Regulatory Impact Analysis for the Supplemental Proposed Amendments to the National Emission Standards for Hazardous Air Pollutants: Lime Manufacturing Plants

EPA-452/ R-24-004
January 2024

Regulatory Impact Analysis for the Supplemental Proposed Amendments to the National Emission Standards for Hazardous Air Pollutants: Lime Manufacturing Plants

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ACKNOWLEDGEMENTS

We acknowledge the contributions of staff from RTI International in preparing the compliance costs for the regulatory options analyzed in this document, and staff from SC&A Incorporated for preparing the demographic analysis underlying the environmental justice analysis in this document.

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1 INTRODUCTION

1.1 Background

The U.S. Environmental Protection Agency (EPA) is supplementing the proposed amendments to the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Lime Manufacturing facilities published in the Federal Register on January 5, 2023. In that action, the EPA proposed hazardous air pollutant (HAP) emissions standards for the following pollutants: hydrogen chloride (HCl), mercury, total hydrocarbon (THC) as a surrogate for organic HAP, and dioxin/furans (D/F). The EPA is proposing revisions to the previously set emission limits for HCl, mercury, organic HAP, and D/F based on additional information gathered since the publication of the January 5, 2023, proposed rule amendments. This document presents the regulatory impact analysis (RIA) for the proposed amendments.

1.2 Basis for the Regulation

The January 5, 2023, proposed rule amended the National Emission Standards for Hazardous Air Pollutants for Lime Manufacturing Plants (Lime Manufacturing NESHAP), to set emission standards for four previously unregulated pollutants. This supplemental proposal revises the emission limits in the January 5, 2023, proposed rule for HCl, mercury, organic HAP, and D/F based on information received from public commenters and other sources of information.

In the *Louisiana Environmental Action Network* v. *EPA (LEAN)* decision issued on April 21, 2020, the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit) held that the EPA has an obligation to address unregulated emissions from a source category when the Agency conducts the 8-year technology review required by Clean Air Act (CAA) section 112(d)(6).[1] To meet this obligation, the EPA issued the January 5, 2023, proposed rule to address unregulated emissions of HAP from the lime manufacturing source category. The proposed amendments defined the maximum achievable control technology (MACT) standard for HCl, mercury, THC as a surrogate for organic HAP, and

[1] Louisiana Environmental Action Network v. EPA, 955 F.3d 1088 (D.C. Cir. 2020) (“LEAN”).

D/F within the lime manufacturing source category pursuant to CAA sections 112(d)(2) and (3). This proposal supplements the January 5, 2023, proposed rule amendments.

1.3 Regulatory History

The EPA promulgated the Lime Manufacturing NESHAP on January 5, 2004 (69 FR 394). The standards are codified at 40 CFR part 63, subpart AAAAA. The lime manufacturing industry consists of facilities that use a lime kiln to produce lime product from limestone by calcination. The source category covered by this MACT standard currently includes 34 facilities.

As promulgated in 2004, the current Lime Manufacturing NESHAP regulates HAP emissions from all new and existing lime manufacturing plants that are major sources, co-located with major sources, or are part of major sources. A lime manufacturing plant is defined as any plant which uses a lime kiln to produce lime product from limestone or other calcareous material by calcination. The NESHAP specifically excludes lime kilns that use only calcium carbonate waste sludge from water softening processes as the feedstock. In addition, lime manufacturing plants located at pulp and paper mills or at beet sugar factories are not subject to the NESHAP. Lime manufacturing operations at pulp and paper mills are subject to the NESHAP for combustion sources at kraft, soda, and sulfite pulp and paper mills.[2] Lime manufacturing operations at beet sugar processing plants would also not be subject to the NESHAP because beet sugar lime kiln exhaust is typically routed through a series of gas washers to clean the exhaust gas prior to process use. Additionally, beet sugar plants typically operate only seasonally, and are not major sources of HAP.[3] Other lime manufacturing plants that are part of multiple operations, such as (but not limited to) those at steel mills and magnesia production facilities, are subject to those NESHAP.

The Lime Manufacturing NESHAP defines the affected source as each lime kiln and its associated cooler and each individual processed stone handling (PSH) operations system. The PSH operations system includes all equipment associated with PSH operations

[2] 66 FR 3180, January 12, 2001
[3] 67 FR 68053, December 20, 2002

beginning at the process stone storage bin(s) or open storage pile(s) and ending where the process stone is fed into the kiln. It includes man-made process stone storage bins (but not open process stone storage piles), conveying system transfer points, bulk loading or unloading systems, screening operations, surge bins, bucket elevators, and belt conveyors.

The current Lime Manufacturing NESHAP established particulate matter (PM) emission limits for lime kilns, coolers, and PSH operations with stacks. The NESHAP also established opacity limits for kilns equipped with electrostatic precipitators (ESP) and fabric filters (FF) and scrubber liquid flow limits for kilns equipped with wet scrubbers. Particulate matter serves as a surrogate for the non-mercury metal HAP. The NESHAP also regulates opacity or visible emissions from most of the PSH operations, with opacity also serving as a surrogate for HAP metals.

The 2020 amendments finalized the residual risk and technology review (RTR) conducted for the Lime Manufacturing NESHAP. The RTR found that the risk associated with air emissions from lime manufacturing was acceptable and that the current NESHAP provides an ample margin of safety to protect public health. The EPA determined that there were no developments in practices, processes, or control technologies that would warrant revisions to the standards. In addition, the 2020 amendments addressed periods of startup, shutdown, and malfunction (SSM) by removing any exemptions during SSM operations. Lastly, the 2020 amendments included provisions requiring electronic reporting.

1.4 Regulatory Options

As discussed in Section 1.2, this proposed rule defines the MACT standard for HCl, mercury, organic HAP, and D/F within the lime manufacturing source category pursuant to CAA sections 112(d)(2) and 112(d)(3). The “MACT floor” for existing sources is calculated based on the average performance of the best-performing units in each category or subcategory and on a consideration of these units’ variability. The MACT floor for new sources is based on the single best-performing source, with a similar consideration of that source’s variability. The MACT floor for new sources cannot be less stringent than the emissions performance that is achieved in practice by the best-controlled similar source.

In addition, the EPA must examine, but is not necessarily required to adopt, more stringent "beyond-the-floor" regulatory options to determine MACT. Unlike the floor minimum stringency requirements, the EPA must consider various impacts of the more stringent regulatory options in determining whether MACT standards are to reflect beyond-the-floor requirements. If the EPA concludes that the more stringent regulatory options have unreasonable impacts, the EPA selects the MACT floor as MACT. However, if the EPA concludes that impacts associated with beyond-the-floor levels of control are reasonable in light of additional emissions reductions achieved, the EPA selects those levels as MACT.

Because of the prescriptive nature of the MACT standard setting process, this RIA does not analyze a less stringent option to the MACT standard. However, for completeness the costs and impacts of the most stringent beyond-the-floor option are presented in Chapters 3 and 4. A detailed summary of the proposed standards is provided in the memorandum titled *Maximum Achievable Control Technology (MACT) Floor Analysis for the Lime Manufacturing Plants Industry Supplemental Proposal*, located in the docket for this action.

1.5 Organization of this RIA

The remainder of this report details the methodology and the results of the RIA. Chapter 2 presents a profile of the lime manufacturing industry. Chapter 3 describes the emissions and engineering cost analysis prepared for this proposed rule. Chapter 4 presents the benefits analysis, which is limited to a qualitative discussion of the health effects associated with HAP emissions from lime manufacturing facilities, because the EPA was unable to monetize the benefits of the proposed amendments. Chapter 5 describes the environmental justice analysis performed for this proposed rule. Chapter 6 presents analyses of economic impacts, impacts on small businesses, and a discussion of potential employment impacts. The economic impacts include estimates of price and output changes in response to the cost of the proposed rule. The small business impact analysis includes estimates of annual cost-to-sales ratios for affected businesses, and compares the estimated impacts for the small businesses to those that are not small. Chapter 7 presents a comparison of the benefits and costs. Chapter 8 contains the references for this RIA.

2 INDUSTRY PROFILE

2.1 Introduction

This chapter provides a brief introduction to the lime manufacturing industry. Section 2.2 presents a description of how lime is produced. For additional information about the types of equipment used in production, see the Economic Impact Analysis (EIA) for the original lime manufacturing MACT standard (U.S. EPA, 2003a). Section 2.3 provides historical market data on U.S. production, consumption, foreign trade, and prices. Section 2.4 provides information about the consumers and uses of lime and related products. Finally, Section 2.5 describes the affected producers and provides economic statistics about the industries with companies that will be affected by this proposed rule.

2.2 Lime Production

The production of lime begins with the quarrying and crushing of limestone. The crushed limestone is then converted into lime by heating the limestone in a kiln, a process known as calcination. When limestone is subjected to high temperatures, it undergoes a chemical decomposition resulting in the formation of lime (CaO) and the emission of CO_2. Because calcination is a reversible chemical reaction, the CO_2 emitted as a result of the process must be removed to prevent recarbonation. Lime as it exits the kiln is known as quicklime. It can be either high calcium or dolomitic, depending on the type of limestone that was calcined. After the quicklime leaves the kiln, it is screened to remove undersized particles. Quicklime can be reacted with water to from hydrated (slaked) lime. Hydrated lime is produced in a vessel called a hydrator, where a precise amount of water is slowly added to crushed or ground quicklime and the mixture is stirred and agitated.

Dead-burned dolomite, also called refractory lime, is a sintered or double-burned form of dolomitic lime. It is used for lining open hearth or electric arc steel furnaces or as an input in the refractory bricks that line basic oxygen steel furnaces.

2.3 Industry Data

Table 1 provides data on the number of lime manufacturing plants in the United States and the production of quicklime, hydrated lime, and dead-burned dolomite from 1998-2021 (USGS, 2002-2021). During this period the number of plants decreased from

107 in 1998 to 83 in 2021, while the overall sales and usage of lime decreased from 20,100 tons in 1998 to 16,800 tons in 2021. However, more recent values likely reflect lingering impacts from the global COVID-19 pandemic.

Table 1 Lime Sales and Usage 1998-2021 (thousand metric tons)

		Sold or Used by Producers by Type			Combined Types			
Year	Plants	Quicklime	Hydrated Lime	Dead-burned dolomite	Lime Sales	Lime Use	Total Lime Sold and Used	Apparent Consumption
1998	107	17,500	2,330	300	17,800	2,320	20,100	20,300
1999	107	17,100	2,310	300	17,400	2,310	19,700	19,700
2000	106	17,300	1,970	200	17,500	2,020	19,500	19,600
2001	103	16,200	2,470	200	17,000	1,840	18,900	18,900
2002	99	15,800	1,930	200	16,500	1,340	17,900	17,900
2003	96	16,400	2,610	200	17,700	1,470	19,200	19,300
2004	91	17,200	2,570	200	18,400	1,520	20,000	20,100
2005	94	17,100	2,700	200	18,600	1,490	20,000	20,200
2006	91	18,000	2,780	200	19,400	1,620	21,000	21,200
2007	89	17,400	2,600	200	18,700	1,540	20,200	20,400
2008	90	17,200	2,420	200	18,400	1,470	19,900	20,000
2009	81	13,600	1,950	200	14,500	1,260	15,800	16,100
2010	85	15,900	2,150	200	16,900	1,380	18,300	18,500
2011	87	16,600	2,240	200	17,700	1,430	19,100	19,400
2012	87	16,300	2,260	200	17,500	1,340	18,800	19,100
2013	85	16,600	2,310	200	17,800	1,380	19,100	19,300
2014	86	16,800	2,470	200	18,100	1,400	19,500	19,600
2015	86	15,600	2,430	200	17,000	1,280	18,300	18,300
2016	86	14,500	2,630	200	16,100	1,230	17,300	17,300
2017	85	14,800	2,640	200	16,400	1,200	17,600	17,600
2018	86	15,200	2,690	200	16,800	1,220	18,000	18,000
2019	84	14,000	2,700	200	15,700	1,180	16,900	16,900
2020	83	13,100	2,570	200	14,700	1,170	15,800	15,900
2021	83	13,900	2,670	200	15,700	1,120	16,800	16,800

Source: USGS Minerals Yearbook: Lime, 2002-2021 (annual).

Notes: Totals may not appear to sum correctly due to rounding. Apparent consumption is calculated as total lime sold or used plus imports minus exports. Imports and exports are presented in Table 2.

Due both to the ready availability of limestone deposits in the U.S. as well as the transportation costs associated with a heavy commodity, imports make up a small percentage of overall lime consumption. For the years 1998-2021, Table 2 presents the quantity of U.S. lime exports and imports, the value of those imports and exports, and the exports and imports as a percentage of domestic production and consumption, respectively (USGS, 2002-2021). While exports as a percentage of production and imports as a percentage of consumption have both increased over time, these percentages are currently approximately two percent. Compared against the world production of lime that also appears in Table 2, U.S. imports and exports of lime are negligible.

Table 2 Exports and Imports of Lime 1998-2021 (thousand metric tons)

Year	Exports	Exports as a Percentage of Production	Exports Value	Imports	Imports as a Percentage of Consumption	Imports Value	World Lime Production
1998	56	0.28%	9,110	231	1.14%	22,700	117,000
1999	59	0.30%	8,270	140	0.71%	15,700	116,000
2000	73	0.37%	9,960	113	0.58%	13,500	121,000
2001	96	0.51%	11,900	115	0.61%	15,100	121,000
2002	106	0.59%	13,100	157	0.88%	19,700	221,000
2003	98	0.51%	13,700	202	1.05%	22,500	238,000
2004	100	0.50%	14,300	232	1.15%	25,900	251,000
2005	133	0.67%	17,500	310	1.53%	33,100	270,000
2006	116	0.55%	19,200	298	1.41%	36,300	285,000
2007	144	0.71%	24,800	375	1.84%	49,600	302,000
2008	174	0.88%	27,100	307	1.53%	39,400	306,000
2009	108	0.68%	18,500	422	2.62%	53,200	291,000
2010	215	1.17%	36,200	445	2.41%	61,500	310,000
2011	231	1.21%	40,100	512	2.64%	69,900	330,000
2012	211	1.12%	36,700	468	2.45%	66,000	330,000
2013	271	1.42%	48,300	394	2.04%	64,100	340,000
2014	320	1.64%	57,600	414	2.11%	67,700	350,000
2015	346	1.89%	62,600	391	2.14%	66,900	370,000
2016	329	1.90%	64,500	376	2.17%	61,500	410,000
2017	391	2.22%	74,200	367	2.09%	62,300	410,000
2018	424	2.36%	83,600	370	2.06%	66,700	420,000
2019	347	2.05%	63,500	342	2.02%	62,500	430,000
2020	266	1.68%	39,100	308	1.94%	57,100	420,000
2021	335	1.99%	53,400	323	1.92%	62,100	430,000

Source: USGS Minerals Yearbook: Lime, 2002-2021 (annual).

Average lime prices between 1998 and 2021 are presented in Table 3 (USGS, 2002-2021). The real (inflation-adjusted) price of lime ranges from $97.75 per metric ton in 2001 to $151.84 per metric ton in 2020. While the 2020 price was likely influenced by the temporary closure of some plants due to the global COVID-19 pandemic, the real price has been on a general upward trend since 2001. Lime producers have cited increased costs of production as a factor in recent price increases (USGS, 2023).

Table 3 Average Lime Prices 1998-2021

Year	Total Value (thousands)	Average Value	
		Current $	2022 $
1998	1,210,000	60.30	101.97
1999	1,190,000	60.40	100.72
2000	1,180,000	60.60	98.81
2001	1,160,000	61.30	97.75
2002	1,120,000	62.60	98.29
2003	1,240,000	64.80	99.78
2004	1,370,000	68.90	103.32
2005	1,500,000	75.00	109.04
2006	1,700,000	81.20	114.52
2007	1,760,000	87.00	119.48
2008	1,840,000	92.40	124.50
2009	1,660,000	105.00	140.58
2010	1,950,000	107.00	141.56
2011	2,130,000	111.50	144.51
2012	2,230,000	118.50	150.76
2013	2,320,000	121.20	151.54
2014	2,390,000	122.40	150.23
2015	2,290,000	124.40	151.18
2016	2,160,000	125.10	150.52
2017	2,230,000	126.40	149.25
2018	2,340,000	130.50	150.47
2019	2,250,000	133.20	150.88
2020	2,150,000	135.80	151.84
2021	2,320,000	138.00	147.67

Source: USGS Minerals Yearbook: Lime, 2002-2021 (annual).

Table 4 provides expenditures for payroll, materials, and capital, and other operating expenses in lime manufacturing from 2002 to 2021 in both current and 2022 dollars (U.S. Census Bureau, 2002-2016, 2017, 2018-2021). Costs of materials include all raw materials, containers, and supplies used in production, repair, or maintenance during the year, as well as the cost of all electricity and fuel consumed. Capital expenditures include permanent additions and alterations to facilities and machinery and equipment used for expanding plant capacity or replacing existing machinery.

The cost of materials is the greatest cost to lime producers. Lime producers typically spend approximately 60 percent of their total costs on materials, with approximately 30 percent of materials costs being fuels.

Table 4 Production Costs for Lime Manufacturing (NAICS 32741) 2002-2021

	Annual payroll (millions)		Total cost of material (millions)		Total capital expenditures (millions)		Total other operating expenses (millions)	
Year	Current $	2022$	Current $	2022$	Current $	2022$	Current $	2022$
2002	173	271	437	686	43	67	-	-
2003	167	256	455	701	56	86	-	-
2004	184	276	492	738	76	115	-	-
2005	208	303	555	807	71	103	-	-
2006	212	300	596	840	143	202	-	-
2007	233	320	848	1,164	214	293	120	164
2008	245	330	899	1,212	228	308	114	153
2009	224	300	754	1,010	105	141	101	135
2010	245	325	902	1,194	106	140	109	144
2011	255	331	978	1,267	142	185	112	145
2012	253	321	1,039	1,322	227	289	116	147
2013	257	321	1,064	1,331	155	193	178	222
2014	260	319	1,017	1,248	226	277	180	221
2015	258	314	1,033	1,256	321	390	182	221
2016	258	311	1,006	1,211	188	226	185	222
2017	282	332	1,049	1,239	167	197	187	221
2018	304	350	1,138	1,313	123	142	186	214
2019	308	349	1,153	1,306	198	224	170	193
2020	298	334	996	1,114	117	131	186	208
2021	301	322	1,123	1,201	119	128	205	219

Source: US Census Bureau Annual Survey of Manufactures, 2002-2016; 2018-2021 (annual), US Census Bureau Economic Census, 2017.
Note: Total other operating expenses not reported for 2002-2006.

2.4 Consumption and Uses of Lime

Lime is widely used in a variety of industries.[4] Table 5 summarizes the primary uses of lime by industry for the period 2014-2021. While many different industries use lime, lime use generally falls into one of the following categories: chemical and industrial (including agriculture), metallurgical (including iron and steel production, the largest single use of lime), construction, environmental, and refractories. In Table 5, a miscellaneous and unidentified category is also included for years when data was withheld to avoid disclosing proprietary information.

[4] Additional information of the use of lime in the industries discussed in this section can be found at https://www.graymont.com/en/markets, https://www.carmeuse.com/na-en/markets-applications, and https://www.lhoist.com/en/market.

Table 5 Lime Usage in the United States (thousand metric tons)

Use	2014	2015	2016	2017	2018	2019	2020	2021
Chemical and industrial								
Fertilizer, including aglime	82	77	75	79	86	60	70	67
Glass	186	178	W	W	W	W	W	W
Paper and pulp	942	943	950	919	877	890	831	816
Precipitated calcium carbonate	803	798	690	659	680	607	440	444
Sugar refining	647	640	647	629	631	585	651	566
Other chemical and industrial	1,590	1,580	1,570	1,350	1,550	1,430	1,280	1,380
Total	4,250	4,220	3,930	3,640	3,830	3,570	3,270	3,270
Metallurgical								
Steel and iron								
Basic oxygen furnaces	2,470	2,140	1,860	1,900	2,300	2,190	1,790	1,960
Electric arc furnaces	3,150	2,570	2,470	2,760	2,650	2,580	2,650	3,100
Other steel and iron	322	251	184	218	237	183	139	197
Total	5,940	4,960	4,520	4,880	5,180	4,950	4,590	5,250
Nonferrous metallurgy	1,390	1,330	1,110	1,100	1,120	1,180	1,120	998
Total metallurgical	7,330	6,280	5,630	5,980	6,300	6,130	5,710	6,250
Construction								
Asphalt	207	196	238	261	247	188	162	141
Building Uses	269	323	272	289	254	251	254	244
Soil stabilization	1,220	1,330	1,410	1,350	1,290	1,470	1,580	1,640
Other construction	43	62	46	32	57	57	62	59
Total	1,740	1,910	1,970	1,930	1,850	1,960	2,060	2,080
Environmental								
Flue gas treatment								
Utility powerplants	3,660	3,310	3,160	3,440	3,400	2,420	2,090	2,450
Incinerators	194	235	203	178	155	150	192	154
Industrial boilers and other flue gas treatment	164	213	255	254	277	271	270	316
Total	4,020	3,760	3,620	3,870	3,830	2,840	2,550	2,920
Sludge treatment								
Sewage	110	104	129	123	133	128	117	130
Other, industrial, and hazardous	196	262	W	W	W	W	W	W
Total	306	365	129	123	133	128	117	130
Water treatment								
Acid-mine drainage	85	88	W	W	W	W	W	W
Drinking water	861	907	808	787	788	815	832	816
Wastewater	517	426	390	364	349	424	383	411
Total	1,460	1,420	1,200	1,150	1,090	1,240	1,220	1,220
Other environmental	190	155	151	221	213	189	131	112
Total environmental	5,980	5,700	5,100	5,370	5,260	4,400	4,020	4,390
Refractories (dead-burned dolomite)	219	200	200	200	200	200	200	200

Use	2014	2015	2016	2017	2018	2019	2020	2021
Miscellaneous and unspecified	-	-	505	538	613	653	588	613
Grand total	19,500	18,300	17,300	17,600	18,000	16,900	15,800	16,800

Source: USGS Minerals Yearbook: Lime, 2002-2021 (annual).
Note: W indicates data withheld to avoid disclosing proprietary data. These values are included in the Miscellaneous and unspecified category.

Table 6 summarizes the use of hydrated lime by industry over the same time period. While quicklime and hydrated lime can often be used interchangeably, some applications prefer one or the other depending on the feed rate of the process or the reactivity required. Likewise, high-calcium and dolomitic quicklime can often be used interchangeably, but some processes and agricultural uses require the magnesium present in dolomitic quicklime. The largest use of hydrated lime is in the construction industry.

Table 6 Hydrated Lime Usage in the United States, 2014-2021 (thousand metric tons)

Use	2014	2015	2016	2017	2018	2019	2020	2021
Chemical and industrial	643	564	554	519	542	615	625	653
Construction								
Asphalt	182	172	215	237	218	149	126	113
Building uses	256	266	268	263	252	248	250	241
Soil stabilization and other construction	471	487	570	574	541	618	607	604
Total	909	925	1,050	1,070	1,010	1,020	984	958
Environmental								
Flue gas treatment:								
Utility powerplants	269	260	332	359	411	361	303	363
Incinerators	31	30	24	27	25	22	22	22
Industrial boilers and other flue gas treatment	56	80	104	99	103	111	97	125
Total	356	369	460	485	539	494	422	511
Sludge treatment								
Sewage	30	29	36	33	42	29	18	17
Other sludge treatment	69	84	82	99	90	91	101	108
Total	99	113	117	132	132	120	119	125
Water treatment								
Acid-mine drainage	27	38	35	35	56	41	43	43
Drinking water	157	159	125	120	111	123	126	138
Wastewater	183	146	151	120	125	138	109	113
Total	367	342	311	275	292	301	277	293
Other environmental	52	54	56	82	88	63	57	37

Use	2014	2015	2016	2017	2018	2019	2020	2021
Metallurgy	44	65	79	74	87	89	84	92
Grand total	2,470	2,430	2,630	2,640	2,690	2,700	2,570	2,670

Source: USGS Minerals Yearbook: Lime, 2002-2021 (annual).

In agriculture, lime is used as a soil conditioner to manage pH and improve soil structure, as an additive to animal feed, and to manage pond pH in aquaculture. In the food industry, hydrated lime is used as a food processing agent, while lime is also used in the storage of fruits and vegetables as well as in sugar production. Lime is used in glass and fiberglass production as a fluxing agent, to manage viscosity, and to improve durability and chemical resistance. In the pulp and paper industry, lime is used for the treatment of liquid wastes from sulfite-pulping processes, it is an important part of the Kraft-pulping process, and it is used as a coagulant in color removal.

In the steel industry, lime is used to convert iron into pig iron, as a fluxing agent to remove impurities from steel being manufactured, or to enhance the refractory life of the furnaces. Hydrated lime may also be used as a lubrication agent when drawing steel rods, for pH correction in wastewater, and for bathing finished steel products or as a whitewash coating on the steel. Lime is a key component in several processes in the production of nonferrous metal.[5]

In the mining industry, both quicklime and hydrated lime are widely used in processes to aid the recovery of valuable minerals and metals from ore. Lime is also used to refine trona ore to produce soda ash (Na_2CO_3) and caustic soda (NaOH), which are themselves widely used in a variety of industries. It is also used in the treatment of mine tailings and land reclamation.

In construction, lime is used for soil conditioning and stabilization, fill drying, and as a filler for asphalt manufacture. Masonry applications include uses as a component of mortars, stucco, or plasters. Environmental uses of lime include its use as a reagent in emissions control devices, particularly in wet and dry flue-gas desulfurization (FGD)

[5] Additional information on metallurgical uses of lime can be found at https://www.lime.org/lime-basics/uses-of-lime/metallurgical-uses-of-lime/.

processes. It is also used for water and sewage treatment, treatment of animal wastes, hazardous waste treatment, and environmental rehabilitation.

Lime kiln dust (LKD), a co-product of the lime manufacturing process, also has a number of uses. It is commonly used for drying, conditioning, and stabilizing construction soils. It is also used for environmental remediation and the treatment of industrial waste.

2.4.1 Substitution Possibilities in Consumption

USGS (2023) notes that limestone can be a substitute for lime in many applications, but there may be some disadvantages because limestone contains less reactive material. However, it is considerably less expensive than lime and is a potential substitute for lime in agricultural applications, as a fluxing agent in the iron and steel industry, and for use in emissions control devices. USGS (2023) further notes that calcined gypsum is a potential alternative material in industrial plasters and mortars, while cement, cement kiln dust, fly ash, and lime kiln dust are potential substitutes for some construction uses of lime. Magnesium hydroxide is a potential substitute for lime in pH control (USGS, 2023; Gibson & Maniocha, 2015), and magnesium oxide is a potential substitute for dolomitic lime as a flux in steelmaking (USGS, 2023).

2.5 Affected Producers

The EPA estimates that there are currently 34 major sources subject to the Lime Manufacturing NESHAP operating in the United States, with no new sources anticipated in the foreseeable future.[6] An affected source under the NESHAP is the owner or operator of a lime manufacturing plant (LMP) that is a major source, or that is located at, or is a part of, a major source of HAP emissions, unless the LMP is located at a kraft pulp mill, soda pulp mill, sulfite pulp mill, beet sugar manufacturing plant, or only processes sludge containing calcium carbonate from water softening processes. An LMP is an establishment engaged in the manufacture of lime products (calcium oxide, calcium oxide with magnesium oxide, or dead burned dolomite) by calcination of limestone, dolomite, shells, or other calcareous substances. A major source of HAP is a plant site that emits or has the potential to emit any

[6] The January 5, 2023, proposed rule estimated that there were 35 major sources subject to the NESHAP. United States Lime & Minerals, Inc. has since indicated that they are completing a permit renewal for their Batesville, AR plant and will no longer be considered a major source.

single HAP at a rate of 9.07 megagrams (10 tons) or more, or any combination of HAP at a rate of 22.68 megagrams (25 tons) or more per year from all emission sources at the plant site.

The North American Industry Classification System (NAICS) code for the Lime Manufacturing industry is 327410. Affected LMPs are also found in facilities with a primary NAICS of 327120 (Clay Building Material and Refractories Manufacturing), 33111 (Iron and Steel Mills and Ferroalloy Manufacturing), 212391 (Potash, Soda, and Borate Mineral Mining), or 327310 (Cement Manufacturing).

NAICS 327410 comprises establishments primarily engaged in manufacturing lime from calcitic limestone, dolomitic limestone, or other calcareous materials, such as coral, chalk, and shells. Lime manufacturing establishments may mine, quarry, collect, or purchase the sources of calcium carbonate. NAICS 327120 comprises establishments primarily engaged in shaping, molding, baking, burning, or hardening clay refractories, nonclay refractories, ceramic tile, structural clay tile, brick, and other structural clay building materials. A refractory is a material that will retain its shape and chemical identity when subjected to high temperatures and is used in applications that require extreme resistance to heat, such as furnace linings. NAICS 33111 comprises establishments primarily engaged in one or more of the following: (1) direct reduction of iron ore; (2) manufacturing pig iron in molten or solid form; (3) converting pig iron into steel; (4) making steel; (5) making steel and manufacturing shapes (e.g., bar, plate, rod, sheet, strip, wire); (6) making steel and forming pipe and tube; and (7) manufacturing electrometallurgical ferroalloys. Ferroalloys add critical elements, such as silicon and manganese for carbon steel and chromium, vanadium, tungsten, titanium, and molybdenum for low- and high-alloy metals. Ferroalloys include iron-rich alloys and more pure forms of elements added during the steel manufacturing process that alter or improve the characteristics of the metal.

In the 2022 NAICS revisions, NAICS 212391 was combined with three similar NAICS codes to form NAICS 212390 (Other Nonmetallic Mineral Mining and Quarrying). NAICS 212390 comprises establishments primarily engaged in developing the mine site, mining, and/or milling or otherwise beneficiating (i.e., preparing) nonmetallic minerals (except coal, stone, sand, gravel, clay, and ceramic and refractory minerals). NAICS 327310 comprises establishments primarily engaged in manufacturing Portland, natural, masonry, pozzolanic, and other hydraulic cements.

The total number of firms and establishments in each NAICS with facilities potentially affected by this proposed rule, as well as their employment and annual payroll are summarized in Table 7 below. The information in Table 7 is not meant to serve as an exhaustive presentation for each affected industry but is instead meant to serve as a high-level summary of potentially relevant information for these industries. The impacts on the specific facilities expected to be affected by this proposed rule, as well as on the companies that own them, are discussed in Chapter 6.

Table 7 Number of Firms and Establishments, Employment, and Annual Payroll for Affected Industries: 2020

NAICS	NAICS Description	Firms	Establishments	Employment	Annual Payroll ($1,000)
212391	Potash, Soda, and Borate Mineral Mining	15	18	3,161	326,765
327120	Clay Building Material and Refractories Manufacturing	346	492	24,146	1,218,005
327130	Cement Manufacturing	89	189	11,819	1,030,337
327410	Lime Manufacturing	31	101	4,371	304,755
33111	Iron and Steel Mills and Ferroalloy Manufacturing	260	409	87,803	7,335,531

Source: U.S. Census Bureau, 2020 Statistics of U.S. Businesses.

3 ENGINEERING COST ANALYSIS

3.1 Introduction

This chapter provides a summary of the engineering cost analysis conducted for this rulemaking. Section 3.2 describes the affected sources. Section 3.3 briefly describes the methodology employed in the engineering cost analysis and presents the results of that analysis. Section 3.4 characterizes the uncertainty in the engineering cost estimates.

3.2 Affected Sources

The current Lime Manufacturing NESHAP defines the affected source as each lime kiln and its associated cooler and each individual processed stone handling (PSH) operations system. The PSH operations system includes all equipment associated with PSH operations beginning at the process stone storage bin(s) or open storage pile(s) and ending where the process stone is fed into the kiln. It includes man-made process stone storage bins (but not open process stone storage piles), conveying system transfer points, bulk loading or unloading systems, screening operations, surge bins, bucket elevators, and belt conveyors. The materials processing operations associated with lime products, lime kiln dust handling, quarry or mining operations, limestone sizing operations, and fuels are not subject to the NESHAP. Finally, lime hydrators and cooler nuisance dust collectors are not included under the definition of affected source under the NESHAP.

This proposed rule addresses currently unregulated emissions of HAP from the lime manufacturing source category. Emissions data collected for the 2020 residual risk and technology review (RTR) from the exhaust stack of existing lime kilns in the source category indicated the following unregulated pollutants were present: HCl, mercury, organic HAP, and D/F. Therefore, the EPA proposed amendments establishing standards that reflect MACT for these four pollutants emitted by the source category.

The January 5, 2023, proposed amendments included standards using THC as a surrogate for organic HAP. The EPA received comments opposing the use of THC as a surrogate for organic HAP. In response to these comments, the EPA re-evaluated the test data of organic HAP emissions and identified 8 pollutants from the data that were found to be consistently emitted by the lime manufacturing source category. The list includes both “high volume” and “low volume” organic HAP. These include the following pollutants: formaldehyde, acetaldehyde, toluene, benzene, xylenes (a mixture of m, o, and p isomers), styrene, ethyl benzene, and napthalene. The EPA believes that the emissions data of these 8 pollutants best represents the typical organic HAP emissions of the source category, and that by controlling the emissions of the 8 pollutants a lime manufacturing facility would also control potential emissions of all other organic HAP. For this reason, the EPA is re-proposing to use an aggregated emission standard of the 8 organic HAP identified in the data analysis as a surrogate for total organic HAP. Other comments received led to revisions and/or corrections in the limits for HCl, mercury, and D/F. A detailed summary of the proposed standards is provided in the memorandum titled *Maximum Achievable Control Technology (MACT) Floor Analysis for the Lime Manufacturing Plants Industry Supplemental Proposal*, located in the docket for this action.

3.3 Capital Investment and Annual Costs

Using test data submitted through the 2017 Information Collection Request (ICR) conducted in support of the 2020 RTR in conjunction with additional data provided by the industry, the costs of control devices expected to be used to meet the proposed standards were estimated using the methods described in the EPA Air Pollution Control Cost Manual (US EPA, 2017). Based on comments received about the January 5, 2023, proposed amendments, the costs of the control technologies were updated. Additionally, all costs were updated to 2022 using the Chemical Engineering Plant Cost Index annual value for 2022. The capital costs were annualized using an interest rate of 8.25 percent and an assumed equipment life for all controls of 20 years.[7]

Detailed information about the control devices used by the industry and assumptions made to estimate the emission reductions, control costs, and cost effectiveness are provided in the memorandum titled *Cost Impacts for the Lime Manufacturing Plants Industry Supplemental Proposal*, located in the docket for this action. That analysis found that Activated Carbon Injection (ACI) was the most cost-effective

[7] The EPA Air Pollution Control Cost Manual (US EPA, 2017) includes a discussion of interest rate selection. Specifically, Chapter 2, Section 2.5.2 discusses appropriate interest rates to use for engineering cost estimation. The prime rate was 8.25 percent in June 2023, when the costs were calculated.

control enabling compliance with the mercury standard. Dry Sorbent Injection (DSI) was the most cost-effective control enabling compliance with the HCl standard, but some units will require the use of a Wet Packed Tower Gas Absorber (WPTGA). The organic HAP standard could be met using ACI with some units also requiring the use of a Regenerative Thermal Oxidizer (RTO). ACI was also the most cost-effective control for meeting the standard for D/F. Some units are estimated to require the use of a gas conditioning tower using water spray injection to lower the temperature of the gas stream for use with these control devices. The costs of two types of gas conditioning towers that differ in the amount of cooling provided were estimated. The modeled control cost for each type of control and gas conditioning tower is presented in Table 8.

Table 8 Modeled Air Pollution Control Device Costs (2022$)

Control Type	HAP(s) Controlled	Total Capital Investment per Control (2022$)	Total Annual Cost per Control (2022$)
Dry Sorbent Injection	HCl	2,920,000	623,000
Activated Carbon Injection	Mercury, D/F, and Organic HAP	2,310,000	1,360,000
Wet Packed Tower Gas Absorber	HCl	20,300,000	3,520,000
Regenerative Thermal Oxidizer	Organic HAP	5,200,000	1,630,000
Gas Conditioning Tower (Type 1)	-	1,710,000	446,000
Gas Conditioning Tower (Type 2)	-	2,070,000	624,000

Note: Values rounded to three significant figures.

The total capital investment represents the cost of installation of the control. The annual cost of the control comprises the annualized payments for that capital cost as well as the annual operation and maintenance costs of these controls. In addition, for the activated carbon injection control, a lime kiln dust sales loss penalty was included to account for the loss of an otherwise sellable product due to the use of this control. The breakdown of total annual cost per control into these components is shown in Table 9.

Table 9 Breakdown of Air Pollution Control Device Total Annual Cost (2022$)

Control Type	Annualized Capital Cost (2022$)	Operation and Maintenance Costs (2022$)	Lime Kiln Dust Penalty (2022$)
Dry Sorbent Injection	303,000	320,000	0
Activated Carbon Injection	239,000	604,000	516,000
Wet Packed Tower Gas Absorber	2,110,000	1,420,000	0
Regenerative Thermal Oxidizer	540,000	1,090,000	0
Gas Conditioning Tower (Type 1)	177,000	269,000	0
Gas Conditioning Tower (Type 2)	215,000	409,000	0

Note: Values rounded to three significant figures.

Table 10 summarizes the total estimated control cost by control type, as well as the percentage of each control type's share of the total capital investment and annual costs. The largest share of total capital investment and total annual costs is associated with the activated carbon injection control.

Table 10 Total Cost of Estimated Controls Required for Compliance with Proposed Standards (2022$)

Control Type	Number of Controls for Proposed Standards	Total Capital Investment (millions)	Percentage of Total Capital Investment	Total Annual Costs (millions)	Percentage of Total Annual Costs
Dry Sorbent Injection	40	117	23%	24.9	14%
Activated Carbon Injection	66	152	30%	89.7	52%
Wet Packed Tower Gas Absorber	4	81.2	16%	14.1	8%
Regenerative Thermal Oxidizer	7	36.4	7%	11.4	7%
Gas Conditioning Tower (Type 1)	66	113	22%	29.4	17%
Gas Conditioning Tower (Type 2)	5	10.4	2%	3.12	2%
Total		510	100%	173	100%

Note: Values rounded to three significant figures.

Table 11 summarizes the total estimated control cost by the pollutant controlled. The largest shares of the control costs are associated with the control of HCl and mercury.

Table 11 Total Cost of Estimated Controls Required for Compliance with Proposed Standards, by Pollutant Controlled (2022$)

HAP	Total Capital Investment (millions)	Percentage of Total Capital Investment	Total Annual Costs (millions)	Percentage of Total Annual Costs
HCl	240	47%	50	29%
Mercury	221	43%	105	61%
Organic HAP	46	9%	16	9%
Dioxins/Furans	3	1%	2	1%
Total	510	100%	173	100%

Note: Values rounded to three significant figures.

While the more stringent beyond-the-floor option was not chosen after consideration of cost-effectiveness, for completeness the costs of estimated controls required to comply with this option are presented in Table 12, and Table 13 summarizes the total estimated control cost of the beyond-the-floor option by the pollutant controlled.

Table 12 Total Cost of Estimated Controls Required for Compliance with Beyond-the-Floor Option (2022$)

Control Type	Number of Controls for Proposed Standards	Total Capital Investment (millions)	Percentage of Total Capital Investment	Total Annual Costs (millions)	Percentage of Total Annual Costs
Dry Sorbent Injection	36	105	10%	22.4	8%
Activated Carbon Injection	72	166	16%	97.8	36%
Wet Packed Tower Gas Absorber	30	609	58%	106	39%
Regenerative Thermal Oxidizer	7	36.4	3%	11.4	4%
Gas Conditioning Tower (Type 1)	67	114	11%	29.9	11%
Gas Conditioning Tower (Type 2)	5	10.4	1%	3.12	1%
Total		1,040	100%	270	100%

Note: Values rounded to three significant figures.

Table 13 Total Cost of Estimated Controls Required for Compliance with Beyond-the-Floor Option, by Pollutant Controlled (2022$)

HAP	Total Capital Investment (millions)	Percentage of Total Capital Investment	Total Annual Costs (millions)	Percentage of Total Annual Costs
HCl	749	72%	137	51%
Mercury	243	23%	115	43%
Organic HAP	46	4%	16	6%
Dioxins/Furans	3	0%	2	1%
Total	1,040	100%	270	100%

Note: Values rounded to three significant figures.

Based on the new and existing source limits for lime kilns, new sources will be required to demonstrate initial compliance within 180 days after start-up, and existing sources must demonstrate initial compliance within 3 years after the promulgation of the final rule. Additionally, consistent with the existing performance testing requirements of the Lime Manufacturing NESHAP, subsequent performance testing will be required every five years. Continuous compliance with the emission limits will be demonstrated through control device parameter monitoring coupled with periodic emissions testing. Consistent with NESHAP general provisions, a source owner will be required to operate and maintain the source, its air pollution control equipment, and its monitoring equipment in a manner consistent with safety and good air pollution control practices for minimizing emissions, to include operating and maintaining equipment in accordance with manufacturer's recommendations. Owners will be required to prepare and keep records of calibration and accuracy checks of the continuous parameter monitoring system (CPMS) to document proper operation and maintenance of the monitoring system. Consistent with existing requirements in the Lime Manufacturing NESHAP, a source owner will be required to submit semi-annual compliance summary reports which document both compliance with the requirements of the Lime Manufacturing NESHAP and any deviations from compliance with any of those requirements. Owners and operators will be required to maintain the records specified by 40 CFR § 63.10 and, in addition, will be required to maintain records of all inspection and monitoring data, in accordance with the Lime Manufacturing NESHAP. The costs of these requirements are presented in Table 14 below and summarized in the supporting statement for the Information Collection Request (ICR) titled *NESHAP for Lime*

Manufacturing (40 CFR Part 63, Subpart AAAAA) (2021 LEAN Proposed Rule), available in the docket for this action.

Table 14 Testing, Monitoring, Recordkeeping, and Reporting Costs (2022$)

Cost Element	Cost per Respondent
One-time Costs	
Development and/or Adjustment of Recordkeeping System	$2,800
Recurring Costs	
Annualized Capital and O&M Costs Associated with Testing and Monitoring	$9,570
Familiarization with Reporting and Recordkeeping Requirements	$234
Inspection and Maintenance	$467
Performance Testing per facility (first year and every five years thereafter)	$4,670
Performance Test Reporting (first year and every five years thereafter)	$234
Recording and Transmitting Information	$18,300
Semiannual Compliance and Emergency SSM Reports	$2,800

Note: Values rounded to three significant figures.

For this proposed rule, we selected an 8-year analysis period and estimated compliance will begin in 2024. We selected an 8-year period for the calculations to follow the technology review cycle in the Clean Air Act (i.e., section 112(d)(6)). Table 15 summarizes for the proposed amendments the total cost of controls as well as testing, monitoring, recordkeeping, and reporting for facilities over the eight-year analysis period. While existing sources must demonstrate initial compliance within 3 years after the promulgation of the final rule, for the purposes of this analysis the initial test is assumed to occur in the first year. Facilities are then assumed to perform an additional test five years later. Likewise, controls are assumed to be installed in the first year of the rule. As previously mentioned in Section 3.3, the total annual cost of controls comprises the annualized capital cost of installed air pollution control devices and the annual operation and maintenance costs of these controls, as well as a lime kiln dust sales loss penalty for the activated carbon injection control. The range of estimated annual costs was $0 to $22.6 million per facility, and the average was $5.1 million per facility.[8]

[8] Detailed results can be found in the 00_LMP_Supplemental_Proposed_Control_Costs_2023.xlsx workbook available in the docket for this rule.

Table 15 Summary of Estimated Costs for the Proposed Amendments in Each of the First 8 Years After the Rule is Final (2022$)

Year	Total Annual Cost of Controls (2022$)	Recordkeeping and Reporting (2022$)	Total (2022$)
2024	$173,000,000	$1,370,000	$174,000,000
2025	$173,000,000	$1,100,000	$174,000,000
2026	$173,000,000	$1,100,000	$174,000,000
2027	$173,000,000	$1,100,000	$174,000,000
2028	$173,000,000	$1,100,000	$174,000,000
2029	$173,000,000	$1,270,000	$174,000,000
2030	$173,000,000	$1,100,000	$174,000,000
2031	$173,000,000	$1,100,000	$174,000,000

Note: Values rounded to three significant figures so totals may not appear to sum correctly.

Table 16 summarizes the costs of the beyond-the-floor option for the same 8-year analysis period. The testing, monitoring, recordkeeping, and reporting requirements are the same for this option as for the proposed amendments, and the difference in cost reflects the different mix of controls needed to meet the more stringent standards. The range of estimated annual costs was $0 to $43.7 million per facility, and the average was $7.95 million per facility.[9]

Table 16 Summary of Estimated Costs for the Beyond-the-Floor Option in Each of the First 8 Years After the Rule is Final (2022$)

Year	Total Annual Cost of Controls (2022$)	Recordkeeping and Reporting (2022$)	Total (2022$)
2024	$270,000,000	$1,370,000	$272,000,000
2025	$270,000,000	$1,100,000	$271,000,000
2026	$270,000,000	$1,100,000	$271,000,000
2027	$270,000,000	$1,100,000	$271,000,000
2028	$270,000,000	$1,100,000	$271,000,000
2029	$270,000,000	$1,270,000	$272,000,000
2030	$270,000,000	$1,100,000	$271,000,000
2031	$270,000,000	$1,100,000	$271,000,000

Note: Values rounded to three significant figures so totals may not appear to sum correctly.

Consistent with the Office of Management and Budget's Circular A-4, we also calculated the present value in 2023 of the costs of the proposed amendments using both 3

[9] Detailed results can be found in the 00_LMP_Supplemental_Proposed_Control_Costs_2023.xlsx workbook available in the docket for this rule.

and 7 percent discount rates (OMB, 2003). Table 17 below shows the undiscounted stream of costs per year for the proposed amendments. Capital costs are presented as completely incurred in their initial year, though large capital expenditures are typically financed over many years. Because the annualized costs presented in Table 8 assume a 20-year equipment life, the undiscounted costs are presented over the entire expected life of the equipment rather than the 8-year period presented in Table 15.

Table 17 Undiscounted Costs of Proposed Amendments 2024-2043 (2022$)

Year	Capital (2022$)	Non-Capital Annual Costs (2022$)	Recordkeeping and Reporting (2022$)	Total (2022$)
2024	$510,000,000	$120,000,000	$1,370,000	$631,000,000
2025	$0	$120,000,000	$1,100,000	$121,000,000
2026	$0	$120,000,000	$1,100,000	$121,000,000
2027	$0	$120,000,000	$1,100,000	$121,000,000
2028	$0	$120,000,000	$1,100,000	$121,000,000
2029	$0	$120,000,000	$1,270,000	$121,000,000
2030	$0	$120,000,000	$1,100,000	$121,000,000
2031	$0	$120,000,000	$1,100,000	$121,000,000
2032	$0	$120,000,000	$1,100,000	$121,000,000
2033	$0	$120,000,000	$1,100,000	$121,000,000
2034	$0	$120,000,000	$1,270,000	$121,000,000
2035	$0	$120,000,000	$1,100,000	$121,000,000
2036	$0	$120,000,000	$1,100,000	$121,000,000
2037	$0	$120,000,000	$1,100,000	$121,000,000
2038	$0	$120,000,000	$1,100,000	$121,000,000
2039	$0	$120,000,000	$1,270,000	$121,000,000
2040	$0	$120,000,000	$1,100,000	$121,000,000
2041	$0	$120,000,000	$1,100,000	$121,000,000
2042	$0	$120,000,000	$1,100,000	$121,000,000
2043	$0	$120,000,000	$1,100,000	$121,000,000

Note: Values rounded to three significant figures so totals may not appear to sum correctly.
Recordkeeping and Reporting values for 2024, 2029, 2034, and 2039 include cost of required performance test.

Table 18 shows the 2023 present values and equivalent annualized values of the costs shown in Table 17 at 3 and 7 percent discount rates. The equivalent annualized value is calculated over 20 years.

Table 18 2023 Present Value and Equivalent Annualized Value of Costs of Proposed Amendments 2024-2043 (2022$)

	3% Discount Rate	7% Discount Rate
Present Value	$2,430,000,000	$2,010,000,000
Equivalent Annualized Value	$164,000,000	$190,000,000

Note: Values rounded to three significant figures.

Table 19 reports the undiscounted stream of costs per year for the beyond-the-floor option over the same 2024-2043 period.

Table 19 Undiscounted Costs of Beyond-the-Floor Option 2024-2043 (2022$)

Year	Capital (2022$)	Non-Capital Annual Costs (2022$)	Recordkeeping and Reporting (2022$)	Total (2022$)
2024	$1,040,000,000	$162,000,000	$1,370,000	$1,200,000,000
2025	$0	$162,000,000	$1,100,000	$163,000,000
2026	$0	$162,000,000	$1,100,000	$163,000,000
2027	$0	$162,000,000	$1,100,000	$163,000,000
2028	$0	$162,000,000	$1,100,000	$163,000,000
2029	$0	$162,000,000	$1,270,000	$164,000,000
2030	$0	$162,000,000	$1,100,000	$163,000,000
2031	$0	$162,000,000	$1,100,000	$163,000,000
2032	$0	$162,000,000	$1,100,000	$163,000,000
2033	$0	$162,000,000	$1,100,000	$163,000,000
2034	$0	$162,000,000	$1,270,000	$164,000,000
2035	$0	$162,000,000	$1,100,000	$163,000,000
2036	$0	$162,000,000	$1,100,000	$163,000,000
2037	$0	$162,000,000	$1,100,000	$163,000,000
2038	$0	$162,000,000	$1,100,000	$163,000,000
2039	$0	$162,000,000	$1,270,000	$164,000,000
2040	$0	$162,000,000	$1,100,000	$163,000,000
2041	$0	$162,000,000	$1,100,000	$163,000,000
2042	$0	$162,000,000	$1,100,000	$163,000,000
2043	$0	$162,000,000	$1,100,000	$163,000,000

Note: Values rounded to three significant figures so totals may not appear to sum correctly. Recordkeeping and Reporting values for 2024, 2029, 2034, and 2039 include cost of required performance test.

Table 20 reports the 2023 present values and equivalent annualized values of the costs shown in Table 19 at 3 and 7 percent discount rates. As before, the equivalent annualized value is calculated over 20 years.

Table 20 2023 Present Value and Equivalent Annualized Value of Costs of Beyond-the-Floor Option 2024-2043 (2022$)

	3% Discount Rate	7% Discount Rate
Present Value	$3,650,000,000	$3,100,000,000
Equivalent Annualized Value	$246,000,000	$292,000,000

Note: Values rounded to three significant figures.

3.4 Secondary Impacts

In addition to the costs associated with installing and running the control devices described in Section 3.3, there are secondary impacts associated with these controls. These secondary impacts typically include the energy needed to power the control devices, solid waste and wastewater generated from operation of the control devices, and air emissions that result from the generation of electricity used to operate the control devices. While the cost of electricity, water, and waste disposal are accounted for in the estimates presented in Section 3.3, estimates of the total energy, solid waste, and wastewater impacts associated with the estimated controls required for compliance with the proposed standards are presented in Table 21. Table 22 presents this information for the estimated controls required for compliance with the beyond-the-floor option that was not selected.

Table 21 Secondary Impacts of Estimated Controls Required for Compliance with Proposed Standards

Control Type	Energy Impacts (mmBtu/yr)	Solid Waste Impacts (ton/yr)	Wastewater Impacts (gallon/yr)
Wet Packed Tower Gas Absorber	89,600	466	1,120,000
Dry Sorbent Injection	89,600	4,270	-
Regenerative Thermal Oxidizer	157,000	-	-
Activated Carbon Injection	148,000	8,650	-
Heat Exchangers	212,000	-	-
Total	696,000	13,400	1,120,000

Note: Values rounded to three significant figures.

Table 22 Secondary Impacts of Estimated Controls Required for Compliance with Beyond-the-Floor Option

Control Type	Energy Impacts (mmBtu/yr)	Solid Waste Impacts (ton/yr)	Wastewater Impacts (gallon/yr)
Wet Packed Tower Gas Absorber	672,000	3,500	8,410,000
Dry Sorbent Injection	80,600	3,840	-
Regenerative Thermal Oxidizer	157,000	-	-
Activated Carbon Injection	161,000	9,440	-
Heat Exchangers	215,000	-	-
Total	1,070,000	16,800	8,410,000

Note: Values rounded to three significant figures.

The energy impacts presented in Table 21 and Table 22 are expected to lead to increased emissions from electricity generating units (EGUs). Secondary emissions typically include carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter (PM), particulate matter less than 2.5 microns ($PM_{2.5}$), sulfur dioxide (SO_2), carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). However, the extent of the increase in these pollutants is highly dependent on the type of fuel used in the EGUs. The EPA does not have any information that suggests that facilities in the lime manufacturing source category generate their own electricity and is requesting comments about the source of electricity for these facilities. Because the EPA is not able to determine the source of electricity for affected lime manufacturing plants, estimates of secondary emissions impacts are not presented in this RIA.

3.5 Characterization of Uncertainty

It is important to note that the cost estimates presented in this chapter are subject to multiple sources of uncertainty. The proposed rule does not dictate that controls must be installed to control pollutants, and companies may find alternative methods to comply with the emissions limits. If companies are able to find alternative methods to comply, then the costs presented in this RIA may be overestimates. Furthermore, while the EPA has estimated the costs of controls in accordance with the methodology laid out in the EPA Air Pollution Control Cost Manual, these estimates necessarily include assumptions that may not be true for all facilities that install controls. The assumptions include but are not limited to the cost of equipment, labor, and utilities, as well as the interest rate firms will be able to obtain when financing capital expenditures. While the EPA has attempted to use the most recent data available and believes these costs are a conservative estimate of the costs of necessary emissions controls, the costs may be overestimated if the amount of emissions reductions required to comply with the standards was overestimated in the engineering cost analysis or if alternative, less expensive controls could be used to obtain the same reductions. Likewise, the costs may be underestimated if the amount of emissions reductions required to comply with the standards was underestimated in the engineering cost analysis or if the controls the EPA assumed will be needed are not able to obtain the required reductions.

The EPA was not able to determine how the compliance measures might affect capacity at facilities, or whether and how long facilities would need to close to complete upgrades and thus lose revenue during that time. However, the EPA did include a penalty for the loss of sales of lime kiln dust associated with the activated carbon injection control, in response to concerns expressed by the industry during the small business outreach process.

Finally, there may be an opportunity cost associated with the installation of environmental controls (for purposes of mitigating the emission of pollutants) that is not reflected in the compliance costs included in this chapter. If environmental investment displaces investment in productive capital, the difference between the rate of return on the marginal investment (which is discretionary in nature) displaced by the mandatory environmental investment is a measure of the opportunity cost of the environmental requirement to the regulated entity. To the extent that any opportunity costs are not included in the control costs, the compliance costs for this proposed action may be underestimated.

4 BENEFITS OF EMISSIONS REDUCTIONS

4.1 Introduction

The EPA was unable to monetize the benefits from the estimated mercury, HCl, THC, and D/F emissions reductions associated with the proposed amendments to the NESHAP. However, it is reasonable to expect that, were the Agency able to do so, reducing emissions of the pollutants below would reduce the incidence of adverse effects among the exposed populations. Monetization of the benefits of reductions in cancer incidences requires several important inputs, including central estimates of cancer risks, estimates of exposure to carcinogenic HAP, and estimates of the value of an avoided case of cancer (fatal and non-fatal). Due to methodology and data limitations, we did not attempt to monetize the health benefits of reductions in HAP in this analysis. Instead, we are providing a qualitative discussion of the health effects associated with HAP emitted from sources subject to control under the proposed action. The EPA remains committed to improving methods for estimating HAP benefits by continuing to explore additional aspects of HAP-related risk from the lime manufacturing sector, including the distribution of that risk. EPA requests comment on approaches for better characterizing the number and value of HAP-attributable adverse effects.

As shown in Table 23, the proposed standards are expected to result in the reduction of 884 tons of HCl per year, 0.23 tons of mercury per year, 20 tons of organic HAP per year, and 0.000000047 tons of dioxins/furans compared to the allowable emissions under the current NESHAP. The beyond-the-floor option that was not selected would have resulted in the reduction of an additional 568 tons of HCl per year and 0.01 tons of mercury per year.

Table 23 Estimated HAP Reductions

		Emissions Reductions (tons/yr)	
HAP	**Baseline Emissions (tons/yr)**	**Proposed Standards**	**Beyond-the-Floor Option**
Hydrogen Chloride (HCl)	2,230	884	1,453
Mercury (Hg)	0.32	0.23	0.24
Organic HAP Aggregate (oHAP)	106	20	20
Dioxins/Furans (DF)	0.0000013	0.000000047	0.000000047

While we expect these emissions reductions to have beneficial effects on air quality and public health for populations exposed to emissions from lime manufacturing facilities, we have determined that quantification of those benefits cannot be accomplished for this proposed rule. This is not to imply that there are no benefits of the proposal. Rather, it is a reflection of the difficulties in modeling the health effects and monetizing the benefits of reducing HAP emissions from this source category with the data currently available. The rest of this chapter provides a qualitative discussion of the health effects associated with the pollutants that will be controlled as a result of the proposed amendments to the NESHAP.

4.2 Hydrogen Chloride

Hydrogen chloride is a corrosive gas that can cause irritation of the mucous membranes of the nose, throat, and respiratory tract. Brief exposure to 35 ppm causes throat irritation, and levels of 50 to 100 ppm are barely tolerable for 1 hour (ATSDR, 2014). The greatest impact is on the upper respiratory tract; exposure to high concentrations can rapidly lead to swelling and spasm of the throat and suffocation. Most seriously exposed persons have immediate onset of rapid breathing, blue coloring of the skin, and narrowing of the bronchioles. Exposure to HCl can lead to RADS, a chemically or irritant-induced type of asthma. Children may be more vulnerable to corrosive agents than adults because of the relatively smaller diameter of their airways. Children may also be more vulnerable to gas exposure because of increased minute ventilation per kg and failure to evacuate an area promptly when exposed. Hydrogen chloride has not been classified for carcinogenic effects (U.S. EPA, 1995a).

4.3 Mercury

Mercury exists in three forms: elemental mercury (Hg, oxidation state 0); inorganic mercury compounds (oxidation state +1, univalent; or +2, divalent); and organic mercury compounds. Elemental mercury can exist as a shiny silver liquid, but readily vaporizes into air. All forms of mercury are toxic, and each form exhibits different health effects. Acute (short-term) exposure to high levels of elemental mercury vapors results in central nervous system (CNS) effects such as tremors, mood changes, and slowed sensory and motor nerve function. Chronic (long-term) exposure to elemental mercury in humans also affects the CNS, with effects such as erethism (increased excitability), irritability, excessive shyness, and tremors. The major effect from chronic ingestion or inhalation of low levels of inorganic mercury is kidney damage. Methylmercury (CH_3Hg+) is the most common organic mercury compound in the environment. Acute exposure of humans to very high levels of methyl mercury results in profound CNS effects such as blindness and spastic quadriparesis. Chronic exposure to methyl mercury, most commonly by consumption of fish from mercury contaminated waters, also affects the CNS with symptoms such as paresthesia (a sensation of pricking on the skin), blurred vision, malaise, speech difficulties, and constriction of the visual field. Ingestion of methyl mercury can lead to significant developmental effects. Infants born to women who ingested high levels of methyl mercury exhibited mental retardation, ataxia, constriction of the visual field, blindness, and cerebral palsy (ATSDR, 2022). The EPA has concluded that mercuric chloride and methyl mercury are possibly carcinogenic to humans (U.S. EPA, 1995b; U.S. EPA, 2001).

4.4 Acetaldehyde

Acetaldehyde is ubiquitous in the ambient environment. It is an intermediate product of higher plant respiration and formed as a product of incomplete wood combustion in fireplaces and woodstoves, coffee roasting, burning of tobacco, vehicle exhaust fumes, and coal refining and waste processing. Acute (short-term) exposure to acetaldehyde results in effects including irritation of the eyes, skin, and respiratory tract. At higher exposure levels, erythema, coughing, pulmonary edema, and necrosis may also occur. Acute inhalation of acetaldehyde has also resulted in a depressed respiratory rate and elevated blood pressure in experimental animals (U.S. EPA, 1991a). Symptoms of chronic (long-term) intoxication of acetaldehyde resemble those of alcoholism (Budavari, 1989). In hamsters, chronic inhalation exposure to acetaldehyde has produced changes in the nasal mucosa and trachea, growth retardation, slight anemia, and increased kidney weight. The EPA has classified acetaldehyde as a probable human carcinogen (Group B2) (U.S. EPA, 1991a).

4.5 Benzene

Acute effects of benzene inhalation exposure in humans include neurological symptoms such as drowsiness, dizziness, headaches, and unconsciousness. Exposure to benzene vapor can cause eye, skin, and upper respiratory tract irritation. Chronic exposure to benzene is associated with blood disorders, such as preleukemia and aplastic anemia (ATSDR, 2007a). The EPA's IRIS database lists benzene as a known human carcinogen (causing leukemia) by all routes of exposure. IRIS found a causal relationship between benzene exposure and acute lymphocytic leukemia and a suggestive relationship between benzene exposure and chronic non-lymphocytic leukemia and chronic lymphocytic leukemia (U.S. EPA, 2003b). IARC has also determined that benzene is a human carcinogen (IARC, 1987).

4.6 Ethylbenzene

Acute (short-term) exposure to ethylbenzene in humans results in respiratory effects, such as throat irritation and chest constriction, irritation of the eyes, and neurological effects such as dizziness. Chronic (long-term) exposure to ethylbenzene by inhalation in humans has shown conflicting results regarding its effects on the blood. Animal studies have reported effects on the blood, liver, and kidneys from chronic inhalation exposure to ethylbenzene. Limited information is available on the carcinogenic effects of ethylbenzene in humans (ATSDR, 2010a). In a study by the National Toxicology Program (NTP), exposure to ethylbenzene by inhalation resulted in an increased incidence of kidney and testicular tumors in rats, and lung and liver tumors in mice (NTP, 1999). The EPA has classified ethylbenzene as a Group D, not classifiable as to human carcinogenicity (U.S. EPA, 1991b). IARC classified ethylbenzene as a Group 2B carcinogen, possibly carcinogenic to humans (IARC, 2000).

4.7 Formaldehyde

Formaldehyde is used mainly to produce resins used in particleboard products and as an intermediate in the synthesis of other chemicals. Both acute and chronic exposure to formaldehyde via inhalation can cause irritation to the eyes, nose, and throat, and increased tearing. Effects from repeated exposure in humans include respiratory tract irritation, chronic bronchitis and nasal epithelial lesions such as metaplasia and loss of cilia. Animal studies suggest that formaldehyde may also cause airway inflammation—including eosinophil infiltration into the airways (ATSDR, 1999c). Some studies have shown that exposure to formaldehyde may cause cancer in animals (nose cancer) and humans (nasopharyngeal cancer). The EPA has classified formaldehyde as a probable human carcinogen (Group B1) (U.S. EPA, 1985b).

4.8 Naphthalene

Naphthalene is used in the production of phthalic anhydride; it is also used in mothballs. Acute exposure of humans to naphthalene by inhalation, ingestion, and dermal contact is associated with hemolytic anemia, damage to the liver, and neurological damage. Cataracts have also been reported in workers acutely exposed to naphthalene by inhalation and ingestion. Chronic (long-term) exposure of workers and rodents to naphthalene has been reported to cause cataracts and damage to the retina. Hemolytic anemia has been reported in infants born to mothers who “sniffed” and ingested naphthalene (as mothballs) during pregnancy (ATSDR, 2005; U.S. EPA, 1998a). Available data are inadequate to establish a causal relationship between exposure to naphthalene and cancer in humans. The EPA has classified naphthalene as a Group C, possible human carcinogen (U.S. EPA, 1998b). IARC classified naphthalene as possibly carcinogenic to humans, Group 2B (IARC, 2002).

4.9 Styrene

Styrene is primarily used in the production of polystyrene plastics and resins. Humans are exposed to styrene through breathing indoor air that has styrene vapors from building materials, consumer products, and tobacco smoke. Acute (short-term) exposure to styrene in humans results in mucous membrane and eye irritation, and gastrointestinal effects (ATSDR, 2010b). Chronic (long-term) exposure to styrene in humans results in effects on the central nervous system (CNS), such as headache, fatigue, weakness, and depression, CSN dysfunction, hearing loss, and peripheral neuropathy (ATSDR, 2010b; U.S. EPA, 1992). The International Agency for Research on Cancer (IARC) has assigned styrene to Group 2B, possibly carcinogenic to humans, based on limited evidence of carcinogenicity in animals but supporting data on mechanisms of carcinogenesis (IARC, 2019). The

National Toxicology Program (NTP) classified styrene as reasonably anticipated to be a human carcinogen based on limited evidence of carcinogenicity from human studies, sufficient evidence of carcinogenicity from animal studies and supporting data on mechanisms of carcinogenesis (NTP, 2021). The EPA has not assigned a formal carcinogen classification to styrene (U.S. EPA, 1992).

4.10 Toluene

Toluene is added to gasoline, used to produce benzene, and used as a solvent. Automobile emissions are the principal source of toluene to the ambient air. Toluene exposure causes toxicity to the central nervous system (CNS) in both humans and animals for acute (short-term) and chronic (long-term) exposures (ATSDR, 2017). CNS dysfunction and narcosis have been frequently observed in humans acutely exposed to elevated airborne levels of toluene; symptoms include fatigue, sleepiness, headaches, and nausea. CNS depression has been reported to occur in chronic abusers exposed to high levels of toluene. Chronic inhalation exposure of humans to toluene also causes irritation of the upper respiratory tract and eyes, sore throat, dizziness, and headache. Human studies have reported developmental effects, such as CNS dysfunction, attention deficits, and minor craniofacial and limb anomalies, in the children of pregnant women exposed to high levels of toluene or mixed solvents by inhalation (ATSDR, 2017). The EPA has concluded that that there is inadequate information to assess the carcinogenic potential of toluene (U.S. EPA, 2005).

4.11 Xylenes

Xylenes are released into the atmosphere as fugitive emissions from industrial sources, from auto exhaust, and through volatilization from their use as solvents. Acute (short-term) inhalation exposure to mixed xylenes in humans results in irritation of the eyes, nose, and throat, gastrointestinal effects, eye irritation, and neurological effects (U.S. EPA, 2003c). Chronic (long-term) inhalation exposure of humans to mixed xylenes results primarily in central nervous system (CNS) effects, such as headache, dizziness, fatigue, tremors, and incoordination; respiratory, cardiovascular, and kidney effects have also been reported (ATSDR, 2007b; U.S. EPA, 2003c). The EPA has classified mixed xylenes as a Group D, not classifiable as to human carcinogenicity (U.S. EPA, 2003c).

4.12 Dioxins and Furans

Dioxins and furans are a group of chemicals formed as unintentional byproducts of incomplete combustion. They are released to the environment during the combustion of fossil fuels and wood, and during the incineration of municipal and industrial wastes (ATSDR, 1998). Dioxins and furans are generally compared to 2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) as a reference (or index) chemical because it is relatively well-studied and the most toxic compound within the group (U.S. EPA, 1985a). Out of all HAPs for which a health benchmark has been assigned, 2,3,7,8-TCDD is the most potent for both cancer and non-cancer hazard. 2,3,7,8-TCDD causes chloracne in humans, a severe acne-like condition. It is known to be a developmental toxicant in animals, causing skeletal deformities, kidney defects, and weakened immune responses in the offspring of animals exposed to 2,3,7,8-TCDD during pregnancy. Human studies have shown an association between 2,3,7,8-TCDD and soft-tissue sarcomas, lymphomas, and stomach carcinomas (ATSDR, 1998). The EPA has classified 2,3,7,8- TCDD as a probable human carcinogen (Group B2) (U.S. EPA, 1985a).

5 ENVIRONMENTAL JUSTICE ANALYSIS

5.1 Introduction

Consistent with the EPA's commitment to integrating environmental justice (EJ) in the Agency's actions, and following the directives set forth in multiple Executive Orders, the Agency has carefully considered the impacts of this action on communities with EJ concerns. The EPA defines EJ as "the just treatment and meaningful involvement of all people regardless of income, race, color, national origin, Tribal affiliation, or disability, in agency decision-making and other Federal activities that affect human health and the environment so that people i) are fully protected from disproportionate and adverse human health and environmental effects (including risks) and hazards, including those related to climate change, the cumulative impacts of environmental and other burdens, and the legacy of racism or other structural or systemic barriers; and ii) have equitable access to a healthy, sustainable, and resilient environment in which to live, play, work, learn grow, worship, and engage in cultural and subsistence practices".[10] In recognizing that particular communities often bear an unequal burden of environmental harms and risks, the EPA continues to consider ways of protecting communities with EJ concerns from adverse public health and environmental effects of air pollution.

5.2 Demographic Analysis

To examine the potential for any EJ issues that might be associated with lime manufacturing facilities, we performed a proximity demographic analysis, which is an assessment of individual demographic groups of the populations living within 5 km (approximately 3.1 miles) and 50 km (approximately 31 miles) of the facilities. The EPA then compared the data from this analysis to the national average for each of the demographic groups. In this section, we focus on the proximity results for the populations living within 5 km of the facilities. A description of the methodology and the results of this proximity analysis for populations living within 50 km are included in the technical report

[10] *https://www.federalregister.gov/documents/2023/04/26/2023-08955/revitalizing-our-nations-commitment-to-environmental-justice-for-all*

titled *Analysis of Demographic Factors for Populations Living Near Lime Manufacturing Facilities*, which is available in the docket for this action.

A summary of the proximity demographic assessment performed for the major source lime manufacturing facilities is presented in Table 24. The results show that for populations within 5 km of the 34 Lime Manufacturing facilities, the following demographic groups were above the national average: Hispanic/Latino (37 percent versus 19 percent nationally), linguistically isolated households (21 percent versus 5 percent nationally), people living below the poverty level (27 percent versus 13 percent nationally), people of color (50 percent versus 40 percent nationally), and people without a high school diploma (17 percent versus 12 percent nationally).

Table 24 Proximity Demographic Assessment Results for Major Source Lime Manufacturing Facilities

Demographic Group	Nationwide	Population within 5 km of Facilities
Total Population	328,016,242	473,343
Race and Ethnicity by Percent		
White	60%	50%
Black	12%	9%
Native American	0.7%	0.9%
Hispanic or Latino (includes white and nonwhite)	19%	37%
Other and Multiracial	8%	3%
Income by Percent		
Below Poverty Level	13%	27%
Above Poverty Level	87%	73%
Education by Percent		
Over 25 and without a High School Diploma	12%	17%
Over 25 and with a High School Diploma	88%	83%
Linguistically Isolated by Percent		
Linguistically Isolated	5%	21%

Notes: Nationwide population and demographic percentages are based on the Census' 2015-2019 American Community Survey 5-year block group averages and include Puerto Rico. Demographic percentages based on different averages may differ. The total population counts within 5 km of all facilities are based on the 2010 Decennial Census block populations.

Minority population is the total population minus the white population.

To avoid double counting, the "Hispanic or Latino" category is treated as a distinct demographic category for these analyses. A person is identified as one of five racial/ethnic categories above: White, Black, Native American, Other and Multiracial, or Hispanic/Latino. A person who identifies as

Hispanic or Latino is counted as Hispanic/Latino for this analysis, regardless of what race this person may have also identified as in the Census.

The human health risk estimated for this source category for the July 24, 2020, RTR (85 FR 44960) was determined to be acceptable, and the standards were determined to provide an ample margin of safety to protect public health. Specifically, the maximum individual cancer risk was 1-in-1 million for actual emissions (2-in-1 million for allowable emissions) and the noncancer hazard indices for chronic exposure were well below 1 (0.04 for actual emissions, 0.05 for allowable emissions). The noncancer hazard quotient for acute exposure was 0.6, also below 1. The proposed changes to the NESHAP subpart AAAAA will reduce emissions by 905 tons of HAP per year, and therefore, further improve human health exposures for populations in these demographic groups. The proposed changes will have beneficial effects on air quality and public health for populations exposed to emissions from lime manufacturing facilities.

6 ECONOMIC AND SMALL BUSINESS IMPACTS

6.1 Introduction

This chapter presents the economic and small business impact analyses performed for this rulemaking. Section 6.2 describes the screening analysis that was performed to determine the impacts to small entities impacted by this proposed rule. Because the EPA was unable to certify that there will not be a significant economic impact on a substantial number of small entities, an initial regulatory flexibility analyses was prepared and appears in Section 6.3. Section 6.4 presents the economic impact modeling that was conducted for this rulemaking, while Section 6.5 concludes with a discussion of potential employment impacts of the proposed rule.

6.2 Screening Analysis

For this proposed rule, the EPA performed a screening analysis for impacts on affected facilities by comparing compliance costs to revenues at the ultimate parent company level. This is known as the cost-to-revenue or cost-to-sales test, or the "sales test." The sales test is an impact methodology the EPA employs in analyzing entity impacts as opposed to a "profits test," in which annualized compliance costs are calculated as a share of profits. The sales test is frequently used because revenues or sales data are commonly available for entities impacted by the EPA regulations, and profits data normally made available are often not the true profit earned by firms because of accounting and tax considerations. Also, the use of a sales test for estimating small business impacts for a rulemaking is consistent with guidance offered by the EPA on compliance with the Regulatory Flexibility Act and is consistent with guidance published by the U.S. Small Business Administration's Office of Advocacy that suggests that cost as a percentage of total revenues is a metric for evaluating cost increases on small entities in relation to increases on large entities (U.S. SBA, 2017).[11]

[11] The RFA compliance guidance to the EPA rule writers can be found at https://www.epa.gov/sites/default/files/2015-06/documents/guidance-regflexact.pdf.

Section 6.2.1 describes the process for identification of small entities, and the cost-to-sales ratios for all of the parent companies of affected facilities are presented and discussed in Section 6.2.2.

6.2.1 Identification of Small Entities

As discussed in Section 2.5, the EPA estimates that there are currently 34 major sources subject to the Lime Manufacturing NESHAP operating in the United States, with no new sources anticipated in the foreseeable future. These 34 affected facilities are owned by 11 different parent companies. EPA prepared a small business screening assessment to determine if any of the identified affected entities are small entities, as defined by the U.S. Small Business Administration (SBA). The parent companies of affected lime manufacturing plants fall into one of the NAICS codes in Table 25, which also presents the associated SBA small entity size threshold for each NAICS code.[12] Two of the ultimate parent companies owning affected facilities are small entities.

Table 25 Affected NAICS Codes and SBA Small Entity Size Standards

NAICS Code	NAICS Industry Description	Size standards in millions of dollars	Size standards in number of employees
212312	Crushed and Broken Limestone Mining and Quarrying		750
212321	Construction Sand and Gravel Mining		500
327120	Clay Building Material and Refractories Manufacturing		750
327320	Ready-Mix Concrete Manufacturing		500
327410	Lime Manufacturing		1,050
331110	Iron and Steel Mills and Ferroalloy Manufacturing		1,500
486110	Pipeline Transportation of Crude Oil		1,500
523910	Miscellaneous Intermediation	$47.0	

Source: U.S. SBA Table of Size Standards (March 17, 2023),

Table 26 provides information about the 11 parent companies that own affected lime manufacturing plants. For each parent company, the primary NAICS code of the business is indicated along with an estimate of the annual sales of the company and the number of employees, the number of affected facilities and their locations, and if they are

[12] The table of SBA's Small Business Size Standards is available at https://www.sba.gov/document/support-table-size-standards.

considered a small business based on the standards presented in Table 25. Of the 11 parent companies, 2 are considered small, and these 2 parent companies own 3 affected facilities.

Table 26 Ultimate Parent Companies Owning Affected Lime Manufacturing Plants

Ultimate Parent Company	Primary NAICS Code	Annual Sales (millions)	Number of Employees	Small Business?	Affected Facilities	Facility Locations
Carmeuse Lime, Inc.	212312	1,720	3,725	No	11	Saginaw, AL Gary, IN Butler, KY Maysville, KY River Rouge, MI Bettsville, OH Grand River, OH Millersville, OH Annville, PA Clear Brook, VA Manitowoc, WI
Cemex, S.A.B. de C.V.	327320	720	40,024	No	1	Ponce, PR
Cleveland-Cliffs Inc.	331110	20,440	11,672	No	1	East Chicago, IN
Genesis Energy, L.P.	486110	2,130	2,100	No	1	Green River, WY
Graymont Limited	327410	820	1,500	No	6	Gulliver, MI Pleasant Gap, PA Delta, UT Eden, WI Green Bay, WI Superior, WI
Greer Industries, Inc.	212312	103	430	Yes	1	Riverton, WV
HBM Holdings	523910	452	621	No	2	Verona, KY Ste. Genevieve, MO
Lhoist Group	327410	2,600	6,400	No	7	Calera, AL (Montevallo Plant) Calera, AL (O'Neal Plant) Peach Springs, AZ Sainte Genevieve, MO Las Vegas, NV Clifton, TX Ripplemead, VA
Magnesita Refratarios SA	327120	283	4,354	No	1	York, PA
Martin Marietta Materials Inc.	212321	4,740	8,700	No	1	Woodville, OH
Pete Lien & Sons, Inc.	327410	150	375	Yes	2	Rapid City, SD Laramie, WY

Note: Primary NAICS code, annual sales, and number of employees for ultimate parent companies were derived from multiple sources, including D&B Hoovers, Reference Solutions, and communication with companies.

United States Lime & Minerals, Inc. was included in the list of ultimate parent companies owning affected lime manufacturing plants for the original proposed rule. However, this company has since indicated that they are completing a permit renewal for their Batesville, AR plant and will no longer be considered a major source.

6.2.2 Small Business Impacts Analysis

The cost-to-sales ratios of the proposed amendments for ultimate owners of affected facilities are presented in Table 27. This table also indicates if the ultimate owner is considered a small entity based on SBA size standards. The impacts range from 0.02% to 3.9%.

Table 27 Cost-to-Sales Ratios of the Proposed Amendments for Ultimate Owners of Affected Facilities

Ultimate Parent Company	Small Business?	Affected Facilities	Affected Facilities with Costs	Sales ($M)	Total Annual Costs Including ICR Costs ($M)	Cost/Sales Including ICR Costs
Carmeuse Lime, Inc.	No	11	11	1,720	47.1	2.7%
Cemex, S.A.B. de C.V.	No	1	1	720	2.5	0.3%
Cleveland-Cliffs Inc.	No	1	1	20,440	4.9	0.02%
Genesis Energy, L.P.	No	1	1	2,130	2.5	0.1%
Graymont Limited	No	6	3	820	31.8	3.9%
Greer Industries, Inc.	Yes	1	1	103	3.5	3.4%
HBM Holdings	No	2	2	1,712	24.4	1.4%
Lhoist Group	No	7	7	2,600	42.7	1.6%
Magnesita Refratarios SA	No	1	1	283	3.6	1.3%
Martin Marietta Materials Inc.	No	1	1	4,740	5.5	0.1%
Pete Lien & Sons, Inc.	Yes	2	2	150	5.4	3.6%

Note: Sales values reflect global sales of all products from parent companies. Because most of the companies in this list are international or include sales from operations other than lime production, these sales are not directly comparable to the value of domestic lime sold that can be derived from Table 31. Information about the lime portion of the sales values in this table is not available.

Table 28 summarizes the cost-to-sales ratios presented in Table 27 by SBA size category. The bulk of the costs are anticipated to be borne by ultimate parent companies that are not small by SBA standards. These companies on average have cost-to-sales ratios that are smaller than those of small entities, but the maximum estimated impact is for a non-small company. The two small companies have an average cost-to-sales ratio of 3.5%.

Table 28 Summary of Cost-to-Sales Ratios of the Proposed Amendments by SBA Size Category

Small Business?	Ultimate Parent Companies	Affected Facilities	Total Annual Costs Including ICR Costs ($M)	Percentage of Total Annual Costs	Cost/Sales Including ICR Costs		
					Minimum	Average	Maximum
No	9	28	165.7	95.2%	0.02%	1.3%	3.9%
Yes	2	3	8.9	5.1%	3.5%	3.5%	3.6%

The cost-to-sales ratios of the beyond-the-floor option that was not selected are presented in Table 29. These impacts range from 0.02% to 5.6%.

Table 29 Cost-to-Sales Ratios of the Beyond-the-Floor Option for Ultimate Owners of Affected Facilities

Ultimate Parent Company	Small Business?	Affected Facilities	Affected Facilities with Costs	Sales ($M)	Total Annual Costs Including ICR Costs ($M)	Cost/Sales Including ICR Costs
Carmeuse Lime, Inc.	No	11	11	1,720	90.6	5.3%
Cemex, S.A.B. de C.V.	No	1	1	720	2.5	0.3%
Cleveland-Cliffs Inc.	No	1	1	20,440	4.9	0.02%
Genesis Energy, L.P.	No	1	1	2,130	2.5	0.1%
Graymont Limited	No	6	3	820	46.1	5.6%
Greer Industries, Inc.	Yes	1	1	103	3.5	3.4%
HBM Holdings	No	2	2	1,712	45.6	2.7%
Lhoist Group	No	7	7	2,600	60.3	2.3%
Magnesita Refratarios SA	No	1	1	283	3.6	1.3%
Martin Marietta Materials Inc.	No	1	1	4,740	5.5	0.1%
Pete Lien & Sons, Inc.	Yes	2	2	150	6.7	4.5%

Note: Sales values reflect global sales of all products from parent companies. Because most of the companies in this list are international or include sales from operations other than lime production, these sales are not directly comparable to the value of domestic lime sold that can be derived from Table 31. Information about the lime portion of the sales values in this table is not available.

Table 30 summarizes the cost-to-sales ratios presented in Table 29 by SBA size category. As with the proposed amendments, the bulk of the costs are anticipated to be borne by ultimate parent companies that are not small by SBA standards. These companies on average have cost-to-sales ratios that are smaller than those of small entities, but the maximum estimated impact is for a non-small company. The two small companies have an average cost-to-sales ratio of 4.0%.

Table 30 Summary of Cost-to-Sales Ratios of the Beyond-the-Floor Option by SBA Size Category

Small Business?	Ultimate Parent Companies	Affected Facilities	Total Annual Costs Including ICR Costs ($M)	Percentage of Total Annual Costs	Cost/Sales Including ICR Costs		
					Minimum	Average	Maximum
No	9	28	261.4	96.2%	0.02%	2.0%	5.6%
Yes	2	3	10.3	3.8%	3.4%	4.0%	4.5%

It is important to note that the cost-to-sales ratios estimated in this analysis may be overstated or understated depending on the accuracy of the information in the underlying data on parent company ownership and parent company revenues in addition to the accuracy of the facility-level engineering costs. The annual sales values for ultimate parent companies were derived from multiple sources, including D&B Hoovers, Reference Solutions, and communication with companies. However, as most of the companies in this industry are privately held and do not publicly report their sales, there is considerable uncertainty regarding the accuracy of this data. Likewise, there are uncertainties associated with the cost estimates. These uncertainties are discussed in Section 3.4.

Because of the magnitude of the estimated impacts on the two small entities affected by this rule, the EPA is unable to certify that there will not be a significant economic impact on a substantial number of small entities. As a result, the EPA prepared an initial regulatory flexibility analysis (IRFA) and convened a Small Business Advocacy Review (SBAR) Panel. These are discussed in the following section.

6.3 Initial Regulatory Flexibility Analysis

This section presents the IRFA for this proposed rule. This section describes the methods used to perform the small entity screening conducted for this proposal and the results of the screening. A small entity screening is used to determine whether a regulatory action may have a significant economic impact on a substantial number of small entities (SISNOSE). Thresholds for what constitutes 'significant' for economic impacts and 'substantial' for the number of small entities are outlined in guidance prepared for the Regulatory Flexibility Act (RFA) as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA).

The EPA did not certify a 'no SISNOSE' determination for this proposal as the small entity screening analysis discussed in Section 6.2 identified the potential for significant cost impacts on a substantial share of the small entities affected by this proposed rule. When a 'no SISNOSE' determination cannot be certified, the agency responsible for issuing the regulation in question must complete an IRFA. This section describes the IRFA conducted for this proposed rule, including summaries of the EPA's small entity outreach and the SBAR Panel's suggestions to reduce impacts on small businesses.

6.3.1 Regulatory Flexibility Act Background

The Regulatory Flexibility Act (RFA; 5 U.S.C.§ 601 et seq.), as amended by the Small Business Regulatory Enforcement Fairness Act (Public Law No. 104-121), provides that whenever an agency is required to publish a general notice of proposed rulemaking, it must prepare and make available an IRFA, unless it certifies that the proposed rule, if promulgated, will not have a significant economic impact on a substantial number of small entities (5 U.S.C. § 605[b]). Small entities include small businesses, small organizations, and small governmental jurisdictions. An IRFA describes the economic impact of the proposed rule on small entities and any significant alternatives to the proposed rule that would accomplish the objectives of the rule while minimizing significant economic impacts on small entities. Pursuant to section 603 of the RFA, the EPA prepared an IRFA that examines the impact of the proposed rule on small entities along with regulatory alternatives that could minimize that impact.

The EPA will prepare a Small Entity Compliance Guide to help small entities comply with this rule when it is finalized. As required by section 604 of the RFA, the EPA will prepare a final regulatory flexibility analysis (FRFA) for this action as part of the final rule. The FRFA will address the issues raised by public comments on the IRFA.

6.3.2 Reasons Why Action is Being Considered

This industry is regulated by the EPA because pollutants emitted from lime manufacturing facilities are considered to cause or contribute significantly to air pollution that may reasonably be anticipated to endanger public health. This action is being proposed to comply with CAA section 112 requirements, which direct the EPA to complete periodic reviews of NESHAPs following initial promulgation. The proposed requirements are being considered to address unacceptable health risks linked to emissions from lime manufacturing facilities and to provide an ample margin of safety to protect public health.

6.3.3 Statement of Objectives and Legal Basis for Proposed Rule

The EPA is required under CAA section 112(d) to establish emission standards for each category or subcategory of major and area sources of HAPs listed for regulation in section 112(b). These standards are applicable to new or existing sources of HAPs and require the maximum degree of emission reduction. These MACT standards are based on emissions levels that are already being achieved by the best-controlled and lowest-emitting sources in an industry. Within eight years of setting the MACT standards, the CAA directs EPA to assess the remaining health risks from each source category to determine whether the MACT standards protect public health with an ample margin of safety and protect against adverse environmental effects. The EPA is also required to review these standards set under CAA section 112 every eight years following their promulgation and revise them as necessary to account for improvements in air pollution controls and/or prevention.

This action proposes to amend the Lime Manufacturing NESHAP, which was previously amended when the EPA finalized the residual risk and technology review on July 24, 2020. In the *Louisiana Environmental Action Network* v. *EPA (LEAN)* decision issued on April 21, 2020, the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit) held that the EPA has an obligation to address unregulated emissions from a source category when the Agency conducts the 8-year technology review required by Clean Air Act (CAA) section 112(d)(6).[13]

This proposed rule addresses currently unregulated emissions of HAP from the lime manufacturing source category. Emissions data collected for the 2020 RTR from the exhaust stack of existing lime kilns in the source category indicated the following unregulated pollutants were present: HCl, mercury, organic HAP, and D/F. Therefore, the EPA is proposing amendments establishing standards that reflect MACT for these four pollutants emitted by the source category, pursuant to CAA sections 112(d)(2) and (3).

6.3.4 Description and Estimate of Affected Small Entities

The Regulatory Flexibility Act (RFA) describes small entities as “small businesses,” “small governments,” and “small organizations” (5 USC 601). The proposed amendments being considered by the EPA in this action are expected to affect a variety of businesses, including small businesses, but would not affect any small governments or small organizations. The “business” is defined as the owner company, rather than the facility. In

[13] Louisiana Environmental Action Network v. EPA, 955 F.3d 1088 (D.C. Cir. 2020) (“LEAN”).

an IRFA, the EPA evaluates affected entities at the highest level of business ownership, or the ultimate parent company level. The analysis uses the size of the ultimate parent company to determine the resources it has available to comply with the rule.

As noted in Section 6.2.2, the 34 affected facilities are owned by 11 ultimate parent companies, 2 of which were determined to be small entities based on the SBA size standards. The rule, as proposed, is expected to have significant economic impacts on both of the small businesses in this source category.

6.3.5 Reporting, Recordkeeping, and Other Compliance Requirements

The proposed rule requires testing every five years for all pollutants. This is considered to be the minimum testing requirement for a NESHAP. This is less burdensome than a continuous emissions monitoring requirement and can therefore be considered to minimize the monitoring burden for all entities.

6.3.6 Related Federal Rules

Lime manufacturing is also regulated by the EPA under the New Source Performance Standards for Lime Manufacturing Plants, proposed May 3, 1977, promulgated March 7, 1978, 40 CFR part 60 subpart HH. That rule limits particulate matter (PM) emissions from rotary and lime hydrator kilns.

6.3.7 Regulatory Flexibility Alternatives

Pursuant to sections 603 and 609(b) of the RFA, the EPA prepared an IRFA for the proposed rule and convened a SBAR Panel to obtain recommendations from small entity representatives (SERs) that would potentially be subject to the proposed rule.

The SBAR Panel reviewed the information provided by the EPA to the SERs and the SERs' oral and written comments from the pre-panel outreach and panel outreach. The Panel's review identified several significant alternatives for consideration by the Administrator of the EPA that accomplish the stated objectives of the CAA and minimize any significant economic impact of the proposed rule on small entities. The significant issues and alternatives identified by the Panel are summarized below. A copy of the full SBAR Panel Report is available in the docket.

6.3.7.1 Health-based standard for HCl

The Panel recommends the EPA consider and take public comment on a health-based standard for HCl based on CAA section 112(d)(4). With respect to pollutants for which a health threshold has been established, the Administrator may consider such threshold level, with an ample margin of safety, when establishing NESHAP emission standards. The Panel notes that there have been two separate risk analyses performed on the health impacts of HCl for this source category and both indicated that ambient levels of HCl resulting from kiln emissions were well below the health effects threshold established in the EPA Integrated Risk Information System. Therefore, the Panel believes these data are sufficient to allow EPA to consider the health impacts threshold when setting an HCl emissions limit. This would be an important step to lessen the impact of the rule on small businesses.

In response to this recommendation, the EPA is considering if it would be appropriate to establish health-based emission standards for HCl under CAA section 112(d)(4), and is soliciting public comment on this issue in the current supplemental proposal.

6.3.7.2 Aggregated organic HAP emission standard

The Panel recommends the EPA consider and take comment on an overall organic HAP limit rather than a THC limit. The proposed rule used THC as a surrogate for establishing an emissions limit for organic HAP. The Panel notes that EPA has the option of setting a standard for organic HAP (the actual pollutant being regulated) rather than relying on a THC surrogate if data are available. There is organic HAP data available to EPA; therefore, EPA has the flexibility to set a specific organic HAP limit.

In response to this recommendation, the EPA re-evaluated the test data of organic HAP emissions and identified 8 pollutants from the data that were found to be consistently emitted by the lime manufacturing source category. The list includes both “high volume” and “low volume” organic HAP. These include the following pollutants: formaldehyde, acetaldehyde, toluene, benzene, xylenes (a mixture of m, o, and p isomers), styrene, ethyl benzene, and napthalene. The EPA believes that the emissions data of these 8 pollutants best represents the typical organic HAP emissions of the source category. Furthermore, the EPA believes that controlling the emissions of these 8 pollutants from a lime manufacturing facility by use of activated carbon or other means would also control potential emissions of all other organic HAP because the same controls applied to control the 8 pollutants would also be effective controls for all organic HAP. For this reason, the EPA is re-proposing to use an aggregated emission standard of the 8 organic HAP identified in the data analysis as a surrogate for total organic HAP.

6.3.7.3 Use of Intra-quarry variability factor in setting mercury emissions limit

The Panel recommends that the EPA consider intra-quarry variability (IQV) of mercury in setting the mercury emissions limit. The Panel believes that the EPA should account for additional sources of variability in this floor determination, namely the long-term variability of the limestone mercury content that is not captured by a short-term emissions test.[14] The EPA is aware that limestone quarries are immense and are customarily used from periods of 50 to 100 years. The Panel notes that taking the average of a three-hour emissions test from one part of the quarry would not necessarily encompass all the different mercury levels throughout the quarry. The Panel notes that industry commenters had provided data on mercury content of kiln feed and core samples of quarry mercury content that they believe could be used to assess this long-term emissions variability.

In response to this recommendation and public comments on the January 5, 2023, proposed rule, the EPA reanalyzed the IQV factor to correct mistaken assumptions and revised the originally proposed mercury emission limit for new and existing quicklime sources from 24.9 pounds per million tons of lime produced (rounded to 25 lb/MMton) for

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[14] Because this source category has more than 30 sources, when setting MACT standards EPA looks to the average emissions of the best performing 12 percent of the sources for which emissions data are available. However, the test data used to set standards are a short-term snapshot of the emissions for the best performing kilns. For this reason, in setting MACT standards EPA assesses variability of the best performers by using a statistical formula designed to estimate a MACT floor level that is equivalent to the average of the best performing sources based on future compliance tests. For this source category the limestone quarry adjacent to a lime kiln is an inherent part of the process and it is not possible to find substitute limestone sources, so variability of mercury emissions is directly tied to the variability of the mercury content of the quarry.

both new and existing sources to 27 lb/MMton for new sources, and 34 lb/MMton for existing sources in the quicklime subcategory.

6.3.7.4 Subcategories for HCl emissions limit

The Panel recommends that the EPA retain the subcategories for the HCl numeric emissions limits unless the EPA sets a health-based standard for HCl. The Panel noted that the EPA does have the flexibility to set subcategories based on size, class, or type. In the proposed rule the EPA exercised this flexibility and established separate HCl emissions limits for different types of lime kilns and different types of lime products. The Panel notes that this flexibility reduces the economic impacts of the HCl standard by accounting for differences in emissions that are inherent to the kiln type. The Panel supports this subcategorization, noting that if the EPA does decide to set a health-based standard then this issue would become moot.

In response to this recommendation, the EPA has retained the subcategories and in response to a public comment has added a vertical kiln (VK): dolomitic lime (DL), dead-burned, dolomitic lime (DB) subcategory.

6.3.7.5 Work practice standard for dioxins/furans

The panel recommends that the EPA consider and take comment on setting a work practice standard for dioxins/furans in place of a numeric limit. The panel believes that the EPA should set a work practice standard for dioxins/furans rather than a numeric emissions limit. The Panel notes that Section 112(h)(2) of the CAA allows the Administrator to set a work practice standard if they determine that the application of measurement methodology to a particular class of sources is not practicable due to technological and economic limitations, and that a significant percentage of the D/F data shows that emissions are below the method detection limit. The Panel believes that the EPA should review these data to determine if they support a finding that it is not feasible in the judgment of the Administrator to prescribe or enforce a numeric emissions limit.

The EPA considered this recommendation but does not find that a work practice standard would be appropriate at this time because the EPA does not have data relating any work practice to dioxin/furan emissions reductions from lime manufacturing operations. Section 112(h)(3) of the CAA requires any work practice to achieve emissions reductions equal to that of an emission standard for the same pollutant.

6.4 Economic Impact Modeling

The proposed rule requires lime manufacturers to meet emission standards for the release of HAPs into the environment. To meet these standards, companies will have to add emissions control devices to reduce emissions of HCl, mercury, organic HAP, and dioxins/furans from kilns located at major sources. These changes may result in higher costs of production for affected producers and impact broader product markets if these costs are transmitted through market relationships. This section describes and quantifies potential economic impacts on lime producers and consumers resulting from the imposition of regulatory costs on lime production facilities.

This section starts with a brief overview of the conceptual approach to estimating potential economic impacts using a partial equilibrium model. We then present a discussion of the baseline data and elasticity estimates used to parameterize the economic model. The results section presents and interprets the results of the economic modeling, including market-level impacts such as changes in price, domestic production, and imports and societal-level impacts such as estimates of the change in producer and consumer welfare. The final section discusses key uncertainties and caveats of the market impact analysis.

6.4.1 Partial Equilibrium Model Description

The EPA based the partial equilibrium model on the model used in the EIA for the 2003 Lime MACT Standard (U.S. EPA, 2003a). We assume prices and quantities are determined in a perfectly competitive market for a single lime commodity, where the market equilibrium is determined by the intersection of market supply and demand curves, as shown in Figure 1. Under the baseline scenario, a market price and quantity (P, Q) are determined by the intersection of the downward-sloping market demand curve (D^M) and the upward-sloping market supply curve (S^M) that reflects the horizontal summation of the individual supply curves of directly affected and indirectly affected facilities.

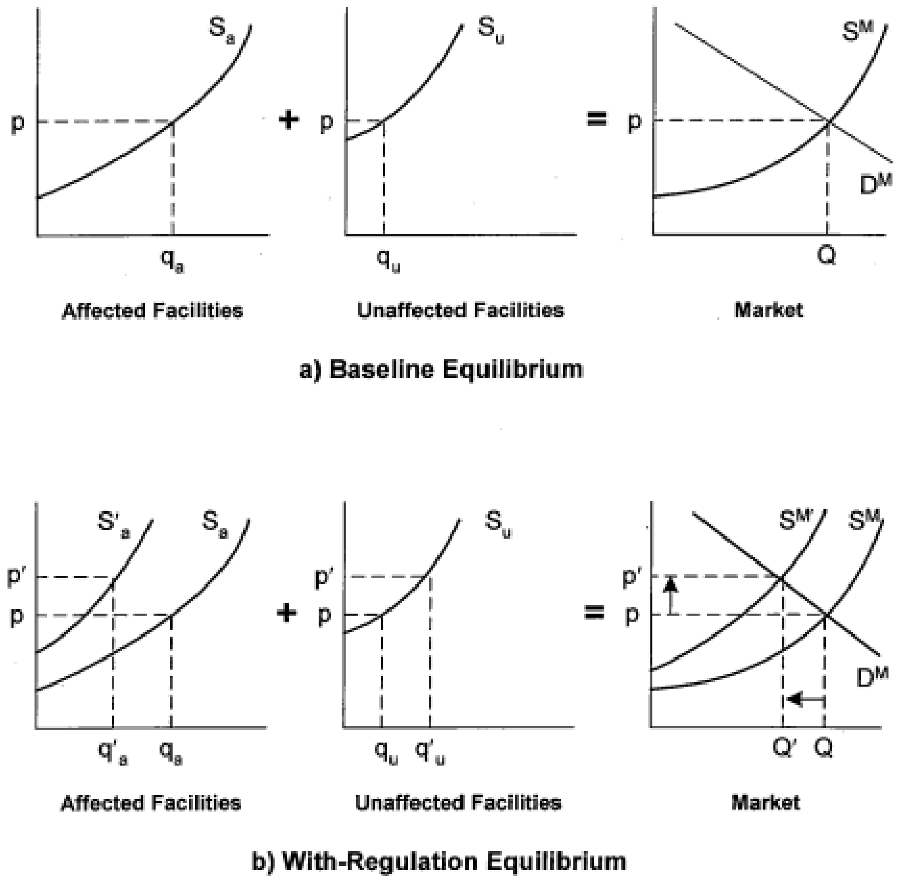

Figure 1 Market Equilibrium without and with Regulation

Under the regulation, the cost of production increases for directly affected producers. The imposition of the compliance costs is represented as an upward shift in the supply curve for each affected facility from S_a to S'_a. As a result, as shown in Figure 1, the market supply curve shifts upward to $S^{M'}$, reflecting the increased costs of production at these facilities. In the baseline scenario without the standards, the industry would produce total output, Q, at the price, P, with affected facilities producing the amount q_a and unaffected facilities accounting for Q minus q_a, or q_u. At the new equilibrium with the regulation, the market price increases from P to P', and market output (as determined from the market demand curve, D^M) declines from Q to Q'. This reduction in market output is the net result from output reductions at affected facilities and increases at unaffected facilities and reductions in consumer demand due to the increases in the market price for the good.

6.4.2 Operational Model

To develop quantitative estimates of economic impacts, the Agency developed an operational model written as a series of equations and solved using the modeling software GAMS. As described above, this model characterizes baseline demand and supply and the behavioral responses to changes in production costs and market prices.

6.4.2.1 Supply

Market supply in the lime market is defined as the sum of domestic and foreign supply, or:

$$Q^S = q_{dom}^S + q_{for}^S \qquad \text{Eq. 1}$$

where Q^S represents the quantity supplied, q_{dom}^S represents supply from domestic plants, and q_{for}^S represents supply from foreign sources (imports).

Parameters of the supply functions were calibrated using baseline production, price data, and the responsiveness of supply to changes in price (supply elasticity). We use a Cobb-Douglas supply function for a single representative supplier to represent the total supply from domestic firms. This function is expressed as follows:

$$q_{dom}^S = A(P - c_{dom})^{\varepsilon_{dom}^S} \qquad \text{Eq. 2}$$

where A is parameter that calibrates the supply equation to replicate baseline production, P is an estimate of the average market price, c_{dom} is the per-unit emissions control costs for domestic firms, and ε_{dom}^s is an estimate of the domestic supply elasticity.

Foreign producers do not face additional costs of production with regulation. However, their output decisions are affected indirectly by price changes expected to result from the regulation on domestic producers. Foreign supply is expressed as follows:

$$q_{for}^S = BP^{\varepsilon_{for}^S} \qquad \text{Eq. 3}$$

where B is a parameter that calibrates the supply equation to replicate baseline production and $\varepsilon_{for}^s$is an estimate of the foreign supply elasticity.

6.4.2.2 *Demand*

Market demand is the sum of domestic and foreign demand, or:

$$Q^D = q_{dom}^D + q_{for}^D \qquad \text{Eq. 4}$$

where q_{dom}^D represents domestic demand and q_{for}^D represents exports to foreign consumers.

Domestic demand is expressed as follows:

$$q_{dom}^D = CP^{\eta_{dom}^D} \qquad \text{Eq. 5}$$

where C is parameter that calibrates the demand equation to replicate domestic demand and η_{dom}^D is an estimate of the domestic demand elasticity.

Foreign demand is expressed similarly, or:

$$q_{for}^D = DP^{\eta_{for}^D} \qquad \text{Eq. 6}$$

where D is parameter that calibrates the demand equation to replicate lime exports and η_{for}^D is an estimate of foreign demand elasticity.

6.4.2.3 *Regulatory-Cost Induced Shifts in the Supply Function*

The upward shift in the supply function is calculated by taking the annual compliance cost estimate and dividing it by baseline output, represented by c_{dom} in Eq. 2, and subtracting this value from the market price faced by producers. Computing the supply shift in this manner treats the compliance costs as the conceptual equivalent of a unit-tax on output.

Typically, the Agency assumes that only the variable cost component of compliance costs varies with output levels. In that case, the variable costs are the only compliance costs that affect the firm's decisions regarding how much to produce, and the supply curve is assumed to shift up by the average variable per-unit operating costs. The fixed cost component of compliance costs is assumed to only influence the facility's decision regarding whether to operate or to exit the market. However, compliance expenditures may depend upon kiln capacity, which is also an important determinant in output levels.

Thus, we determined that including annual capital costs as part of the supply shift was appropriate for this analysis.

6.4.2.4 Estimating Changes in Producer and Consumer Surplus

From an economic perspective, the impact of a regulatory action is traditionally measured by the change in economic welfare that it generates. The regulation's welfare impacts, or the social costs required to achieve environmental improvements, will extend to consumers and producers alike. Consumers experience welfare impacts due to changes in market prices and consumption levels associated with the rule. Producers experience welfare impacts resulting from changes in pre-tax earnings corresponding with the changes in production levels and market prices. The relative changes between producer and consumer surplus provide an estimate of the distribution of regulatory costs between producers and consumers. However, it is important to emphasize that this measure does not include benefits that occur outside the market for the specific product, that is, the impact of reduced air pollution for which there may be substantial market and nonmarket economic values.

Changes in consumer surplus (ΔCS) are estimated from changes in prices and quantities using the following linear approximation formula:

$$\Delta CS = -\Delta P * Q_{baseline} + 0.5 * \Delta P * \Delta Q \qquad \text{Eq. 7}$$

We estimate the changes in consumer surplus for domestic and foreign consumers separately.

Changes in producer surplus (ΔPS) are estimated from changes in prices and quantities using the following linear approximation formula:

$$\Delta PS = \Delta P * Q_{baseline} \mp 0.5 * \Delta P * \Delta Q \qquad \text{Eq. 8}$$

where ΔP represents the net price to the producer. We estimate the changes in producer surplus for domestic and foreign producers separately. In calculating the producer surplus change for domestic producers, we additionally deduct the per ton of output estimate of compliance costs from the new price in calculating the change in price faced by domestic producers under the rule.

6.4.2.5 Baseline Data and Elasticity Estimates

To estimate a model of this type, the EPA would ideally have information on the quantities of lime produced for commercial sale and for captive use at each facility, as well as regional market prices. However, there are no publicly available data distinguishing lime produced for commercial and captive use at the state or regional level, and data on lime production are often not available at the state or regional level because states with low levels of production are aggregated or not reported to avoid disclosing individual company information. Thus, the market for lime was modeled as a national perfectly competitive market. The perfectly competitive market structure reflects the assumption that individual facilities have negligible power over the market price of the products and thus take the prices as "given" by the market.

While affected facilities will have three years to comply with the final regulation once it is issued, we do not have projections of lime market prices and quantities for future years. As a result, we analyze the most recent year for which we have baseline data, 2021. That the economics of future years will differ from 2021 is an important source of uncertainty in this analysis.

In 2021, the United States had 83 lime plants. These plants produced a total of 16.8 million metric tons of lime. About 15.7 million metric tons was sold commercially, and 1.1 million metric tons was used by producers themselves. Of the lime sold commercially, quicklime constituted 13.2 million metric tons (84 percent), and hydrated lime constituted 2.5 million metric tons (16 percent).

We used the data in Table 31 to characterize the market in 2021. Domestic production and import and export quantities for lime were collected from the U.S. Geological Survey (USGS).[15] We used the average price of lime for 2021 as reported by the USGS. Figure 2 displays trends in aggregate consumption, exports, imports, and inflation-adjusted prices.

[15] We obtained unrounded "Salient Statistics—United States" figures from USGS for 2021 (L. Apodaca, USGS, personal communication, September 22, 2023).

Table 31 Lime Market Baseline Data, 2021

Price ($/metric ton in 2022 dollars)[a]	148
Domestic Production (metric tons/year)	15,700
Domestic Consumption (metric tons/year)[b]	15,700
Domestic (metric tons/year)	15,400
Imports (metric tons/year)	323
Exports (metric tons/year)	335

Notes: [a] Converted from a 2021 estimate of average price to 2022 using the Gross Domestic Product-Implicit Price Deflator.

[b] Domestic consumption adjusted downward to account for approximately 1,100 tons of lime captive consumption by producers.

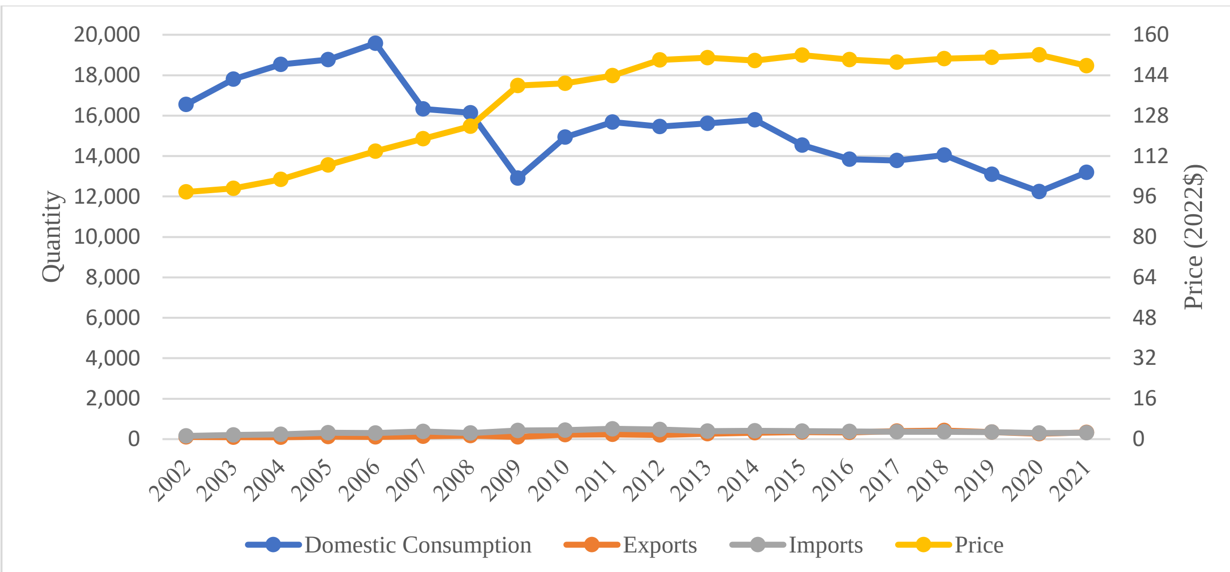

Figure 2 Market Trends

Table 32 shows the supply and demand elasticities used in the model. In the absence of available empirical estimates, the domestic supply elasticity was assumed to be 1.0. Empirical estimates are available for similar commodities (i.e., Portland cement), or aggregate commodity groups such as stone, clay, and glass, of which lime is one component. We used the domestic demand elasticity of -0.20 for cement as estimated by Miller et al. (2023) and foreign supply elasticity of 2.0 for cement as estimated by Broda et al. (2008). Ho and Jorgensen (1998) report an export demand elasticity of -1.2 for the stone, clay, and glass industry, which was used in this analysis for the lime export demand elasticity. These elasticities are also allowed to vary independently to provide estimate ranges for changes in prices and equilibrium quantities.

Table 32 Supply and Demand Elasticities

	Supply	Demand
Domestic	1.0[a]	-0.20[b]
Foreign	2.0[c]	-1.2[d]

[a] Assumed value.
[b] Miller et al. (2023)
[c] Broda et al. (2008)
[d] Ho and Jorgensen (1998)

6.4.2.6 Control Cost Inputs

As described in Section 3 of this RIA, the EPA developed compliance cost estimates for kilns subject to the proposed rule. To serve as inputs to the analysis, the affected kilns and associated compliance costs for each category of control are aggregated to the sector-level. The total annual compliance costs are expressed per unit of output and serve as "cost-shifters" for the industry aggregate domestic supply function. These costs are reported in Table 33 for the proposed amendments and the beyond-the-floor option that was not selected.

Table 33 National Engineering Control Cost Estimates (millions of 2022 dollars)

	Total Capital Investment	Non-capital Annual Costs	Total Annualized Costs
Proposed Amendments	510	121	174
Beyond-the-Floor Option	1,041	164	272

Note: Figures are rounded to the nearest million dollars. Total capital investment is annualized over an equipment life of 20 years using an interest rate of 8.25 percent.

Detailed information about the control devices used by the industry and assumptions made to estimate the emission reductions, control costs, and cost-effectiveness are provided in the memorandum titled *Cost Impacts for the Lime Manufacturing Plants Industry Supplemental Proposal*, located in the docket for this action.

6.4.3 Economic Impact Results

The model presented above suggests that regulated producers attempt to mitigate the impacts of higher-cost production by shifting the burden on to other economic agents to the extent the market conditions allow. We would expect the model to project upward pressure on prices for lime as producers reduced domestic output rates in response to higher costs. Unaffected foreign production (imports) would increase in response to higher prices. Consumption rates (domestic and exports) would be expected to fall. These interacting market adjustments determine the social costs of the regulation and its distribution across stakeholders (producers and consumers). We use the model equations, baseline data, and elasticities described in Section 6.4.2 and a solver application from the GAMS software package to compute the price and quantity changes necessary to achieve a post-regulation equilibrium. The GAMS code used in this analysis can be found in the docket for this action.

6.4.3.1 National-level Market Impacts

The increased cost of production due to the regulation is expected to increase the price of lime and reduce lime production and consumption from baseline levels. The level of increase depends on the responsiveness of consumers and producers to changes in price, measured by market demand and supply elasticities. As shown in Table 34, the price of lime increases 5.9 percent under the proposed amendments and 9.3 percent under the beyond-the-floor option that was not selected. While individual firms in a perfectly competitive market have no ability to unilaterally increase their price, the market price they receive will change in response to changes in market conditions, such as the increase in the cost of producing lime under the regulation.

Table 34 National-Level Market Impacts of the Proposed Amendments and Beyond-the-Floor Option: 2021

			Proposed Amendments		Beyond-the-Floor Option	
		Baseline	**Change**	**Change (%)**	**Change**	**Change (%)**
Price ($/metric ton in 2022$)		148	8.8 [5.7, 9.6]	5.9 [3.8, 6.3]	13.8 [9.0, 15.0]	9.3 [6.1, 10.2]
Quantity (thousand metric tons/year)	Domestic Production	15,700	-243 [-379, -137]	-1.5 [-2.4, -0.9]	-374 [-585, -213]	-2.4 [-3.7, -1.4]
	Imports	323	40 [25, 43]	12.3 [7.8, 12.5]	63 [30, 69]	19.5 [12.5, 21.4]
	Exports	335	-22 [-46, -8]	-6.7 [-13.7, -2.7]	-34 [-68, -12]	-10.1 [-20.3, -3.6]
	Domestic Consumption	15,700	-180 [-315, -80]	-1.1 [-2.0, -0.5]	-277 [-485, -129]	-1.8 [-3.1, -0.8]

Note: Point estimates are presented for the assumed elasticities. As a sensitivity analysis, elasticities were allowed to be their originally assumed to be half their originally assumed elasticity, equal to their originally assumed elasticity, or double their originally assumed elasticity. With three options per elasticity, this results in 81 (or 3^4) combinations. The same estimation procedure was used as was used to produce the point estimates. The ranges of estimates for the values articulated above appear in brackets and do not represent standard confidence intervals, nor do they imply any distribution or correlation.

Under the proposed amendments, domestic production is estimated to decline by 243,000 metric tons (1.5 percent), imports are estimated to increase by 40,000 metric tons (12.3 percent), and exports are estimated to decline by 22,000 metric tons (6.7 percent), resulting in an estimated net decline in the quantity of lime distributed to the domestic market by about 180,000 metric tons (1.1 percent). Under the beyond-the-floor option, these impacts are more pronounced. Domestic production is estimated to decline by 374,000 metric tons (2.4 percent), imports are estimated to increase by 63,000 metric tons (19.5 percent), and exports are estimated to decline by 34,000 metric tons (10.1 percent), resulting in an estimated net decline in the quantity of lime distributed to the domestic market of about 277,000 metric tons (1.8 percent). Although foreign lime suppliers are estimated to gain under the proposed amendments and the beyond-the-floor option, imports of lime account for such a small share of the U.S. lime market in the baseline that even a fairly large percentage increase in imports results in only a small increase in the quantity of lime imported. The fact that imports account for such a small share of the U.S. lime market implies that transportation costs are too high for imported lime to be competitive in the majority of the U.S.

In addition to some substitution of imported lime for domestic lime, it is expected that there would be some substitution towards lime substitutes in response to an increase in the price of lime. There are substitutes for lime in many of the markets in which it competes, such as crushed limestone, caustic soda, soda ash, and other products, although none of these products is a perfect substitute. Potential substitution is not explicitly quantified in this analysis because of insufficient data.

6.4.3.2 Social Costs

The economic analysis accounts for behavioral responses by producers and consumers to the regulation (i.e., shifting costs to other economic agents). This approach provides insights into the way in which the regulatory burden is distributed across stakeholders. As shown in Table 35, the economic model estimates a partial equilibrium estimate of the total social cost of the proposed amendments of $173 million and $269 million for the beyond-the-floor option. As noted above, these social cost estimates are incomplete as they do not account for economic impacts beyond the lime sector or the potential beneficial impacts of the regulation arising from the projected emissions reductions.

As a result of higher prices and lower consumption levels, domestic consumers are projected to lose $137 million in consumer surplus under the proposed amendments and foreign consumers are projected to lose $3 million in consumer surplus. Domestic producer surplus is estimated to decline by $36 million. Foreign producers are estimated to gain from the regulation with producer surplus increasing by about $3 million. Under the beyond-the-floor option, domestic consumers are projected to lose $214 million in consumer surplus and foreign consumers are projected to lose $4 million in consumer surplus. Domestic producer surplus is estimated to decline by $55 million under the beyond-the-floor option. Foreign producers are estimated to gain under the beyond-the-floor option with producer surplus increasing by about $5 million under this option. Under both the proposed amendments and beyond-the-floor option, foreign producers benefit from the higher prices associated with additional control costs on domestic producers and the fact that they do not have to incur the costs. As shown in Table 35, the majority of costs associated with the proposed amendments and beyond-the-floor option are passed on to consumers.

Table 35 Distribution of Social Costs Associated with the Proposed Amendments and Beyond-the-Floor Option (millions 2022$)

	Proposed Amendments	**Beyond-the-Floor Option**
Change in Consumer Surplus		
Domestic	*-137*	*-214*
Foreign	*-3*	*-4*
Change in Producer Surplus		
Domestic	*-36*	*-55*
Foreign	*3*	*5*
Total Surplus Change	**-173**	**-269**

6.4.4 Caveats and Limitations of the Market Analysis

The lime market impact analysis presented in this section is subject to several caveats and limitations. As with any modeling exercise, the market impact analysis depends crucially on uncertain input parameters. These parameters include the cost to firms of compliance, baseline price and quantity data, and elasticity estimates.

Of particular importance in model interpretation is that the model estimates the impact of regulatory costs on the production and consumption of a lime aggregate, where in reality there are several types of lime products used for different purposes. To the extent that the regulatory costs differ across different lime products, the economic impact results of this single-product model would differ from a model that characterized differentiated lime products.

As mentioned earlier, we do not have projections of lime market prices and quantities for future years. As a result, we analyze the most recent year for which we have baseline data, 2021. That the economics of future years will differ from 2021 is an important source of uncertainty in this analysis. This analysis also uses a single-period model whereas dynamic effects of regulation on investment may be an important feature of the lime market.

This analysis does not distinguish between different regions of the United States. The cost of producing lime products likely varies over the U.S. Compliance costs may also vary regionally. Impacts to lime production would likely be larger in regions with higher production costs or higher compliance costs. This could result in different price changes in different regions of the country to the extent lime cannot be easily transported large distances.

The choice of supply and demand elasticities are important sources of uncertainty. As discussed earlier, we were unable to obtain lime-specific elasticity estimates and chose available estimates for similar products from the cement, stone, clay, and glass industries, as well as making the strong assumption that the domestic elasticity of supply is 1.0 absent an empirical estimate. The choice of trade elasticities is also especially important in that lime may not be traded internationally to the same extent as the trade on the products from which the trade elasticities were estimated.

6.5 Employment Impacts

This section presents an overview of the various ways that environmental regulation can affect employment. Employment impacts of environmental regulations are generally composed of a mix of potential declines and gains in different areas of the economy over time. Regulatory employment impacts can vary across occupations, regions, and industries; by labor and product demand and supply elasticities; and in response to other labor market conditions. Isolating such impacts is a challenge, as they are difficult to disentangle from employment impacts caused by a wide variety of ongoing, concurrent economic changes. The EPA continues to explore the relevant theoretical and empirical literature and to seek public comments in order to ensure that the way the EPA characterizes the employment effects of its regulations is reasonable and informative.

Environmental regulation "typically affects the distribution of employment among industries rather than the general employment level" (Arrow et al., 1996). Even if impacts are small after long-run market adjustments to full employment, many regulatory actions have transitional effects in the short run (U.S. OMB, 2015). These movements of workers in and out of jobs in response to environmental regulation are potentially important and of interest to policymakers. Transitional job losses have consequences for workers that operate in declining industries or occupations, have limited capacity to migrate, or live in communities or regions with high unemployment rates.

As indicated by the potential impacts on lime markets discussed in Section 6.4, this proposed rule is projected to cause changes in lime production and price. As a result, demand for labor employed in lime manufacturing-related activities and associated industries might experience adjustments as there may be increases in compliance-related labor requirements as well as changes in employment due to quantity effects in directly regulated sectors and sectors that consume lime.

7 COMPARISON OF COSTS AND BENEFITS

7.1 Results

The net benefits for the proposed amendments to the NESHAP for Lime Manufacturing facilities are presented in Table 36. This table includes the present values (PV) and the equivalent annualized values (EAV) of the proposed amendments and the beyond-the-floor option from Table 18 and Table 20. Because the EPA estimated the compliance costs of the proposed amendments but was unable to monetize the health benefits of this rule, there is no value reported in this table for monetized benefits and the net benefits of this rule are therefore unclear. However, the proposed changes will have beneficial effects on air quality and public health for populations exposed to emissions from lime manufacturing facilities.

Table 36 Summary of Benefits, Costs and Net Benefits for the Proposed Amendments and Beyond-the-Floor Option from 2024 to 2043 (Million 2022$)

	Proposed Amendments				Beyond-the-Floor Option			
	3%		7%		3%		7%	
	PV	EAV	PV	EAV	PV	EAV	PV	EAV
Monetized Benefits	N/A		N/A		N/A		N/A	
Total Annual Costs	$2,430	$164	$2,010	$190	$3,650	$246	$3,100	$292
Net Benefits	N/A		N/A		N/A		N/A	
Non-Monetized Benefits	• 884 tpy of HCl • 0.23 tpy of mercury • 20 tpy of organic HAP • 0.000000047 tpy of D/F • Health effects of reduced exposure to HCl, mercury, organic HAP, and D/F				• 1,453 tpy of HCl • 0.24 tpy of mercury • 20 tpy of organic HAP • 0.000000047 tpy of D/F • Health effects of reduced exposure to HCl, mercury, organic HAP, and D/F			

Note: While we expect these emissions reductions to have beneficial effects on air quality and public health for populations exposed to emissions from lime manufacturing facilities, we have determined that quantification of those benefits cannot be accomplished for this proposed rule. This is not to imply that there are no benefits of the proposal. Rather, it is a reflection of the difficulties in modeling the health effects and monetizing the benefits of reducing HAP emissions from this source category with the data currently available.

7.2 Uncertainties and Limitations

The analysis presented in this RIA is subject to many sources of uncertainty. This analysis includes many data sources as inputs, including information about the types of affected units derived from information collection request responses, equipment and labor costs derived from the EPA Air Pollution Control Cost Manual and other sources, and assumptions regarding the current state of the lime manufacturing industry and how individual facilities carry out their operations.

As noted in Section 3.5, the proposed rule does not dictate that controls must be installed to control pollutants, and companies may find alternative methods to comply with the emissions limits. Furthermore, the cost estimates necessarily include assumptions that may not be true for all facilities that install controls. There is also uncertainty about the specific components of the engineering costs, such as the costs of the equipment and labor required to comply with the proposal and how the costs might change over time, as well as the interest rate firms may be able to obtain when financing capital expenditures. One specific issue for this source category is that data on the current emissions of the pollutants being regulated in this action is limited. Because emissions of mercury, HCl, organic HAP and dioxin/furans are not currently regulated, the emissions test datasets are small. As a result, for the majority of sources the current uncontrolled emissions of these pollutants are not known but rather are estimated based on the average values of the sources for which emissions are known. If the true emissions differ from these estimates, the costs and emissions reductions may be overestimated or underestimated.

This analysis is also unable to account for the future state of the industry or the future state of the world (*e.g.*, regulations, technology, economic activity, and human behavior). While no new major sources are currently predicted in the industry, this could change as the economy evolves.

Health benefits are not quantified and monetized in this RIA. The risk results and environmental justice analysis are also subject to several sources of uncertainty. First, there is uncertainty in the baseline emissions dataset and the modeling conducted to estimate the emissions reductions due to the proposal. There is also uncertainty associated with the inputs and assumptions used in the dispersion modeling, the inhalation exposure estimates, and the dose-response relationships in the human health risk assessment estimated for this source category for the July 24, 2020, RTR.

Finally, there is uncertainty in the small business impact assessment and economic impact modeling conducted for this analysis. The cost-to-sales ratios for individual firms reported in Section 6.2.2 are based upon the best information the EPA had available, but because the actual sales are often not publicly available and the cost estimates are subject to the uncertainty described above, the cost-to-sales ratios may overestimate or underestimate the true impact for affected firms. Uncertainties in the economic impact modeling are discussed in Section 6.4.4 and include data limitations and the lack of product and regional specificity in the model.

Despite these uncertainties and limitations, the EPA believes these costs are a conservative estimate of the costs and impacts of the proposed rule.

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United States Environmental Protection Agency	Office of Air Quality Planning and Standards Health and Environmental Impacts Division Research Triangle Park, NC	Publication No. EPA-452/R-24-004 January 2024