PROJECT REPORT

CalPortland Company, Inc. > Rillito, AZ

Arizona Department of Environmental Quality

Regional Haze Four-Factor Analysis

CALPORTLAND-RILLITO PLANT
11115 NORTH CASA GRANDE HIGHWAY
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TABLE OF CONTENTS

1. EXECUTIVE SUMMARY 1-1

2. INTRODUCTION 2-1

3. BASELINE EMISSION RATES 3-1

4. FOUR-FACTOR ANALYSIS 4-1

4.1. **Clinker to Overhead Crane Building – PM_{10} Controls** 4-1
4.1.1. Identification of Potential Control Technologies 4-1
4.1.2. Elimination of Technically Infeasible Control Options 4-1
4.1.3. Rank of Remaining Control Technologies Based on Control Effectiveness 4-2
4.1.4. Evaluation of Impacts for Remaining Control Technologies 4-2
4.1.5. Cost of Compliance 4-3
4.1.6. Timing of Compliance 4-3
4.1.7. Energy Impacts and Non-Air Quality Environmental Impacts 4-3
4.1.8. Remaining Useful Life 4-3
4.1.9. Conclusion 4-3

4.2. Unpaved Road Vehicle Traffic – PM_{10} Controls 4-3
4.2.1. Identification of Potential Control Technologies 4-3
4.2.2. Elimination of Technically Infeasible Control Options 4-5
4.2.3. Rank of Remaining Control Technologies Based on Control Effectiveness 4-6
4.2.4. Evaluation of Impacts for Remaining Control Technology 4-6
4.2.5. Cost of Compliance 4-6
4.2.6. Timing of Compliance 4-7
4.2.7. Energy Impacts and Non-Air Quality Environmental Impacts 4-7
4.2.8. Remaining Useful Life 4-7
4.2.9. Conclusion 4-7

4.3. Paved Road Vehicle Traffic – PM_{10} Controls 4-7
4.3.1. Identification of Potential Control Technologies 4-7
4.3.2. Elimination of Technically Infeasible Control Options 4-9
4.3.3. Rank of Remaining Control Technologies Based on Control Effectiveness 4-10
4.3.4. Evaluation of Impacts for Remaining Control Technologies 4-10
4.3.5. Cost of Compliance 4-10
4.3.6. Timing of Compliance 4-10
4.3.7. Energy Impacts and Non-Air Environmental Quality Impacts 4-10
4.3.8. Remaining Useful Life 4-11
4.3.9. Conclusion 4-11

4.4. Material Handling – PM_{10} Controls 4-11
4.4.1. Identification of Potential Control Technologies 4-11
4.4.2. Elimination of Technically Infeasible Control Options 4-11
4.4.3. Rank of Remaining Control Technologies Based on Control Effectiveness 4-12
4.4.4. Evaluation of Impacts for Remaining Control Technologies 4-12

4.5. Wind Erosion – Iron Stockpile – PM_{10} Controls 4-12
4.5.1. Identification of Potential Control Technologies 4-12
4.5.2. Elimination of Technically Infeasible Control Options 4-14
4.5.3. Rank of Remaining Control Technologies Based on Control Effectiveness 4-14
4.5.4. Evaluation of Impacts for Remaining Control Technologies 4-15

4.6. Finish Mill Baghouses – PM_{10} Controls ... **4-15**
4.6.1. Identification of Potential Control Technologies ... *4-15*
4.6.2. Elimination of Technically Infeasible Control Options ... *4-15*
4.6.3. Rank of Remaining Control Technologies Based on Control Effectiveness ... *4-16*
4.6.4. Evaluation of Impacts for Remaining Control Technologies ... *4-16*
4.6.5. Cost of Compliance ... *4-16*
4.6.6. Timing of Compliance ... *4-16*
4.6.7. Energy Impacts and Non-Air Quality Impacts ... *4-17*
4.6.8. Remaining Useful Life ... *4-17*
4.6.9. Conclusion ... *4-17*
4.7. Clinker Cooler – PM_{10} Controls ... **4-17**
4.7.1. Identification of Potential Control Technologies ... *4-17*
4.7.2. Elimination of Technically Infeasible Control Options ... *4-17*
4.7.3. Rank of Remaining Control Technologies Based on Control Effectiveness ... *4-18*
4.7.4. Evaluation of Impacts for Remaining Control Technologies ... *4-18*
4.7.5. Cost of Compliance ... *4-18*
4.7.6. Timing of Compliance ... *4-18*
4.7.7. Energy Impacts and Non-Air Quality Impacts ... *4-18*
4.7.8. Remaining Useful Life ... *4-18*
4.7.9. Conclusion ... *4-19*
4.8. Quarry Crusher – PM_{10} Controls ... **4-19**
4.8.1. Identification of Potential Control Technologies ... *4-19*
4.8.2. Elimination of Technically Infeasible Control Options ... *4-19*
4.8.3. Rank of Remaining Control Technologies Based on Control Effectiveness ... *4-19*
4.8.4. Evaluation of Impacts for Remaining Control Technologies ... *4-20*
4.8.5. Cost of Compliance ... *4-20*
4.8.6. Timing of Compliance ... *4-20*
4.8.7. Energy Impacts and Non-Air Quality Impacts ... *4-20*
4.8.8. Remaining Useful Life ... *4-20*
4.8.9. Conclusion ... *4-20*
4.9. Blasting – NO_X Controls ... **4-20**

5. SUMMARY & CONCLUSION **5-1**

APPENDIX A: BAGHOUSE COST CALCULATIONS

APPENDIX B: FOUR-FACTOR ANALYSIS SPREADSHEET

1. EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) Regional Haze Rule (RHR) is designed to improve visibility at national Class I areas to natural levels by 2064. The program is designed to achieve this goal by assessing visibility during various "planning" periods, demonstrate that visibility improvements are progressing along the Uniform Rate of Progress (URP), and require controls to demonstrate reasonable progress. The current planning period requires that states submit updated implementation plans no later than July 31, 2021. The analysis requires the development of a "Source Screening" approach to remove sources from further consideration. Sources that are not screened out are subject to additional review such as a four-factor analysis (4FA).

The Arizona Department of Environmental Quality (ADEQ) informed the CalPortland Rillito facility (the Facility) that they were selected for a 4FA. The ADEQ has also provided CalPortland with a list of the processes that are subject to the 4FA. This report details the methodology used to complete the 4FA for these processes and summarizes the associated results. Table 1-1 summarizes the results of the 4FA for the Facility.

Table 1-1. CalPortland Rillito – Four Factory Analysis Conclusions

Unit Process Description	Pollutant	Proposed Control	Post Control Emission Rate (tpy)	Proposed Emission Rate Averaging Period
Clinker to overhead crane building	PM_{10}	None economically feasible	N/A	N/A
Unpaved Roads	PM_{10}	None economically feasible	N/A	N/A
Paved Roads	PM_{10}	None economically feasible	N/A	N/A
Material Drops	PM_{10}	None technically feasible	N/A	N/A
Wind Erosion	PM_{10}	Artificial Wind-Break	6.31	Annual
D2-PC Baghouse	PM_{10}	None economically feasible	N/A	N/A
D3-1-DC2 Baghouse	PM_{10}	None economically feasible	N/A	N/A
H2-GB Baghouse	PM_{10}	None economically feasible	N/A	N/A
B2-DC1 Baghouse	PM_{10}	None economically feasible	N/A	N/A
Blasting	NOx	None technically feasible	N/A	N/A

Many of the sources identified by ADEQ were deemed not economically or technically feasible because the Facility is subject to 40 CFR 63, Subpart LLL, also known as Portland Cement MACT (PC MACT). PC MACT applies to each clinker cooler, finish mill, and conveying system transfer point, and entails specific emission limits and monitoring requirements for most of the sources identified by ADEQ. For example, material handling operations are limited to a 10 percent opacity limit, the Kiln 4 clinker cooler and finish mill baghouses are fitted with bag leak detection monitoring systems and have strict particulate matter (PM) emission limits that can be considered Best Available Control Technology (BACT), and piles of clinker that result from accidental spillage or clinker storage cleaning operations must be cleaned up within 3 days. Most of the effective PM_{10} controls for the sources identified by ADEQ have already been implemented due to the requirements of PC MACT, and any further control is cost prohibitive.

2. INTRODUCTION

CalPortland operates a portland cement manufacturing plant in Rillito, Arizona. This report documents the results of a four-factor control technology analysis for oxides of nitrogen (NOx) and particulate matter smaller than 10 microns in diameter (PM_{10}) sources at the Facility. The Facility operates under the jurisdiction of the air quality program of the Arizona Department of Environmental Quality (ADEQ).

The U.S. Environmental Protection Agency (EPA) Regional Haze (RH) program is designed to improve visibility at national Class I areas (such as Superstition Wilderness) to natural levels by 2064. The program is designed to achieve this goal by assessing visibility during various “implementation” periods, demonstrate that visibility improvements are progressing along the Uniform Rate of Progress (URP), and require controls to demonstrate reasonable progress. As part of the first “implementation” period, states were required to submit implementation plans no later than December 17, 2007. The second “implementation” period requires that states submit updated implementation plans no later than July 31, 2021.

In order to decide which sources are subject to RH requirements, a “Source Screening” approach was taken by the Arizona Department of Environmental Quality (ADEQ) in order to eliminate sources from additional consideration. The ADEQ preliminary “Source Screening” approach was based on a ratio of 2014 to 2017 annual emissions of visibility affecting pollutants (determined to be NOx, SO_2, and PM_{10} for Arizona), known as “Q” in tons per year (tpy), and distance to Class I area, known as “d” in kilometers (km). Arizona has diverged from WRAP guidance regarding using a threshold of “Q/d > 10” to screen sources in and instead utilized a higher threshold of “Q/d > 20.” Based on the results of the initial “Q/d > 20” screening approach, the ADEQ identified the Facility as subject to the requirement to develop a “four-factor” analysis.

The following sources at CalPortland were included in the four-factor analysis evaluated PM_{10} emissions:

- Clinker to overhead crane building transfer points
- Vehicle traffic on paved and unpaved roads
- Material drops
- Wind erosion for the Sonoran hematite pile
- D2 Finish Mill D2-PC Baghouse
- D3 Finish Mill D3-1-DC2 Baghouse
- Kiln 4 Clinker Cooler H2-GB Baghouse
- Quarry Crusher B2-DC1 Baghouse

The following source will be evaluated for NOx emissions:

- Blasting

This report contains the “baseline” emission rates defined by EPA guidance[1] as “*source conditions assumed to be the starting point for the analysis of additional measures based on the four statutory factors and possibly visibility benefits.*” that represent a realistic depiction of anticipated annual emissions. In addition, a four-factor analysis is provided for each of the aforementioned sources, which reviews the following four statutory factors:

Factor 1. Costs of compliance

[1] Per EPA “*Draft Guidance on Progress Tracking Metrics, Long-Term Strategies, Reasonable Progress Goals and Other Requirements for Regional Haze State Implementation Plans for the Second Implementation Period*”, July 2016.

Factor 2. Time necessary for compliance
Factor 3. Energy and non-air quality environmental impacts of compliance
Factor 4. Remaining useful life of the kilns

Factors 1 and 3 of the four factors that are listed above were considered by conducting a step-wise review of emission reduction options in a top-down fashion, similar to the top-down approach that is included in the EPA RHR guidelines[2] for conducting a review of Best Available Retrofit Technology (BART) for a unit. These steps are as follows:

Step 1. Identify all available retrofit control technologies
Step 2. Eliminate technically infeasible control technologies
Step 3. Evaluate the control effectiveness of remaining control technologies
Step 4. Evaluate impacts and document the results

Factor 4 is also addressed in the step-wise review of the emission reduction options, primarily in the context of the costing of emission reduction options and whether any capitalization of expenses would be impacted by limited equipment life. Once the stepwise review of control options was completed, a review of the timing of the emission reductions is provided to satisfy Factor 2 of the four factors.

A review of the four factors for NOx and PM_{10} can be found in Section 4 of this report. Section 3 of this report includes information on CalPortland's existing/baseline emission.

[2] The BART provisions were published as amendments to the EPA's RHR in 40 CFR Part 51, Section 308 on July 5, 2005.

3. BASELINE EMISSION RATES

Pursuant to 40 CFR 51.308(d)(3)(iv), states are responsible for identifying the sources that contribute to the most impaired days (MID) in the Class I areas. To accomplish this, the ADEQ reviewed 2014 emission inventory data for sources of PM_{10}, NO_x, and SO_2, and developed a "source screening" approach using a "Q/d" analysis, to remove sources from further consideration. In this analysis "Q" is the aggregate tons per year of PM_{10}, NO_x, and SO_2, and "d" is the distance (km) of a facility to a Class I area. Arizona utilized guidance from the Western Regional Air Partnership (WRAP) regarding using a threshold of "Q/d > 10" to screen out insignificant sources. Additionally, the ADEQ evaluated 2018 facility operations and emissions to determine which processes have installed an "effective control" within the last five years. Those processes which have an "effective control" were deferred from further evaluation during this planning period.[3] Based on the results of the initial "Q/d > 10" and "effective control" screening approach, ADEQ identified the Facility is not "screened out" and as subject to the requirements to develop a 4FA. For facilities that are subject to the requirement to develop a 4FA, ADEQ determined that the 4FA must be completed for processes at these facilities contributing to the top 80% of the "Q" emissions.

The Facility is in Pima County, Arizona. The nearest class I area is Saguaro Wilderness, located approximately 8 kilometers from the facility. Table 3-1 and 3-2 contain a list of the top 80% processes that are subject to the 4FA based on ADEQ communication.[4]

This section summarizes emission rates that were used as baseline rates in the four factor analyses presented in Section 4 of this report. These baseline emission rates were provided by ADEQ, except for the baghouses, which were modified to represent expected vendor guarantees as opposed to stack testing information which was provided in past emission inventories. Source tests show actual emission rates are significantly below the grain loading rates used in the analysis.

[3] ADEQ 2021 Regional Haze State Implementation Plan Source Screening Methodology

[4] Per "Four Factor Processes" spreadsheet received September 2019.

Table 3-1. PM_{10} Emitting Activities Subject to Four-Factor Analysis

Source Type	Baseline Throughput		Baseline PM_{10} Emissions [1]
	Value	Units	(tpy)
Clinker to overhead crane building	4,380,245	Tons	66.9
Unpaved Roads	109,883	Miles Driven	58.8
Paved Roads	24,195	Miles Driven	10.6
Material Drops	9,602,945	Tons	20.3
Wind Erosion – Iron Stockpile	1.04	Acre	8.4
Finish Mill-D2 Area	6,087	Hours	36.5
Finish Mill-D3 Area	6,491	Hours	31.7
Kiln 4 Clinker Cooler	8,600	Hours	42.4
Quarry Crusher System	1,621	Hours	6.6

[1] Per 2028 projections received from ADEQ

Table 3-2. NO_x Emitting Activities Subject to Four-Factor Analysis

Source Type	Baseline Throughput		Baseline NO_x Emissions [1]
	Value	Units	(tpy)
Blasting	840	tons ANFO	7.1

[1] Per 2028 projections received from ADEQ

4.1. CLINKER TO OVERHEAD CRANE BUILDING – PM_{10} CONTROLS

This section presents the stepwise review of control options for PM_{10} for clinker to overhead crane building conveyor transfer point.

4.1.1. Identification of Potential Control Technologies

The Clinker to Overhead Crane Building emission sources are clinker material handling sources that handle clinker within a building that is enclosed on three sides. One side of the building is open to allow for crane movement in and out of the building. As such, CalPortland reviewed the feasibility of installing the following PM_{10} control technologies for reduction of PM_{10} from these material handling sources:

- Fabric Filter Baghouse
- Full Enclosure

In order to identify all feasible control technologies, the RACT/BACT/LAER Clearinghouse (RBLC) database, Western Regional Air Partnership (WRAP) guidance[5], as well as technical literature was reviewed. Using these sources, potentially applicable PM_{10} control technologies for clinker material transfers were identified based on the principles of control technology and engineering experience for conveyors at cement plants.

Step 1 of the top-down control review is to identify available retrofit control options. Each control technology is described in detail below:

4.1.1.1. *Full Enclosure*

Enclosure is one of the control techniques used for material handling sources.[6] The sources in the overhead crane building already achieve 75% control due to its location in a three-sided enclosure. As such, full enclosure of the building would represent the maximum achievable control for these sources.

4.1.1.2. *Fabric Filter Baghouse*

Fabric filter baghouses work by filtering fugitive PM_{10} emissions through a filter bag. The collected particles are periodically removed from the bag through a pulse jet or reverse flow mechanism.

4.1.2. Elimination of Technically Infeasible Control Options

Step 2 of the top-down control review is to eliminate technically infeasible PM_{10} control options that were identified in the first step.

The technical feasibility of each of the control options is reviewed below:

4.1.2.1. Full Enclosure Feasibility

The overhead crane building is designed to allow the overhead crane to exit on either end of the building. In order to implement full enclosure of the building, modifications will have to be made to the overhead crane building

[5] Per WRAP Fugitive Dust Handbook, 2006, https://www.wrapair.org/forums/dejf/fdh/content/FDHandbook_Rev_06.pdf
[6] RBLC database

while still allowing for maintenance of the crane and loader/haul truck access at either end. These modifications will include the following:

- Extension of the building on the east end to accommodate crane maintenance (through roof ports/hatches). The top portion of the east face of the building (50 to 60% of the total building height) will be enclosed. The east face will include a roll-up door on the bottom to provide access to haul trucks, maintenance equipment, and other vehicles or equipment, as necessary.
- Enclosure of the building on the west end. The top portion (50 to 70% of the total building height) of the west end face will be enclosed. The west face will remain open on the bottom to facilitate loader traffic (moving clinker in and out of the building) and other equipment access as needed.
- Structural changes and/or reinforcements to the building to accommodate the additional weight of the extended building and walls, as well as changes to the wind loading of the structure.
- For the building to be fully enclosed, dust collection will be required to maintain visibility for the crane operators to ensure their health and safety. The building will not be able to structurally support new dust collection equipment either on top of or inside the structure. That said, the Facility may be able to re-purpose the existing H5-5 baghouse (for Kilns 1, 2, and 3) to provide dust collection for the clinker storage building.
    - Note that to repurpose the H5-5 baghouse for fugitive dust collection, additional ducting will need to be installed at the east end of the building to connect to the existing ducting at the end of Kilns 1, 2, and 3/inlet to the H5-5 baghouse.

Full enclosure of the building is a technically feasible control measure; however, the cost associated with rebuilding the overhead crane building would be likely cost-prohibitive making it economically infeasible. The cost concerns associated with this control technology are discussed further in Section 4.1.4.

4.1.2.2. Fabric Filter Baghouse Feasibility

The building structure cannot safely support or house a baghouse, and the building is not currently fully enclosed. As noted in section 4.1.2.1 above, even after restructuring the building to allow for a full enclosure, it will not be structurally capable of accommodating a baghouse. Therefore, installing a new baghouse is not a technically feasible option for this analysis.

4.1.3. Rank of Remaining Control Technologies Based on Control Effectiveness

Step 3 of the top-down control review is to rank the technically feasible options according to effectiveness. Full enclosure of the overhead crane building is the only technically feasible control technology.

4.1.4. Evaluation of Impacts for Remaining Control Technologies

The fourth step of the top-down control review is the impact analysis. The impact analysis considers the:

- Cost of compliance;
- Time necessary to comply with the control;
- Energy impacts and non-air quality impacts; and
- The remaining useful life of the source.

Below, the cost of compliance for full enclosure of the overhead crane building was estimated.

4.1.5. Cost of Compliance

The total annual cost to fully enclose the overhead crane building is $127,565, which is based on a capital cost of $1,076,037 for reconstructing the east and west end of the overhead crane building, representing an annualized cost of $84,523 based on a 7.86% recovery factor. Additional operating costs include administration, taxes, and insurance. These costs contribute $84,523 annually. Therefore, based on an annual cost of $127,565 and an associated PM_{10} reduction of 16.06 tpy, the cost of compliance for the implementation of a full enclosure is $7,945/ton. Therefore, it is economically infeasible for CalPortland to restructure the overhead crane building to allow for a full enclosure.

4.1.6. Timing of Compliance

The estimated time of compliance is 6 months which is based on time needed to design and reconstruct the overhead crane building.

4.1.7. Energy Impacts and Non-Air Quality Environmental Impacts

CalPortland expects that the associated energy and non-air quality impacts will be minimal.

4.1.8. Remaining Useful Life

CalPortland estimates that the source and controls will remain in service for a 20-year amortization period.

4.1.9. Conclusion

The estimated cost to rebuild the overhead crane building is economically infeasible.

4.2. UNPAVED ROAD VEHICLE TRAFFIC – PM_{10} CONTROLS

This section presents the stepwise review of control options for PM_{10} for unpaved vehicle traffic at the Facility.

4.2.1. Identification of Potential Control Technologies

CalPortland reviewed the feasibility of installing the following control technologies for reduction of PM_{10} from unpaved road traffic:

- Development of traffic management plans, speed limits, and speed bumps;
- Application of additional water;
- Application and maintenance of surface gravel;
- Paving the road surfaces; and
- Application of chemical dust suppressant.

In order to identify all feasible control technologies, the RBLC database, ADEQ's Draft List of Potential PM_{10} Controls for Nonpoint Source Sectors[7], WRAP guidance[8], as well as technical literature was reviewed. Using these sources, potentially applicable PM_{10} control technologies for unpaved road vehicle traffic at CalPortland were identified based on the principles of control technology and engineering experience for unpaved road vehicle traffic.

[7] ADEQ Draft List of PM_{10} for non-point source sectors, paved road dust and unpaved road dust
[8] Per WRAP Fugitive Dust Handbook, 2006, https://www.wrapair.org/forums/dejf/fdh/content/FDHandbook_Rev_06.pdf

Step 1 of the top-down control review is to identify available retrofit control options for unpaved road vehicle traffic for PM_{10}. Each control technology is described in detail below.[9]

4.2.1.1. Traffic Management Plans, speed limits and speed bumps

Traffic management plans include the implementation of speed limits and the construction of speed bumps or limiting the amount traffic on road to reduce PM_{10} emissions associated with vehicle travel on unpaved roads. Reducing the speed at which haul trucks travel from 50 km/h to 30 km/h would reduce air pollution.[10] An example of traffic management plan could be restricting road travel to only certain vehicle types. [11]

4.2.1.2. Additional Water Application

Applying additional water to unpaved roads would assist in the reduction of PM_{10} emissions associated with vehicle traffic. Water acts as a dust suppressant by forming cohesive moisture films among the discrete grains of surface material. Moisture content depends on the frequency of water application, the amount of vehicle travel along the routes, the amount of water applied to the surface, and evaporation rates. Vehicle traffic intensifies the drying process by increasing air movement over the surface which increases the evaporation rate and reduces the moisture content.[12] It is also important to note that water is more cost effective than chemical suppressants in the case of temporary roads which are common at quarries.[13]

4.2.1.3. Applying and Maintaining Surface Gravel

Applying and maintaining surface gravel could assist in the reduction of PM_{10} emissions associated with vehicle travel by reducing the silt content of the traffic routes. Covering the road surface with a material of lower silt content, such as gravel, would result in reduced PM_{10} emissions. The control efficiency associated with graveling unpaved roads depends on the silt content. This control is only effective if the silt content is already high enough to result in a reduction in roadway silt content, i.e. higher control efficiency.[14]

4.2.1.4. Paving the Road Surface

Paving the roads would assist in the reduction of PM_{10} emissions associated with vehicle travel. Pavement reduces PM_{10} emissions by changing the physical characteristics of the existing road surface material and forming a hardened surface that binds particles together. Paving is highly effective; however, the high initial cost can be prohibitive in addition to the infeasibility of paving for industrial road subject to heavy vehicles and/or spillage of material in transport. [15]

4.2.1.5. Applying Chemical Dust Suppressant

Applying chemical dust suppressant would assist in the reduction of PM_{10} emissions associated with vehicle travel. Chemical dust suppressants may last several months when applied to unpaved roads.[16] When compared to plain water under summertime conditions, the reapplication frequency of water ranges from minutes or hours

[9] AP-42 reduction percentages cited in this report were taken from AP-42, Chapter 1, External Combustion Sources, unless otherwise noted.
[10] K. Ahn, H. Rakha Transportation Research Part D, page 412
[11] EPA Control of Open Fugitive Dust Sources, page 3-6, https://www3.epa.gov/ttn/chief/old/ap42/ch13/s025/reference/ref_10c13s025_1995.pdf
[12] WRAP Fugitive Dust Handbook, 2006, page 1-3
[13] Ibid, page 6-9
[14] EPA Control of Open Fugitive Dust Sources, page 3-11
[15] WRAP Fugitive Dust Handbook, 2006 Pg 6-9
[16] Ibid, page 1-8

while the reapplication frequency of chemical dust suppressants ranges from several weeks to a few months.[17] Chemical dust suppressants reduce PM_{10} emissions by changing the physical characteristics of the existing road surface material and forming a hardened surface that binds particles together.[18] Chemical dust suppressants provide a PM_{10} control efficiency of about 80% when applied at regular intervals of 2 weeks to 1 month. If chemical dust suppressant is not applied regularly, the silt content of loose material on a controlled surface may be substantially higher than when the surface was uncontrolled and may lead to an increase in emissions.

4.2.2. Elimination of Technically Infeasible Control Options

Step 2 of the top-down control review is to eliminate technically infeasible PM_{10} control options that were identified in the first step.

The technical feasibility of each control option is reviewed below.

4.2.2.1. Traffic Management Feasibility

A traffic management plan is already in effect at the Facility. The Facility is already using the most efficient traffic patterns and roadways possible. Additional restrictions would impede facility operation and bottleneck facility processes. Additional speed restrictions would also require more vehicles than are currently in use, representing an increase in not only PM_{10} emissions, but also NOx and sulfur oxide (SOx) emissions. Therefore, the current control methodology is a technically feasible option, but no additional changes can be made.

4.2.2.2. Additional Water Application Feasibility

The current baseline emission rate for road watering has been demonstrated to be a 65% control efficiency. An 86% reduction in PM_{10} emissions can be achieved with additional watering, representing an overall 95% PM_{10} control efficiency. However, the amount of water that would be required to meet an overall 95% control efficiency is not available at the Facility, as the amount of water that can be obtained is limited by the local aquifer, the number of production wells, the wellhead pumps, and existing infrastructure for filling the existing water trucks. As such, additional water application is not a technically feasible control option.

4.2.2.3. Application and Maintenance of Surface Gravel Feasibility

As previously mentioned, application of gravel is only feasible if the silt content is high enough to result in a meaningful control efficiency. The current silt content at CalPortland (6.4%)[19] is equivalent to the silt content that would be achieved by applying gravel to the unpaved road. As such, the application of gravel is a technically feasible option with no associated PM_{10} reduction.

4.2.2.4. Paved Road Surface Feasibility

The quarry roads cannot be paved as the weight and size of the haul trucks would destroy the pavement. In order to accommodate the frequency and weight of the trucks that would need to travel on paved roads, an 18-inch concrete foundation would need to be poured for a rebar supported asphalt roadway. Additionally, haul roads will change as the quarry pit is developed. Therefore, this not a technically feasible control option.

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[17] Ibid, page 6-10
[18] Ibid, page 6-12
[19] 6.4% is a conservative value obtained from the "Field Tests of Unpaved Road Dust Control" report that was conducted for CalPortland, dated March 13, 2006, with project No. 310559.1.002. Most of the silt content percentages in the report are far below 6.4%.

4.2.2.5. Chemical Dust Suppressant Feasibility

The application of chemical dust suppressants would reduce PM_{10} emissions on the unpaved roads. Currently, a high efficiency lignin-based dust suppressant is being applied and alternated with water. Magnesium chloride is another chemical dust suppressant used for unpaved PM_{10} road emission reduction. However, magnesium chloride is corrosive and can damage equipment at the plant. In addition, it less effective at dust control than lignin-based dust suppressant. Therefore, chemical dust suppressant is already implemented and is a technically feasible option.

4.2.3. Rank of Remaining Control Technologies Based on Control Effectiveness

Step 3 of the top-down control review is to rank the technically feasible options according to effectiveness. Table 4-1 provides a ranking of the control levels for the controls listed in the previous section.

Table 4-1. Control Effectiveness of Technically Feasible Unpaved Road Travel PM_{10} Control Technologies

Control Technology	Estimated Control Level (%)
Develop traffic management plans, speed limits, speed bumps	Base Case
Apply chemical dust suppressant	Base Case
Application and maintenance of surface gravel	0%
Additional water application	86%[1]

[1] Additional control based on 95% overall PM_{10} control

4.2.4. Evaluation of Impacts for Remaining Control Technology

The fourth step of the top-down control review is the impact analysis. The impact analysis considers the:

- Cost of compliance;
- Time necessary to comply with the control;
- Energy impacts and non-air quality impacts; and
- The remaining useful life of the source.

Given that the development of traffic management plans, speed limits, speed bumps, the application of chemical dust suppressant, and application and maintenance of surface gravel all represent no associated reduction in PM_{10} emissions, these control technologies are considered cost infeasible. Below, the cost of compliance for additional water application was estimated using published methods and vendor quotes

4.2.5. Cost of Compliance

The total annual cost for additional water application to unpaved roads is $1,062,186, which is based on a capital cost of $3,160,000 for eight trucks, representing an annualized cost of $248,219 based on a 7.86% recovery factor. Additional operating costs include administration, taxes, and insurance, and the fixed operating cost of obtaining the additional water required to achieve an overall 95% PM_{10} control. These costs contribute $126,400 and $687,567 annually, respectively. Therefore, based on an annual cost of $1,062,186 and an associated PM_{10} reduction of 50.37 tpy, the cost of compliance for the implementation of additional water application is $21,086/ton. However, as mentioned previously, it would not be possible for CalPortland to obtain the amount of water that would be necessary to achieve this control efficiency.

4.2.6. Timing of Compliance

The estimated time of compliance is 3 years which is based on procurement of equipment and implementation of new operations.

4.2.7. Energy Impacts and Non-Air Quality Environmental Impacts

The reduction of PM_{10} emissions would see an increase in other criteria pollutants and greenhouse gases from the additional tailpipe emissions.

4.2.8. Remaining Useful Life

CalPortland estimates that the source and controls will remain in service for a 20-year amortization period.

4.2.9. Conclusion

It is cost infeasible and technically infeasible for CalPortland to implement additional water application on the unpaved road surfaces at the Facility. The infrastructure does not exist to pump and fill the number of water trucks that would be necessary to apply the amount of water needed, and the amount of water truck traffic required would severely impede facility operations. Additionally, the estimated cost is economically infeasible.

4.3. PAVED ROAD VEHICLE TRAFFIC – PM_{10} CONTROLS

This section presents the stepwise review of control options for PM_{10} for paved road vehicle travel at CalPortland.

4.3.1. Identification of Potential Control Technologies

CalPortland reviewed the feasibility of installing the following control technologies for reduction of PM_{10} from paved road traffic:

- Cover haul trucks;
- Pave, vegetate, or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads;
- Route traffic around and rapidly clean up non-preventable dust on paved roads;
- Require improved material specification for and reduction of usage of skid control sand or salt;
- Require curbing and pave or stabilize shoulders of paved roads;
- Provide for storm water drainage to prevent erosion of dirt or sand onto paved roads
- Stabilize medians of paved roads;
- Ensure stabilization of unpaved roads during weed abatement and vegetation management activities; and
- Employ PM_{10} certified street sweepers

In order to identify all feasible control technologies, the RACT/BACT/LAER Clearinghouse (RBLC) database, WRAP guidance[20], as well as technical literature was reviewed. Using these sources, potentially applicable PM_{10} control technologies for paved road vehicle traffic.

Step 1 of the top-down control review is to identify available retrofit control options. Each control technology is described in detail below:

4.3.1.1. Cover Haul Trucks

Covering haul trucks would assist in the reduction of PM_{10} emissions associated with haul truck travel. Haul truck coverage is a preventive control implemented to prevent material from being deposited onto surface.[21] It is one of the control methods recommended by ADEQ PM_{10} controls to prevent unpaved road spills. [22]

4.3.1.2. Pave, Vegetate, or chemically stabilize access points

Paving or vegetating the paved road reduces PM_{10} emissions. Alternatively, oil or chemical suppressants can be applied and maintained. This control method limits visible dust opacity emissions to 20%.[23] For the application of this PM_{10} control method, a threshold of an average daily vehicle trips of 500 or more must be met.

4.3.1.3. Route Traffic Around and Rapidly Clean up Non-Preventable Dust.

Routing traffic and rapidly cleaning up non-preventable dust is an efficient PM_{10} control technology. If the wind or water born deposition is cleaned up within 24 hours, a 100% control efficiency can be applied.[24] This assumes that before traffic resumes the entire spill is cleaned up.

4.3.1.4. Require Curbing and Pave or Stabilize Shoulders

An average shoulder width of either 4ft or 8ft can be required to reduce PM_{10} emissions. Alternatively, curbing adjacent to and contiguous with a paved lane or shoulder can be applied.[25] The third control option is construction of intersections, auxiliary entry and exit lanes adjacent and contiguous with a paved roadway. These controls will limit visible dust emissions to 20% dust opacity and maintain stabilize surface.

4.3.1.5. Provide for Storm Water Drainage to Prevent Erosion of Dirt or Sand Roads

Storm water control is recommended for erosion from stormwater washing onto streets. This control method would assist in PM_{10} reduction associated with paved road travel.

4.3.1.6. Employ PM_{10} Certified Street Sweepers.

Implementing street sweeping programs with PM_{10} efficient vacuum units (14-day frequency) can reduce paved road PM_{10} emissions by up to 26%.[26] PM_{10} vacuum sweeping is a mitigative control that removes surface deposition by entraining particles in a moving air stream.[27] The removed particles are collected in a hopper and

[20] Per "*Supplementary Information for Four Factor Analyses by WRAP States*", May 2009.
[21] WRAP Fugitive Dust Handbook Section 5, Table 5.5, https://www.wrapair.org/forums/dejf/fdh/content/Ch5-Paved_Roads_Rev06.pdf
[22] ADEQ Draft List of PM_{10} for non-point source sectors, paved road dust and unpaved road dust
[23] WRAP Fugitive Dust Handbook Section 5, Table 5.6, https://www.wrapair.org/forums/dejf/fdh/content/Ch5-Paved_Roads_Rev06.pdf
[24] Ibid, Table 5.5
[25] WRAP Fugitive Dust Handbook Section 5, Table 5.6, https://www.wrapair.org/forums/dejf/fdh/content/Ch5-Paved_Roads_Rev06.pdf
[26] Ibid
[27] EPA Control of Open Fugitive Dust Sources, page 2-22

a filter system in an open loop exhausts the air. Alternatively, a regenerative sweep can be employed where the air is continuously recycled. For efficient PM_{10} removal, the sweepers are equipped with gutter and other brooms. [28]

4.3.2. Elimination of Technically Infeasible Control Options

Step 2 of the top-down control review is to eliminate technically infeasible PM_{10} control options that were identified in the first step.

The technical feasibility of each control option is reviewed below.

4.3.2.1. Cover Haul Trucks Feasibility

Covers are not available to accommodate the size of the haul trucks at CalPortland. In addition, requiring operators to cover haul trucks would pose a safety hazard as they would have to exit the vehicles in order to roll the cover down. There aren't any known implementations of covering haul trucks.

4.3.2.2. Pave, Vegetate, Or Chemically Stabilize Access Points Feasibility

CalPortland has already implemented this control methodology; therefore, is a technically feasible option.

4.3.2.3. Route Traffic and Rapidly Clean Up Non-Preventable Dust Feasibility

CalPortland is required by PC MACT to clean-up any clinker spills within three days[29], but CalPortland conducts clean-up of spills daily, as necessary. Increased clean-up frequencies do not represent a feasible control technology as the implementation of new routes for rerouting traffic would prevent efficient vehicle traffic along the roadways. The paved roadways are in space confined areas as well, which would severely restrict operations if traffic would need to be stopped at an increased frequency in order to clean up dust spills.

4.3.2.4. Require Curbing and Pave or Stabilize Shoulders Feasibility

The weight and intensity of haul truck traffic would quickly destroy any stabilizing shoulders on paved roads. As a such, frequent replacement of the pavement or stabilization of the shoulders would be required since it would be quickly be degraded by the weight and movement of the trucks. Due to these considerations, this is not a technically feasible control option.

4.3.2.5. Provide for Storm Drainage to Prevent Erosion of Dirt or Sand Feasibility

This control technology is already being implemented at the Facility and is a technically feasible control technology.

4.3.2.6. Employ PM_{10} Certified Street Sweepers Feasibility

Application of PM_{10} certified street sweepers is a technically feasible option and can be implemented to reduce PM_{10} emissions. However, PM_{10} certified street sweepers can have internal cementation issues with the addition of water to the dry materials normally present at cement plants.

[28] Ibid
[29] Pursuant to Permit No. 61522, Condition IV.B.5

4.3.3. Rank of Remaining Control Technologies Based on Control Effectiveness

Step 3 of the top-down control review is to rank the technically feasible options according to effectiveness. Table 4-2 provides a ranking of the control levels for the controls listed in the previous section.

Table 4-2. Control Effectiveness of Technically Feasible Unpaved Road Travel PM_{10} Control Technologies

Control Technology	Estimated Control Level (%)
Provide for storm water drainage to prevent erosion of dirt or sand	Base Case
Pave, vegetate, or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads	Base Case
Employ PM_{10} certified street sweepers	26%[1]

[1] Per WRAP Fugitive Dust Handbook Section 5, Table 5.5

4.3.4. Evaluation of Impacts for Remaining Control Technologies

The fourth step of the top-down control review is the impact analysis. The impact analysis considers the:

- Cost of compliance;
- Time necessary to comply with the control;
- Energy impacts and non-air quality impacts; and
- The remaining useful life of the source.

Given that providing for storm water drainage to prevent erosion of dirt or sand, and paving, vegetating, or chemically stabilizing access points where unpaved traffic surfaces adjoin paved roads are all currently being implemented, these control technologies are considered cost infeasible.

4.3.5. Cost of Compliance

The capital cost associated with obtaining PM_{10} certified street sweepers is $250,000, which represents a $19,638 annualized cost at a 7.86% recovery cost factor. Additional operating costs include administration, taxes, and insurance, and the fixed operating cost of operating the street sweeper. These costs contribute $10,000 and $12,500 annually, respectively. Therefore, based on an annual cost of $42,138 and an associated PM_{10} reduction of 2.75 tpy, the cost of compliance for the implementation of certified PM_{10} street sweepers is $15,333/ton.

4.3.6. Timing of Compliance

The estimated time of compliance is 3 years which is based on procurement of equipment and implementation of new operations.

4.3.7. Energy Impacts and Non-Air Environmental Quality Impacts

The reduction of PM_{10} emissions would see an increase in other criteria pollutants and greenhouse gases from the additional tailpipe emissions.

4.3.8. Remaining Useful Life

CalPortland estimates that the source and controls will remain in service for a 20-year amortization period.

4.3.9. Conclusion

It is cost infeasible to implement a certified PM_{10} street sweeper at the Facility. While the annual costs are relatively low compared to other control technologies, the amount of PM_{10} that is controlled by the street sweeper is also low, and the reduction in a minimal amount of PM_{10} emissions is economically infeasible.

4.4. MATERIAL HANDLING – PM_{10} CONTROLS

4.4.1. Identification of Potential Control Technologies

CalPortland reviewed the feasibility of installing the following control technologies for reduction of PM_{10} from material handling sources:

- Water Sprays
- Baghouse
- Full or Partial Enclosure

In order to identify all feasible control technologies, the RACT/BACT/LAER Clearinghouse (RBLC) database, WRAP guidance[30], as well as technical literature was reviewed. Using these sources, potentially applicable PM_{10} control technologies for material drops were identified based on the principles of control technology and engineering experience for material handling.

Each control technology is described in detail below.

4.4.1.1. Water Sprays

Water Sprays are commonly used to increase the moisture content of the material. If continuously applied the moisture content will increase leading to a reduction of ambient PM_{10} concentrations.

4.4.1.2. Baghouse

Fabric filter baghouses work by filtering fugitive PM_{10} emissions through a filter bag. The collected particles are periodically removed from the bag through a pulse jet or reverse flow mechanism.

4.4.1.3. Full or Partial Enclosure

Full or partial enclosure is commonly applied as a control measure for material drops. This control method can be as efficient as 90% at reducing PM_{10} emissions. [31]

4.4.2. Elimination of Technically Infeasible Control Options

Step 2 of the top-down control review is to eliminate technically infeasible PM_{10} control options that were identified in the first step.

[30] Per "*Supplementary Information for Four Factor Analyses by WRAP States*", May 2009.
[31]

The technical feasibility of each of the control options identified in the previous section is reviewed below.

4.4.2.1. Water Sprays Feasibility

The location and operations of the material drops impedes the ability to apply additional controls. Water sprays are not a technically feasible control for this analysis. The materials without control cannot become damp because the material will clump and cause issues with operations. Additional moisture affects the quality of the product, it causes plugging in the pre-heater tower, and causes other process related difficulties that in the long run will add more NOx and SOx due to the moisture that would have to be driven off and additional process upsets that cause excess emissions with a breakdown.

Additionally, for a source like Clinker Conveyor Bypass (Truck) – Clinker Conveyor Bypass Bin to Truck Transfer, water cannot be applied to clinker.

Lastly, most quarry material transfers would require additional water trucks to water loading material into the haul truck at the rock face. These trucks would generate more dust, NOx, and CO emissions for each truck.

4.4.2.2. Full Enclosure Feasibility

The location of the material drops impedes the ability to apply additional controls. This is not technically feasible control for this analysis. For example, the Alumina at Plant (Loader) – Loader to D4 Hopper transfer point cannot be enclosed, as enclosing this process for a baghouse is not physically feasible as there would be no way to get the material into the hopper. Additionally, spraying this material causes clogs/clumps in the hopper, on the conveyors, and in the storage bin.

4.4.2.3. Baghouse Feasibility

The location and operations of the material drops impedes the ability to apply additional controls. This is not technically feasible control for this analysis.

4.4.3. Rank of Remaining Control Technologies Based on Control Effectiveness

There are no technologically feasible controls.

4.4.4. Evaluation of Impacts for Remaining Control Technologies

The cost of compliance for control technology was not estimated as no technically feasible controls were identified.

4.5. WIND EROSION – IRON STOCKPILE – PM_{10} CONTROLS

This section presents the stepwise review of control options for PM_{10} for wind erosion from the iron stockpile at the Facility.

4.5.1. Identification of Potential Control Technologies

CalPortland reviewed the feasibility of installing the following control technologies for reduction of PM_{10} from iron stockpile wind erosion:

- Applying water;

- Applying chemical dust suppressant;
- Erecting artificial windbreak;
- Planting trees or shrubs as windbreak;
- Compacting piles; and
- Covering piles with tarps.

In order to identify all feasible control technologies, the RBLC database, WRAP guidance[32], as well as technical literature was reviewed. Using these sources, potentially applicable PM_{10} control technologies for windblown dust from stockpiles were identified based on the principles of control technology and engineering experience.

Each control technology is described in detail below.[33]

4.5.1.1. Additional Water Application

Applying additional water to the stockpile would assist in the reduction of PM_{10} emissions associated with wind erosion. Applying water to the surface of the stockpile stabilizes the erodible surface by increasing the moisture content of the material being stored. [34] Watering the pile can reduce the PM_{10} emissions by 90%. [35]

4.5.1.2. Applying Chemical Dust Suppressant

Applying chemical dust suppressant would assist in the reduction of PM_{10} emissions associated with wind erosion. The chemical dust suppressant stabilizes the surface of the material, reducing the amount of wind-blown dust that is generated.

4.5.1.3. Erecting Artificial Windbreak

Erecting an artificial windbreak would assist in the reduction of PM_{10} emissions associated with windblown dust from the stockpile. A three-sided enclosure with 50% porosity shields the pile from the ambient wind and reduces PM_{10} emissions by 75%. [36,37]

4.5.1.4. Planting Trees or Shrubs as Windbreak

Planting trees or shrubs as windbreak would assist in the reduction of PM_{10} emissions associated with windblown dust from the stockpile much in the same way an artificial wind-break would.

4.5.1.5. Compacting Piles

Compacting the pile could assist in the reduction of PM_{10} emissions associated with windblown dust from the stockpile.

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[32] Per "*Supplementary Information for Four Factor Analyses by WRAP States*", May 2009.

[33] AP-42 reduction percentages cited in this report were taken from AP-42, Chapter 1, External Combustion Sources, unless otherwise noted.

[34] WRAP Fugitive Dust Handbook, 2006 Pg 9-8

[35] Fitz, D., K. Bumiller, 2000. Evaluation of Watering to Control Dust in High Winds, J.AWMA, April.

[36] WRAP Fugitive Dust Handbook, 2006 Pg 9-8

[37] Sierra Research, 2003. Final BACM Technological and Economic Feasibility Analysis, report prepared for the San Joaquin Valley Unified Air Pollution Control District, March 21.

4.5.1.6. Covering Piles with Tarps

Covering the stockpile would assist in the reduction of PM_{10} emissions associated with windblown dust. Utilizing tarps to cover piles provides shelter from the ambient wind and can provide a control efficiency of 90% for PM_{10} emissions. [35]

4.5.2. Elimination of Technically Infeasible Control Options

Step 2 of the top-down control review is to eliminate technically infeasible PM_{10} control options that were identified in the first step.

The technical feasibility of each of the control options identified in the previous section is reviewed below.

4.5.2.1. Water Application Feasibility

Sonoran hematite is a very fine material, and water application would cause clumping of the material. Clumping causes operational issues, such as clogging and plugging of process equipment. Therefore, water application is not a technically feasible control method.

4.5.2.2. Chemical Dust Suppressant Feasibility

All the issues that exist with water spraying also exist for chemical dust suppressants. Therefore, this not a technically feasible option.

4.5.2.3. Erection of Artificial Windbreak Feasibility

The iron stockpile was moved to a horseshoe pit with windbreak on three sides and this control is currently being implemented. Therefore, this is a technically feasible control option representing 75% control.

4.5.2.4. Planting Trees or Shrubs as Windbreak Feasibility

The artificial windbreak represents a 75% control at no cost, making it the most cost-effective control technology. Planting trees or shrubs as a windbreak would represent a 25% control efficiency[38] at a greater cost. Therefore, planting trees or shrubs is not evaluated further as a technically feasible control option as a windbreak since a more effective windbreak control technology has already been implemented.

4.5.2.5. Pile Compaction Feasibility

The iron stockpile is actively used with material being added to and removed from the area. This makes pile compaction operationally infeasible to implement thereby rendering it a technically infeasible control option.

4.5.2.6. Pile Coverage Feasibility

As noted above in section 4.5.2.5, the iron stockpile is actively used with material being added and removed frequently. Coverage of the pile with a tarp or other means will impede with operational activities at CalPortland; therefore, this is not a feasible control technology.

4.5.3. Rank of Remaining Control Technologies Based on Control Effectiveness

The currently implemented and operating PM_{10} controls are the most cost-effective option for PM_{10} emission reduction and control at this facility.

[38] 25% control efficiency according to WRAP Fugitive Dust Handbook.

4.5.4. Evaluation of Impacts for Remaining Control Technologies

The artificial windbreak is the only feasible control technology. The cost of compliance for control technology was not estimated as the use of an artificial windbreak has already been implemented and represents a reduction of 6.31 tpy of PM_{10} at no additional operating cost. In the upcoming Title V renewal application (due in September 2020) CalPortland will update the permit to include the artificial windbreak as an enforceable requirement for the iron stockpile.

4.6. FINISH MILL BAGHOUSES – PM_{10} CONTROLS

This section presents the stepwise review of control options for the reduction of PM_{10} emissions from the D2-PC and D3-1-DC2 finish mill baghouses.

4.6.1. Identification of Potential Control Technologies

CalPortland reviewed the feasibility of installing the following control technologies for reduction of PM_{10} from the finish mill baghouses:

- Baghouses with Lower Grain Loading Rates

In order to identify all feasible control technologies, the RACT/BACT/LAER Clearinghouse (RBLC) database, WRAP guidance[39], as well as technical literature was reviewed. Using these sources, potentially achievable PM_{10} grain loading rates were identified based on the principles of control technology and engineering experience for finish mills.

Step 1 of the top-down control review is to identify available retrofit control options. Each control technology is described in detail below:

4.6.1.1. Baghouse

Fabric filter baghouses work by filtering fugitive PM_{10} emissions through a filter bag. The collected particles are periodically removed from the bag through a pulse jet or reverse flow mechanism.

4.6.2. Elimination of Technically Infeasible Control Options

Step 2 of the top-down control review is to eliminate technically infeasible PM_{10} control options that were identified in the first step.

The technical feasibility of each of the control options identified in the previous section is reviewed below.

4.6.2.1. Lowering Grain Loading Rate Feasibility

CalPortland already utilizes the D2-PC and D3-1-DC2 baghouses for the finish mills. The tested grain loading rates are low, therefore CalPortland is assuming the baghouses currently operate under a vendor guaranteed grain loading rate of 0.01 gr/dscf. Based on review of other similar sources at other portland cement facilities, a grain loading rate of 0.005 gr/dscf is achievable. Therefore, this control technology is feasible.

[39] Per "*Supplementary Information for Four Factor Analyses by WRAP States*", May 2009.

4.6.3. Rank of Remaining Control Technologies Based on Control Effectiveness

There is only one feasible control technology that was reviewed for the finish mill baghouses.

4.6.4. Evaluation of Impacts for Remaining Control Technologies

The fourth step of the top-down control review is the impact analysis. The impact analysis considers the:

- Cost of compliance;
- Time necessary to comply with the control;
- Energy impacts and non-air quality impacts; and
- The remaining useful life of the source.

4.6.5. Cost of Compliance

The cost of implementing lower grain loading baghouses at each of the finish mills are reviewed separately.

4.6.5.1. *D2-PC Baghouse Cost*

The total annual cost of operating a new baghouse with a lower grain loading rate for D2-PC is estimated at $535,231 based on Section 6, Chapter 1 of EPA's Control Cost Manual[40]. The calculations associated with determining the annual cost are attached in Appendix A. These calculations do not include additional costs associated with the dismantling and removal of the existing baghouse, which would be difficult and costly due to its location.

Given an assumed existing grain loading rate of 0.01 gr/dscf reduced to an achievable grain loading rate of 0.005 gr/dscf, this baghouse would achieve an 18.26 tpy reduction of PM_{10} emissions. Therefore, the cost of compliance for the implementation of a lower grain loading rate is $29,310 per ton of PM_{10} reduced.

4.6.5.2. *D3-1-DC2 Baghouse Cost*

The total annual cost of operating a new baghouse with a lower grain loading rate for D3-1-DC2 is estimated at $487,584 based on Section 6, Chapter 1 of EPA's Control Cost Manual[41]. The calculations associated with determining the annual cost are attached in Appendix A. These calculations do not include additional costs associated with the dismantling and removal of the existing baghouse, which would be difficult and costly due to its location.

Given an assumed existing grain loading rate of 0.01 gr/dscf reduced to an achievable grain loading rate of 0.005 gr/dscf, this baghouse would achieve a 15.85 tpy reduction of PM_{10} emissions. Therefore, the cost of compliance for the implementation of a lower grain loading rate is $30,763 per ton of PM_{10} reduced.

4.6.6. Timing of Compliance

The estimated time of compliance is 3 years which is based on procurement of equipment and implementation of new operations.

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[40] https://www3.epa.gov/ttn/ecas/docs/cs6ch1.pdf
[41] https://www3.epa.gov/ttn/ecas/docs/cs6ch1.pdf

4.6.7. Energy Impacts and Non-Air Quality Impacts

No associated energy and non-air quality impacts are assessed because the control technology is simply an improved version of controls that already exist at the sources.

4.6.8. Remaining Useful Life

CalPortland estimates that the source and controls will remain in service for a 20-year amortization period.

4.6.9. Conclusion

It is cost infeasible to implement lower grain loading rate baghouses at the finish mills. The annual costs are high due to the requirement to install new baghouses and the reduction in PM_{10} emissions is low as the baghouses currently operate at low grain loading rates.

4.7. CLINKER COOLER – PM_{10} CONTROLS

This section presents the stepwise review of control options for the reduction of PM_{10} emissions from the H2-GB Kiln 4 Clinker Cooler baghouse.

4.7.1. Identification of Potential Control Technologies

CalPortland reviewed the feasibility of installing the following control technologies for reduction of PM_{10} from the Kiln 4 clinker cooler baghouse:

- Baghouses with Lower Grain Loading Rates

In order to identify all feasible control technologies, the RACT/BACT/LAER Clearinghouse (RBLC) database, WRAP guidance[42], as well as technical literature was reviewed. Using these sources, potentially achievable PM_{10} grain loading rates were identified based on the principles of control technology and engineering experience for clinker coolers.

Step 1 of the top-down control review is to identify available retrofit control options. Each control technology is described in detail below:

4.7.1.1. Baghouse

Fabric filter baghouses work by filtering fugitive PM_{10} emissions through a filter bag. The collected particles are periodically removed from the bag through a pulse jet or reverse flow mechanism.

4.7.2. Elimination of Technically Infeasible Control Options

Step 2 of the top-down control review is to eliminate technically infeasible PM_{10} control options that were identified in the first step.

The technical feasibility of each of the control options identified in the previous section is reviewed below.

[42] Per "*Supplementary Information for Four Factor Analyses by WRAP States*", May 2009.

4.7.2.1. Lowering Grain Loading Rate Feasibility

CalPortland already utilizes the H2-GB baghouse for the clinker cooler. The tested grain loading rates are low, therefore CalPortland is assuming the baghouse currently operates under a vendor guaranteed grain loading rate of 0.01 gr/dscf. Based on review of other similar sources at other portland cement facilities, a grain loading rate of 0.005 gr/dscf is achievable. Therefore, this control technology is feasible.

4.7.3. Rank of Remaining Control Technologies Based on Control Effectiveness

There is only one feasible control technology that was reviewed for the Kiln 4 clinker cooler baghouse.

4.7.4. Evaluation of Impacts for Remaining Control Technologies

The fourth step of the top-down control review is the impact analysis. The impact analysis considers the:

- Cost of compliance;
- Time necessary to comply with the control;
- Energy impacts and non-air quality impacts; and
- The remaining useful life of the source.

4.7.5. Cost of Compliance

The total annual cost of operating a new baghouse with a lower grain loading rate for H2-GB is estimated at $638,954 based on Section 6, Chapter 1 of EPA's Control Cost Manual[43]. The calculations associated with determining the annual cost are attached in Appendix A. These calculations do not include additional costs associated with the dismantling and removal of the existing baghouse, which would be difficult and costly due to its location.

Given an assumed existing grain loading rate of 0.01 gr/dscf reduced to an achievable grain loading rate of 0.005 gr/dscf, this baghouse would achieve a 21.19 tpy reduction of PM_{10} emissions. Therefore, the cost of compliance for the implementation of a lower grain loading rate is $30,149 per ton of PM_{10} reduced.

4.7.6. Timing of Compliance

The estimated time of compliance is 3 years which is based on procurement of equipment and implementation of new operations.

4.7.7. Energy Impacts and Non-Air Quality Impacts

No associated energy and non-air quality impacts are assessed because the control technology is simply an improved version of controls that already exist at the source.

4.7.8. Remaining Useful Life

CalPortland estimates that the source and controls will remain in service for a 20-year amortization period.

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[43] https://www3.epa.gov/ttn/ecas/docs/cs6ch1.pdf

4.7.9. Conclusion

It is cost infeasible to implement a lower grain loading rate baghouse at the Kiln 4 clinker cooler. The annual costs are high due to the requirement to install a new baghouse and the reduction in PM_{10} emissions is low as the baghouse currently operates at a low grain loading rate.

4.8. QUARRY CRUSHER – PM_{10} CONTROLS

This section presents the stepwise review of control options for the reduction of PM_{10} emissions from the B2-DC1 Quarry Crusher baghouse.

4.8.1. Identification of Potential Control Technologies

CalPortland reviewed the feasibility of installing the following control technologies for reduction of PM_{10} from the B2-DC1 baghouse:

- Baghouses with Lower Grain Loading Rates

In order to identify all feasible control technologies, the RACT/BACT/LAER Clearinghouse (RBLC) database, WRAP guidance[44], as well as technical literature was reviewed. Using these sources, potentially achievable PM_{10} grain loading rates were identified based on the principles of control technology and engineering experience for quarry crusher baghouses.

Step 1 of the top-down control review is to identify available retrofit control options. Each control technology is described in detail below:

4.8.1.1. Baghouse

Fabric filter baghouses work by filtering fugitive PM_{10} emissions through a filter bag. The collected particles are periodically removed from the bag through a pulse jet or reverse flow mechanism.

4.8.2. Elimination of Technically Infeasible Control Options

Step 2 of the top-down control review is to eliminate technically infeasible PM_{10} control options that were identified in the first step.

The technical feasibility of each of the control options identified in the previous section is reviewed below.

4.8.2.1. Lowering Grain Loading Rate Feasibility

CalPortland already utilizes the B2-DC1 baghouse for the quarry crusher. The tested grain loading rates are low, therefore CalPortland is assuming the baghouse currently operates under a vendor guaranteed grain loading rate of 0.05 gr/dscf. Based on review of other similar sources at other portland cement facilities, a grain loading rate of 0.005 gr/dscf is achievable. Therefore, this control technology is feasible.

4.8.3. Rank of Remaining Control Technologies Based on Control Effectiveness

There is only one feasible control technology that was reviewed for the quarry crusher baghouse.

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[44] Per "*Supplementary Information for Four Factor Analyses by WRAP States*", May 2009.

4.8.4. Evaluation of Impacts for Remaining Control Technologies

The fourth step of the top-down control review is the impact analysis. The impact analysis considers the:

- Cost of compliance;
- Time necessary to comply with the control;
- Energy impacts and non-air quality impacts; and
- The remaining useful life of the source.

4.8.5. Cost of Compliance

The total annual cost of operating a new baghouse with a lower grain loading rate for B2-DC1 is estimated at $171,346 based on Section 6, Chapter 1 of EPA's Control Cost Manual[45]. The calculations associated with determining the annual cost are attached in Appendix A. These calculations do not include additional costs associated with the dismantling and removal of the existing baghouse, which would be difficult and costly due to its location.

Given an assumed existing grain loading rate of 0.05 gr/dscf reduced to an achievable grain loading rate of 0.005 gr/dscf, this baghouse would achieve a 5.92 tpy reduction of PM_{10} emissions. Therefore, the cost of compliance for the implementation of a lower grain loading rate is $28,966 per ton of PM_{10} reduced.

4.8.6. Timing of Compliance

The estimated time of compliance is 3 years which is based on procurement of equipment and implementation of new operations.

4.8.7. Energy Impacts and Non-Air Quality Impacts

No associated energy and non-air quality impacts are assessed because the control technology is simply an improved version of controls that already exist at the source.

4.8.8. Remaining Useful Life

CalPortland estimates that the source and controls will remain in service for a 20-year amortization period.

4.8.9. Conclusion

It is cost infeasible to implement a lower grain loading rate baghouse at the quarry crusher. The annual costs are high due to the requirement to install a new baghouse and the reduction in PM_{10} emissions is low as the baghouse currently operates at a low grain loading rate.

4.9. BLASTING – NO_X CONTROLS

CalPortland hires contractors to do the mixing and preparation of the blasting medium. The blasting medium is pre-mixed, and the formula cannot be altered by CalPortland. Additionally, there are safety concerns with regards

[45] https://www3.epa.gov/ttn/ecas/docs/cs6ch1.pdf

to implementing controls during the blasting operations. Also, no blasting control methods were available through the RBLC; therefore, there are no technically feasible NOx control options for quarry blasting.

5. SUMMARY & CONCLUSION

CalPortland has reviewed the four factors for each of the PM_{10} and NOx sources identified by ADEQ and found that all available control technologies are either technically or economically infeasible, except for implementation of a three-sided enclosure for the Sonoran hematite stockpile. The table below summarizes the findings for each source.

Unit Process Description	Pollutant	Proposed Control	Post Control Emission Rate (tpy)	Proposed Emission Rate Averaging Period
Clinker to overhead crane building	PM_{10}	None economically feasible	N/A	N/A
Unpaved Roads	PM_{10}	None economically feasible	N/A	N/A
Paved Roads	PM_{10}	None economically feasible	N/A	N/A
Material Drops	PM_{10}	None technically feasible	N/A	N/A
Wind Erosion	PM_{10}	Artificial Wind-Break	6.31	Annual
D2-PC Baghouse	PM_{10}	None economically feasible	N/A	N/A
D3-1-DC2 Baghouse	PM_{10}	None economically feasible	N/A	N/A
H2-GB Baghouse	PM_{10}	None economically feasible	N/A	N/A
B2-DC1 Baghouse	PM_{10}	None economically feasible	N/A	N/A
Blasting	NOx	None technically feasible	N/A	N/A

Additionally, Appendix B contains information specific to each source and control technology, outlining the associated factors for each.

APPENDIX A: BAGHOUSE COST CALCULATIONS

Table 1. Capital Costs for Fabric Filter System at D2 Finish Mill D2-PC Baghouse

Cost Item	Factor	Cost
<u>Direct Costs</u>		
Purchased equipment cost		
Fabric Filter (with insulation) EC	A	$266,352.00
Bags and cages	A	$ 44,195.89
Auxiliary equipment	A	$ 50,000.00
	Sum=A	**$ 360,547.89**
Instrumentation	0.10 A	$ 36,054.79
Sales taxes	0.03 A	$ 10,816.44
Freight	0.05 A	$ 18,027.39
Purchased Equipment Cost, PEC	B=1.18 A	**$ 425,446.50**
Direct Installation Costs		
Foundations & supports	0.04 B	$ 17,017.86
Handling & erection	0.50 B	$ 212,723.25
Electrical	0.08 B	$ 34,035.72
Piping	0.01 B	$ 4,254.47
Insulation for ductwork	0.07 B	$ 29,781.26
Painting	0.04 B	$ 17,017.86
Direct installation cost	0.74 B	**$ 314,830.41**
Site preparation	As required, SP	-
Buildings	As required, Bldg.	-
Total Direct Cost	1.74 B + SP + Bldg.	**$ 740,276.92**
<u>Indirect Costs (installation)</u>		
Engineering	0.10 B	$ 42,544.65
Construction and field expense	0.20 B	$ 85,089.30
Contractor fees	0.10 B	$ 42,544.65
Start-up	0.01 B	$ 4,254.47
Performance test	0.01 B	$ 4,254.47
Contingencies	0.03 B	$ 12,763.40
Total Indirect Cost, IC	0.45 B	**$ 191,450.93**
Total Capital Investment=DC + IC	2.19 B + SP + Bldg.	**$ 931,728**

Table 2. Annual Costs for Fabric Filter System

Cost Item	Calculations	Cost	Units	References
Direct Annual Costs, DC				
Operating labor				
Operator	$\frac{2\ h}{shift} \times \frac{3\ shifts}{day} \times \frac{254\ days}{yr} \times \frac{\$17.26}{h}$	$ 26,265.41	$ dollars	EPA cost manual, Table 1.11, page 1-55
Supervisor	15% of operator	$ 3,939.81	$ dollars	EPA cost manual, Table 1.11, page 1-55
Operating materials		-		
Maintenance				
Labor	$\frac{1\ h}{shift} \times \frac{3\ shifts}{day} \times \frac{254\ days}{yr} \times \frac{\$17.74}{h}$	$ 13,497.92	$ dollars	
Material	100% of maintenance labor	$ 13,497.92	$ dollars	
C_B	bag and cages X 1.08 [1]	$ 47,731.56	$ dollars	Initial bag cost including taxes and freight ($)
Maintenance labor rate		$ 29.65	$ dollars	Including overhead, EPA cost manual, page 1-52
10 min per bag	(rounded up)	298	hours	
C_L		$ 8,835.70	$ dollars	EPA cost manual, page 1-52
CRF_B	Capital recovery factor for a 4.75% interest rate and a 2 year bag life	53.59%	factor	EPA cost manual Equation 1.13, page 1-46
Replacement parts, bags	$CRC_B = (C_B + C_L) \times CRF_B$	$ 4,750.95	$/year	EPA cost manual, Equation 1.13, page 1-46
Utilities				
Electricity	$0.000181 \times 140{,}000\ acfm \times 10\ in\ H_2O \times \frac{6{,}087\ h}{yr} \times \frac{\$\ 0.0671}{kWh}$	$ 103,498.11	$ dollars	EPA cost manual, Equation 1.14, page 1-47
Compressed air (dried and filtered) [2]	$\frac{2\ scfm}{1{,}000\ acfm} \times 140{,}000\ acfm \times \frac{\$0.25}{1{,}000\ scf} \times \frac{60\ min}{h} \times \frac{6{,}087\ h}{yr}$	$ 25,565.40	$ dollars	EPA cost manual, Table 1.11, page 1-55
Waste Disposal	as $25/ton on-site for essentially 100% collection	$ 456.53	$ dollars	EPA cost manual, Table 1.11, page 1-56
	$\frac{0.005\ gr}{ft^3} \times \frac{1\ lb}{7{,}000\ gr} \times 140{,}000\ ft^3 \times \frac{60\ min}{h} \times \frac{6{,}087\ h}{yr} \times \frac{1\ ton}{2{,}000\ lb} \times \frac{\$25}{ton}$			
Total DC	(rounded)	**$ 191,472**	$ dollars	
Indirect Annual Costs, IC				
Overhead	60% of sum of operating, supv., & maint. labor & maint. Materials	$ 34,320.64	$ dollars	EPA cost manual, Table 1.11, page 1-56
Administrative Charges	2% of Total Capital Investment	$ 18,634.56	$ dollars	EPA cost manual, Table 1.11, page 1-57
Property Tax	1% of Total Capital Investment	$ 9,317.28	$ dollars	EPA cost manual, Table 1.11, page 1-58
Insurance	1% of Total Capital Investment	$ 9,317.28	$ dollars	EPA cost manual, Table 1.11, page 1-59
Capital Recovery	$CRF*(TCI-C_B-C_L)$	$ 82,606.41	$ dollars	EPA cost manual, Table 1.11, page 1-60
Total IC (rounded)		**$ 154,196.16**		EPA cost manual, Equation 1.16
Total Annual Cost (1998)		**$ 345,668**		Calculated
Total Annual Cost (2018)		**$ 535,231**		Calculated

[1] The 1.08 factor is for freight and sales taxes

[2] Typical consumption is about 2 scfm/1,000 cfm of gas filtered, page 1-48

[3] The capital recovery cost factor, CRF, is a function of the fabric filter or equipment life and the opportunity cost of the capital (i.e., interest rate). For example, for a 20-year equipment life and a 4.75% interest rate, CRF = 0.07855

Chemical Engineering Plant Cost Index

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1985	325.3
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1998	389.5
1999	391.8
2000	394.1
2001	394.3
2002	395.6
2003	402.0
2004	444.2
2005	468.2
2006	499.6
2007	525.4
2008	575.4
2009	521.9
2010	550.8
2011	593.2
2012	584.6
2013	567.3
2014	576.1
2015	556.8
2016	541.7
2017	567.5
2018	603.1
2019	-

Table 3. Parameters and Calculated Costs

Parameters			
Baghouse parameters		**units**	**Reference/Notes**
Type	Pulse-jet (common housing)	-	Most popular because it occupies less space + less expensive
Figure No	1.8	-	EPA cost manual, Table 1.7
Gas-to-cloth ratio	5	cfm/ft^2	Engineering judgment based on modern baghouses with low grain loading rates
Flue gas flowrate	140,000	scfm	6/1/2004 Baghouse Source Testing
Operating hours	6,087	hours/year	6/1/2004 Baghouse Source Testing
Operating hours	254	days/year	For 24 hours/day
System pressure drop	10	inches	EPA cost manual , Section 1.3.2
Bag diameter	6	in	EPA cost manual, Table 1.8
Individual bag cost	0.81	$\$/ft^2$	EPA cost manual, Table 1.8 for 6-inch polypropylene bag, top removal
Cage length	10	ft	EPA cost manual , Table 1.8 6-inch x 10 ft cages
Calculated values			
Gross Cloth Area (GCA)	28,000.00	ft^2	Calculated
Cost of baghouse w/o bag	$202,871.00	$ dollars	EPA cost manual, Figure 1.8, $Cost = 2{,}307 + 7.136 \times (GCA)$
Bag cost	$22,680.00	$ dollars	Calculated
Insulation	$63,481.00	$ dollars	EPA cost manual, Insulation is required, page 1-51, $Cost = 1041 + 2.23 \times (GCA)$
Fabric area per cage	15.71	ft^2	EPA cost manual, page 1-51
Number of Cages	1783	cages	EPA cost manual, page 1-52, rounded up to the next integer
Individual cage cost	12.07	per cage	EPA cost manual, Table 1.8 in 500 cage lots
Total cage cost	$21,515.89	$ dollars	EPA cost manual, page 1-51
Auxiliary equipment	$50,000.00	$ dollars	Conservative estimate based on EPA's example auxiliary costs, EPA cost manual, page 1-52

Table 1. Capital Costs for Fabric Filter System at D3 Finish Mill D3-1-DC2 Baghouse

Cost Item	Factor	Cost
Direct Costs		
Purchased equipment cost		
Fabric Filter (with insulation) EC	A	$217,418.23
Bags and cages	A	$ 35,972.92
Auxiliary equipment	A	$ 50,000.00
	Sum=A	**$ 303,391.15**
Instrumentation	0.10 A	$ 30,339.12
Sales taxes	0.03 A	$ 9,101.73
Freight	0.05 A	$ 15,169.56
Purchased Equipment Cost, PEC	B=1.18 A	**$ 358,001.56**
Direct Installation Costs		
Foundations & supports	0.04 B	$ 14,320.06
Handling & erection	0.50 B	$ 179,000.78
Electrical	0.08 B	$ 28,640.12
Piping	0.01 B	$ 3,580.02
Insulation for ductwork	0.07 B	$ 25,060.11
Painting	0.04 B	$ 14,320.06
Direct installation cost	0.74 B	**$ 264,921.15**
Site preparation	As required, SP	-
Buildings	As required, Bldg	-
Total Direct Cost	1.74 B + SP + Bldg	**$ 622,922.71**
Indirect Costs (installation)		
Engineering	0.10 B	$ 35,800.16
Construction and field expense	0.20 B	$ 71,600.31
Contractor fees	0.10 B	$ 35,800.16
Start-up	0.01 B	$ 3,580.02
Performance test	0.01 B	$ 3,580.02
Contingencies	0.03 B	$ 10,740.05
Total Indirect Cost, IC	0.45 B	**$ 161,100.70**
Total Capital Investment=DC + IC	2.19 B + SP + Bldg.	**$ 784,023**

Table 2. Annual Costs for Fabric Filter System

Cost Item	Calculations	Cost	Units	References
Direct Annual Costs, DC				
Operating labor				
Operator	$\frac{2\ h}{shift} \times \frac{3\ shifts}{day} \times \frac{270\ days}{yr} \times \frac{\$17.26}{h}$	$ 28,008.67	$ dollars	EPA cost manual, Table 1.11, page 1-55
Supervisor	15% of operator	$ 4,201.30	$ dollars	EPA cost manual, Table 1.11, page 1-55
Operating materials		-		
Maintenance				
Labor	$\frac{1\ h}{shift} \times \frac{3\ shifts}{day} \times \frac{270\ days}{yr} \times \frac{\$17.74}{h}$	$ 14,393.79	$ dollars	
Material	100% of maintenance labor	$ 14,393.79	$ dollars	
C_B	bag and cages X 1.08[1]	$ 38,850.76	$ dollars	Initial bag cost including taxes and freight ($)
Maintenance labor rate		$ 29.65	$ dollars	Including overhead, EPA cost manual, page 1-52
10 min per bag	(rounded up)	242	hours	
C_L		$ 7,175.30	$ dollars	EPA cost manual, page 1-52
CRF_B	Capital recovery factor for a 4.75% interest rate and a 2 year bag life	53.59%	factor	EPA cost manual Equation 1.13, page 1-46
Replacement parts, bags	$CRC_B = (C_B + C_L) \times CRF_B$	$ 3,861.14	$/year	EPA cost manual, Equation 1.13, page 1-46
Utilities				
Electricity	$0.000181 \times 113{,}952\ acfm \times 10\ in\ H_2O \times \frac{6{,}491\ h}{yr} \times \frac{\$\ 0.0671}{kWh}$	$ 89,832.74	$ dollars	EPA cost manual, Equation 1.14, page 1-47
Compressed air (dried and filtered)[2]	$\frac{2\ scfm}{1{,}000\ acfm} \times 113{,}952\ acfm \times \frac{\$0.25}{1{,}000\ scf} \times \frac{60\ min}{h} \times \frac{6{,}491\ h}{yr}$	$ 22,189.87	$ dollars	EPA cost manual, Table 1.11, page 1-55
Waste Disposal	as $25/ton on-site for essentially 100% collection	$ 396.25	$ dollars	EPA cost manual, Table 1.11, page 1-56
	$\frac{0.005\ gr}{ft^3} \times \frac{1\ lb}{7{,}000\ gr} \times 113{,}952\ ft^3 \times \frac{60\ min}{h} \times \frac{6.941\ h}{yr} \times \frac{1\ ton}{2{,}000\ lb} \times \frac{\$25}{ton}$			
Total DC	(rounded)	**$ 177,278**	$ dollars	
Indirect Annual Costs, IC				
Overhead	60% of sum of operating, supv., & maint. labor & maint. Materials	$ 36,598.53	$ dollars	EPA cost manual, Table 1.11, page 1-56
Administrative Charges	2% of Total Capital Investment	$ 15,680.47	$ dollars	EPA cost manual, Table 1.11, page 1-57
Property Tax	1% of Total Capital Investment	$ 7,840.23	$ dollars	EPA cost manual, Table 1.11, page 1-58
Insurance	1% of Total Capital Investment	$ 7,840.23	$ dollars	EPA cost manual, Table 1.11, page 1-59
Capital Recovery	$CRF*(TCI-C_B-C_L)$	$ 69,659.57	$ dollars	EPA cost manual, Table 1.11, page 1-60
Total IC (rounded)		**$ 137,619.04**		EPA cost manual, Equation 1.16
Total Annual Cost (1998)		**$ 314,897**		Calculated
Total Annual Cost (2018)		**$ 487,584**		Calculated

[1] The 1.08 factor is for freight and sales taxes

[2] Typical consumption is about 2 scfm/1,000 cfm of gas filtered, page 1-48

[3] The capital recovery cost factor, CRF, is a function of the fabric filter or equipment life and the opportunity cost of the capital (i.e., interest rate). For example, for a 20-year equipment life and a 4.75% interest rate, CRF = 0.07855

Chemical Engineering Plant Cost Index

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2001	394.3
2002	395.6
2003	402.0
2004	444.2
2005	468.2
2006	499.6
2007	525.4
2008	575.4
2009	521.9
2010	550.8
2011	593.2
2012	584.6
2013	567.3
2014	576.1
2015	556.8
2016	541.7
2017	567.5
2018	603.1
2019	-

Table 3. Parameters and Calculated Costs

Parameters			
Baghouse parameters		**units**	**Reference/Notes**
Type	Pulse-jet (common housing)	-	Most popular because it occupies less space + less expensive
Figure No	1.8	-	EPA cost manual, Table 1.7
Gas-to-cloth ratio	5	cfm/ft^2	Engineering judgment based on modern baghouses with low grain loading rates
Flue gas flowrate	113,952	scfm	6/1/2004 Baghouse Source Testing
Operating hours	6,491	hours/year	6/1/2004 Baghouse Source Testing
Operating hours	270	days/year	For 24 hours/day
System pressure drop	10	inches	EPA cost manual , Section 1.3.2
Bag diameter	6	in	EPA cost manual, Table 1.8
Individual bag cost	0.81	$\$/ft^2$	EPA cost manual, Table 1.8 for 6-inch polypropylene bag, top removal
Cage length	10	ft	EPA cost manual , Table 1.8 6 in x 10 ft cages
Calculated values			
Gross Cloth Area (GCA)	22,790.40	ft^2	Calculated
Cost of baghouse w/o bag	$165,554.64	$ dollars	EPA cost manual, Figure 1.8, $Cost = 2{,}307 + 7.136 \times (GCA)$
Bag cost	$18,460.22	$ dollars	Calculated
Insulation	$51,863.59	$ dollars	EPA cost manual, Insulation is required, page 1-51, $Cost = 1041 + 2.23 \times (GCA)$
Fabric area per cage	15.71	ft^2	EPA cost manual, page 1-51
Number of Cages	1451	cages	EPA cost manual, page 1-52, rounded up to the next integer
Individual cage cost	12.07	per cage	EPA cost manual, Table 1.8 in 500 cage lots
Total cage cost	$17,512.70	$ dollars	EPA cost manual, page 1-51
Auxiliary equipment	$50,000.00	$ dollars	Conservative estimate based on EPA's example auxiliary costs, EPA cost manual, page 1-52

Table 1. Capital Costs for Fabric Filter System at Kiln 4 Clinker Cooler (H2-GB Baghouse)

Cost Item	Factor	Cost
Direct Costs		
Purchased equipment cost		
Fabric Filter (with insulation) EC	A	$273,396.75
Bags and cages	A	$ 68,092.20
Auxiliary equipment	A	$ 50,000.00
	Sum=A	**$ 391,488.95**
Instrumentation	0.10 A	$ 39,148.90
Sales taxes	0.03 A	$ 11,744.67
Freight	0.05 A	$ 19,574.45
Purchased Equipment Cost, PEC	B=1.18 A	**$ 461,956.96**
Direct Installation Costs		
Foundations & supports	0.04 B	$ 18,478.28
Handling & erection	0.50 B	$ 230,978.48
Electrical	0.08 B	$ 36,956.56
Piping	0.01 B	$ 4,619.57
Insulation for ductwork	0.07 B	$ 32,336.99
Painting	0.04 B	$ 18,478.28
Direct installation cost	0.74 B	**$ 341,848.15**
Site preparation	As required, SP	-
Buildings	As required, Bldg	-
Total Direct Cost	1.74 B + SP + Bldg	**$ 803,805.12**
Indirect Costs (installation)		
Engineering	0.10 B	$ 46,195.70
Construction and field expense	0.20 B	$ 92,391.39
Contractor fees	0.10 B	$ 46,195.70
Start-up	0.01 B	$ 4,619.57
Performance test	0.01 B	$ 4,619.57
Contingencies	0.03 B	$ 13,858.71
Total Indirect Cost, IC	0.45 B	**$ 207,880.63**
Total Capital Investment=DC + IC	2.19 B + SP + Bldg.	**$ 1,011,686**

Table 2. Annual Costs for Fabric Filter System

Cost Item	Calculations	Cost	Units	References
Direct Annual Costs, DC				
Operating labor				
Operator	$\frac{2\ h}{shift} \times \frac{3\ shifts}{day} \times \frac{358\ days}{yr} \times \frac{\$17.26}{h}$	$ 37,109.00	$ dollars	EPA cost manual, Table 1.11, page 1-55
Supervisor	15% of operator	$ 5,566.35	$ dollars	EPA cost manual, Table 1.11, page 1-55
Operating materials		-		
Maintenance				
Labor	$\frac{1\ h}{shift} \times \frac{3\ shifts}{day} \times \frac{358\ days}{yr} \times \frac{\$17.74}{h}$	$ 19,070.50	$ dollars	
Material	100% of maintenance labor	$ 19,070.50	$ dollars	
C_B	bag and cages X 1.08[1]	$ 73,539.58	$ dollars	Initial bag cost including taxes and freight ($)
Maintenance labor rate		$ 29.65	$ dollars	Including overhead, EPA cost manual, page 1-52
10 min per bag	(rounded up)	306	hours	
C_L		$ 9,072.90	$ dollars	EPA cost manual, page 1-52
CRF_B	Capital recovery factor for a 4.75% interest rate and a 2 year bag life	53.59%	factor	EPA cost manual Equation 1.13, page 1-46
Replacement parts, bags	$CRC_B = (C_B + C_L) \times CRF_B$	$ 4,878.06	$/year	EPA cost manual, Equation 1.13, page 1-46
Utilities				
Electricity	$0.000181 \times 115{,}000\ acfm \times 10\ in\ H_2O \times \frac{8{,}600\ h}{yr} \times \frac{\$\ 0.0671}{kWh}$	$ 120,115.04	$ dollars	EPA cost manual, Equation 1.14, page 1-47
Compressed air (dried and filtered)[2]	$\frac{2\ scfm}{1{,}000\ acfm} \times 115{,}000\ acfm \times \frac{\$0.25}{1{,}000\ scf} \times \frac{60\ min}{h} \times \frac{8{,}600\ h}{yr}$	$ 29,670.00	$ dollars	EPA cost manual, Table 1.11, page 1-55
Waste Disposal	as $25/ton on-site for essentially 100% collection	$ 529.82	$ dollars	EPA cost manual, Table 1.11, page 1-56
	$\frac{0.005\ gr}{ft^3} \times \frac{1\ lb}{7{,}000\ gr} \times 115{,}000\ ft^3 \times \frac{60\ min}{h} \times \frac{8{,}600\ h}{yr} \times \frac{1\ ton}{2{,}000\ lb} \times \frac{\$25}{ton}$			
Total DC	(rounded)	**$ 236,009**	$ dollars	
Indirect Annual Costs, IC				
Overhead	60% of sum of operating, supv., & maint. labor & maint. Materials	$ 48,489.81	$ dollars	EPA cost manual, Table 1.11, page 1-56
Administrative Charges	2% of Total Capital Investment	$ 20,233.72	$ dollars	EPA cost manual, Table 1.11, page 1-57
Property Tax	1% of Total Capital Investment	$ 10,116.86	$ dollars	EPA cost manual, Table 1.11, page 1-58
Insurance	1% of Total Capital Investment	$ 10,116.86	$ dollars	EPA cost manual, Table 1.11, page 1-59
Capital Recovery	CRF*(TCI-C_B-C_L)	$ 87,695.23	$ dollars	EPA cost manual, Table 1.11, page 1-60
Total IC (rounded)		**$ 176,652.47**		EPA cost manual, Equation 1.16
Total Annual Cost (1998)		**$ 412,662**		Calculated
Total Annual Cost (2018)		**$ 638,964**		Calculated

[1] The 1.08 factor is for freight and sales taxes

[2] Typical consumption is about 2 scfm/1,000 cfm of gas filtered, page 1-48

[3] The capital recovery cost factor, CRF, is a function of the fabric filter or equipment life and the opportunity cost of the capital (i.e., interest rate). For example, for a 20-year equipment life and a 4.75% interest rate, CRF = 0.07855

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2013	567.3
2014	576.1
2015	556.8
2016	541.7
2017	567.5
2018	603.1
2019	-

Table 3. Parameters and Calculated Costs

Parameters			
Baghouse parameters		**units**	**Reference/Notes**
Type	Pulse-jet (common housing)	-	Most popular because it occupies less space + less expensive
Figure No	1.8	-	EPA cost manual, Table 1.7
Gas-to-cloth ratio	4	cfm/ft^2	Engineering judgment based on modern baghouses with low grain loading rates
Flue gas flowrate	115,000	scfm	6/1/2004 Baghouse Source Testing
Operating hours	8,600	hours/year	6/1/2004 Baghouse Source Testing
Operating hours	358	days/year	For 24 hours/day
System pressure drop	10	inches	EPA cost manual , Section 1.3.2
Bag diameter	6	in	EPA cost manual, Table 1.8
Individual bag cost	1.6	$\$/ft^2$	EPA cost manual, Table 1.8 for 6-inch fiberglass bag, top removal
Cage length	10	ft	EPA cost manual , Table 1.8 6 in x 10 ft cages
Calculated values			
Gross Cloth Area (GCA)	28,750.00	ft^2	Calculated
Cost of baghouse w/o bag	$208,243.25	$ dollars	EPA cost manual, Figure 1.8, $Cost = 2{,}307 + 7.136 \times (GCA)$
Bag cost	$46,000.00	$ dollars	Calculated
Insulation	$65,153.50	$ dollars	EPA cost manual, Insulation is required, page 1-51, $Cost = 1041 + 2.23 \times (GCA)$
Fabric area per cage	15.71	ft^2	EPA cost manual, page 1-51
Number of Cages	1830	cages	EPA cost manual, page 1-52, rounded up to the next integer
Individual cage cost	12.07	per cage	EPA cost manual, Table 1.8 in 500 cage lots
Total cage cost	$22,092.20	$ dollars	EPA cost manual, page 1-51
Auxiliary equipment	$50,000.00	$ dollars	Conservative estimate based on EPA's example auxiliary costs, EPA cost manual, page 1-52

Table 1. Capital Costs for Fabric Filter System at Quarry Primary Crusher B2-DC1 Baghouse

Cost Item	**Factor**	**Cost**
Direct Costs		
Purchased equipment cost		
Fabric Filter (with insulation) EC	A	$38,894.87
Bags and cages	A	$ 5,973.39
Auxiliary equipment	A	$ 50,000.00
	Sum=A	**$ 94,868.26**
Instrumentation	0.10 A	$ 9,486.83
Sales taxes	0.03 A	$ 2,846.05
Freight	0.05 A	$ 4,743.41
Purchased Equipment Cost, PEC	B=1.18 A	**$ 111,944.55**
Direct Installation Costs		
Foundations & supports	0.04 B	$ 4,477.78
Handling & erection	0.50 B	$ 55,972.27
Electrical	0.08 B	$ 8,955.56
Piping	0.01 B	$ 1,119.45
Insulation for ductwork	0.07 B	$ 7,836.12
Painting	0.04 B	$ 4,477.78
Direct installation cost	0.74 B	**$ 82,838.96**
Site preparation	As required, SP	-
Buildings	As required, Bldg	-
Total Direct Cost	1.74 B + SP + Bldg	**$ 194,783.51**
Indirect Costs (installation)		
Engineering	0.10 B	$ 11,194.45
Construction and field expense	0.20 B	$ 22,388.91
Contractor fees	0.10 B	$ 11,194.45
Start-up	0.01 B	$ 1,119.45
Performance test	0.01 B	$ 1,119.45
Contingencies	0.03 B	$ 3,358.34
Total Indirect Cost, IC	0.45 B	**$ 50,375.05**
Total Capital Investment=DC + IC	2.19 B + SP + Bldg.	**$ 245,159**

Table 2. Annual Costs for Fabric Filter System

Cost Item	Calculations	Cost	Units	References
Direct Annual Costs, DC				
Operating labor				
Operator	$\frac{2\,h}{shift} \times \frac{3\,shifts}{day} \times \frac{203\,days}{yr} \times \frac{\$17.26}{h}$	$ 20,983.85	$ dollars	EPA cost manual, Table 1.11, page 1-55
Supervisor	15% of operator	$ 3,147.58	$ dollars	EPA cost manual, Table 1.11, page 1-55
Operating materials		-		
Maintenance				
Labor	$\frac{1\,h}{shift} \times \frac{3\,shifts}{day} \times \frac{203\,days}{yr} \times \frac{\$17.74}{h}$	$ 10,783.70	$ dollars	
Material	100% of maintenance labor	$ 10,783.70	$ dollars	
C_B	bag and cages X 1.08[1]	$ 6,451.26	$ dollars	Initial bag cost including taxes and freight ($)
Maintenance labor rate		$ 29.65	$ dollars	Including overhead, EPA cost manual, page 1-52
10 min per bag	(rounded up)	41	hours	
C_L		$ 1,215.65	$ dollars	EPA cost manual, page 1-52
CRF_B	Capital recovery factor for a 4.75% interest rate and a 2 year bag life	53.59%	factor	EPA cost manual Equation 1.13, page 1-46
Replacement parts, bags	$CRC_B = (C_B + C_L) \times CRF_B$	$ 667.36	$/year	EPA cost manual, Equation 1.13, page 1-46
Utilities				
Electricity	$0.000181 \times 18{,}922\,acfm \times 10\,in\,H_2O \times \frac{1{,}621\,h}{yr} \times \frac{\$\,0.0671}{kWh}$	$ 3,725.21	$ dollars	EPA cost manual, Equation 1.14, page 1-47
Compressed air (dried and filtered)[2]	$\frac{2\,scfm}{1{,}000\,acfm} \times 18{,}922\,acfm \times \frac{\$0.25}{1{,}000\,scf} \times \frac{60\,min}{h} \times \frac{1{,}621\,h}{yr}$	$ 920.18	$ dollars	EPA cost manual, Table 1.11, page 1-55
Waste Disposal	as $25/ton on-site for essentially 100% collection	$ 6.57	$ dollars	EPA cost manual, Table 1.11, page 1-56
	$\frac{0.002\,gr}{ft^3} \times \frac{1\,lb}{7{,}000\,gr} \times 18{,}922\,ft^3 \times \frac{60\,min}{h} \times \frac{1621\,h}{yr} \times \frac{1\,ton}{2{,}000\,lb} \times \frac{\$25}{ton}$			
Total DC	(rounded)	**$ 51,018**	$ dollars	
Indirect Annual Costs, IC				
Overhead	60% of sum of operating, supv., & maint. labor & maint. Materials	$ 27,419.30	$ dollars	EPA cost manual, Table 1.11, page 1-56
Administrative Charges	2% of Total Capital Investment	$ 4,903.17	$ dollars	EPA cost manual, Table 1.11, page 1-57
Property Tax	1% of Total Capital Investment	$ 2,451.59	$ dollars	EPA cost manual, Table 1.11, page 1-58
Insurance	1% of Total Capital Investment	$ 2,451.59	$ dollars	EPA cost manual, Table 1.11, page 1-59
Capital Recovery	$CRF*(TCI-C_B-C_L)$	$ 22,416.84	$ dollars	EPA cost manual, Table 1.11, page 1-60
Total IC (rounded)		**$ 59,642.47**		EPA cost manual, Equation 1.16
Total Annual Cost (1998)		**$ 110,661**		Calculated
Total Annual Cost (2018)		**$ 171,346**		Calculated

[1] The 1.08 factor is for freight and sales taxes

[2] Typical consumption is about 2 scfm/1,000 cfm of gas filtered, page 1-48

[3] The capital recovery cost factor, CRF, is a function of the fabric filter or equipment life and the opportunity cost of the capital (i.e., interest rate). For example, for a 20-year equipment life and a 4.75% interest rate, CRF = 0.07855

Chemical Engineering Plant Cost Index

Year	Index
1985	325.3
1995	381.1
1996	381.7
1997	386.5
1998	389.5
1999	391.8
2000	394.1
2001	394.3
2002	395.6
2003	402.0
2004	444.2
2005	468.2
2006	499.6
2007	525.4
2008	575.4
2009	521.9
2010	550.8
2011	593.2
2012	584.6
2013	567.3
2014	576.1
2015	556.8
2016	541.7
2017	567.5
2018	603.1
2019	-

Table 3. Parameters and Calculated Costs

Parameters			
Baghouse parameters		**units**	**Reference/Notes**
Type	Pulse-jet (common housing)	-	Most popular because it occupies less space + less expensive
Figure No	1.8	-	EPA cost manual, Table 1.7
Gas-to-cloth ratio	5	cfm/ft^2	Engineering judgment based on modern baghouses with low grain loading rates
Flue gas flowrate	18,922	scfm	6/1/2004 Baghouse Source Testing
Operating hours	1,621	hours/year	6/1/2004 Baghouse Source Testing
Operating hours	203	days/year	For 8 hours/day
System pressure drop	10	inches	EPA cost manual , Section 1.3.2
Bag diameter	6	in	EPA cost manual, Table 1.8
Individual bag cost	0.81	$\$/ft^2$	EPA cost manual, Table 1.8 for 6-inch polypropylene bag, top removal
Cage length	10	ft	EPA cost manual , Table 1.8 6-in x 10 ft cages
Calculated values			
Gross Cloth Area (GCA)	3,784.40	ft^2	Calculated
Cost of baghouse w/o bag	$29,414.66	$ dollars	EPA cost manual, Figure 1.8, $Cost = 2{,}307 + 7.136 \times (GCA)$
Bag cost	$3,065.36	$ dollars	Calculated
Insulation	$9,480.21	$ dollars	EPA cost manual, Insulation is required, page 1-51, $Cost = 1041 + 2.23 \times (GCA)$
Fabric area per cage	15.71	ft^2	EPA cost manual, page 1-51
Number of Cages	241	cages	EPA cost manual, page 1-52, rounded up to the next integer
Individual cage cost	12.07	per cage	EPA cost manual, Table 1.8 in 500 cage lots
Total cage cost	$2,908.03	$ dollars	EPA cost manual, page 1-51
Auxiliary equipment	$50,000.00	$ dollars	Conservative estimate based on EPA's example auxiliary costs, EPA cost manual, page 1-52

APPENDIX B: FOUR-FACTOR ANALYSIS SPREADSHEET

Table 1a. CalPortland Rillito - 4FA - Summary - PM_{10} Sources

Source Characteristics		Baseline Throughput		Baseline PM_{10} Emissions[1]					
Type	**Operation ID**	**Value**	**Units**	**(tpy)**	**Four Factor Analysis Statutory Factor**	**Technically Feasible Controls**			
Clinker to OH Crane BLDG	Various	4,380,245	tons	66.9	**Control Type**	**Baghouse**	**Full Enclosure**		
					Cost of Compliance ($/tpy)	No technologically feasible controls identified	$7,945		
					Time Necessary for Compliance		0.5		
					Energy and Non-Air Environmental Impacts		Minimal		
					Remaining Useful Life of the Source		20		
Unpaved Roads	Various	109,883	VMT	58.8	**Control Type**	**Develop traffic management plans, speed limits, speed bumps**	**Additional Water Application to Unpaved Roads**	**Apply Chemical Dust Suppressant to Unpaved Roads**	**Apply and Maintain Surface Gravel to Unpaved Roads**
					Cost of Compliance ($/tpy)	Already Implemented	$21,086	Already Implemented	No improvement in emissions
					Time Necessary for Compliance	N/A	3	N/A	N/A
					Energy and Non-Air Environmental Impacts	N/A	The reduction of PM_{10} emissions would see an increase in other criteria pollutant emissions along with hazardous air pollutants and greenhouse gases from the additional tailpipe emissions.	N/A	N/A
					Remaining Useful Life of the Source	N/A	20	N/A	N/A
Paved Roads	Various	24,195	VMT	10.6	**Control Type**	**Pave, vegetate, or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads**	**Provide for storm water drainage to prevent erosion of dirt or sand onto paved roads**	**Employ PM_{10} certified street sweepers**	
					Cost of Compliance ($/tpy)	Already Implemented	Already Implemented	$15,333	
					Time Necessary for Compliance	N/A	N/A	3	
					Energy and Non-Air Environmental Impacts	N/A	N/A	The reduction of PM_{10} emissions would see an increase in other criteria pollutant emissions along with hazardous air pollutants and greenhouse gases from the additional tailpipe emissions.	
					Remaining Useful Life of the Source	N/A	N/A	20	

Table 1a. CalPortland Rillito - 4FA - Summary - PM_{10} Sources

Source Characteristics		Baseline Throughput		Baseline PM_{10} Emissions[1]			
Type	Operation ID	Value	Units	(tpy)	Four Factor Analysis Statutory Factor	Technically Feasible Controls	
Material Drops	Various	9,602,945	tons	20.3	**Control Type**	No technically feasible controls identified	
					Cost of Compliance ($/tpy)		
					Time Necessary for Compliance		
					Energy and Non-Air Environmental Impacts		
					Remaining Useful Life of the Source		
Wind Erosion	WindIron	1.04	acres	8.4	**Control Type**	**Erect Artificial Windbreak**	
					Cost of Compliance ($/tpy)	$0	
					Time Necessary for Compliance	0	
					Energy and Non-Air Environmental Impacts	N/A	
					Remaining Useful Life of the Source	N/A	
Finish Milling-D2 area	D2-PC	6,087	hours	36.5	**Control Type**	**Lower Grain Loading**	
					Cost of Compliance ($/tpy)	$29,310	
					Time Necessary for Compliance	3	
					Energy and Non-Air Environmental Impacts	N/A	
					Remaining Useful Life of the Source	20	
Finish Milling-D3 area	D3-1-DC2	6,491	hours	31.7	**Control Type**	**Lower Grain Loading**	
					Cost of Compliance ($/tpy)	$30,763	
					Time Necessary for Compliance	3	
					Energy and Non-Air Environmental Impacts	N/A	
					Remaining Useful Life of the Source	20	
Kiln 4 Clinker Cooler	H2-GB	8,600	hours	42.4	**Control Type**	**Lower Grain Loading**	
					Cost of Compliance ($/tpy)	$30,149	
					Time Necessary for Compliance	3	
					Energy and Non-Air Environmental Impacts	N/A	
					Remaining Useful Life of the Source	20	
Quarry Crusher System	B2-DC1	1,621	hours	6.6	**Control Type**	**Lower Grain Loading**	
					Cost of Compliance ($/tpy)	$28,966	
					Time Necessary for Compliance	3	
					Energy and Non-Air Environmental Impacts	N/A	
					Remaining Useful Life of the Source	20	

Table 1b. CalPortland - Rillito - 4FA - Summary - NOx sources

Source Characteristics		Baseline Throughput		Baseline NOx Emissions		
Type	**Operation ID**	**Value**	**Unit**	**(tpy)**	**Four Factor Analysis Statutory Factor**	**Technically Feasible Controls**
Blasting	Blasting	840	tons ANFO	7.1	**Control Type**	No technically feasible controls identified
					Cost of Compliance ($/tpy)	
					Time Necessary for Compliance	
					Energy and Non-Air Environmental Impacts	
					Remaining Useful Life of the Source	

Table 2 - CalPortland Rillito - 4 FA - Clinker to Overhead Crane Building - Control Review & Cost Analysis

Parameter		Baghouse		Full Enclosure	
Value	**Units**	**Value**	**Reference**	**Value**	**Reference**
Technical Feasibility					
Is this technology feasible?		No		Yes	
If not, please explain		The building cannot safely support or house a baghouse, and the building is not currently fully enclosed. Even after restructuring the building to allow for a full enclosure, it will not be structurally capable of accommodating a baghouse.			
If Control Technology is Technically Feasible, Complete the Following					
Potential PM_{10} Reduction					
PM_{10} Reduction	%			24%	[2]
Rating	tons throughput			4,380,245	[1]
PM_{10} - Existing control	tpy			66.90	[1]
PM_{10} - Additional Control	tpy			50.84	Calculated
PM_{10} Reduced	tpy			16.06	Calculated
Capital Implementation Costs					
Total Cost	$			$1,076,037	[3]
Cost Obtained from Vendor Quote?	Yes / No			No	
Capital Recovery Factor	%			7.86%	[4]
Annualized Cost	$/yr			$84,523	Calculated
Admin, Taxes, Insurance	$/yr			$43,041	[5]
Fixed Operating Cost	$/yr			-	[6]
Variable Operating Cost	$/yr			-	[6]
Total Annual Cost	$/yr			$127,565	Calculated
Cost of Compliance (Statutory Factor 1)					
Cost of Control	$/ton removed			$7,945	Calculated
Post-Control Emission Rate	lb/VMT			N/A	
Averaging Period				N/A	
Time Necessary for Compliance (Statutory Factor 2)					
Time Necessary for Compliance	Years			0.5	[7]
Energy and Non-Air Environmental Impacts (Statutory Factor 3)					
Energy and Non-Air Environmental Impacts				Minimal	
Remaining Useful Life of the Source (Statutory Factor 4)					
Remaining Useful Life	Years			20	Estimated

1. 2028 Projected Emissions per ADEQ Emissions Projection Methodology
2. Assumes PM_{10} control efficiency associated with full enclosure + baghouse is 99% and existing partial enclosure control efficiency is 75% per South Coast Air Quality Management District Document on Fugitive Dust Mitigation Measures.
3. Cost to restructure east and west end building including cost to cover man-door openings.
4. Capital Recovery factor (CRF) calculated as follows $$\frac{i * (1+i)^n}{(1+i)^n - 1}$$

Where:

i = Interest Rate 4.75%

n = Remaining Useful Life Varies

Note that the number of years corresponds to the remaining life of the unit after 2028, the earliest time that controls are expected to be installed. Per EPA "Guidance on Regional Haze State Implementation Plans for the Second Implementation Period" dated August 20, 2019:

"Typically, the remaining useful life of the source itself will be longer than the useful life of the emission control system under consideration unless there is an enforceable requirement for the source to cease operation sooner ... annualized compliance costs are typically based on the useful life of the control equipment rather than the life of the source, unless the source is under an enforceable requirement to cease operation"

5. Admin, Taxes, Insurance assumed to be: 4.00%
6. The fixed operating cost and variable operating cost were conservatively not included.
7. CalPortland estimates that it would take approximately 6 months for design and reconstructing the overhead crane building.

Table 3 - CalPortland Rillito - 4 FA - Vehicular Traffic - Unpaved Roads - Control Review & Cost Analysis

Parameter		Develop traffic management plans, speed limits, speed bumps		Additional Water Application to Unpaved Roads		Apply Chemical Dust Suppressant to Unpaved Roads		Apply and Maintain Surface Gravel to Unpaved Roads		Pave the Road Surface of Unpaved Roads	
Road Surface		Unpaved		Unpaved		Unpaved		Unpaved		Unpaved	
Value	Units	Value	Reference	Value	Reference	Value	Reference	Value	Reference	Value	Reference
Technical Feasibility											
Is this technology feasible?		Yes		Yes		Yes		Yes		No	
If not, please explain										Quarry roads cannot be paved	
Additional Comments		This control method is already being used at the CalPortland Rillito facility. Additional restrictions would impede with facility operation and bottleneck facility processes.		The additional number of water trucks necessary, along with the amount of additional traffic would interfere with facility operations.		This is already being implemented and CalPortland is using a high efficiency lignin based dust suppressant		The current silt content (6.4%) is equivalent to the silt content that would be achieved by applying gravel to the unpaved roads. As such, there would be no associated PM_{10} reduction.		The quarry roads cannot be paved as the weight and size of the haul trucks would destroy the pavement. Additionally, haul roads change as the mine is developed.	
If Control Technology is Technically Feasible, Complete the Following											
Potential PM_{10} Reduction											
PM_{10} Reduction	%	0%	Already Implemented	86%	[2]	0%	[7]	0%	[8]		
Rating	VMT	109,883	[1]	109,883	[1]	109,883	[1]	109,883	[1]		
PM_{10} - No control	tpy	58.77	[1]	58.77	[1]	58.77	[1]	58.77	[1]		
PM_{10} - Additional Control	tpy	35.25	Calculated	8.40	[3]	35.25	Calculated	35.25	Calculated		
PM_{10} Reduced	tpy	23.52	Calculated	50.37	Calculated	23.52	Calculated	23.52	Calculated		
Capital Implementation Costs											
Total Cost	$	-	-	$3,160,000	Cost of 8 trucks	-	-	-	-		
Cost Obtained from Vendor Quote?	Yes / No	-	-	No		-	-	-	-		
Capital Recovery Factor	%	-	-	7.86%	[4]	-	-	-	-		
Annualized Cost	$/yr	-	-	$248,219	Calculated	-	-	-	-		
Admin, Taxes, Insurance	$/yr	-	-	$126,400	[5]	-	-	-	-		
Fixed Operating Cost	$/yr	-	-	$687,567	[6]	-	-	-	-		
Variable Operating Cost	$/yr	-	-	-	-	-	-	-	-		
Total Annual Cost	$/yr	-	-	$1,062,186	Calculated	-	-	-	-		
Cost of Compliance (Statutory Factor 1)											
Cost of Control	$/ton removed	ND	-	$21,086	Calculated	ND	-	ND	-		
Post-Control Emission Rate	lb/VMT	0.64	Calculated	0.15	Calculated	0.64	Calculated	0.64	Calculated		
Averaging Period											
Time Necessary for Compliance (Statutory Factor 2)											
Time Necessary for Compliance	Years			3	Estimate based on procurement of equipment and implementation of new operations						
Energy and Non-Air Environmental Impacts (Statutory Factor 3)											
Energy and Non-Air Environmental Impacts				The reduction of PM_{10} emissions would see an increase in other criteria pollutant emissions along with hazardous air pollutants and greenhouse gases from the additional tailpipe emissions.							
Remaining Useful Life of the Source (Statutory Factor 4)											
Remaining Useful Life	Years			20	Estimated						

1. 2028 Projected Emissions per ADEQ Emissions Projection Methodology
2. Additional control based on 95% overall PM_{10} control.
3. Based on 95% control, which is achievable based on the upper limit of AP-42 Section 13.2.2, Figure 13.2.2-5.
4. Capital Recovery factor (CRF) calculated as follows $$\frac{i*(1+i)^n}{(1+i)^n-1}$$

Where:

i = Interest Rate 4.75%

n = Remaining Useful Life Varies

Note that the number of years corresponds to the remaining life of the unit after 2028, the earliest time that controls are expected to be installed. Per EPA "Guidance on Regional Haze State Implementation Plans for the Second Implementation Period" dated August 20, 2019:

"Typically, the remaining useful life of the source itself will be longer than the useful life of the emission control system under consideration unless there is an enforceable requirement for the source to cease operation sooner ... annualized compliance costs are typically based on the useful life of the control equipment rather than the life of the source, unless the source is under an enforceable requirement to cease operation"

5. Admin, Taxes, Insurance assumed to be: 4.00% Per EPA Air Pollution Control Cost Manual, Sixth Ed., 2002, Sect. 2.5.5.8, pg 2-34
6. Fixed operating cost accounts for the cost difference in water required, along with a 5% annual maintenance costs based on capital cost of water trucks.
7. CalPortland uses a lignin based chemical suppressant. Magnesium chloride cannot be used as it causes damage to operating equipment onsite.
8. The current silt content of the haul roads of 6.4% is equivalent to the lowest silt content of gravel from WRAP Fugitive Dust Handbook

Table 4 - CalPortland Rillito - 4 FA - Vehicular Traffic - Paved Roads - Control Review & Cost Analysis

Parameter		Cover Haul Trucks		Pave, vegetate, or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads		Route traffic around and rapidly clean up non-preventable dust on paved roads		Require curbing and pave or stabilize shoulders of paved roads		Provide for storm water drainage to prevent erosion of dirt or sand onto paved roads		Employ PM_{10} certified street sweepers	
Road Surface		Paved		Paved		Paved		Paved		Paved		Paved	
Value	Units	Value	Reference	Value	Reference	Value	Reference	Value	Reference	Value	Reference	Value	Reference
Technical Feasibility													
Is this technology feasible?		No		Yes		No		No		Yes		Yes	
If not, please explain		No way to cover the haul trucks				Would prevent proper operations		Haul trucks would destroy shoulders					
Additional Comments		Requiring operators to cover haul trucks would pose a safety hazard, and not aware of any current technology for covering haul trucks		Already implemented		Already implemented; the implementation of additional clean-up would bottleneck operations and cause additional pollution		The weight and intensity of haul truck traffic would quickly destroy any stabilizing shoulders on paved roads		Already implemented		Along with the cost of PM_{10} street sweepers, they can cause issues at cement plants if they use water and aren't cleaned out quickly enough	
If Control Technology is Technically Feasible, Complete the Following													
Potential PM_{10} Reduction													
PM_{10} Reduction	%			0%	Already Implemented					0%	Already Implemented	26%	[2]
Rating	VMT			24,195	[1]					24,195	[1]	24,195	[1]
PM_{10} - No control	tpy			10.57	[1]					10.57	[1]	10.57	[1]
PM_{10} - Additional Control	tpy			10.57	Calculated					10.57	Calculated	7.82	Calculated
PM_{10} Reduced	tpy			0.00	Calculated					0.00	Calculated	2.75	Calculated
Capital Implementation Costs													
Total Cost	$			-	-					-	-	$250,000	[3]
Cost Obtained from Vendor Quote?	Yes / No			-	-					-	-	Yes	
Capital Recovery Factor	%			-	-					-	-	7.86%	[4]
Annualized Cost	$/yr			-	-					-	-	$19,638	Calculated
Admin, Taxes, Insurance	$/yr			-	-					-	-	$10,000	[5]
Fixed Operating Cost	$/yr			-	-					-	-	$12,500	[6]
Variable Operating Cost	$/yr			-	-					-	-	-	-
Total Annual Cost	$/yr			-	-					-	-	$42,138	Calculated
Cost of Compliance (Statutory Factor 1)													
Cost of Control	$/ton removed			N/A	-					N/A	-	$15,332.81	-
Post-Control Emission Rate	lb/VMT			0.87	Calculated					0.87	Calculated	0.65	Calculated
Averaging Period													
Time Necessary for Compliance (Statutory Factor 2)													
Time Necessary for Compliance	Years											3	Estimate based on procurement of equipment and implementation of new operations
Energy and Non-Air Environmental Impacts (Statutory Factor 3)													
Energy and Non-Air Environmental Impacts												The reduction of PM_{10} emissions would see an increase in other criteria pollutant emissions along with hazardous air pollutants and greenhouse gases from the additional tailpipe emissions.	
Remaining Useful Life of the Source (Statutory Factor 4)													
Remaining Useful Life	Years											20	Based on new street sweeper

1. 2028 Projected Emissions per ADEQ Emissions Projection Methodology
2. Control efficiency based on WRAP Fugitive Dust Guidance, Table 5-5 for 14-day frequency street sweeping at arterial/collector streets
3. The cost of a PM_{10} street sweeper is based on a vendor quote.
4. Capital Recovery factor (CRF) calculated as follows $\frac{i * (1+i)^n}{(1+i)^n - 1}$

Where:
i = Interest Rate 4.75%
n = Remaining Useful Life Varies

Note that the number of years corresponds to the remaining life of the unit after 2028, the earliest time that controls are expected to be installed. Per EPA "Guidance on Regional Haze State Implementation Plans for the Second Implementation Period" dated August 20, 2019:
"Typically, the remaining useful life of the source itself will be longer than the useful life of the emission control system under consideration unless there is an enforceable requirement for the source to cease operation sooner ... annualized compliance costs are typically based on the useful life of the control equipment rather than the life of the source, unless the source is under an enforceable requirement to cease operation"

5. Admin, Taxes, Insurance assumed to be: 4.00% Per EPA Air Pollution Control Cost Manual, Sixth Ed., 2002, Sect. 2.5.5.8, pg 2-34
6. Fixed Operating Cost based on 5% of capital costs.

Table 5 - CalPortland Rillito - 4 FA - Material Drops - Control Review & Cost Analysis

Parameter		Water Sprays		Baghouse		Full or Partial Enclosure	
Value	Units	Value	Reference	Value	Reference	Value	Reference
Technical Feasibility							
Is this technology feasible?		No					
If not, please explain		The location and operations of the material drops impedes the ability to apply additional controls. Water sprays are not a technically feasible control for this analysis. The materials without control cannot become damp because the material will clump and cause issues with operations. Additional moisture affects the quality of the product, it causes plugging in the pre-heater tower, and causes other process related difficulties that in the long run will add more NOx and SOx due to the moisture that would have to be driven off and additional process upsets that cause excess emissions with a breakdown. Additionally, for a source like Clinker Conveyor Bypass (Truck) – Clinker Conveyor Bypass Bin to Truck Transfer, water cannot be applied to clinker. Lastly, most quarry material transfers would require additional water trucks to water loading material into the haul truck at the rock face. These trucks would generate more dust, NOx, and CO emissions for each truck.		The location of the material drops impedes the ability to apply additional controls. This is not technically feasible control for this analysis. For example, the Alumina at Plant (Loader) – Loader to D4 Hopper transfer point cannot be enclosed, as enclosing this process for a baghouse is not physically feasible as there would be no way to get the material into the hopper. Additionally, spraying this material causes clogs/clumps in the hopper, on the conveyors, and in the storage bin.		The location and operations of the material drops impedes the ability to apply additional controls.	
If Control Technology is Technically Feasible, Complete the Following							
Potential PM_{10} Reduction							
PM_{10} Reduction	%						
Rating	Tons throughput						
PM_{10} - No control	tpy						
PM_{10} - Control	tpy						
PM_{10} Reduced	tpy						
Capital Implementation Costs							
Total Cost	$						
Cost Obtained from Vendor Quote?	Yes / No						
Capital Recovery Factor	%						
Annualized Cost	$/yr						
Admin, Taxes, Insurance	$/yr						
Fixed Operating Cost	$/yr						
Variable Operating Cost	$/yr						
Total Annual Cost	$/yr						
Cost of Compliance (Statutory Factor 1)							
Cost of Control	$/ton removed						
Post-Control Emission Rate	lb/VMT						
Averaging Period							
Time Necessary for Compliance (Statutory Factor 2)							
Time Necessary for Compliance	Years						
Energy and Non-Air Environmental Impacts (Statutory Factor 3)							
Energy and Non-Air Environmental Impacts							
Remaining Useful Life of the Source (Statutory Factor 4)							
Remaining Useful Life	Years						

Table 6. CalPortland Rillito - 4 FA - Wind Erosion - Control Review & Cost Analysis

Parameter		Additional Water Application		Apply Chemical Dust Suppressant		Erect Artificial Windbreak		Plant Trees or Shrubs as Windbreak		Pile Compaction		Cover with Tarps	
Value	Units	Value	Reference	Value	Reference	Value	Reference	Value	Reference	Value	Reference	Value	Reference
Technical Feasibility													
Is this technology feasible?		No		No		Yes		Yes		Yes		Yes	
If not, please explain		Sonoran hematite is a very fine material, and water application would cause clumping of the material. Clumping causes operational issues, such as clogging and plugging of process equipment.		All the issues that exist with water spraying also exist for chemical dust suppressants.		The iron tailings pile are being moved to a horseshoe pit with windbreak on 3 sides - this control is currently being implemented		An artificial wind-break is being implemented. These control technologies Pile coverage would require additional equipment, operational overhead, and incurred costs.					
If Control Technology is Technically Feasible, Complete the Following													
Potential PM_{10} Reduction													
PM_{10} Reduction	%					75%	[2]						
Rating	Acres of piles					1.04	[1]						
PM_{10} - No control	tpy					8.41	[1]						
PM_{10} - Control	tpy					2.10	Calculated						
PM_{10} Reduced	tpy					6.31	Calculated						
Capital Implementation Costs													
Total Cost	$					-	-						
Cost Obtained from Vendor Quote?	Yes / No					-	-						
Capital Recovery Factor	%					-	-						
Annualized Cost	$/yr					-	-						
Admin, Taxes, Insurance	$/yr					-	-						
Fixed Operating Cost	$/yr					-	-						
Variable Operating Cost	$/yr					-	-						
Total Annual Cost	$/yr					-	-						
Cost of Compliance (Statutory Factor 1)													
Cost of Control	$/ton removed					-	-						
Post-Control Emission Rate	lb/acre					-	-						
Averaging Period						-	-						
Time Necessary for Compliance (Statutory Factor 2)													
Time Necessary for Compliance	Years					0	Control is already implemented						
Energy and Non-Air Environmental Impacts (Statutory Factor 3)													
Energy and Non-Air Environmental Impacts						-	-						
Remaining Useful Life of the Source (Statutory Factor 4)													
Remaining Useful Life	Years					N/A	Located in a pit						

1. 2028 Projected Emissions per ADEQ Emissions Projection Methodology
2. Control based on South Coast Air Quality Management District Document on Fugitive Dust Mitigation Measures

Table 7. CalPortland Rillito - 4 FA - Blasting - Control Review & Cost Analysis

Parameter		Induction of Blast Additives: Aluminum powder; coal dust; urea or excess fuel oil		Water Contamination Reduction		Confinement Enhancement		Drill Cutting Contamination Reduction	
Value	Units	Value	Reference	Value	Reference	Value	Reference	Value	Reference
Technical Feasibility									
Is this technology feasible?		No							
If not, please explain		ANFO is purchased from contractor and prepared offsite							
If Control Technology is Technically Feasible, Complete the Following									
Potential NOx Reduction									
NOx Reduction	%								
Rating	tons explosive								
NOx - No control	tpy								
NOx - Controlled	tpy								
NOx Reduced	tpy								
Capital Implementation Costs									
Total Cost	$								
Cost Obtained from Vendor Quote?	Yes / No								
Capital Recovery Factor	%								
Annualized Cost	$/yr								
Admin, Taxes, Insurance	$/yr								
Fixed Operating Cost	$/yr								
Variable Operating Cost	$/yr								
Total Annual Cost	$/yr								
Cost of Compliance (Statutory Factor 1)									
Cost of Control	$/ton removed								
Post-Control Emission Rate	lb/lb explosive								
Averaging Period									
Time Necessary for Compliance (Statutory Factor 2)									
Time Necessary for Compliance	Years								
Energy and Non-Air Environmental Impacts (Statutory Factor 3)									
Energy and Non-Air Environmental Impacts									
Remaining Useful Life of the Source (Statutory Factor 4)									
Remaining Useful Life	Years								

Table 8 - CalPortland Rillito - 4 FA - D2 Finish Mill D2-PC Baghouse - Control Review & Cost Analysis

Parameter		Lower Grain Loading Rate	
Value	Units	Value	Reference
Technical Feasibility			
Is this technology feasible?		Yes	
If not, please explain			
If Control Technology is Technically Feasible, Complete the Following			
Potential PM_{10} Reduction			
Current Guaranteed Grain Loading	gr/dscf	0.01	[2]
Updated Grain Loading	gr/dscf	0.005	[3]
Flow	dscf	140,000	[1]
Operating Hours	hrs	6,087	[1]
PM_{10} - Current Control	tpy	36.52	Calculated
PM_{10} - Potential Control	tpy	18.26	Calculated
PM_{10} Reduced	tpy	18.26	Calculated
Capital Implementation Costs			
Total Cost	$	-	-
Cost Obtained from Vendor Quote?	Yes / No	-	-
Capital Recovery Factor	%	-	-
Annualized Cost	$/yr	-	-
Admin, Taxes, Insurance	$/yr	-	-
Fixed Operating Cost	$/yr	-	-
Variable Operating Cost	$/yr	-	-
Total Annual Cost	$/yr	$535,231	Calculated using EPA Cost Manual
Cost of Compliance (Statutory Factor 1)			
Cost of Control	$/ton removed	$29,310	Calculated
Post-Control Emission Rate	gr/dscf	0.005	Calculated
Time Necessary for Compliance (Statutory Factor 2)			
Time Necessary for Compliance	Years	3	Estimated based on permitting process and purchase from vendors
Energy and Non-Air Environmental Impacts (Statutory Factor 3)			
Energy and Non-Air Environmental Impacts		N/A	
Remaining Useful Life of the Source (Statutory Factor 4)			
Remaining Useful Life	Years	20	EPA Cost Manual

1. 2028 Projected Emissions per ADEQ Emissions Projection Methodology
2. Baseline emissions from baghouses are based on conservative grain loading rates that would be guaranteed by vendors.
3. Achievable grain loading rate based on RACT/BACT/LAER Clearinghouse information.

Table 9 - CalPortland Rillito - 4 FA - D3 Finish Mill D3-1-DC2 Baghouse - Control Review & Cost Analysis

Parameter		Lower Grain Loading Rate	
Value	Units	Value	Reference
Technical Feasibility			
Is this technology feasible?		Yes	
If not, please explain			
If Control Technology is Technically Feasible, Complete the Following			
Potential PM_{10} Reduction			
Current Guaranteed Grain Loading	gr/dscf	0.01	[2]
Updated Grain Loading	gr/dscf	0.005	[3]
Flow	dscf	113,952	[1]
Operating Hours	hrs	6,491	[1]
PM_{10} - Current Control	tpy	31.70	Calculated
PM_{10} - Potential Control	tpy	15.85	Calculated
PM_{10} Reduced	tpy	15.85	Calculated
Capital Implementation Costs			
Total Cost	$	-	-
Cost Obtained from Vendor Quote?	Yes / No	-	-
Capital Recovery Factor	%	-	-
Annualized Cost	$/yr	-	-
Admin, Taxes, Insurance	$/yr	-	-
Fixed Operating Cost	$/yr	-	-
Variable Operating Cost	$/yr	-	-
Total Annual Cost	$/yr	$487,584	Calculated using EPA Cost Manual
Cost of Compliance (Statutory Factor 1)			
Cost of Control	$/ton removed	$30,763	Calculated
Post-Control Emission Rate	gr/dscf	0.005	Calculated
Time Necessary for Compliance (Statutory Factor 2)			
Time Necessary for Compliance	Years	3	Estimated based on permitting process and purchase from vendors
Energy and Non-Air Environmental Impacts (Statutory Factor 3)			
Energy and Non-Air Environmental Impacts		N/A	
Remaining Useful Life of the Source (Statutory Factor 4)			
Remaining Useful Life	Years	20	EPA Cost Manual

1. 2028 Projected Emissions per ADEQ Emissions Projection Methodology
2. Baseline emissions from baghouses are based on conservative grain loading rates that would be guaranteed by vendors.
3. Achievable grain loading rate based on RACT/BACT/LAER Clearinghouse information.

Table 10 - CalPortland Rillito - 4 FA - Kiln 4 Clinker Cooler H2-GB Baghouse - Control Review & Cost Analysis

Parameter		Lower Grain Loading Rate	
Value	**Units**	**Value**	**Reference**
Technical Feasibility			
Is this technology feasible?		Yes	
If not, please explain			
If Control Technology is Technically Feasible, Complete the Following			
Potential PM_{10} Reduction			
Current Guaranteed Grain Loading	gr/dscf	0.01	[2]
Updated Grain Loading	gr/dscf	0.005	[3]
Flow	dscf	115,000	[1]
Operating Hours	hrs	8,600	[1]
PM_{10} - Current Control	tpy	42.39	Calculated
PM_{10} - Potential Control	tpy	21.19	Calculated
PM_{10} Reduced	tpy	21.19	Calculated
Capital Implementation Costs			
Total Cost	$	-	-
Cost Obtained from Vendor Quote?	Yes / No	-	-
Capital Recovery Factor	%	-	-
Annualized Cost	$/yr	-	-
Admin, Taxes, Insurance	$/yr	-	-
Fixed Operating Cost	$/yr	-	-
Variable Operating Cost	$/yr	-	-
Total Annual Cost	$/yr	$638,954	Calculated using EPA Cost Manual
Cost of Compliance (Statutory Factor 1)			
Cost of Control	$/ton removed	$30,149	Calculated
Post-Control Emission Rate	gr/dscf	0.005	Calculated
Time Necessary for Compliance (Statutory Factor 2)			
Time Necessary for Compliance	Years	3	Estimated based on permitting process and purchase from vendors
Energy and Non-Air Environmental Impacts (Statutory Factor 3)			
Energy and Non-Air Environmental Impacts		N/A	
Remaining Useful Life of the Source (Statutory Factor 4)			
Remaining Useful Life	Years	20	EPA Cost Manual

1. 2028 Projected Emissions per ADEQ Emissions Projection Methodology
2. Baseline emissions from baghouses are based on conservative grain loading rates that would be guaranteed by vendors.
3. Achievable grain loading rate based on RACT/BACT/LAER Clearinghouse information.

Table 11 - CalPortland Rillito - 4 FA - Quarry Crusher B2-DC1 Baghouse - Control Review & Cost Analysis

Parameter		Lower Grain Loading Rate	
Value	**Units**	**Value**	**Reference**
Technical Feasibility			
Is this technology feasible?		Yes	
If not, please explain			
If Control Technology is Technically Feasible, Complete the Following			
Potential PM_{10} Reduction			
Current Guaranteed Grain Loading	gr/dscf	0.05	[2]
Updated Grain Loading	gr/dscf	0.005	[3]
Flow	dscf	18,922	[1]
Operating Hours	hrs	1,621	[1]
PM_{10} - Current Control	tpy	6.57	Calculated
PM_{10} - Potential Control	tpy	0.66	Calculated
PM_{10} Reduced	tpy	5.92	Calculated
Capital Implementation Costs			
Total Cost	$	-	-
Cost Obtained from Vendor Quote?	Yes / No	-	-
Capital Recovery Factor	%	-	-
Annualized Cost	$/yr	-	-
Admin, Taxes, Insurance	$/yr	-	-
Fixed Operating Cost	$/yr	-	-
Variable Operating Cost	$/yr	-	-
Total Annual Cost	$/yr	$171,346	Calculated using EPA Cost Manual
Cost of Compliance (Statutory Factor 1)			
Cost of Control	$/ton removed	$28,966	Calculated
Post-Control Emission Rate	gr/dscf	0.005	Calculated
Time Necessary for Compliance (Statutory Factor 2)			
Time Necessary for Compliance	Years	3	Estimated based on permitting process and purchase from vendors
Energy and Non-Air Environmental Impacts (Statutory Factor 3)			
Energy and Non-Air Environmental Impacts		N/A	
Remaining Useful Life of the Source (Statutory Factor 4)			
Remaining Useful Life	Years	20	EPA Cost Manual

1. 2028 Projected Emissions per ADEQ Emissions Projection Methodology
2. Baseline emissions from baghouses are based on conservative grain loading rates that would be guaranteed by vendors.
3. Achievable grain loading rate based on RACT/BACT/LAER Clearinghouse information.

Table A. CalPortland Rillito - Parameters for Control Analysis

Parameter	Value	Units	Notes
Median Reclaim Water Cost in AZ	0.001	$/gal	https://efc.sog.unc.edu/sites/default/files/2017/2017%20Arizona%20Water%20&%20Wastewater%20Rates%20Report_0.pdf
Median Reclaim Water Cost in AZ	0.209	$/ton	http://www.townofkearny.com/water.html
Water application rate for Program C - Quarry Roads	0.64	gal/yd^2	Facility Dust Control Plan
Water application rate for Program C - Plant/Quarry Roads	0.16	gal/yd^2	Facility Dust Control Plan
Water application rate for Program C - Plant Roads	0.40	gal/yd^2	Facility Dust Control Plan
Chemical Suppressant Control Efficiency for Program C	46%	% Control	Facility Dust Control Plan
Water Application Control for 95% Total Unpaved Road Control	91%	% Control	Calculated
Potential Average Hourly Daytime Evaporation Rate	0.515	mm/hr	Facility Dust Control Plan
Time between applications	12	hours	Facility Dust Control Plan
Quarry Road System hourly traffic rate	38.1	vehicles/hr	Facility Dust Control Plan
Plant/Quarry Road System hourly traffic rate	9.6	vehicles/hr	Facility Dust Control Plan
Plant Road System hourly traffic rate	23.8	vehicles/hr	Facility Dust Control Plan
Water Application Rate for 95% Total Unpaved Road Control - Quarry	4.49	gal/yd^2	Calculated
Water Application Rate for 95% Total Unpaved Road Control - Plant/Quarry	1.13	gal/yd^2	Calculated
Water Application Rate for 95% Total Unpaved Road Control - Plant	2.81	gal/yd^2	Calculated
Unpaved Road VMT Converted to yards for Quarry Roads	15,795,883	yd/yr	2028 Baseline
Unpaved Road VMT Converted to yards for Plant/Quarry Roads	3,948,971	yd/yr	2028 Baseline
Unpaved Road VMT Converted to yards for Plant Roads	9,872,427	yd/yr	2028 Baseline
Unpaved Road Square Footage for Quarry Roads	157,958,827	yd^2	Calculated - VMT converted to yards times 10 yard road width (estimated)
Unpaved Road Square Footage for Quarry/Plant Roads	39,489,707	yd^2	Calculated - VMT converted to yards times 10 yard road width (estimated)
Unpaved Road Square Footage for Plant Roads	98,724,267	yd^2	Calculated - VMT converted to yards times 10 yard road width (estimated)
Baseline 2028 Projected Gallon Application for Quarry Roads	101,093,649	gal/yr	Calculated
Baseline 2028 Projected Gallon Application for Quarry/Plant Roads	6,318,353	gal/yr	Calculated
Baseline 2028 Projected Gallon Application for Plant Roads	39,489,707	gal/yr	Calculated
Baseline 2028 Costs for Quarry Roads	87,951	$/yr	Calculated
Baseline 2028 Costs for Quarry/Plant Roads	5,497	$/yr	Calculated
Baseline 2028 Costs for Plant Roads	34,356	$/yr	Calculated
Increased Watering Gallon Application for Quarry Roads	709,790,851	gal/yr	Calculated
Increased Watering Gallon Application for Quarry/Plant Roads	44,711,235	gal/yr	Calculated
Increased Watering Gallon Application for Plant Roads	277,116,507	gal/yr	Calculated
Increased Watering Costs for Quarry Roads	617,518	$/yr	Calculated
Increased Watering Gallon Application for Quarry/Plant Roads	38,899	$/yr	Calculated
Increased Watering Gallon Application for Plant Roads	241,091	$/yr	Calculated
Cost of Watering Truck	395,000	$	https://www.machinerytrader.com/listings/construction-equipment/for-sale/27306867/2013-cat-740b
Additional Water Trucks necessary	8	Trucks	Calculated based on additional water application necessary
Additional Truck Capital Cost	3,160,000	$	Calculated
Cost of Certified PM_{10} Street Sweeper	250,000	$	Quote from vendor
PM_{10} Street Sweeper Control Efficiency	26	%	https://www.wrapair.org/forums/dejf/fdh/content/Ch5-Paved_Roads_Rev06.pdf
PM_{10} Emission Factor for Iron Stockpile	44.31	lb/acre-day	2018 EI