves space within the soil to absorb and hold water from the next rainfall event. This water uptake role of trees reduces soil saturation, ensuring soils are very absorptive, and reduce the volume of surface runoff.
- Trees give three-dimensional structure to forested landscapes. They provide habitats, food, and shelter to many forest organisms.
- Tree root systems give strength to soils, helping soils remain in place and resist the forces of erosion.
- Trees provide sustainable and renewable resources to humans and represent a significant and historical component of the Belizean economy.

Forest Damage

- Deforested areas by the mine shall represent reduction or loss of those ecological services mentioned above from the local site.
- Forests are damaged by all aspects of mining, including service roads connected to the mining, processing, storage, and spoil disposal sites, and areas where these facilities set.
- Besides the total deforestation that occurs at mining sites, impact of the edge effect, whereby the ecological changes created by deforestation reaches into the surrounding forest, modifying the ecological characteristics well inside of the remaining forest area, increases the impact of the deforestation site (Harper et al., 2005).

Air and Dust Pollution

Activities involved during limestone extraction, including drilling, blasting, loading, transportation, and crushing of rock material generate dust, introducing it into the surrounding area causing air pollution in the form of suspended particulate matter, the finest particles causing the greatest health risks, are carried long distances by wind. The gaseous pollutants released into the air are attributed by the combustion engines used throughout the life of the mine site (see Lamare and Singh, 2016) and by blasting. Noise is energy waves traveling through the air from the site, with machinery, and blasting contributing to the set of associated impacts.

- Limestone dust falling on plants cause leaf injury or death in plants due to blocking of light for photosynthesis and clogging of leaf stoma, reducing gas exchange (Darley, 1966; Lerman and Darley, 1975; Howard and Cameron, 1998).
- Daily deposition of dust on roof tops of homes downwind of the mine contaminates collected rainwater (see Lamare and Singh, 2016).

- Dust can spread over surrounding areas during dry weather, leach into soil during wet season storms, and create harmful conditions for plants and animals (Vermeulen and Whitten, 1999).
- Dust is produced by drilling, blasting, excavation, road traffic, crushing, and screening, the intensity affected by rock properties (different densities and hardness of limestone), ground moisture, humidity, ambient air quality, air currents, prevailing winds, and the size of the mining operation (Langer, 2001).
- Blasting releases poisonous gases that contribute to air pollution (Gupta et al. 1992).
- Drilling, blasting, extraction, transporting, crushing, and screening of aggregate materials generate significant amounts of near constant noise pollution that can impose negative psychological and physical health effects (see Lamare and Singh, 2016).
- The primary source of noise is from blasting, rubble extraction, aggregate processing, and earthmoving equipment (Langer, 2001).
- Noise can affect wildlife by interfering with communication, covering the sounds made by predators and prey, and can cause temporary or permanent hearing loss (Fletcher and Busnel, 1978)
- The impacts of noise on the receiver are dependent on the sound source, topography, land use, ground cover of the surrounding site, and climatic conditions, and the beat, rhythm, pitch, and distance from the noise source (Langer, 2001).
- Barriers produced by topography and vegetated areas can shield or absorb noise.
- Sound travels greater distances in cold, dense air than in warm air and it is focused (compressed) by atmospheric inversions.

Blasting

Dynamite blasting creates a wide range of impacts, with toxic gases and noise listed in the previous section. Environmental problems, including flyrock, air overpressure, ground vibration, dust, and fumes, may result from the number of explosives used, the design of the blast pattern, geological structure of the area and the direction of the blast (Drew et al. 2002; Khandelwal and Singh 2006; Khandelwal and Kankar, 2011).

- High numbers of explosives are used in the mining of crushed stone material to create rubble of desired size range and reduce the demand on crushing equipment (Langer, 2001).
- Air blast is the suddenly released energy by unconfined blasting, confined blasting not properly set up, and blasting to break boulders, and is transient, traveling through the air as a compression wave with the velocity of sound, with air particle movement along the direction of wave propagation (Gupta et al. 1992).

- A factor affecting the generation of air blasts is the sudden release of energy from unconfined blast, improper design of confined blast, and secondary blasting used for breaking boulders. (Vermeulen and Whitten, 1999).

- Air blast can disturb colonies of bats, swiftlets, and other wildlife at least up to 1,500 meters from the mine (Vermeulen and Whitten, 1999).

- The propagation of air blast is affected by air temperature, pressure, and humidity, and by the occurrence of temperature inversions that cause air blast energy to be refracted back to the ground, increasing air blast level by focusing energy, dependent on the height of the blast above the ground, and the direction of the blast face (Gupta et al. 1992).

- The amplitude of ground vibration created by blasting is dependent on the weight of explosives used, the geological characteristics of the blasted rock, and the sequence of delay detonators for each blast pattern (Gupta et al. 1992).

- Blasting in mines may collapse existing conduits within the karst or open new passages, resulting in changes in direction of groundwater flow (Ekmekçi, 1993).

- Blasting can change the flow patterns of groundwater, thereby modifying surface water flow (Langer, 2001).

- Blasting can fracture of mine pit walls, increasing permeability and drainage of water from the rock behind the blast face (Gagen and Gunn, 1987; Gunn and Bailey, 1993).

- Blasting operations may create environmental effects to areas near the blast site if blasting occurs near buildings and other structures or if the blast strategy has been poorly designed (Kuzu 2008; Ak et al. 2009; Gorgulu et al. 2013; Gonzalez-Nicieza et al. 2014).

- Karst deposits beneath the blast shall have a high fracture density, reduced porosity, and few un-collapsed conduits (Smart et al., 1991).

- High energy ground vibration from blasting has negative effects on the structures, groundwater deposits, and ecology of nearby area (Singh and Singh 2005; Ozer et al. 2008)

- Ground vibration is a wave motion created by elastic strain waves transferred to surrounding rocks (Duvall and Petkof 1959), which dissipates away from the blast to nearby areas (Khandelwal and Singh 2009).

- Ground vibration is influenced by blast design, number of explosives used, physical characteristics of the rock mass, distance from the blast face, and topographical conditions (Wiss and Linehan 1978; Ak and Konuk 2008; Bakhshandeh et al. 2012).

- Most blast energy from a well-positioned blast pattern works to break rock from the blast face, and the left-over energy becomes vibrations traveling through the Earth and over its surface and through the air (Langer, 2001).

- Vibration energy traveling through the Earth reaches the surface short distance from the blast site and moves as a surface wave creating ground shaking (Langer, 2001).

- Vibrational energy released from a blast travel through air as audible sound and considered noise or high-level, unpleasant, unnatural sound. Part of the energy is subaudible, creating a concussion wave or air blast that is more noticeable when in a closed building where a difference in pressure inside and outside of the building make it vibrate (Langer, 2001).

- Poorly executed blast plans or poorly controlled blasts can create flyrock, rocks projected a big distance from the blast site, as has happened in road quarries in Belize (Langer, 2001).

- The effects of blasting on manatees, crocodiles, and other wildlife are unknown but there is concern among conservationists knowledgeable about this proposed project about the effects of blasting on behavior patterns.

Caves

Caves are particularly important features in Karst landscapes, and in Belize they are protected by the National Institute of History and Culture (NICH) given the extensive use of caves by Ancient Maya. Not only do caves harbor archaeological relics that yield knowledge about the Ancient Maya, but they also contain both fossil and living organisms, many of which have yet to be described. Caves are extremely vulnerable to limestone strip mining. The purpose of limestone mining is to remove rock material blasted from the walls of the mine, resulting in the destruction of relict and active caves, natural sinkholes, and their habitats (Gunn and Gagen, 1987).

- Blast-induced vibrations and shock waves can cause stalagmites and stalactites to break off and cause cave roofs to crack or collapse at sites outside of the mine footprint.
- Rock removal in mining destroys any cave passages and chambers, the karst crystalline materials crushed into aggregate materials (Langer, 2001).
- Cave fauna within transition zones may be able to relocate, but those fauna confined to deeper areas of the cave system and dependent on cave humidity, temperature, water quality, and water availability conditions shall perish (Langer, 2001).
- Archaeological value of caves within the mine site shall be lost.
- Caves as research sites shall also be lost.

Environmental Effects of the Conveyer Bridge

According to the verbally described plan by VMC representatives, aggregates shall be moved from the mine site and/or processing site to awaiting cargo vessels for transport to major ports in the southeastern U.S. using a large conveyer bridge. This superstructure shall support a heavy-duty conveyer belt above the ground and water to vessels docked offshore of the coastline. The bridge, supported by steel and/or concrete towers is proposed to stretch across the largest Hawksbill Turtle nesting beach in Belize. There are concerns about this strategy.

Figure 1. Section of a conveyer bridge overpassing a highway (screenshot from promotional material).

Figure 2. Conveyer bridge filling cargo vessel offshore (screenshot from promotional material).

- Presence of a large conveyer bridge across the landscape shall spoil the scenic value of the landscape.
- This visible component shall industrialize this segment of the coastal area of Belize that currently has large tourism potential.
- Support towers for the elevated structure shall be installed across the landscape, with anchor footings established in the nesting beach and offshore.
- Dust and rock debris shall be scattered below the structure during its continuous use.
- It is uncertain how the continual vibrations of the conveyer bridge will affect nesting turtles, developing eggs, and young turtles.

- It is uncertain how the continual vibrations of the conveyer bridge will affect benthic organisms and other marine life.

- Construction of the over-water section of the conveyer bridge shall require supports installed in the seafloor, similar to a long bridge, creating large amounts of suspended sediments during construction.

- Like a long bridge, this structure shall have an impact on currents within the area.

- If destroyed during a hurricane, debris from this large structure can create new snags that hamper boat traffic.

Environmental Effects of Dredging for a Deep-Water Port

Pamamax class self-loading cargo vessels shall be used to transport aggregates from Belize to ports in the southeastern U.S. (Figure 3). These ships are 228 m and larger in length with 13.5 m and deeper draft. Even though the vessels are to be loaded offshore, a large area shall have to be dredged to accommodate these deep-draft vessels and provide room for tugboats to turn the ships around. Concerns are raised about obvious and subtle impacts from this proposed component of the operation.

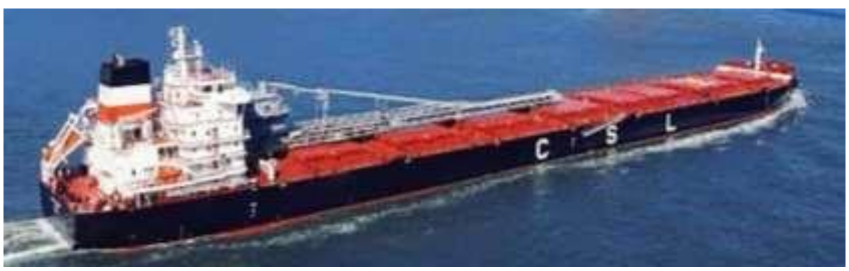

Figure 3. Panamex vessel similar to those used by VMC at the Calica mine (screenshot from promotional material).

- Enormous amounts of sediment shall be suspended during construction of the channel, anchorage, and a turning basin.

- Disposal of dredge spoil shall have an additional impact on other sections of the seafloor, smothering benthic fauna and disrupting sediment layers.

- Resuspension of organic material from deeper anaerobic layers shall reduce oxygen in the water column due to increased microbial activity triggered by the release of this detrital food source.

- Resuspension of sediments may also re-introduce sequestered metals, chlorinated hydrocarbons and other buried and potentially harmful materials.

- Deep-draft vessels are at risk of running aground and damaging grassbeds, patch reefs, and other marine habitats.

- Prop wash from these large vessels and from port service vessels shall be a continual source of sediment resuspension.

- Bilge water discharge into the Inner Canal is a potential source of heavy metals, hydrocarbons, and other potential pollutants.

- Boat traffic within the offshore harbor shall be increased due to the movement of large ships into and out of the port, tugboat and tender boat traffic, security vessels, fuel barges, and other vessels.

- These large vessels are diesel driven and shall require refueling offshore, with the risk of fuel spillage.

Health and Social Effects of Limestone Mining

Limestone typically contains varying amounts of silica in the form of silica dioxide, essentially quartz. Blasting and processing of rock material into aggregate size pieces produces a lot of dust, including particles of freshly exposed silica small enough to be breathed into the lungs and become captured within the lung tissue. Particles less than 10 microns in size can be inhaled beyond the larynx and particles less than 4 microns can be inhaled into the lungs (see Nartey et al., 2012). Not just silica, but limestone particles less than 10 microns are also of major concern.

Limestone dust is a particularly high-risk disease-causing agent to miners, especially those working ten years or longer in conditions of exposure. Long term exposure can lead to asthma, emphysema, acute infections of the respiratory tract, eyes, and ears, silicosis, pulmonary tuberculosis, pneumonia, lung cancer, cardiovascular diseases, autoimmune disease, and other diseases (Nartey et al., 2012, Randolph, 2018). Besides workers, any people living downwind, of an active strip mine are exposed over a long term to these micro-particles.

Noise can also impose a serious impact on people, blasting being a particularly disturbing noise. Continual noise can induce stress on some people, leading to other health complications. Most people eventually become accustomed to the noise and youth raised with the background noise of an active strip mine may not even notice the sound unless it is pointed out. However, long term impacts of mining noises need further investigation.

A large strip mine brings jobs to surrounding areas, and often greater income than available through local jobs. Often benefits are given to local schools through company community outreach programs. The mining company also buys at least some commodities and services from local suppliers and businesses. Sometimes other industries that provide services for the strip-mining operation follow with their own jobs and benefits.

Negative social impacts of limestone mining from the perspective of the people can range widely. Towns and rural communities change rapidly when the strip mine is opened and the work begins. As forests are cleared and denuded hills occur in the horizon, traffic moves in and out of the mine, and blasting starts, the reality of the new strip mine begins to have an impact. With the construction of the conveyer bridge across the landscape and over the highway, the mine moves from a remote site out into the public presence. Soon the new sights and sounds of the mine will fade into the background of consciousness and will be little noticed, even considered normal. Within a short generation the old ways are virtually gone as youth seek employment with the company rather than following farming and other traditional livelihoods. By then many families and communities will have become dependent on their jobs at the mine at the cost of self-dependency. Jobs attract many other people into the area from around Belize and abroad. As outside people move into the rural area, housing development begins, imposing its own set of impacts to the landscape. Stores and other businesses occur, and soon the local culture is pushed into the background.

The Calica Strip Mine—A Glimpse of an Industrialized Belize?

The VMC Calica (Calizas Industriales del Carmen, a subsidiary company of Vulcan) strip mine is located along the Mexican Yucatán coast just to the southwest of Playa del Carmen, and about 70km south-southwest of Cancun (Figure 4) is on a 400-hectare property that is actually part of the municipality of Cozumel. The entrance to the mine on Highway 307 is just 7.8km from the center of Playa del Carmen (Figure 5). The property has an industrial port blasted into the limestone shore and can accommodate cargo freighters and cruise ships. This facility exports about 12 million tons of limestone to the US yearly.

Vulcan currently has two international lawsuits filed against the Mexican Government, one for a shutdown in February 2022 for $1.1 billion, and the second for a shutdown in May 2022 for $1.5 billion. The Mexican Government has forced the closure due to the impact of underwater limestone mining on the local environment and the water table that supplies water to coastal communities. In May 10 US Republican senators sent a letter to US President Biden requesting him to take stronger action against the Mexican Government for harassing a US company.

A quick assessment of the mine using Google Earth Pro© shows the main components of the mine, including the actual strip-mined area where the vegetation was removed, except for a zig-zag green space in the center of the 925.0-hectare active area. It is surrounded by 9 or 10 large mine pits carved into the water table (Figure 6). Cleared space on the eastern side of the mine site is the staging area and crushing machine fed by a network of conveyer bridges from piles of collected rubble. A couple of roads and a conveyer bridge connect the staging area to the loading wharf and a 210m wide and 480m long canal connected to the sea.

Considering clearing patterns and assuming crews clear up to the line, total holdings are estimated to be about 1,440.0 hectares consisting of the mine complex on the northwestern side of Highway 307 and the port facility on the other side (Figure 7). Within the remaining uncleared land in the northwestern piece exploration roads have been cut and a preliminary mining effort conducted in one area.

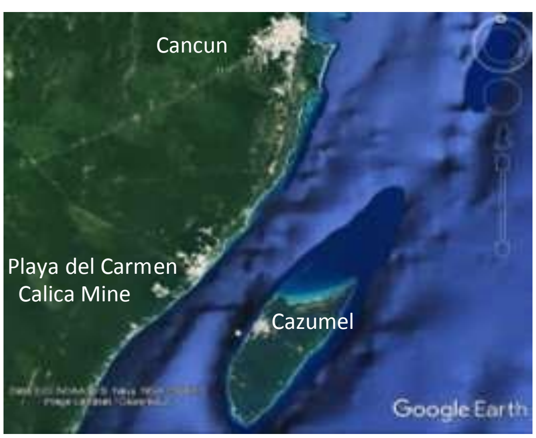

Figure 4. Location of Calica Mine within the northeastern Yucatan Peninsula.

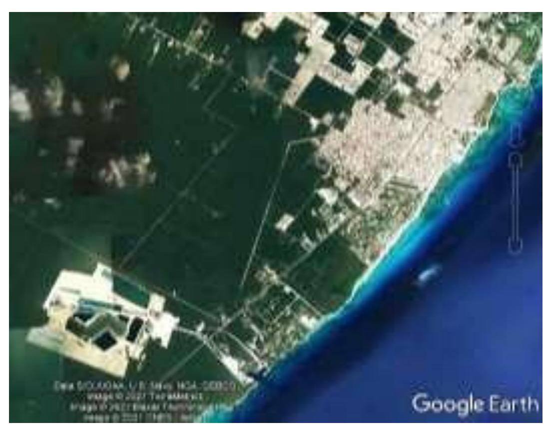

Figure 5. Calica Mine and Playa del Carmen.

Figure 6. View of the whole mining facility, including mining, staging, processing, conveyer transport, and shipping.

A close-up view of the quarried area shows a network of dendritic hauling roads used by large dump trucks to carry harvested blast rubble to the staging area in the front of the mined area (Figure 8). Most roads converge into a main road that enters the staging are on its northwestern side (left hand side of Figure 8), where piles of dumped material is seen. The total surface area of the mine pits is over 182.9 hectares, with at least two new pits being dug. The lighter photos are from 2019 and the darker images are 2017. Pits have increased in numbers and size significantly in 2 years.

Figure 7. Assumed property boundaries.

Figure 8. Close-up of the mine area showing dendritic roads, mine pits and the staging/processing area.

A more detailed view of the staging and processing area is given in Figure 9. The main access road enters this area from the west to feed several staging areas. A secondary road enters from the southwest and appears to feed a staging area in the southeastern corner of the area. A network of conveyer belts is assembled and lead from four main staging areas to nodes that may be crushing and sorting equipment. Crushed and sorted material leave the yard by way of an elevated conveyer bridge that parallels the road running east-southeast from the strip-mine area to connect to Highway 307.

Just north of the road leaving the mine site, sitting on the edge of the cleared land is what appears to the office, probably a lab, mechanic shop, fuel storage, and other facilities necessary to keep a mine site functioning. Several secondary roads intersect the main road after it leaves the mine site and before it crosses the highway. This includes what look like exploratory roads, likely checking quality of limestone deposits slated for future extraction. One site north of the road, along a secondary road (leading to the north end of the port) runs through a cleared area that may be developed into another mine site. The main road turns southeast and crosses the highway at an overpass connected to the highway with entrance and exit ramps. The conveyer bridge continues running east-southeast for a short way before turning and running southeast, crossing beneath the highway. Using conveyer bridges and being just 3.0km from the port, extra traffic that would have been created by a fleet of dump trucks carrying aggregate loads to the port has been eliminated.

Figure 9. Details of the staging area, conveyer bridges, offices, fuel storage, and roads and large conveyer bridge.

The main conveyer bridge runs 3.25km from the processing facilities to the wharf front. It travels under the highway rather than over it, probably as a safety precaution, avoiding any chance of aggregate materials from falling on traffic traveling the highway. Figure 11 shows the main conveyer bridge running down the center of the main wharf and offloading into a seven-hold cargo vessel at dock. The ship measures about 230m in length, one of the smaller Panamex vessels. The main canal is 480m long and 210m wide. Ships may be able to reverse out of the port or be tugboat-assisted to turn around using the side channel, given that the main channel is narrower than the vessel is long. Large cruise liners also use this port for docking during daily visits to the area.

Figure 10. Road and conveyer bridge network leading from the mine site to north and south sides of the port.

Figure 11. Detailed view of the Calica Mine port facilities with a vessel docked and being filled.

Considering these vessels have about 13.5 to 14m drafts, it is assumed the canals of the harbor would be dredged to at least 15m in depth. Construction of this harbor involved removal of an estimated 2,097,000 m^3 of material, in addition to another estimated 700,000 m^3 of seafloor sediments to clear the approach to the harbor, visible in Figure 11. A similar land-based port is not being proposed to service the White Ridge hills project, but a significant volume of marine sediments would have to be removed to accommodate the large vessels within the shallow Inner Channel, including turning vessels around. An approach may also have to be dredged out if a deep enough channel is not already available.

The mining strategy is very different at the Calica strip mine than planned for the White Ridge Farm. The Calica mine is on a flat coastal slab of limestone overlying an intricate underground watershed of streams, rivers, and caverns (some of if not the most pristine, geologically rich underwater caves in the world, harboring fossils and artifacts), and involves mining to and beneath the water table. The White Ridge hills would be broken up and processed similar as the effort at Gracie Rock., and transported away, only much more rapidly, filling freighters rather than dump trucks. Actual mining into the water table has been happening and is the cause behind the recent shutdown by the Mexican Government.

However, just as in the Calica strip mine, conveyer bridges are being considered to move processed material to vessels waiting to be filled. In the case of the White Ridge plan, the conveyer bridge is to be run out into the inner channel to load vessels. The conveyer may be run over the road or under it, considering expense involved in trying to run the conveyer through an underpass or installing a bridge.

What shall be similar between the two sites are the reactions of people to the development of a large strip mine within their communities and the subsequent industrialization of their neighborhood landscapes. This includes increased levels of noise (blasting, heavy machinery, crushing and sorting equipment, conveyer belts, etc.), dust, including micro-particles, and the loss of scenic quality.

In 2016 the documentary, *Erosion*, was first shown at the Merida and Yucatan International Film Festival. The documentary gives the community perspective of VMC and the Calica strip mine, environmental and social impact, non-compliance with regulations, and the hidden impact on incredible underwater cave networks. It is important to view this film to gain a better understanding of what Belize is facing. For more information, go to htpps://revesonline.com/2018/02/15/calica-laminera-que-arrasa-con-todo-en-playa-del-carmen.

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Appendix A

Key Administrators within VMC

J. Thomas Hill	Chairman of the Board, President and Chief Executive Officer
Suzanne H. Wood	Senior Vice President and Chief Financial Officer
Thompson S. Baker II	Chief Operating Officer
Stanley G. Bass	Chief Strategy Officer
Denson N. Franklin III	Senior Vice President, General Counsel and Secretary
Jerry F. Perkins Jr.	Senior Vice President, Southern & Gulf Coast and Southwest Divisions
Darren L. Hicks	Vice President, Human Resources
Janet F. Kavinoky	Vice President, External Affairs and Corporate Communications
Lindsay L. Sinor	President, Vulcan Lands, Inc.
Mark D. Warren	Vice President, Investor Relations
Ernesto Enriquez-Castillo	President, International Division

Appendix B

Brief History of VMC with a Focused on Growth of Aggregates Business

1909 Birmingham Slag Company founded as a family-owned construction company.

1916 Charles Lincoln Ireland bought Birmingham Slag

1939 Birmingham Slag supplies the Tennessee Valley Authority projects.

1942 Birmingham Slag signs a three-year contract providing construction materials for the war, Oak Ridge, Redstone Arsenal, and military projects within the US.

1944 Birmingham Slag enters into a joint venture with Lambert Brothers, Inc., one of the South's largest aggregates businesses, located in Knoxville, Tennessee.

1950 Birmingham Slag has 600 employees, sales of more than $20 million, and net profits between $1.5 million and $2 million per year.

1956 Birmingham Slag merges with Vulcan Detinning Company of Sewaren, New Jersey to become Vulcan Materials Company, becoming a publicly traded company.

1957 VMC asks for stockholder approval to merge with seven other aggregates companies and Union Chemicals and Lambert Brothers.

1957 VMC Chemicals Division is formed through a merger with Union Chemicals and Materials Corporation.

1959 VMC purchases W.E. Graham & Sons, a North Carolina family-owned aggregates and general contracting firm.

1968 VMC builds a world-class chlorinated organic chemical plant on a greenfield site in Geismar, Louisiana.

1980 VMC acquires the Port Edward, Wisconsin, chloralkali plant from BASF.

1987 VMC and a Mexican partner, Grupo ICA, form the Crescent Market Companies produce limestone from a Yucatan quarry for shipment to U.S. Gulf Coast markets company.

1987 VMC acquires White's Mines, Inc. and affiliated companies, greatly expanding Texas construction materials operations.

1990 VMC acquires the Reed Quarry, in Kentucky, giving access to stone markets reached by barge shipments along the Mississippi River and Tennessee-Tombigbee Waterway.

1999 VMC acquires CalMat, Inc., expanding the Company's aggregates operations into California, Arizona and New Mexico.

2000 VMC starts construction of a new plant in Geismar, Louisiana, to produce HCC 240fa for ozone-friendly hydrofluorocarbons (HFCs) used in insulation and construction foam.

2000 VMC acquires Tarmac America's aggregates operations, increasing operations in the eastern United States.

2001 VMC acquires Grupo ICA's interests in the Crescent Market Companies producing aggregates in the Yucatan and transports/sells aggregates to U.S. Gulf Coast markets.

2005 VMC sells its Chemicals Division, divesting its Chloralkali assets in Wichita and Geismar to Basic Chemicals, LLC, a unit of Occidental Chemicals,

2007 VMC acquires Florida Rock Industries, Inc., originally founded in 1929, adding aggregates facilities in Florida and Georgia.

2014 VMC acquires aggregate operations that enhance the greater Dallas market. The Company completes the acquisition of one quarry in southern Oklahoma with rail distribution capabilities into Texas and two distribution yards in the Dallas area.

2015 VMC completes the acquisition of three aggregates facilities in Arizona and New Mexico, and one aggregates facility in Tennessee.

2016 VMC launches MyVulcan.com, a new online customer service center, giving customers direct control of their Vulcan accounts to track orders and pay online.

2016 VMC receives approval for new greenfield site quarries in the Central Valley of California, Medina County in Texas and greater Columbia in South Carolina.

2016 VMC acquires a distribution business in Georgia to complement its aggregates logistics and distribution activities.

2017 VMC reaches an agreement to acquire Aggregates USA LLC, including 31 facilities providing markets in Georgia, Florida, Tennessee, South Carolina and Virginia.

2018 VMC begins operation of the Southwest Gulf Railroad, serving Houston markets from its new Medina County, Texas quarry.

2021 Vulcan representatives visit White Ridge Farm property and Gales Point, conduct test drilling of the property.

2022 Vulcan files two international lawsuits against the Mexican Government for $1.1 and $1.5 billion dollars for closure of the Calico mine due to the extensive damage underwater mining has done to the environment and the water table.

2022 Vulcan buys White Ridge Farm and starts application process for the Environmental Impact Assessment.