<u>EXHIBIT E</u>

IEPA Calculation Sheet

CALCULATION SHEET

Facility: Vulcan Construction Materials, LP	ID: 091806AAB
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Introduction:

Permit application from Vulcan Construction Materials, LP (Vulcan) for a revised Construction Permit/PSD Approval for upgrade and restart of a lime plant in Manteno. The proposed plant would have one rotary lime kiln with a capacity of 600 tons per day. The potential emissions of NOx, CO, and SO_2 from the proposed plant are above 100 tons per year. Particulate matter (PM) emissions are above the various significant emission rates for PM. As emissions are above the major source levels and significant emission rates, Vulcan submitted a PSD application that included a Best Available Control Technology (BACT) analysis and air quality analysis.

Background:

Lime is manufactured in kilns by high-temperature roasting or "calcination" of limestone or other material rich in calcium carbonate to convert calcium carbonate ($CaCO_3$) to lime or calcium oxide (CaO). This lime plant would produce dolomitic lime as the "limestone" being quarried by Vulcan in Manteno is dolomitic limestone, which is a combination of magnesium carbonate and calcium carbonate. Dolomitic lime is typically used as a fluxing agent in the manufacturing of steel. The kiln is a long, cylindrical, slightly inclined, refractory-lined rotary furnace, through which the limestone and combustion gases pass in opposite directions, in counter-current flow.

The kiln is the principal sources of emissions of the plant. Originally, Vulcan proposed to install two identical rotary kilns, each with a capacity of 600 tons per day. However, only one kiln was constructed and Vulcan is no longer proposing to construct a second kiln. Other emission units at the plant includes handling and preparation of the limestone, handling of the fuel used for the kilns, handling and loadout of the lime produced at the plant, and plant roadways. These other units only emit PM and emissions are controlled by various measures. Emissions from the handling of limestone and other materials are minimized by the condition of the materials, which minimizes the generation of PM emissions. Lime handling and storage are controlled by fabric filters. Fugitive emissions from vehicle traffic on plant roadways is controlled by a dust control program for plant roads and truck wheel wash station.

For the kiln, the original PSD permit, issued in February 1996, required a fabric filter or baghouse as BACT for PM. For SO_2 BACT, the permit relied upon the natural ability of the dust from the limestone fed to the kiln to ad SO_2. The use of combustion system designed to minimize the NO_x emissions was considered BACT. As is common control practice, BACT for kilns emissions of CO were good combustion practices.

The kiln began operation in 1998. Emission testing indicated that the kiln exceeded the BACT limits for NO_x, SO_2 and CO. The underlying cause was likely that the consequences for emissions from the processing of dolomitic limestone, rather than high-calcium limestone, were not recognized and appropriately addressed in the initial application and the issuance of the original permit. In response to the violations of various permit limits, Vulcan applied for a revised permit that would provide for installation of a double alkali scrubber to control the SO_2 emission, since the natural ability of limestone dust to control SO_2 was not sufficient to comply with the SO_2 limit. Higher limits for NO_x and CO emissions were also requested. A revised permit was issued in October 2002.

However, the plant then ceased operation in 2003. The proposed scrubber was never installed. The plant has been idle since 2003. Given the length of time that the plant has been idle, Vulcan would have to obtain a revised permit to restart the plant, as well as to address any changes to its plans for the plant that have occurred during the intervening years.

Current Application and Proposed Changes to the Lime Plant:

The application that is now being addressed is Vulcan's new application for another revised permit. This application was originally submitted in October 2003, There have been several updates to this application, most significantly in 2006 and more recently in November 2008.

In this application, Vulcan now proposes to install a spray dryer absorber, also known as dry scrubber, to control the kiln's emission of SO_2. Vulcan also proposes to add a pre-heater tower to the kiln, shortening the length of the kiln. This will improve the energy efficiency of the kiln as the limestone feed to the kiln would be preheated in this tower by the hot exhaust from the kiln. Vulcan also proposes to rearrange the system for handling lime product. It would install several smaller baghouses that would replace a central baghouse for handling of lime products, which would provide improved control of PM. Other changes include reconfiguring of certain fugitive dust units and roads at the plant, which would reduce the fugitive dust emissions.

The restart of the plant with installation of a dry scrubber on the kiln and other changes now proposed by Vulcan requires a new PSD review and BACT determination for SO_2, NO_x, CO and PM. Vulcan has updated its BACT analysis for the plant several times, with the most recent update submitted in November 2008.

Review of Proposed Kiln:

The permit requires the emissions from the kiln to be controlled by use of preheater tower or similar heat recovery device for improved fuel efficiency, a spray dryer absorber, and fabric filter (baghouse). The emissions will also be minimized by other requirement which include low excess air to minimize NO_x, good combustion practices to minimize formation of CO, and the natural absorptive capacity of lime dust for SO_2. These provisions are based on the review of the BACT determination made, based on the information provided in the updated BACT analysis submitted by Vulcan as well further research into relevant technologies, further analysis of costs, and general knowledge of the type of operations at the plant.

PM - BACT for PM is a fabric filter or baghouse. Baghouses are still generally considered the most effective control technology for the PM emissions of the lime kiln. The appropriate BACT limits for PM_{10}, includes both filterable and condensable, is 0.246 lb per ton of stone feed. This limit is would be accompanied by a BACT limit for filterable particulate of 0.10 lb per tons of stone feed, which is the limit set as MACT by the federal NESHAP of Lime Manufacturing, 40 CFR 63, Subpart AAAAA. Filter fabric with a PTFE membrane or equivalent filter fabric must be used to enhance control of fine particulate.

SO_2 - For SO_2, identified control technologies include adsorption of SO_2 in dust collected by the baghouse, conventional spray dryer absorption, spray dryer absorption using pulverized lime, dry lime injection, wet scrubbers, reduced sulfur coal/coke fuels, use of a preheater tower, fuel switch to natural gas, and fuel switch to biomass fuel or other clean "innovative" fuels.

Although the natural adsorption of SO_2 on limestone dust and dry lime injection are technically feasible control technologies, the control efficiencies provided by these technologies are not sufficient to adequately control SO_2 emissions of the proposed kiln. Natural scrubbing must be supplemented with an add-on scrubber system. Moreover, given the enhancements to the filter material used in the baghouse and the change in configuration with the preheater, natural adsorption cannot be relied upon to even provide the level of SO_2 control previously provided and should not be factored into the evaluation of add-on SO_2 control equipment.

Wet scrubbers, such as tray or Dynawave® froth tower scrubbers, are feasible control technologies but rejected as BACT due to environmental impacts. This is because the PM emission from these scrubbers could not comply with the applicable PM limit due to the formation of solid containing droplets that cannot be reliably controlled by current mist eliminators. In addition, given problems with the wet scrubber installed at Vulcan's McCook lime plant, the simpler and more robust design of dry scrubber is preferable.

Reducing sulfur content of fuel (coal/coke fuel blends or coal fuel) is technically feasible but would not provide sufficient reduction in SO_2 emission. The further changes to the ratio of the fuel used in kiln may not provide the efficient burning in the kiln and may also alter the required product specification. A limitation on sulfur content of fuel would also constrain Vulcan's ability to obtain fuels for the kiln on a commercial basis, in circumstances where it not practical to assess the sulfur content of fuels that would be available in the marketplace in the future. These factors also lead to the rejection of biomass fuels and other innovative fuels.

Vulcan has proposed use of dry scrubber control technology for SO_2. Dry scrubbing is a robust technology that will provide appropriate control of SO_2 emissions. As it controls SO_2 and other acid gases without forming water droplets, it will also serve to minimize formation of precursors to condensable particulate.

Fuel switch to natural gas is technically feasible for lime kiln. However, the cost impacts are excessive, especially when considered in terms of incremental cost-effectiveness. (The cost impacts are not as obvious in terms of average cost-effectiveness. However, this is because the dry scrubber is so inexpensive, so that it "subsidizes" the average cost for natural gas.) In actual practice, natural gas is used as the fuel at kilns that are producing food grade lime. The lime produced by these types of kilns has different product specification and value than the general purpose lime that Vulcan would produce. Furthermore, while SO_2 emissions could potentially be reduced with natural gas, this would be counter-productive, as it would act to increase NO_x emissions from the kiln. Similarly, low-sulfur oil, would be a much more expensive fuel than natural gas with very high cost impacts.

BACT for SO_2 emission from kiln is determined to be a preheater tower with dry scrubber. An appropriate SO_2 BACT emission limit with the scrubber is 2.20 lbs SO_2 per ton of stone feed to the kiln, 3-hour average, subject to downward adjustment (as low as 1.8 lbs/ton of stone feed) based on evaluation of the actual operation and SO_2 emissions of the kiln after operation with the planned improvement. The issued permit also includes SO_2 limits that would apply on a 30-day rolling average, 2.0 lbs SO_2 per ton of stone feed to the kiln, subject to downward adjustment (as low as 1.5 lbs/ton of stone feed) based on evaluation of the actual operation. The BACT limit must include this provision for further evaluation of the SO_2 limit because of the interaction or overlap between natural scrubbing and add-on scrubbing for SO_2 emissions and the potential negative effect of the improvement of the filter fabric in the baghouse. This makes the full extent of the further reduction in SO_2 emissions that will be reliably achieved with the add-on scrubber uncertain.

NO_x - For NO_x, identified control technologies include selective catalytic reduction (SCR), $SCONO_X$™ catalytic absorption system, selective non-catalytic reduction (SNCR), Low NO_x burners, overfire air (OFA), flue gas recirculation, gas reburning, and combustion controls and low oxygen firing. Except for combustion controls, low oxygen firing and SCR, the identified NOx control technologies listed above are not considered feasible.

SCR technology is "problematic" for lime kilns given the operating temperatures at the locations at which reagent could be injected. Before the baghouse, the flue gas is too dusty for SCR technology to be considered feasible. After the baghouse, the temperature of the flue gas would be lower than the minimum operating temperature of an SCR system. While the gas could be reheated at this point with natural gas to the temperature regime for SCR, this would add significantly to the cost of SCR, while posing issues for the design of the SCR system that have not been confronted in practices for SCR systems installed on coal-fired boilers. $SCONO_X$™ technology is another catalytic technology has not been applied to rotary kiln. SNCR technology is also not feasible for lime kiln given the operating temperature at the locations at which reagent could be injected.

Overfire air (OFR) and flue gas recirculation (FGR) control technologies are also not feasible as it is normally used to control NO_x emissions from the boilers. This is because with OFR control technology, portion of combustion air is diverted to overfire air ports allowing the delay in completion of oxidation. This technique has not applied to rotary lime kilns. In FGR, portion of flue gas is recirculated to the burner portion through the draft fan. This technology is not feasible to rotary kiln because the flue gas from lime kiln contains high particulate loading which may cause the damage to the burner causing burner instability and safety problems.

Gas reburning control technology requires dividing the combustion chamber into three combustion zones. This technology is not feasible as combustion occurs for lime kiln occurs at end of the kiln. Introducing fuel at mid kiln for lime manufacturing creates conditions that potentially affect the quality of the lime produced.

NOx BACT continues to be combustion controls with established burner technology. The initial BACT limit continues to be 4.5 lb NO_x/ton of stone feed to the kiln, 24-hour average, accompanied by an alternative requirement addressing control of excess air to minimize NO_x emissions, expressed as a limit for the concentration of oxygen in the exhaust from the kiln. The revised permit would revise this alternative provision for the maximum level of oxygen in the exhaust of the kiln from 1.0 to 1.25 percent, hourly average. This change would be made to ensure that this alternative provision would not restrict the level of oxygen to such a degree that it interferes with good combustion practices and contributes to incomplete combustion of fuel. The revised BACT determination would also provide that the numerical BACT limit may be subject to downward adjustment (as low as 3.5 lb NO_x/ton of stone feed) based on evaluation of actual operation and NOx emissions of the kiln with improvement. The issued permit also includes NO_x limits that would apply on a 30-day rolling average, 4.0 lbs per ton of stone feed to the kiln, subject to downward adjustment (as low as 3.0 lbs/ton of stone feed) based on evaluation of the actual operation.

CO - CO control technologies potentially identified for BACT include use of excess air, thermal oxidizer, catalytic oxidizer, and proper kiln design and operation. Based on the review of these technologies, use of excess air and catalytic oxidizer control technologies were deemed infeasible for lime kiln. This is because introducing excess air in rotary kiln is extremely difficult. While CO emissions could potentially be reduced with introduction of additional excess air, this would be counter-productive, as it would act to increase NO_x emissions and reduce thermal efficiency of the kiln.

As for catalytic oxidizer, this is because the high levels of SO_2 in the gas stream would poison the catalytic bed combined with the limited operating temperature range of the catalytic oxidizer would again require reheating the gas stream from the baghouse. Thermal oxidizer control technology although technically feasible, would require additional fuel and electricity which results in formation of additional NO_x emissions from the plant.

BACT for CO continues to be good combustion practice. For this kiln producing Dolomitic lime, an appropriate BACT limit would now be 11.48 lb CO per ton of stone feed to the kiln, 24-hour average

Operational Limits - Operational limit in draft permit includes the limit on stone feed input to kiln which is permitted at 1,296 tons per day and 473,040 tons per year.

Summary of Permitted Emissions – Short-term and annual emission limits for kiln are based on these operational limits.

Pollutant	Short-Term Limits (Lbs/Hr) Limit	Average	Annual Limits (Tons/Yr)
PM	5.4	3-hour	23.7
PM (total, filterable & condensable)	13.3	3-hour	58.3
SO_2	119.0	3-hour	473.0*
	119.0	daily, 24-hour	
NO_x	243.0	3-hour	946.0*
CO	620.0	daily, 24-hour	2,716.0
VOM	7.9	3-hour	34.6
Sulfuric Acid Mist	1.0	3-hour	4.4
Lead	0.055	3-hour	0.24

* Subject to adjustment based on the evaluation.

Discussion of Non-Applicability - The lime plant is not considered a major source for HAP emissions because the emissions of individual HAP from the plant are less than 10 tons per year and combined HAPs from the plant are less than 25 tons per year. The lime kiln is not subject to the federal NESHAP, 40 CFR 63, Subpart AAAAA, because the plant is not major source for purposes of HAPs.

Review of Limestone Crushing Plant and Material Conveyor System and Other Operation:

The existing crushing plant at the quarry will provide the limestone to the lime plant. The limestone will be transferred to the lime plant by a conveyor system and stockpiled in a storage pile before being transferred to the kiln by another conveyor system. Limestone that is too small or too large for the preheater will be sent to the crushing plant. Solid fuel will be stockpiled in a storage pile and transferred to fuel feed bin by a conveyor. A final conveyor system will be used to transfer the dust collected by the fabric filter on the kiln to a storage silo. The fabric filter dust will be transported off-site. Lime product from the cooler will pass through a set of two crushers to ensure that oversize material is reduced to a size appropriate for product storage and loadout. These units are address in Condition 2.2 of the permit.

The BACT for units that are subject to NSPS for Nonmetallic Mineral Processing Plant is determined to be the requirement from the NSPS. These requirements include opacity from each crusher not exceed the opacity of 10 and 15 percent for each unit where capture system is used and not used, respectively. For the emission units that have stack emissions, the requirement for emission not to exceed 0.05 gram/dscm (0.022 gr/dscf) and opacity not to exceed 7 percent. Other unit, such as enclosed building, BACT has been determined to be equivalent to the BACT for crusher or emission unit with stack for fugitive and stack emissions, respectively. As an alternatively, no visible emission from the vents from the buildings and the emission limit equivalent to the emission unit with stack above shall be exceeded.

The BACT for units that are not subject to the above limits are determined for fugitive emission not to exceed 10 percent opacity, for stack emission unit 0.01 gr/dscf with less than 7 percent opacity and for enclosed building equivalent emission limit equivalent to the NSPS requirement.

Review of Material Handling Equipment:

The lime plant will have equipment for processing the lime produced by the kiln, including lime loadout, lime cooler, feeder, bucket elevator, and briquetter. It will also have equipment for solid fuel for the kiln will be held in feed bin prior to ground and fed to the kiln. Lime slurry prepared for use in the spray dryer absorber on the kiln which processes dust collected by the fabric filter on the kiln that is transfer by the conveyor system. These units are addressed in Condition 2.3 of the draft permit. As mentioned above the Vulcan has proposed several smaller fabric filters instead of one central baghouse for this equipment to better control PM emissions.

The BACT for these units are determined to be enclosure and fabric filters. The fabric filters are permitted with stack emission not to exceed 0.005 grains per standard cubic feet and opacity less than 7 percent. The total PM, as allowed in Condition 2.3.6(a), emission from these units is permitted to 2.93 tons per year.

Review of Roadways:

Fugitive dust or particulate matter emissions from vehicle traffic and wind erosion on the roadways and parking area are minimized by fugitive dust control program. The fugitive dust control program requires water spraying or dust suppressant application for the units that are not paved. It also requires vacuum sweeping or water flushing for the units that are paved. The draft permit also requires work practices for these units including requirement of pavement of all regularly travelled entrances and exits from the plant and a wheel wash system for transport trucks leaving the plant.

The fugitive dust control program and the opacity of PM emission are considered as BACT for these units. Plant wide PM emission from these units are permitted at 5.80 and 1.64 tons per year for PM and PM_{10}, respectively.

Air Quality Analysis:

Vulcan also has updated air quality analysis for the lime plant based on the proposed changes. Air Quality Planning Section (AQPS) has performed detail review of this material and has concluded that the lime plant does not cause or contribute to any exceedance. See separate memorandum prepared by the Air Quality Planning Section.

Issued Permit:

In addition to the above requirement, the revised Construction Permit/PSD permit establishes appropriate compliance procedures for ongoing operation of the plant, including emission testing, work practices, operational monitoring, recordkeeping and reporting. This revised permit does not revise requirements for testing, recordkeeping, and reporting for individual units.

Consistent with the improved format for significant permits, the conditions in the revised permit are organized into three sections, including plant-wide conditions, unit-specific conditions, and general conditions.

Public Comment Period:

A public comment period, with hearing, was held on the proposed issuance of this revised permit. The comment period began on April 17, 2009. Oral comments were received during the hearing on June 4, 2009. Lengthy written comments were also received from the Sierra Club. These comments have been addressed in a lengthy Responsiveness Summary.

See the attached listing for changes made between the draft of revised PSD permit and the issued permit.

Recommendation:

Grant revised permit.

MP