Hawaii State Department of Health

# Regional Haze Progress Report for Second Planning Period State Implementation Plan

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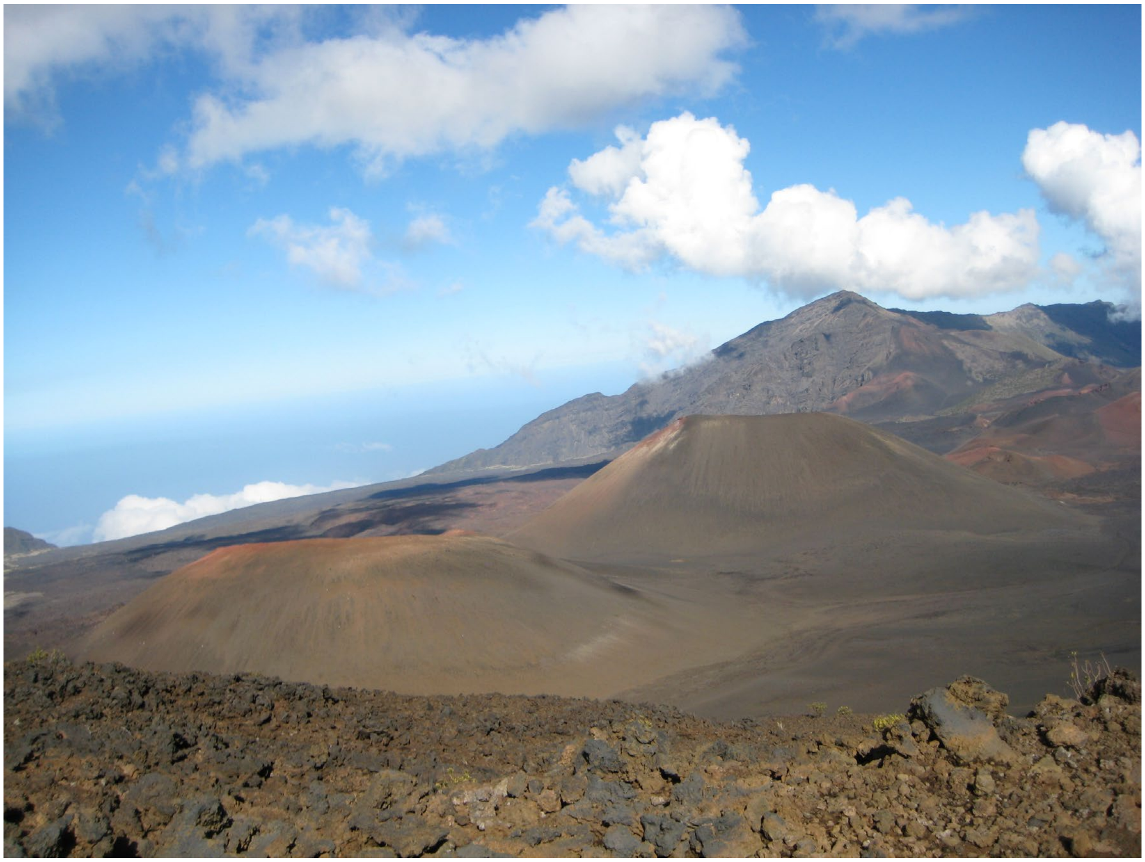

Haleakala Crater from Sliding Sands, Hawaii Volcanoes National Park, Photo by C. Fukushima

Kilauea Caldera from Uekahuna, Hawaii Volcanoes National Park, Photo by Janice Wei, National Park Service

## Executive Summary

In 1977, Congress amended the Clean Air Act (CAA) to include provisions of a national visibility goal to protect the scenic vistas of the nation's national parks and wilderness areas. In Section 169A of the CAA, Congress established the following national visibility goal:

> "The prevention of any future, and the remedying of any existing impairment of visibility in mandatory class I Federal areas which impairment results from manmade air pollution."

On July 1, 1999, the Environmental Protection Agency (EPA) issued the Regional Haze Rule (RHR) to establish goals and emission control strategies that make reasonable progress towards improving visibility in Mandatory Federal Class I areas. The goal of the RHR is to restore natural visibility conditions at all 156 Mandatory Federal Class I areas by 2064. States are required to prepare Regional Haze State Implementation Plans (RH-SIPs) that provide long-term strategies for complying with the RHR. Hawaii's Mandatory Federal Class I areas are Haleakala National Park on Maui Island and Hawaii Volcanoes National Park on the Big Island (Hawaii Island).

In accordance with 40 CFR §51.308(g), Hawaii must submit a progress report by January 31, 2025 describing progress made toward reasonable progress goals established in the Hawaii's RH-SIP for the second planning period (2018-2028). This report evaluates progress towards achieving reasonable progress goals (RPGs) for each National Park.

For the RH-SIP, Sulfur dioxide ($SO_2$), nitrogen oxides ($NO_X$), and particulate ($PM_{10}$/$PM_{2.5}$) were the primary anthropogenic pollutants affecting visibility in Hawaii's Class I areas. Statewide anthropogenic emissions of these visibility impairing pollutants have decreased significantly from 2014 to 2020. Emission reductions from federally enforceable control measures in Hawaii's RH-SIP will ensure further reductions of theses pollutants from large point sources near the national parks.

A new 40-45 MW power plant is proposed for Maui Island in the vicinity of Haleakala National Park. However, control measures will be used at the plant to reduce pollutants that can impact visibility. The plant will operate diesel engine generators with $NO_X$ controls (e.g., selective catalytic reduction or Tier 4 on-engine technology) and burn ultra-low sulfur diesel or gaseous fuel to minimize $SO_{2,}$ $NO_{X,}$ $PM_{10,}$ and $PM_{2.5,}$

The Hawaii Department of Health Clean Air Branch (DOH-CAB) has determined that control strategies in the existing Regional Haze Plan are adequate. Pursuant to 40 CFR §51.308(h)(1), Hawaii declares that no further revision of the second planning period RH-SIP is needed at this time.

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|---|---|
| AGP | Agricultural Burning Permit |
| Aerosols | Suspensions of tiny liquid and/or solid particles in the air |
| AirSHED | Emissions Inventory System Software from Lakes Environmental |
| Asian Dust | A meteorological phenomenon which affects must of East Asia. The dust originates in the deserts of Mongolia, northern China and Kazakhstan where high winds and intense dust storms kick up dense clouds of fine dry soil particles. The clouds are then carried eastward by prevailing winds. |
| BART | Best Available Retrofit Technology |
| $b_{ext}$ | Reconstructed Light Extinction |
| CAA | Clean Air Act |
| CALPUFF | Transport and Dispersion Model |
| CFR | Code of Federal Regulations |
| CM | Coarse Mass |
| COVID-19 | Coronavirus Disease 2019 |
| CSP | Covered Source Permit |
| CT | Combustion Turbine |
| CY | Cubic Yard |
| DEG | Diesel Engine Generator |
| DERA | Diesel Emissions Reduction Act |
| DOH-CAB | Department of Health Clean Air Branch (State of Hawaii) |
| DRR | Diesel Replacement Rebate |
| dv | Deciview, a measurement of visibility impairment |
| EC | Elemental Carbon |
| EEPS | Energy Efficiency Portfolio Standard |
| EGUs | Electric Generating Units |
| EIS | EPA’s Emissions Inventory System |
| EPA | US Environmental Protection Agency |
| ESP | Electrostatic Precipitator for particulate control |
| FIP | Federal Implementation Plan |
| FITR | Fuel Injection Timing Retard for $NO_X$ control |
| FLM | Federal Land Manager |
| ft | Feet |
| gal | gallon |
| GHG | Greenhouse Gas |
| Glidepath | The linear rate of improvement sufficient to attain natural conditions by 2064. |
| GWh | Gigawatt Hour (unit of electrical energy) |
| HACR1 | Haleakala Crater Visibility Monitoring Site |
| HALE1 | Haleakala Visibility Monitoring Site Outside Haleakala National Park |
| HAR | Hawaii Administrative Rules |
| HAVO1 | Hawaii Volcanoes National Park Visibility Monitoring Site |
| HCEI | Hawaii Clean Energy Initiative |
| Hawaiian Electric (HE) | Hawaiian Electric Company, Inc. |
| Hawaiian Electric Light (HL) | Hawaiian Electric Light Company, Inc. |
| HI | Haze Index |
| HNEI | Hawaii Natural Energy Institute |
| hr | Hour |
| HRS | Hawaii Revised Statute |
| HSEO | Hawaii State Energy Office |

| List of Acronyms and Definitions | |
|---|---|
| IMPROVE | Interagency Monitoring of Protected Visual Environments |
| IPP | Independent Power Producer |
| KIUC | Kaua‘i Island Utility Cooperative |
| kW | Kilowatt |
| LERZ | Lower East Rift Zone |
| m | meter |
| MECO | Maui Electric Company |
| MERZ | Middle East Rift Zone |
| $Mm^{-1}$ | Inverse mega meters |
| MVA | Megavolt Amp |
| MW | Megawatt |
| NA ECA | North American Emissions Control Area |
| NEI | National Emissions Inventory |
| NERZ | Northeast Rift Zone |
| $NH_3$ | Ammonia |
| $NO_X$ | Nitrogen oxides |
| NP | National Park |
| NPS | National Park Service |
| OC | Organic Carbon |
| PBFA | Public Benefits Fee Administrator |
| PGV | Puna Geothermal Venture |
| $PM_{2.5}$ | Particulate matter less than or equal to 2.5 micrometers in diameter |
| $PM_{10}$ | Particulate matter less than or equal to 10 micrometers in diameter |
| PMF | Positive Matrix Factorization |
| POM | Particulate Organic Mass |
| PSIP | Power Supply Improvement Plan |
| PUC | Public Utilities Commission |
| PY | Program Year |
| RH-SIP | Regional Haze State Implementation Plan |
| RHR | Regional Haze Rule |
| RPG | Reasonable Progress Goal |
| RPS | Renewable Portfolio Standard |
| SCR | Selective Catalytic Reduction for $NO_X$ control |
| SIP | State Implementation Plan |
| SLEIS | State and Local Emissions Inventory System Software from Windsor Solutions. |
| $SO_2$ | Sulfur dioxide Gas |
| SNCR | Selective Non-catalytic Reduction for $NO_X$ control |
| SUV | Sport Utility Vehicle |
| ton | US ton = (metric tons)*(0.90718474) |
| tonnes | Tonne = metric ton = (1/0.90718474)*(US tons) |
| TPY | Tons per year |
| TSS | Technical Support System |
| ULSD | Ultra Low Sulfur Diesel |
| URP | Uniform Rate of Progress |
| USDI | US Department of Interior |
| USDI-NSP | US Department of Interior – National Park Service |
| USGS-HAVO | United States Geological Survey Hawaii Volcano Observatory |
| VAP | Vehicle Assistance Program |
| VOC | Volatile organic compound |

| List of Acronyms and Definitions | |
|---|---|
| Vog | This is a local term that refers to “volcanic smog” or a hazy air pollution condition attributed to the active volcano. |
| Water Injection System | A system that injects demineralized water into the turbine generator’s combustion chamber to reduce the formation of thermal $NO_X$. |
| WEP/AOI | Weighted Emissions Potential / Area of Influence |
| WESTAR | Western States Air Resources Council |
| WRAP | Western Regional Air Partnership |
| yr | Year |

# Chapter 1 Overview

## 1.0 Introduction

Regional haze causes visibility impairment over a large region primarily from sources that emit fine particulate (PM$_{2.5}$) and its precursors into the air. Fine particulate that absorb and scatter light to cause the haze include sulfates, nitrates, coarse mass, organic carbon, elemental carbon, soil dust, and sea salt. Sources of particulate can be man-made (anthropogenic) or from natural events. Anthropogenic emissions from Hawaii sources include primary (directly emitted) PM$_{2.5}$ such as fugitive dust from aggregate processing or road dust from vehicle travel on unpaved roads. Natural emissions of primary PM$_{2.5}$ include aerosolized salts from sea spray. Precursors of PM$_{2.5}$, such as sulfur dioxide (SO$_2$), nitrogen oxides (NO$_X$), ammonia (NH$_3$), and volatile organic compounds (VOCs) can also react in the atmosphere to form secondary PM$_{2.5}$. For example, volcanic activity on Hawaii Island has emitted extremely large quantities of natural SO$_2$ as a secondary PM$_{2.5}$ source. Volcanic SO$_2$ emissions create vog when SO$_2$ reacts with sunlight and constituents in the air to form secondary sulfate aerosols (fine particulates) that cause haze on Hawaii Island and on other islands hundreds of miles away. Other sources of visibility impairing pollutants include primary and secondary particulate from combustion (e.g., electric and industrial plants, motor vehicles, agricultural burning, wildfires) etc.

Hawaii Island was created from six different volcanoes: Mahukona (oldest of the six), Kohala, Mauna Kea (tallest from the seafloor), Hualalai, Mauna Loa, and Kilauea (most active).[1] Three of them (Hualalai, Mauna Loa, and Kilauea) are still active. Figure 1.0-1 shows five of the volcanoes that contributed to the creation of Hawaii Island. Mahukona, a sixth volcano, is below the sea level to the NW of the figure's image. Kilauea, the youngest and most active volcano has erupted almost continuously since 1983 causing considerable property damage and vog from sulfates. Many starts and stops occurred in the Kilauea eruption between 2021 and 2023.[2]

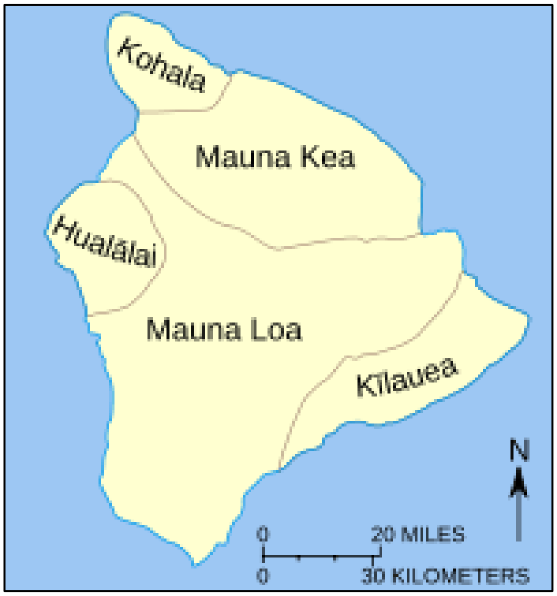

**Figure 1.0-1** Hawaii Island Volcanoes Map[1]

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[1] See https://www.lovebigisland.com/hawaii-blog/hawaii-volcano-history/. Image courtesy of the U.S. Geological Survey.

[2] Detailed explanation on Hawaii's volcanoes eruption between 2018 and 2022 is included in RH-SIP 2021, Revision 1, Appendix A.

Hawaii volcanic activity has been dominated by frequent Kilauea Volcano eruptions. At the onset of these eruptions, tens of thousands to hundreds of thousands of tons per day of $SO_2$ is released. For example, in the morning of June 7, 2023, the Kilauea Volcano resumed erupting after a three month break. Approximately 65,000 tonnes (about 72,000 tons) per day of $SO_2$ was measured immediately after the June 7th eruption.[3] The Mauna Loa Volcano eruption was another volcanic event that occurred simultaneously with the Kilauea Volcano eruption from November 27, 2022, to December 13, 2022. The $SO_2$ emission rate, measured on November 30, 2022, from the Mauna Loa eruption, was approximately 250,000 tonnes (about 275,600 tons) per day.[4] See Appendix A for recent volcanic activity.

While $SO_2$ emissions from volcanic activity have typically overwhelmed that from anthropogenic sources, $SO_2$ emissions decrease significantly when the volcanic eruptions stop. Emissions of $SO_2$ from the Kilauea Volcano on a typical day during a break in the eruption were less than 200 tons per day.[5] During periods when eruptions stop, contributions from anthropogenic sources to emissions that can cause haze are more significant.

## 1.1 Regional Haze Rule

Pursuant to Section 169A of the 1977 Clean Air Act (CAA) amendments for addressing Regional Haze, goals were established to protect visibility in 156 National Parks and wilderness areas designated by Congress as Mandatory Federal Class I areas (see Figure 1.1-1).[6] To meet these goals, the Regional Haze Rule (RHR) was established that requires State Implementation Plans (SIPs) to address visibility in Mandatory Federal Class I areas.

The primary purpose of the RHR is to assure reasonable progress toward meeting the national goal of preventing any future, and remedying any existing, impairment of visibility in Mandatory Federal Class I areas from human cause air pollution.[7] Under the RHR, states develop implementation plans with long-term strategies for protecting visibility in Class I areas. Requirements from the RHR are specified in 40 CFR Part 51, Subpart P, Protection of Visibility. The objective of the rule is to improve the visibility on the most impaired days at each Class I area and protect the visibility in these areas on the clearest days. The ultimate goal from implementing the RHR is to achieve natural visibility conditions in Class I areas by 2064. In accordance with the RHR, progress reports are due by January 31, 2025, July 31, 2033, and every 10 years thereafter.[7]

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[3] See June 8, 2023, at: https://volcanoes.usgs.gov/hans2/search.

[4] See Mauna Loa Has Begun Erupting | U.S. Geological Survey (usgs.gov)

[5] See April 26, 2023, at: https://volcanoes.usgs.gov/hans2/search

[6] See https://www.epa.gov/visibility/regional-haze-program

[7] 40 CFR, Part 51, Requirements for Preparation, Adoption, and Submittal of Implementation Plans, Subpart P, Protection of Visibility.

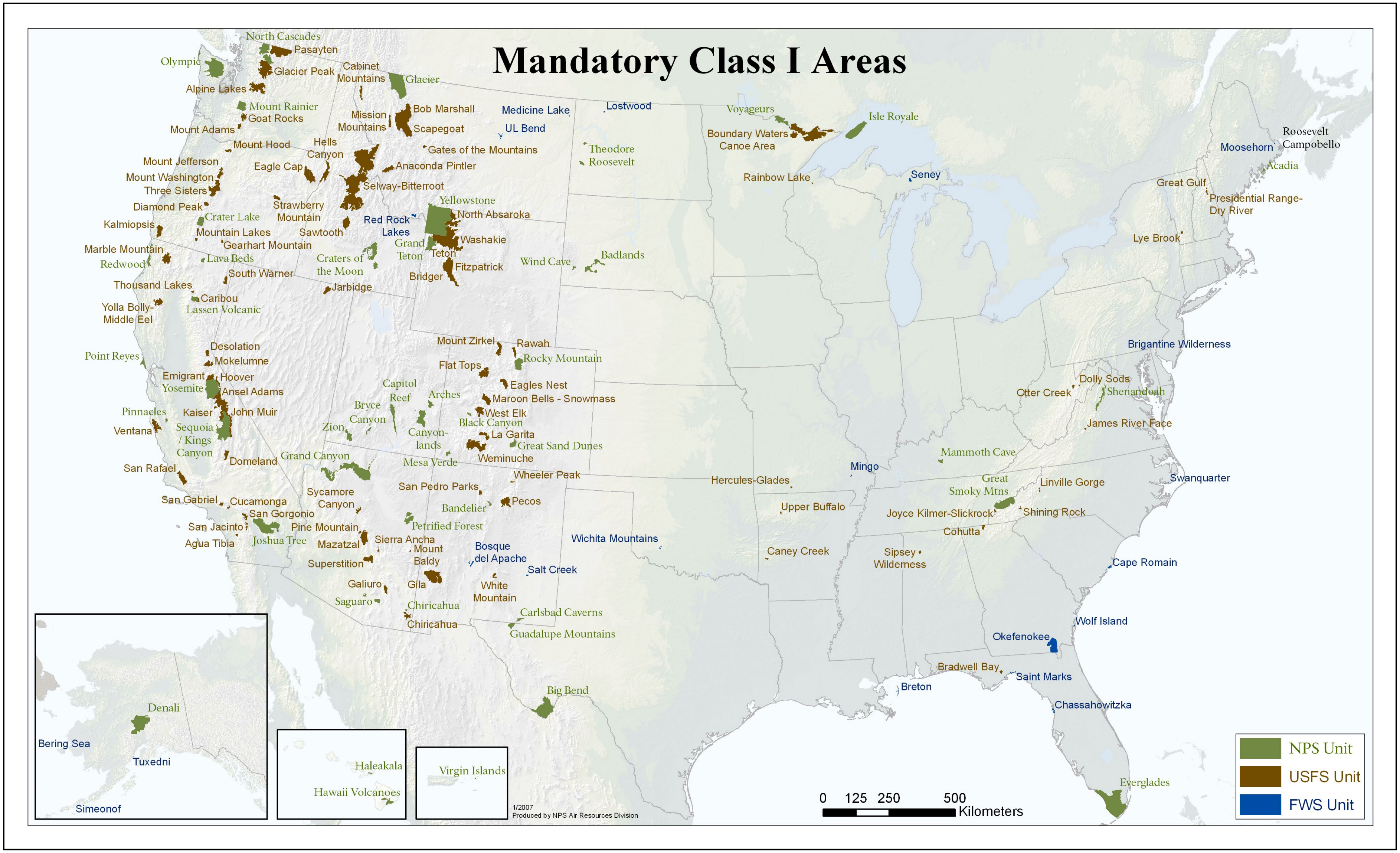

**Figure 1.1-1** Mandatory Class I areas within the United States[6]

## 1.2 Hawaii's Class I Areas

Hawaii's two Mandatory Federal Class I areas are Haleakala National Park on Maui and Hawaii Volcanoes National Park on the Big Island (Hawaii). As indicated in Note 3 on Page 1-3 of Reference 8 below, Class I areas include certain National Parks (over 6,000 acres), wilderness areas and national memorial parks (over 5,000 acres), and international parks which existed as of August 1977.[8] Table 1.2-1 below provides information on the acreage of Hawaii's two National Parks (one on Maui and the other on the Big Island). The National Parks are shaded in green in Figures 1.3-1 and 1.3-2.

**Table 1.2-1** Hawaii's Class I areas

| Class I Area | Island | Federal Land Manager | Acreage |
|---|---|---|---|
| Haleakala National Park | Maui | NPS | 33,265 |
| Volcanoes National Park | Hawaii | NPS | 229,616 |

## 1.3 Hawaii's IMPROVE Monitoring Sites

Visibility is measured at Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring sites to track Regional Haze progress. The HALE1 IMPROVE monitor, identified with blue dot in Figure 1.3-1, began operation on Maui in 1990 at a site approximately 3.5 miles outside of Haleakala National Park.[9] In 2007, a second IMPROVE monitor (HACR1 identified with pink dot in Figure 1.3-1) was installed at a higher elevation within Haleakala National Park. The HACR1 IMPROVE site was considered more representative of visibility conditions within Haleakala National Park and replaced the HALE1 monitoring station in 2012.[9] The HAVO1, Hawaii Volcanoes National Park IMPROVE monitor, started operation on the Big Island in 1988 and is identified with yellow dot in Figure 1.3-2. Topographical maps with IMPROVE monitoring sites, MesoWest weather observation locations, elevations, and mountain peaks for Maui and Hawaii Island are provided in Appendix B. Table 1.3-1 below provides additional information on the IMPROVE monitoring sites.

**Table 1.3-1** Hawaii's IMPROVE Monitoring Stations [9]

| Class I Area | IMPROVE Site | Island | Location | | Elevation | |
|---|---|---|---|---|---|---|
| | | | Latitude | Longitude | m | ft |
| Haleakala NP | HACR1[a] | Maui | 20.7585 | -156.2479 | 2,158 | 7,080 |
| | HALE1[b] | Maui | 20.8086 | -156.2823 | 1,153 | 3,783 |
| Hawaii Volcanoes NP | HAVO1 | Hawaii | 19.40309 | -155.2579 | 1,259 | 4,130 |

[a] Monitoring at HACR1 began in 2007.

[b] Monitoring at HALE1 site was discontinued in 2012.

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[8] Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule, U.S. EPA, September 2003.

[9] WRAP Regional Haze Rule Reasonable Progress Summary Report, June 28, 2013; Appendix A.

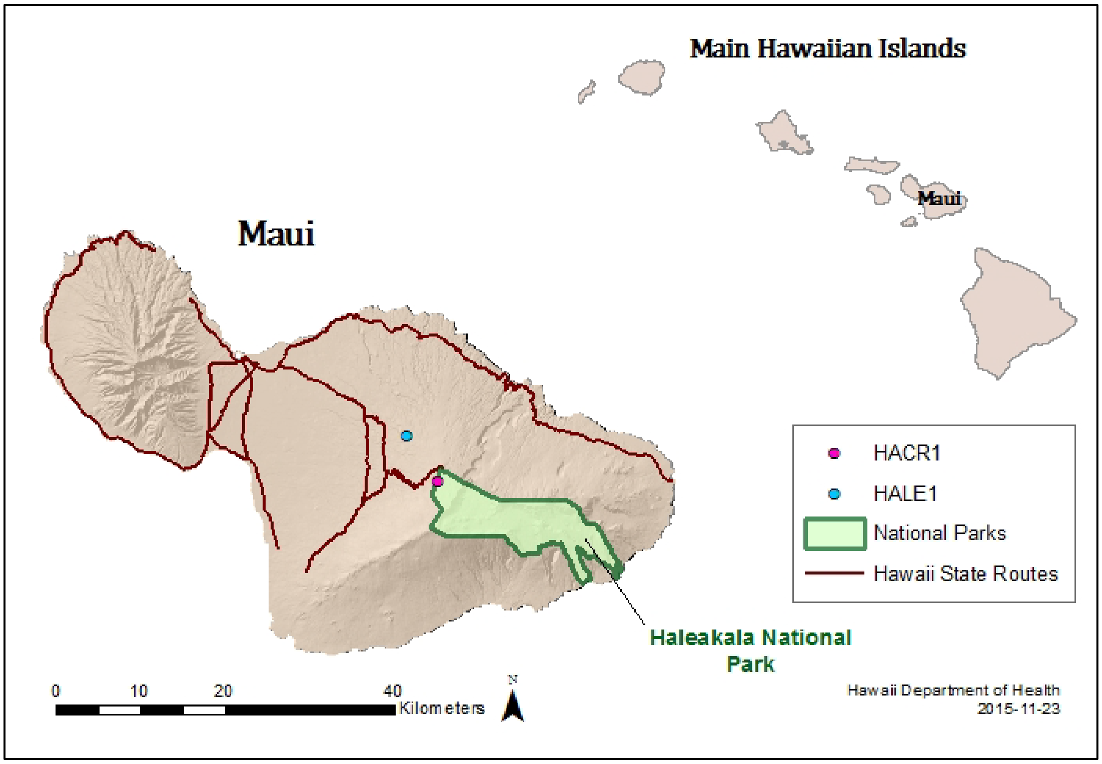

**Figure 1.3-1** Haleakala National Park Visibility Monitoring Sites (IMPROVE Sites HALE1 and HACR1)

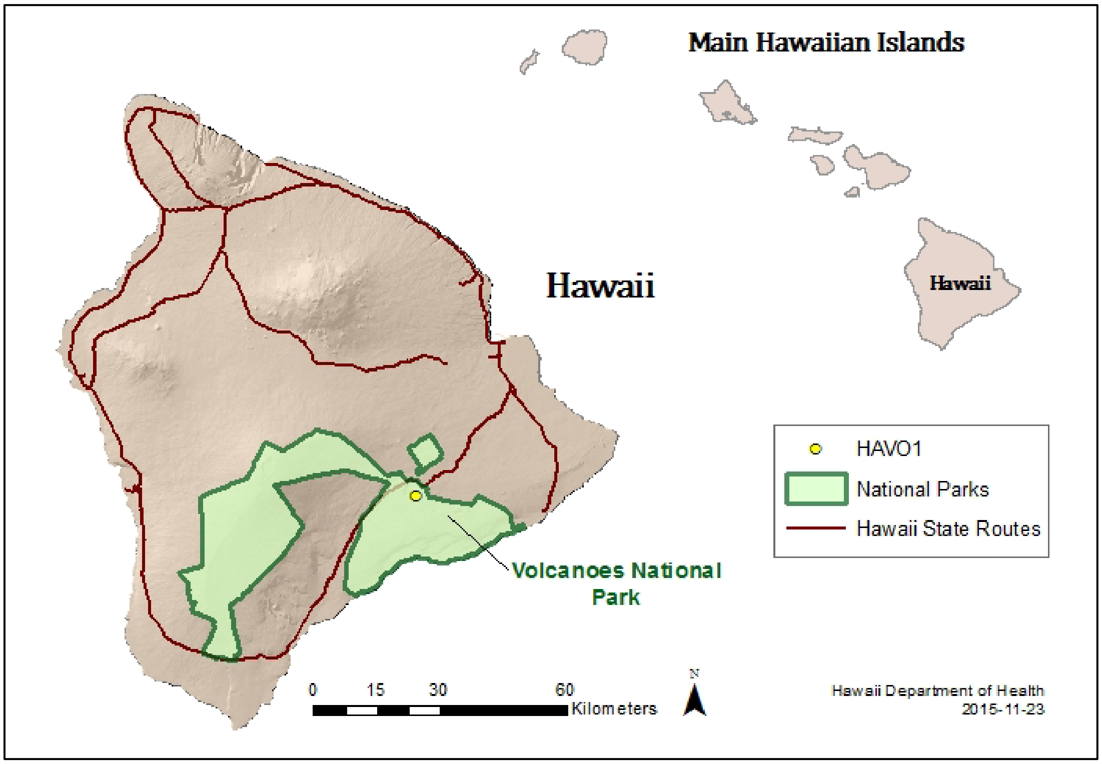

**Figure 1.3-2** Volcanoes National Park Visibility Monitoring Sites (IMPROVE Site HAVO1)

## 1.4 Estimating Visibility Impairment

Particles and gases in the atmosphere can both absorb and scatter light. The absorption and scattering of light result in light extinction (visibility impairment between the viewer and the light source) creating haze.

The particulate concentration data is converted into reconstructed light extinction (“$b_{ext}$”) in units of inverse mega meters ($Mm^{-1}$) with the IMPROVE equation.[10] The IMPROVE equation is used to convert the measured or modeled concentrations into extinction for each pollutant chemical species and totals the extinction values accounting for the effect of relative humidity. The equation also accounts for the Rayleigh scattering that occurs in pure air.[10] The IMPROVE equation, that was revised in December 2005, is listed below in Figure 1.4-1.

$$\begin{aligned}
b_{ext} = {} & 2.2 \times f_s(RH) \times [\text{small sulfate}] + 4.8 \times f_L(RH) \times [\text{large sulfate}] \\
& +2.4 \times f_s(RH) \times [\text{small nitrate}] + 5.1 \times f_L(RH) \times [\text{large nitrate}] \\
& +2.8 \times [\text{small organic mass}] + 6.1 \times [\text{large organic mass}] \\
& +10 \times [\textit{elemental carbon}] \\
& +1 \times [\textit{fine soil}] \\
& +1.7 \times f_{ss}(RH) \times [\text{sea salt}] \\
& +0.6 \times [\textit{coarse mass}] \\
& +\text{Rayleigh scattering (site specific)} \\
& +0.33 \times [NO_2\ (\text{pbb})]
\end{aligned}$$

**Figure 1.4-1** Revised IMPROVE Equation[10]

Bracketed items in the IMPROVE equation are the measured concentrations in $ug/m^3$ of the particulate constituents collected by the IMPROVE monitoring station.[10] The f(RH) is a water growth factor for sulfate and nitrate, that are hygroscopic (these particles tend to attract water). The $f_s$, $f_L$, and $f_{ss}$ parameters are water growth factors for small (“s”) and large (“L”) fractions of sulfate and nitrate, and for sea salt (“ss”).[10]

## 1.5 Measures of Visibility

Parameters for evaluating visibility include light extinction - $b_{ext}$, haze index (HI) in units of dv, and visual range in units of kilometers or miles. Reference 10 discloses the following information for these parameters:

Light Extinction ($b_{ext}$) – This parameter is the attenuation of light due to scattering and absorption as it passes through a medium. Light extinction is the most useful parameter for evaluating the relative contributions of pollutants to visibility impairment. Light extinction affects the clarity and color of the object being viewed.[10]

Haze Index (deciview) – This parameter is required by the RHR for tracking visibility conditions. Generally, a one deciview change in the haze index is likely humanly perceptible under ideal conditions. The deciview is a useful measure for tracking

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[10] Technical Support Document for the Proposed Action on the Federal Implementation Plan for the Regional Haze Program in the State of Hawaii, U.S. EPA Region 9, May 14, 2012.

progress in improving visibility because each deciview change is an equal incremental change in visibility perceived by the human eye from pristine to highly impaired.[10]

Visual Range – This parameter is the greatest distance, in kilometers or miles, at which a dark object can be viewed against the sky.[10, 11]

Relationships between extinction ($Mm^{-1}$) or ($10^{-6}m^{-1}$), haze index (dv), and visual range (km or mi) are as follows:

1. There is a logarithmic range between the haze index (dv) and reconstructed light extinction ($Mm^{-1}$) expressed by the following equation:

   HI (Haze Index) = 10 ln($b_{ext}$/10+ Raleigh Scattering/10)[10]

2. The relationship between extinction ($Mm^{-1}$), haze index (dv), and visual range (km) is provided in Figure 1.5-1.

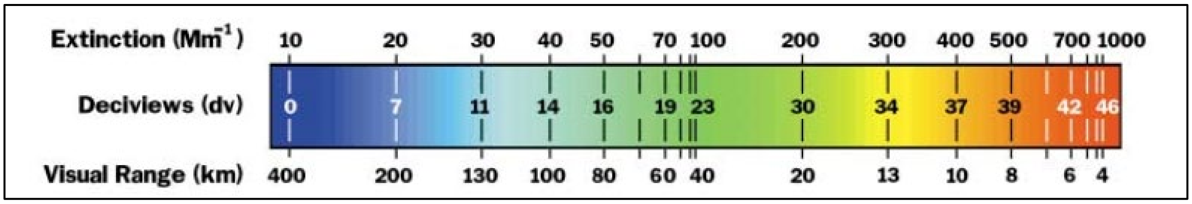

**Figure 1.5-1** Comparison of Extinction, Deciview, and Visual Range [10, 11]

## 1.6 Visibility Conditions

For each Class I area, the following definitions apply as part of the determination of reasonable progress:

Natural Visibility – Natural visibility conditions are defined as visibility (contrast, coloration, and texture) that would have existed under natural conditions. Natural visibility conditions vary with time and location, are estimated or inferred rather than directly measured, and may have long-term trends due to long-term trends in natural conditions.[12] In accordance with the RHR, natural visibility conditions include naturally occurring phenomena that reduce visibility, such as humidity, fire events, dust storms, volcanic activity, and biogenic emissions from soils and trees.

Baseline Visibility – Baseline visibility is the starting point for the improvement of visibility conditions. Pursuant to 40 CFR 51.308(d)(2)(i), the period for establishing baseline visibility conditions is 2000 to 2004. Also, baseline visibility conditions must be calculated, using available monitoring data, by establishing the average degree of visibility impairment for the most and least impaired days for each calendar year from 2000-2004 and the baseline visibility conditions are the average of these annual values.[10]

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[11] William C. Malm, Introduction to Visibility, May 1999, Page 35.

[12] Guidance on Regional Haze State Implementation Plans for the Second Implementation Period, U.S. EPA, August 20, 2019.

Current Visibility – Current visibility conditions are assessed for the most impaired and clearest days using the most recent five (5)-year period for which data is available.[12] According to 40 CFR §51.308(f)(1)(iii) in Reference 7, current visibility conditions must be calculated based on the annual average level of visibility impairment for the most impaired and clearest days for each of these five (5) years.[10] The most recent five (5)-year period for which data were available for the second planning period RH-SIP is 2014 through 2018.

Least Impaired Days – Means the twenty (20) percent monitored days in a calendar year with the lowest amounts of visibility impairment.[12]

Most Impaired Days – Means the twenty (20) percent of monitored days in a calendar year with the highest amounts of anthropogenic visibility impairment.[12]

Clearest Days – Means the twenty (20) percent of monitored days in a calendar year with the lowest values on the deciview index.[12]

Deciview Index – Also referred to as haze index (HI), means a value for a day derived from calculated or measured light extinction, such that uniform increments of index correspond to uniform incremental changes in perception across the entire range of conditions, from pristine to very obscured.[12]

Smoke from wildfires and natural dust storms were the major natural contributors to light extinction at many Class I areas in the first planning period (2008–2018), therefore, a new approach was developed by EPA for tracking visibility. The new approach for this second planning period (2018-2028) focuses on the twenty percent (20%) most anthropogenic impaired days and the clearest days at Class I areas.[12] In contrast, for the first regional haze implementation period (2008-2018), states selected the least and most impaired monitored days with the lowest and highest deciview levels irrespective of the source of particulate causing the visibility impairment. The least impaired days for setting the RPGs is now referred to as the twenty percent (20%) clearest days in an effort to be as specific as possible.[13] It is unnecessary to assign extinction on the clearest days to anthropogenic and natural fractions.[13]

The EPA either requires states to use the new second planning period approach for choosing the twenty percent (20%) most impaired visibility days or to allow each state to choose between using the original twenty percent worst overall visibility days and the new approach. Hawaii will use the new approach to track visibility for the twenty percent (20%) most impaired days with additional adjustments for volcanic activity. The WRAP TSS[14] provides annual average haze index in deciviews calculated by either the first planning period metric or the second planning period metric including. Adjustments are no longer made for volcanic activity.

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[13] Draft Guidance on Progress Tracking Metrics, Long-term Strategies, Reasonable Progress Goals and Other Requirements for Regional Haze State Implementation Plans for the Second Implementation Period, U.S. EPA, July 2016.

[14] WRAP TSS at: https://views.cira.colostate.edu/tssv3/About/Default.aspx.

## 1.7 Uniform Rate of Progress

Pursuant to Reference 10, the Uniform Rate of Progress (URP) is the calculation of the uniform slope, or glide path, of the line between the baseline visibility conditions over the 60-year period.[15] By comparing baseline conditions with natural conditions, the uniform rate of visibility improvement, or progress, needed to reach natural conditions by 2064 can be determined for each Class I area.[15] For example, in Figure 1.7-1 below, the 20% worst visibility baseline condition is 29 dv and the natural visibility condition is 11dv. Therefore, the URP is 4.2 dv over the first planning period. This is equivalent to 0.3 dv per year over a 14 year time frame. The 4.2 dv value is determined as follows: 18 dv/60 yr = 14yr/ x dv, x = 18 dv/60 yr x 14 yr = 4.2 dv.

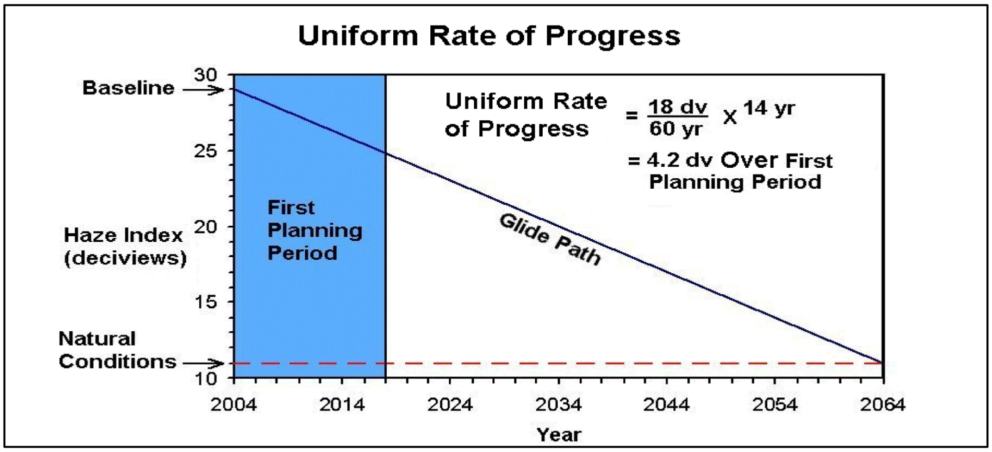

**Figure 1.7-1** Uniform Rate of Progress Example[15]

## 1.8 Regional Haze Rule Progress Report

Hawaii's requirements for reports describing progress towards the reasonable progress goals (RPGs) for each of its two Class I areas are specified in 40 CFR §51.308(g). The progress report for the second regional haze planning period (2018-2028) is due on January 31, 2025. The progress report must contain, at a minimum, the following elements[7]:

(1) A description of the status of implementation of all measures included in the implementation plan for achieving reasonable progress goals for mandatory Class I Federal Areas both within and outside the state.
(2) A summary of the emissions reductions achieved throughout the State through implementation of the measures described in Paragraph 40 CFR §51.308(g)(1).
(3) Address the following visibility conditions and changes, with values for most impaired and least impaired days expressed in terms of 5-year averages of these annual values for each mandatory Class I Federal area:

    i. The current visibility conditions for the most impaired and least impaired days;
    ii. The difference between current visibility conditions for the most impaired and least impaired days and baseline visibility conditions; and

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[15] Guidance for Setting Reasonable Progress Goals Under the Regional Haze Program, U.S. EPA, June 1, 2007.

    iii. The change in visibility impairment for the most impaired and least impaired days over the past five (5) years.

(4) An analysis tracking the change over the past five (5) years in emissions of pollutants contributing to visibility impairment from all sources and activities within the State.
(5) An assessment of any significant changes in anthropogenic emissions within or outside the State that have occurred over the past five (5) years that have limited or impeded progress in reducing pollutant emissions and improving visibility.
(6) An assessment of whether the current implementation plan elements and strategies are sufficient to enable the State to meet all established reasonable progress goals.
(7) A review of the State's visibility monitoring strategy and any modifications to the strategy as necessary.

At the same time the 5-year progress report is submitted to EPA, the state must review the adequacy of the existing implementation plan in accordance with 40 CFR §51.308(h) and revise if necessary. If there are no revisions, the state must include a negative declaration that no further revisions of the implementation plan are needed.

## 1.9 Environmental Justice

Mitigating haze-causing pollution is a vital part of our efforts to address environmental justice concerns to reduce visibility impairing emissions from anthropogenic sources that may disproportionately affect those who are socially or economically disadvantaged. The purpose of Hawaii's RH-SIP is for implementing requirements of EPA's Regional Haze Rule by achieving emission reductions to improve visibility in Hawaii's national parks. The permit modifications incorporating regional haze control measures for large sources on Hawaii and Maui Islands are important measures to reduce anthropogenic visibility impacts. The DOH-CAB strongly supports the fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. For the public comment period, a hard copy of the RH-SIP, associated permit amendments, and appendices were provided at designated DOH offices located on all main Hawaiian Islands for personal viewing. The RH-SIP and associated documents were also posted on DOH-CAB's website for communities to give feedback on the proposed strategy for reducing visibility impairing pollutants.

As an additional measure to consider environmental justice relating to Hawaii's regional haze control measures, the 2023 EPA's EJ Screen tool was utilized to examine communities surrounding the facilities selected for pollution control measures. Community screen reports were generated for each facility, encapsulating communities contained in both 3-mile and 10-mile radii. These reports provide socioeconomic indicators as percentages, for demographic index, people of color, low income, unemployment rate, limited English speaking households, less than high school education, age under 5, age over 54, and low life expectancy. The environmental justice analysis investigated the presence of any disparities in environmental pollution impact on vulnerable communities through the analysis of potential patterns.

To determine if vulnerable communities are disproportionately affected, whether positively or negatively, by the regional haze control measures for the selected pollution sources, DOH-CAB used a tally ranking system by assigning a “1” for each socioeconomic indicator that was above the statewide average, or a “0” if the value was equal to or below the statewide average. The results are shown in Tables 1.9-1 and 1.9-2 for the 3-mile radius, and 1.9-3 and 1.9-4 for the 10-mile radius.

**Table 1.9-1** Socioeconomic Indicator Percentages and Tally – Hawaii Island, 3-mile Radius

| Socioeconomic Indicator | Statewide Average | Puna GS | Kanoelehua-Hill GS | Mauna Loa Mac. Nut Corp. Plant |
|---|---|---|---|---|
| People of Color | 74% | 88% | 87% | 91% |
| Low Income | 21% | 34% | 38% | 20% |
| Unemployment Rate | 5% | 4% | 8% | 4% |
| Limited English Speaking Households | 5% | 6% | 5% | 5% |
| < High School Education | 7% | 9% | 7% | 7% |
| < 5 Years of Age | 5% | 3% | 5% | 3% |
| > 64 Years of Age | 19% | 28% | 21% | 26% |
| Tally | | **5** | **4** | **2** |

**Table 1.9-2** Socioeconomic Indicator Percentages and Tally – Maui Island, 3-mile Radius

| Socioeconomic Indicator | Statewide Average | Kahului GS | Maalaea GS |
|---|---|---|---|
| People of Color | 74% | 88% | 58% |
| Low Income | 21% | 19% | 21% |
| Unemployment Rate | 5% | 5% | 3% |
| Limited English Speaking Households | 5% | 7% | 3% |
| < High School Education | 7% | 11% | 3% |
| < 5 Years of Age | 5% | 4% | 3% |
| > 64 Years of Age | 19% | 19% | 17% |
| Tally | | **3** | **0** |

**Table 1.9-3** Socioeconomic Indicator Percentages and Tally – Hawaii Island, 10-mile Radius

| Socioeconomic Indicator | Statewide Average | Puna GS | Kanoelehua-Hill GS | Mauna Loa Mac. Nut Corp. Plant |
|---|---:|---:|---:|---:|
| People of Color | 74% | 79% | 83% | 80% |
| Low Income | 21% | 33% | 30% | 33% |
| Unemployment Rate | 5% | 7% | 6% | 7% |
| Limited English Speaking Households | 5% | 4% | 4% | 4% |
| < High School Education | 7% | 7% | 7% | 7% |
| < 5 Years of Age | 5% | 5% | 5% | 5% |
| > 64 Years of Age | 19% | 21% | 21% | 21% |
| Tally |  | **4** | **4** | **4** |

**Table 1.9-4** Socioeconomic Indicator Percentages and Tally – Maui Island, 10-mile Radius

| Socioeconomic Indicator | Statewide Average | Kahului GS | Maalaea GS |
|---|---:|---:|---:|
| People of Color | 74% | 78% | 74% |
| Low Income | 21% | 19% | 19% |
| Unemployment Rate | 5% | 5% | 5% |
| Limited English Speaking Households | 5% | 5% | 5% |
| < High School Education | 7% | 8% | 8% |
| < 5 Years of Age | 5% | 6% | 5% |
| > 64 Years of Age | 19% | 17% | 19% |
| Tally |  | **3** | **1** |

A tally value of 4 or greater indicates a significant percentage of vulnerable communities in the vicinity of the given source. The data provided by EJ Screen shows that the communities surrounding the Puna Generating Station, Kanoelehua-Hill Generating Station, and Mauna Loa Macadamia Nut Corporation Plant include disproportionate quantities of vulnerable populations. The selected Regional Haze control measures for these facilities are a fuel switch from Fuel Oil #2 to ULSD for the Puna Boiler, and enforceable shut down dates for the primary boilers at both Kanoelehua-Hill Generating Station and Mauna Loa Macadamia Nut Corporation Plant. These control measures will reduce air pollution in the surrounding environment and provide an even greater air quality benefit to those communities than will be seen in the national parks. Locations of these facilities in relation to the national parks are shown in Figures 2.0-1 and 2.0-2. The EJ Screen Community Reports and additional maps are provided in Appendix C.

# Chapter 2 Status of Control Measures for RH-SIP, Revision 1

## 2.0 Status of Control Measures - 40 CFR §51.308(g)(1)

Section 2 provides the status of control measures specified for sources evaluated in Revision 1 of the RH-SIP, to achieve RPGs during the second planning period (2018-2028). Point sources subject to regional haze control measures on Maui and Hawaii Islands are listed in Tables 2.0-1 and 2.0-2, respectively. New proposed sources for Maui Island are shown in Table 2.0-3. These sources are also shown on map in Figures 2.0-1 (Maui Island) and Figure 2.0-2 (Hawaii Island).

The Weighted Emissions Potential / Area of Influence (WEP/AOI) analysis showed that sources nearby the Class I areas had the greatest potential to contribute to visibility impairment in Hawaii's national parks on the most impaired days (2014-2018). The Kalaeloa Partners L.P., Kahe, and Waiau Power Plants on the island of Oahu, initially screened with Q/d, did not rank high in their potential to impair visibility when considering meteorology, haze species, emissions, and distance using the WEP/AOI analysis. Control measures ultimately selected were those below the $6,800/ton of pollutant removed cost threshold for reductions in visibility impairing pollutants ($SO_2$, $NO_X$, and $PM_{10}$).

The WEP point source contribution potential for the Kalaeloa Partners L.P., Kahe, and Waiau power plants on Oahu ranged from 0.04% to 0.86% and 0.02% to 0.15% for nitrates and sulfates, respectively. Kalaeloa Partners, L.P., Kahe, and Waiau power plants were excluded from requiring controls in this second regional haze planning period. For Hawaii, prevailing trade winds from the northeast transport pollutants from point sources on Oahu located down-wind of the Class I areas away from the Class I areas a majority of the time. Please refer to Figure 2.0-3 with wind data from Honolulu International Airport, Molokai Airport, and Kahului International Airport showing predominate northeast trade winds for these islands between years 2018 and 2022. Wind roses with the wind data are shown in Appendix D.

The Kahului, Maalaea, and Kanoelehua-Hill power plants were facilities with the greatest potential to contribute to visibility impairment at Haleakala National Park. The percentage of contribution potential, based on WEP/AOI point source rankings for ammonium nitrate after excluding airports, ranged from 10.92% to 86.91% for the Kahului Power Plant, and Maalaea Power Plant, respectively. The percentage contribution potential, based on WEP/AOI rankings for ammonium sulfate after excluding airports, ranged from 2.04% to 13.38% to 83.78% for the Kanoelehua-Hill, Maalaea, and Kahului power plants, respectively.

The Kanoelehua-Hill, Mauna Loa Macadamia Nut Corporation, and Puna plants had the greatest potential to contribute to visibility impairment at Hawaii Volcanoes National Park. The percentage of contribution potential, based on WEP/AOI rankings for ammonium nitrate after excluding airports, ranged from 7.20% to 9.16% to 79.63% for the Puna, Mauna Loa, and Kanoelehua-Hill facilities, respectively. The percentage of contribution potential, based on WEP/AOI rankings for ammonium sulfate after excluding airports, ranged from 15.26% to 84.06% for the Puna and Kanoelehua-Hill power plants, respectively.

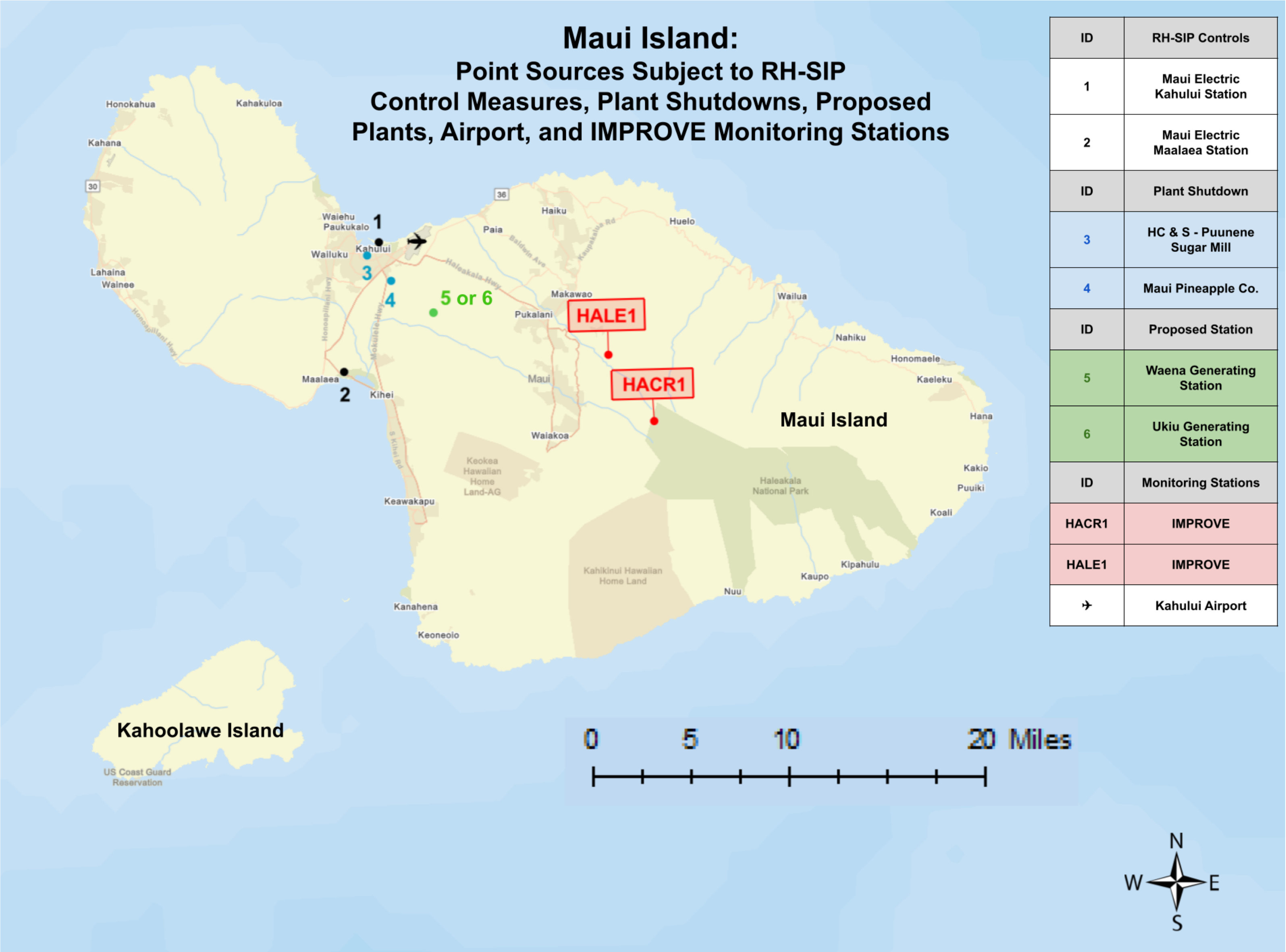
| **Table 2.0-1** Point Sources Subject to Regional Haze Controls on Maui Island | | | | | | |
|---|---|---|---|---|---|---|
| Facility | Type | Location (decimal degrees) | | Distance from Station (miles) | | |
| | | Longitude | Latitude | HACR1 | HALE1 | HAVO1 |
| Kahului Power Plant | Electric Generation | -156.4624 | 20.8964 | 16.7 | 13.1 | 128.9 |
| Maalaea Power Plant | Electric Generation | -156.4927 | 20.8013 | 16.1 | 13.6 | 124.9 |

| **Table 2.0-2** Point Sources Subject to Regional Haze Controls on Hawaii Island | | | | | | |
|---|---|---|---|---|---|---|
| Facility | Type | Location (decimal | | Distance from Station (miles) | | |
| | | Longitude | Latitude | HACR1 | HALE1 | HAVO1 |
| Kanoelehua-Hill Power Plant | Electric Generation | -155.0551 | 19.6999 | 105.8 | 110.0 | 24.3 |
| Mauna Loa Macadamia Nut Corporation Plant | Macadamia Nuts and Chocolates | -155.0084 | 19.6572 | 110.6 | 114.6 | 23.8 |
| Puna Power Plant | Electric Generation | -155.0319 | 19.6328 | 110.8 | 114.9 | 21.3 |

Hawaiian Electric is proposing to construct a new plant (Waena Generating Station) using exclusively biodiesel (B100) on Maui Island for the projected 30-year life units at the facility. The proposed facility would consist of a roughly 40 MW generating station with a group of Tier 4 engines using on-engine technology for $NO_X$, $PM_{10}$ and $PM_{2.5}$. ULSD may be used to replace biodiesel which Hawaiian Electric is seeking permits for. After 2044, the proposed facility would only use biodiesel as a source of fuel to comply with the state law that requires 100% renewable energy by 2045. The start date of the facility is critical, since the Kahului Power Plant on Maui Island is required to be shut down by the end of 2028. Figure 2.0-1 includes the of Waena plant in green (source #5). Also, another plant may be constructed instead of the Waena Generating Station to provide power on Maui.

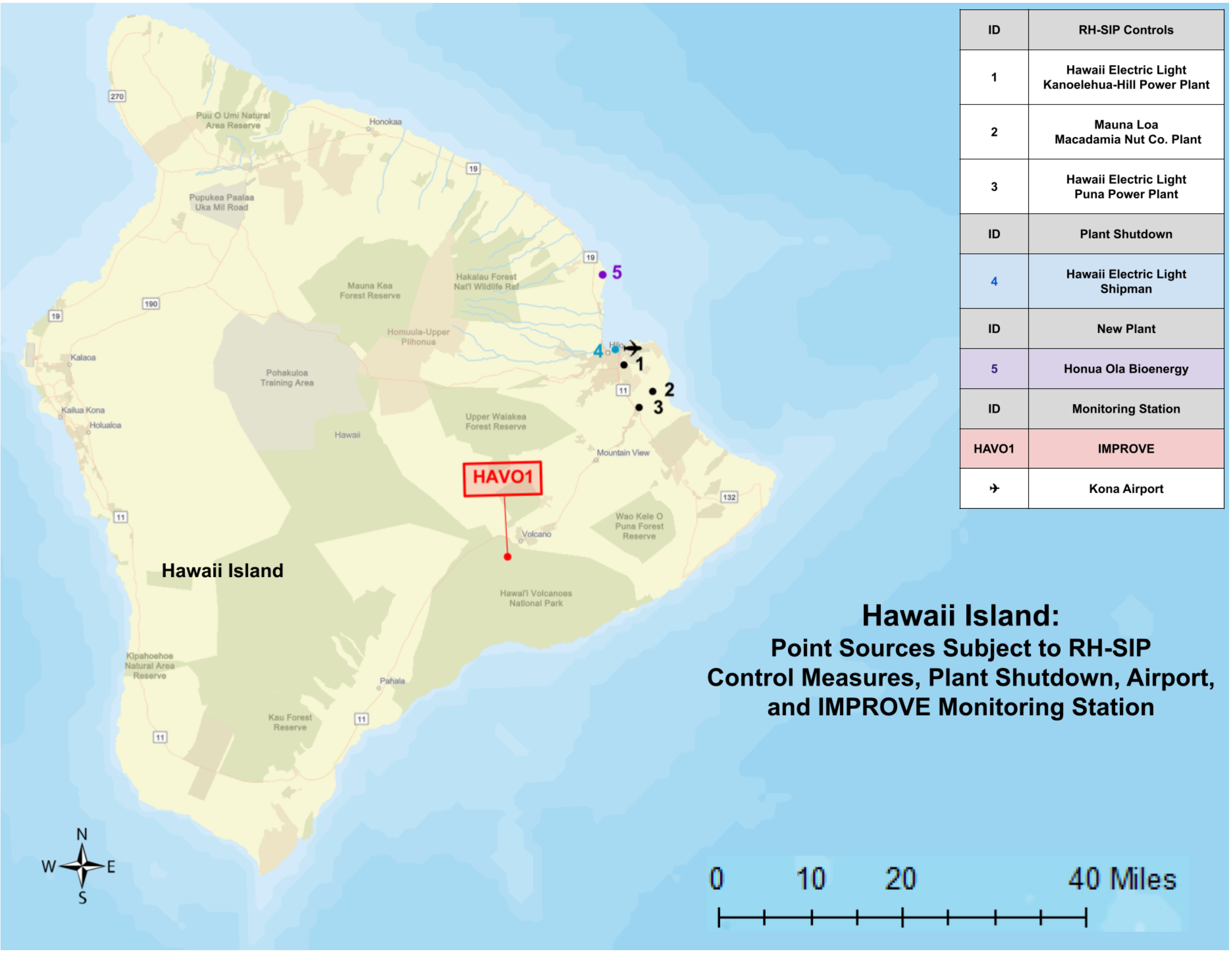
DOH-CAB received another permit application from Ukiu Energy, LLC to build a 45 MW plant located near the Waena substation on the Island of Maui with six 7.5 MW Wartsila reciprocating internal combustion engines. The engines will be equipped with SCR for controlling $NO_X$ and an oxidation catalyst to reduce CO and formaldehyde. The engines will be capable of burning either liquid or gaseous fuel. The engines will be primarily fueled with renewable fuels including ultra-low sulfur renewable diesel. Figure 2.0-1 includes the proposed location of the power plant in green (source # 6). Either the Ukiu Energy, LLC plant operating as an IPP or the Waena Generating Station operated by Hawaiian Electric will be constructed to provide energy to Maui. Only one plant will be built. Table 2.0-3 shows that the plants are at the same location.

| **Table 2.0-3** New Proposed Sources on Maui Island | | | | | | |
|---|---|---|---|---|---|---|
| Facility | Type | Location (decimal degrees) | | Distance from Station (miles) | | |
| | | Longitude | Latitude | HACR1 | HALE1 | HAVO1 |
| HE Waena Power Plant | Electric Generation | -156.4164 | 20.6999 | 9.0 | 12.5 | 124.7 |
| Ukiu Energy, LLC Plant | Electric Generation | -156.4164 | 20.8470 | 9.0 | 12.5 | 124.7 |



| ID | RH-SIP Controls |
|---|---|
| 1 | Maui Electric Kahului Station |
| 2 | Maui Electric Maalaea Station |
| ID | Plant Shutdown |
| 3 | HC & S - Puunene Sugar Mill |
| 4 | Maui Pineapple Co. |
| ID | Proposed Station |
| 5 | Waena Generating Station |
| 6 | Ukiu Generating Station |
| ID | Monitoring Stations |
| HACR1 | IMPROVE |
| HALE1 | IMPROVE |
| ✈ | Kahului Airport |

**Figure 2.0-1** Point Sources on Maui Island



| ID | RH-SIP Controls |
|---|---|
| 1 | Hawaii Electric Light<br>Kanoelehua-Hill Power Plant |
| 2 | Mauna Loa<br>Macadamia Nut Co. Plant |
| 3 | Hawaii Electric Light<br>Puna Power Plant |
| **ID** | **Plant Shutdown** |
| 4 | Hawaii Electric Light<br>Shipman |
| **ID** | **New Plant** |
| 5 | Honua Ola Bioenergy |
| **ID** | **Monitoring Station** |
| HAVO1 | IMPROVE |
| ✈ | Kona Airport |

**Hawaii Island:**
**Point Sources Subject to RH-SIP Control Measures, Plant Shutdown, Airport, and IMPROVE Monitoring Station**

**Figure 2.0-2** Point Sources on Hawaii Island

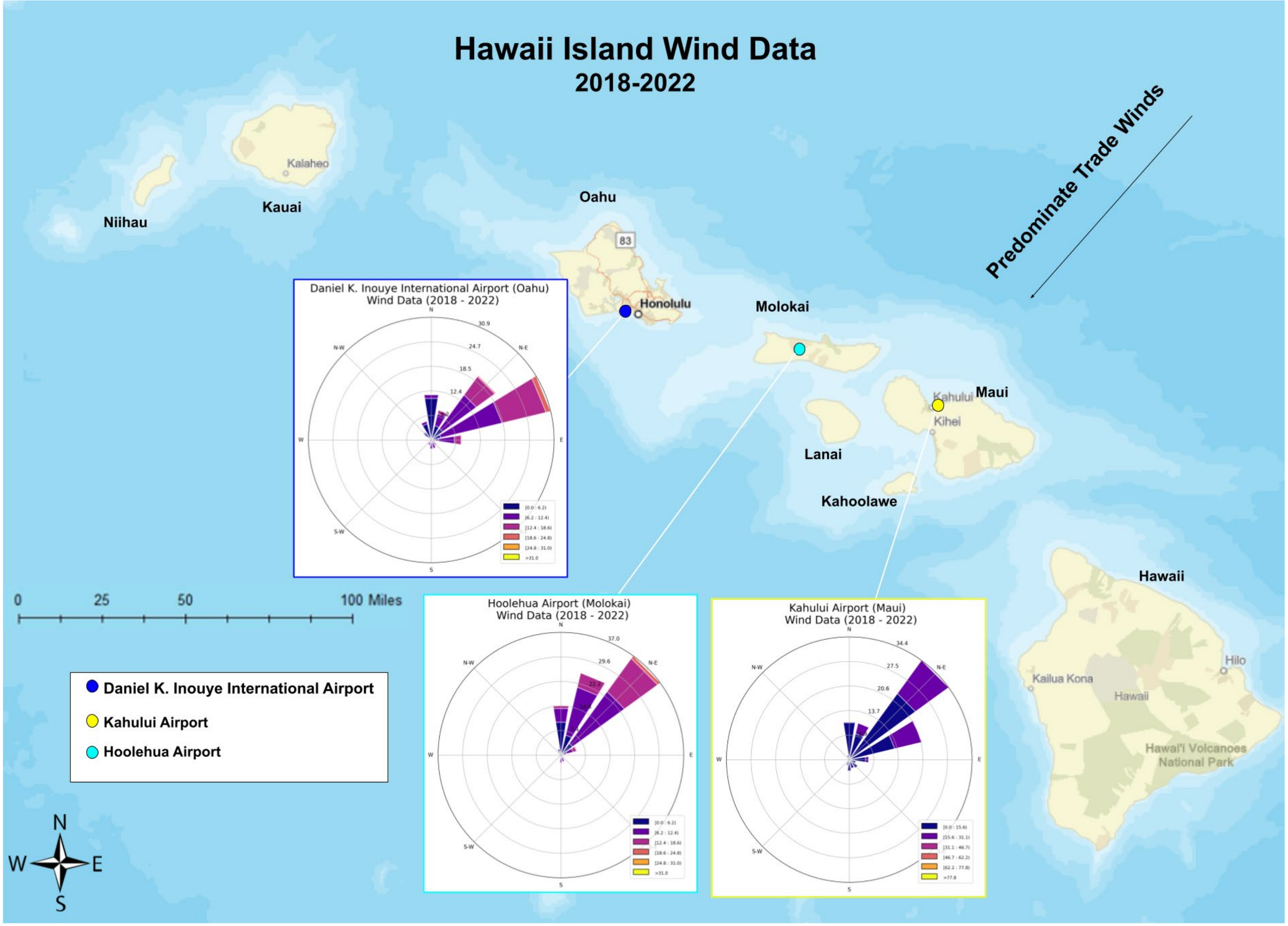


**Figure 2.0-3** Five Years (2018 – 2022) of Wind Data for Oahu, Molokai, and Maui Islands

## 2.1 Major Control Measures

Various control measures were addressed in Hawaii's Regional Haze State Implementation Plan (RH-SIP) for the second planning period (2018 – 2028). Table 2.1-1 below lists the major control measures from Chapter 7 of the RH-SIP, Revision 1.

**Table 2.1-1** Major Control Measures in Hawaii RH-SIP, Revision1 for Second Planning Period

| Control Measure | Description of Control Measure | Effective Date of Measure(s) |
|---|---|---|
| Maui Electric - Kahului Plant<br>Control Measures Selected in Four-Factor Analysis for Second Planning Period RH-SIP | Shut down of Boilers K-1, K-2, K-3, and K-4. | December 31, 2028 |
| Maui Electric-Maalaea Plant<br>Control Measures Selected in Four-Factor Analysis for Second Planning Period RH-SIP | FITR for DEG M1 and M3. | December 31, 2027 |
| | SCR for DEGs M7, M10, M11, M12 and M13. | December 31, 2027 |
| | Shut down DEG M7 as option to SCR. | December 31, 2037 |
| | Shut down DEGs M10 and/or M11 as option to SCR. | December 31, 2030 |
| | Shut down DEGs M10 and/or M11 if one unit installs SCR or shuts down by December 31, 2030. | December 31, 2032 |
| | Shut down DEGs M12 and M13 as option to SCR. | December 31, 2037 |
| Hawaii Electric Light -Kanoelehua-Hill Plant<br>Control Measures Selected in Four-Factor Analysis for Second Planning Period RH-SIP | Shut down of Boilers Hill 5 and Hill 6. | December 31, 2028 |
| Mauna Loa Macadamia Nut Corporation Plant<br>Control Measure Selected in Four-Factor Analysis for Second Planning Period RH-SIP | Shut down of Main Boiler. | December 31, 2026 |
| Hawaii Electric Light -Puna Plant<br>Control Measures Selected in Four-Factor Analysis for | Fuel Switch to ULSD for Puna Boiler. | August 10, 2026. |

| **Table 2.1-1** Major Control Measures in Hawaii RH-SIP, Revision1 for Second Planning Period | | |
|---|---|---|
| Control Measure | Description of Control Measure | Effective Date of Measure(s) |
| Second Planning Period RH-SIP | | |
| $SO_2$ Emissions Cap carried over from RH-FIP and incorporated into permits for RH-SIP | The RH- FIP specified an $SO_2$ emissions cap for three generating stations on the Hilo side of the Big Island not to exceed 3,550 tons of $SO_2$ per year as the sum of the total of five affected units for these plants over a rolling twelve (12) month period. Affected units are Kanoelehua Hill Generating Stations, Boilers Hill 5 and Hill 6; Puna Power Plant, Boiler 1; and Shipman Power Plant Boilers S-3 and S-4. Shipman Boilers S-3 and S-4 shut down in 2015. | On and After December 31, 2018 |
| Hawaii's Renewable Portfolio Standard (RPS)[a] | Replace electric generated from burning fossil fuel with renewable energy. | 10% RPS by December 31, 2010<br>15% RPS by December 31, 2015<br>30% RPS by December 31, 2020<br>40% RPS by December 31, 2030<br>70% RPS by December 31, 2040<br>100% RPS by December 31, 2045 |
| Hawaii's Energy Efficiency Portfolio Standard (EEPS)[a] | Increasing demand side energy efficiency to reduce electric generation from fuel oil combustion. | 4,300 GWh electricity savings statewide by December 31, 2030 |
| NA ECA | The United States together with Canada and France established the NA ECA under the auspices of Annex VI of the International Convention for the Prevention of Pollution from Ships; a treaty developed by the International Maritime Organization. This NA ECA applies to ships operating 200 nautical miles of the majority of the U.S. and Canadian coastline, including the U.S. Gulf Coast and Hawaii. | August 2012 |
| Federal Mobile Source Regulations and State Mobile Source Programs | Non-road Mobile Diesel Emissions Program.<br>Tier 2 Vehicle and Gasoline Program.<br>2007 Heavy-Duty Highway Rule.<br>Tier 3 Vehicle and Gasoline Program.<br>Diesel Replacement Rebate Program. | 2004<br>2004<br>2007-2010<br>2014<br>2022 |

| **Table 2.1-1** Major Control Measures in Hawaii RH-SIP, Revision1 for Second Planning Period | | |
|---|---|---|
| Control Measure | Description of Control Measure | Effective Date of Measure(s) |
| Federal Mobile Source Regulations and State Mobile Source Programs | Control of Air Pollution Emissions Standards from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards.<br>Multi-Pollutant Emission Standards for Model Years 2027 and Later Light-Duty and Medium Duty Vehicles. | 2022<br>2024<br>2024 |
| Construction Activity Mitigation | HAR §11-60.1-33(a) and §11-60.1-192(a) fugitive dust provisions. | February 8, 2024 |
| Hawaii's Agricultural Open Burning Regulations | HAR, § 11.60-1 Subchapter 3. Open Burning includes agricultural, residential, and prescribed burning. | February 8, 2024 |
| Plant/Unit Shutdowns | Hawaii Island<br>• Kanoelehua-Hill Power Plant – Permanent shut down of Boilers Hill 5 and Hill 6<br>• Mauna Loa Macadamia Nut Corporation Plant – Permanent shut down of main boiler<br>Maui Island<br>• Kahului Power Plant – Permanent shut down of main boiler<br>• Maalaea Power Plant – Diesel engine generators M7, M10, M11, M12, and M13 shut down or have selective catalytic reduction (SCR) installed | M7 by the end of 2037<br>M10 or M11 by the end of 2032 if one unit installs an SCR system, otherwise both by the end of 2030.On and after December 31, 2027, M7, M10, M11, M12, and M13 shall not be operated without an SCR system fully installed or shut down according to the staggered shut down schedule<br>M12 and M13 by the end of 2037 |
| BART | Applicable to certain large stationary sources that have been in operation between 1962 and 1977. A stationary source is BART eligible if 1) it belongs to one of 26 BART source categories; 2) has emission units which were in existence on August 7, 1977, but not in operation before 1962; and 3) has total combined emission units with the potential to emit more than 250 tons per year of any single visibility impairing pollutant (SO2, NOX, and PM). | No Additional Controls Required. |

| **Table 2.1-1** Major Control Measures in Hawaii RH-SIP, Revision1 for Second Planning Period | | |
|---|---|---|
| Control Measure | Description of Control Measure | Effective Date of Measure(s) |
| State Greenhouse Gas (GHG) Regulation | HAR, §11.60-1 Subchapter 11 was enacted to further implement the goals of Act 234, 2007 to effect policies on climate change. Carbon dioxide equivalent ($CO_2e$) emissions shall be reduced from large stationary sources. The GHG cap applies to facilities with the potential to emit equal to or above 100,000 short tons of $CO_2e$ per year excluding municipal waste combustion operations. | A reduction in statewide GHG emissions to levels at or below the best estimates of statewide GHG emissions for 1990 by January 2020. |
| | Act 15, 2018 | Established a statewide carbon net-negative goal by 2045. |
| | Act 238, 2022 | Established a goal for the level of statewide GHG emissions be at least 50 percent below 2005 levels by year 2030. |
| Note: Diesel Engine Generator (DEG), Fuel Injection Timing Retard (FITR), Selective Catalytic Reduction (SCR), Ultra-Low Sulfur Diesel (ULSD) | | |

a. State implements requirements as a matter of State Law. Noncompliance penalty is at the discretion of the Hawaii PUC which can assess penalties.

## 2.2 Major Control Measure Status

The status of control measures listed in Table 2.1-1 are provided below.

Maui Electric Kahului Plant

Covered Source Permit (CSP) No. 0232-01-C for the Kahului Power Plant was amended on August 10, 2022, to incorporate an enforceable commitment to shut down Boilers K-1, K-2, K-3, and K-4 by December 31, 2028, as a control measure from the RH-SIP. The permit was later amended on January 16, 2024 to extend the date of boiler shut downs from December 31, 2027, to December 31, 2028. Hawaiian Electric chose to shut down the boilers by the end of 2028 instead of implementing controls selected in the four-factor analysis.

Maui Electric Maalaea Plant

CSP No. 0067-01-C for the Maalaea Power Plant was amended on January 16, 2024, to incorporate control measures from the RH-SIP for diesel engine generators (DEGs) M1, M3, M7, and M10 - M13. The amendment incorporates requirements to retrofit M1 and M3 with fuel injection timing retard (FITR), include staggered shut down dates for M7 and M10 – M13, and provide options to retrofit M7 and M10 – M13 with selective catalytic reduction (SCR) to reduce $NO_X$ emissions instead of shutting down the units. Units M7, M12, and M13 shall be shut down by the end of 2037 if not installing SCR. M10 or M11 may be shut down by the end of 2032 if one of the units shuts down by 2030 or is equipped with SCR.

Hawaii Electric Light Kanoelehua-Hill Plant

CSP No. 0234-01-C for the Kanoelehua-Hill Power Plant was amended on August 10, 2022, to incorporate an enforceable commitment to shut down Boilers Hill 5 and Hill 6 by December 31, 2027 as a control measure in the RH-SIP. The permit was later amended on January 16, 2024, to extend the date of boiler shut down from December 31, 2027, to December 31, 2028. Hawaiian Electric chose to shut down the boilers by the end of 2028 instead of implementing controls selected in the four-factor analysis.

Combustion Turbine CT-1 was considered a limited use unit based on its operation in 2017, and therefore a four-factor analysis was not conducted for this unit. The emissions reported for this unit through SLEIS; however, shows a steady increase in the use of the unit from 2017 to 2022. The $NO_X$ emissions ranged from 0.30 tons per year in 2017 to 4.36 tons per year in 2018 to 9.0 tons per year in 2019 to 14.76 tons per year in 2020 to 20.7 tons per year in 2021 to 27.6 tons per year in 2022. Another round of screening sources using four-factor analysis will be performed in the third regional haze planning period. CT-1 has no air pollution controls and is permitted to burn fuel oil No. 2 with maximum 0.4% sulfur content.

Diesel Engine Generators D-11, D-15, D-16, and D-17 operated on a limited basis in 2017, and therefore a four-factor analysis was not conducted for these units. The $NO_X$ emissions from these units remained below 5 tons per year from 2017 to 2021. However, for 2022, $NO_X$ emissions are greater than 7 tons per year for Diesel Engine Generators D15, D16, and D-17. A four-factor analysis may be appropriate for these units during the third regional haze planning period if future emissions increase.

Hawaii Electric Light Puna Plant

CSP No. 0235-01-C for the Puna Power Plant was amended on August 10, 2022, to incorporate a regional haze control measures for the Puna Boiler. The permit amendment incorporates a fuel switch for the Puna Boiler to only ultra-low sulfur diesel (ULSD) with 0.0015% maximum sulfur content by August 10, 2026, for reducing $SO_2$, $NO_x$, and $PM_{10}$ emissions. The permit amendment also carries over existing regional haze provisions to cap $SO_2$ emissions from boilers at the Hilo power plants.

Combustion Turbine CT-3 operated on a limited basis in 2017, and therefore a four-factor analysis was not conducted for this unit. However, emissions reported in SLEIS shows a steady increase in use of this unit from 2017 to 2022. The $NO_X$ emissions ranged from 2.9 tons per year in 2017 to 16.7 tons per year in 2018 to 23.0 tons per year in 2019 to 19.8 tons per year in 2020 to 35.2 tons per year in 2021 to 52.5 tons per year in 2022. A four-factor analysis may be appropriate for the combustion turbine generator during the third regional haze planning period if future emissions increase. The combustion turbine is currently equipped with water injection to control $NO_X$ emissions and is limited to burning fuel oil No. 2 with maximum sulfur content of 0.4%.

Mauna Loa Macadamia Nut Corporation Plant

CSP No. 0317-02-C was amended on January 16, 2024, to incorporate an enforcement commitment to shut down the Kipper & Sons Engineers, Inc., main boiler by December 31, 2026. The replacement unit for the main boiler is subject to the process for modifying the permit and must comply with all relevant aspects of the RHR.

Sulfur Dioxide ($SO_2$) Emissions Cap

Based on the reasonable progress analysis in the RH-FIP, an $SO_2$ emissions cap was incorporated into air permits for Hilo power plants on the Big Island in accordance with 40 CFR Part 52, Subpart M. In Subpart M, the affected EGUs shall not emit or cause to be emitted $SO_2$ in excess of a total of 3,550 tons per year, calculated as the sum of the total for five (5) units over a rolling twelve (12) month period.[16] Affected units are Kanoelehua Hill Generating Station, Boilers Hill 5 and Hill 6; Puna Power Plant, Boiler 1; and Shipman Power Plant, Boilers S-3 and S-4. The primary fuel for these plants is fuel oil No. 6 fired by large boilers. Since the Shipman Power Plant permanently discontinued operations on December 31, 2015, the $SO_2$ emissions cap only applies to the Puna and Kanoelehua Hill Generating Stations. These plants are #1, and #3 in Figure 2.0-2 and Table 2.0-2 for the Puna and Hill plants, respectively.

Renewable Portfolio Standard (RPS)

The main focus of the State of Hawaii's RPS is on transitioning companies that generate and sell electricity for consumption from using fossil fuels to renewable sources. These standards are codified in Hawaii Revised Statute (HRS) §269-92 (refer to Appendix E) which establishes a percentage of net electricity each company sells for consumption that must be generated from renewable energy sources by the end of the identified years shown in Table 2.2-1 below. The 2024 RPS Report from the Hawaii Public Utilities Commission on Hawaii's Renewable Portfolio Standards, prepared by the Hawaii Natural Energy Institute (HNEI) School of Ocean and Earth Science and Technology, University of Hawaii, was submitted to the 2024 Hawaii State Legislature in December 2023.

**Table 2.2-1** Hawaii's Renewable Portfolio Standards by Year

| Compliance Year | RPS Requirement (% of Generation) |
|---|---|
| 2010 | 10% |
| 2015 | 15% |
| 2020 | 30% |
| 2030 | 40% |
| 2040 | 70% |
| 2045 | 100% |

The State of Hawaii's Public Utilities Commission (PUC) is required by HRS §269-95 to evaluate the RPS every five (5) years, beginning in 2013, and subsequently revise the standards based on the best information available at the time to determine if the standards established by HRS §269-92 remain effective and achievable. The PUC is then required to report its findings and RPS revisions based on its own studies and other information, twenty (20) days prior to the Hawaii State's Legislature every five (5) years. The latest PUC Report to the 2024 Hawaii State's Legislature on RPS (refer to Appendix F) indicates that while there is some uncertainty regarding the requirements in 2030 for Hawaiian Electric, the existing benchmarks remain appropriate and effective and are expected to be met based on the best currently available information. Findings in the December 2023 report include:

i. The 2030 RPS requirement of 40% renewable energy generation is likely to be met by the Hawaiian Electric and the Kauai Island Utility Cooperative (KIUC). Achievement of the 2030 requirement is essentially certain for KIUC and Hawaii

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[16] 40 CFR, Part 52, Approval and Promulgation of Implementation Plans, Subpart M, Hawaii

Island ("Big Island") because they both have already surpassed the 40% threshold.

ii. Hawaiian Electric territories, which include Oahu, Maui County, and Hawaii Island, are expected to reach the 40% requirement by 2030 based on the current plans for the PUC approved Stage 1 and Stage 2 solar + storage projects. However, unforeseen circumstances and related supply chain issues have created problems for Stage 1 and Stage 2 projects.
iii. The 2023 Maui wildfires and cancellations of four out of five Stage 1 and Stage 2 projects could negatively impact the pace of new renewable energy generation on Maui.
iv. Although the RPS has led to substantial reductions of greenhouse gas (GHG) emissions from the electricity sector, GHGs have not diminished significantly in other sectors (transportation, buildings, etc.) as originally predicted by the Hawaii Clean Energy Initiative (HCEI).
v. There is concern that increased electric loads due to widespread electric vehicle adoption may make it more difficult to achieve future RPS targets. However, adoption of electric vehicles should ultimately decrease statewide emissions.
vi. Costs of renewable energy projects under development and recently proposed in Hawaii are expected to remain comparative at or below costs of oil-fired generation making renewable projects cost-competitive alternatives when compared to continuing to utilize fossil fuel generation resources.
vii. An initial analysis by HNEI to explore the feasibility of integrating solar + storage or solar/wind and storage suggest that the 70% RPS target by 2040 is feasible and is likely cost effective with current technologies. However, land use restriction, community acceptance, and transmission still pose known and unknown challenges and will need to be carefully managed.
viii. Overall, the RPS remains effective in helping the State achieve its policies and objectives with respect to developing renewable energy resources in Hawaii.

40 CFR 51.308(f)(2)(iv)(A) requires states to consider emission reductions due to ongoing air pollution control programs, including measures to address reasonably attributable visibility impairment.

To characterize the impact of the RPS, sales of electricity from renewable generation sources from Section 5 of the PUC RPS Report to the 2024 Legislature is shown below. Figures 2.2-1 and 2.2-2 below show the renewable generation percentages by resource for Hawaiian Electric companies and KIUC. The figures also show the historical percentages of renewable resources along with the contracted and announced projects that would add to the renewable portfolio of the respective companies. Additionally, recent statuses of approved Stage 1 and Stage 2 construction projects as of December 2023, including those currently under construction and canceled, are shown below in Table 2.2-2.

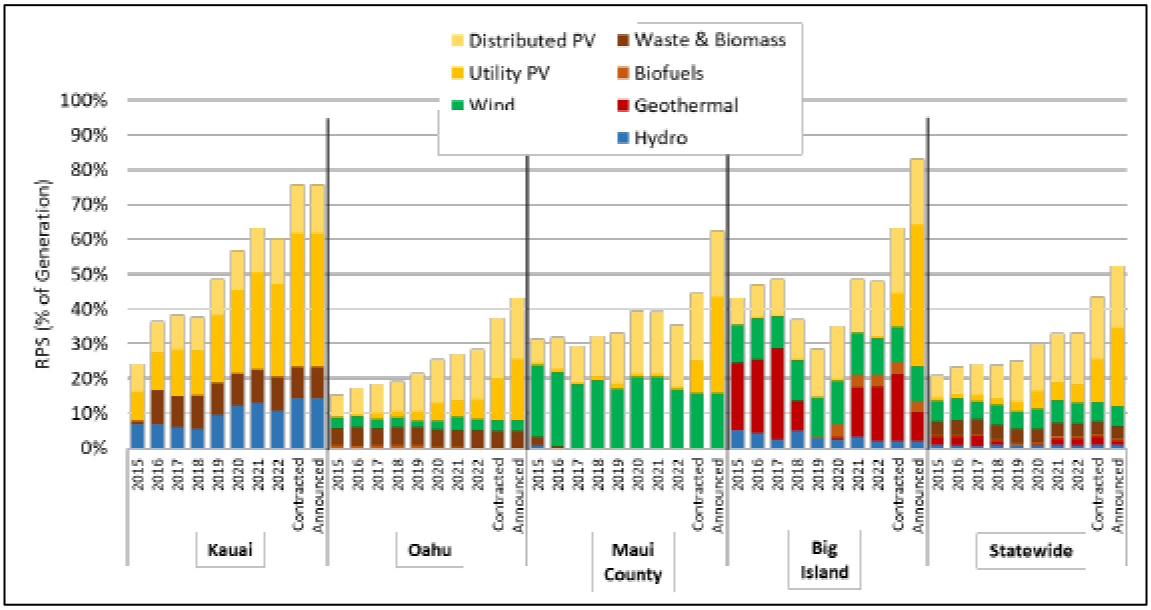

**Figure 2.2-1** Projected RPS attainment, assuming completion of contracted projects. The "announced" column includes proposed Stage 3 variable renewable projects which do not yet have regulatory approval.

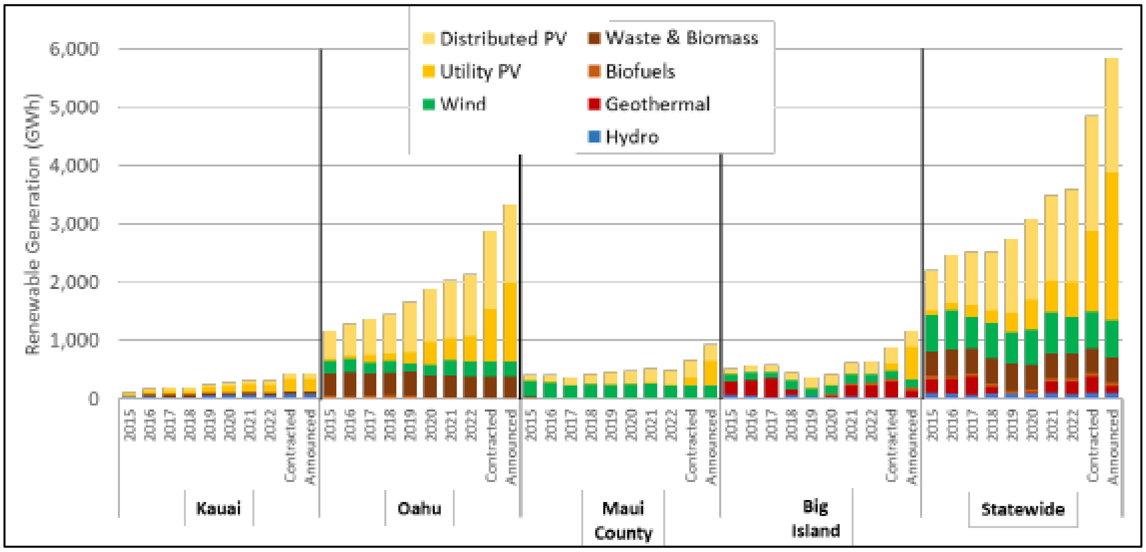

**Figure 2.2-2** Projected RPS generation, assuming completion of contracted projects. The "announced" column includes proposed Stage 3 variable renewable projects which do not yet have regulatory approval.

**Table 2.2-2** Recent Status of Approved Stage 1 and Stage 2 Projects as of December 2023, shown in MW

| Island | Oahu | Maui | Big Island | Total |
|---|---|---|---|---|
| Operating | 75 | 0 | 30 | 105 |
| Construction | 144 | 60 | 30 | 234 |
| Canceled | 208 | 115 | 120 | 443 |
| Total | 426 | 175 | 180 | 781 |
| Standalone Batteries [b] | 185 | 40 [a] | 12 [a] | 237 |

a. Awaiting PUC approval
b. Standalone batteries are largely for grid services and will not significantly impact RPS

Given the plans outlined by KIUC and Hawaiian Electric, it appears reasonable that the state will achieve its RPS goal of 40% by 2030. However, unforeseen events such as the 2023 Lahaina wildfires have highlighted concerns about events that can result in significant delays and cancellations despite already developed plans and awarded contracts. Additionally, requirements beyond 2030 are uncertain due to the uncertainties regarding that amount of growth in electricity demand across the state. Cross-sector efforts to reduce emissions by turning to electric alternatives further exacerbates the uncertainty of the feasibility of the 2040 and 2045 RPS goals of 70% and 100% respectively.

Energy Efficiency Portfolio Standard (EEPS)

The main focus of the State of Hawaii's EEPS is on reducing consumption or demand peaks of electricity by improving efficiency. These standards are codified in HRS §269-96 (see Appendix E), which is designed to achieve a reduction in the consumption of 4,300 gigawatt hours (GWh) of electricity statewide by 2030. The HRS tasks the PUC with establishing interim goals for 2015, 2020, and 2025, adjusting the 2030 standard, and with establishing incentives and penalties based on performance in achieving those standards. The HRS further tasks the PUC to determine if the EEPS remains effective and achievable and report findings and revisions of the EEPS to Hawaii's State Legislature every five (5) years. The most recent EEPS report from the State of Hawaii Public Utilities Commission was submitted to the 2024 Hawaii State Legislature in December of 2023.

Unlike the RPS, the PUC lacks jurisdiction over many large consumers of electricity. Therefore, the PUC contracts with a Public Benefits Fee Administrator ("PBFA") to design and implement the Hawaii Energy program where at least 70% of the PBFA budget is designated for direct incentives in the form of cash rebates or services for customers. The third and latest PUC Report to the 2024 Hawaii State Legislature on the EEPS (see Appendix G) found the following:

- The EEPS Goals remain effective for accelerating the deployment of energy efficiency resources throughout Hawaii.
- The Hawaii Energy portfolio continues to deliver the majority of the total energy savings towards the EEPS interim goals. Hawaii Energy contributed 58% of the first-year energy savings (62% cumulative persisting savings) during the First Performance Period and delivered 77% of the first-year savings (53% cumulative persisting savings) during the Second Performance Period.
- Hawaii Energy continues to be a cost-effective energy resource.
- Energy efficiency helps to reduce usage and costs of low-to-moderate income customers.
- Energy efficiency provides support as the lowest-cost resource for the RPS goal of a 100% renewable energy portfolio by reducing and offsetting energy demand.
- As easier and cheaper efficiency measures are implemented and near future goals are met, more expensive measures will need to be pursued and implemented to maintain the same level of achievement per year moving forward.
- To meet the 2030 energy savings goal, efforts will need to be scaled up to make up for measures that will reach end of useful lives between 2020 and 2030 as well as the gap between the current savings and the 4,300 GWh goal.
- Residual negative effects from the COVID-19 pandemic will likely affect Hawaii Energy's ability to reach their annual target during the near terms.

Figures 2.2-3 and 2.2-4 below, show the annual statewide first year energy efficiency accomplishments and the annual statewide cumulative persisting energy efficiency accomplishments respectively. The First Year interim savings target was exceeded by 21% (1,176 GWh of 975 GWh) during the second Performance Period and was exceeded by 32% (3,096 GWh of 2,350 GWh) during the combined first and second Performance Periods. At the end of the Second Performance Period, 104% of the EEPS First Year interim goal was achieved (2,453 GWh of 2,350 GWh). Despite the promising First Year results, the State will need to consistently and materially exceed annual 1st year savings goals to make up for the drop off in savings measured in the cumulative persisting metric. During the First Performance Period, 124% of the interim goal (1,704 GWh of 1,375 GWh) was achieved while only 77% of the interim goal (748 GWh of 975 GWh) was achieved during the Second Performance Period.

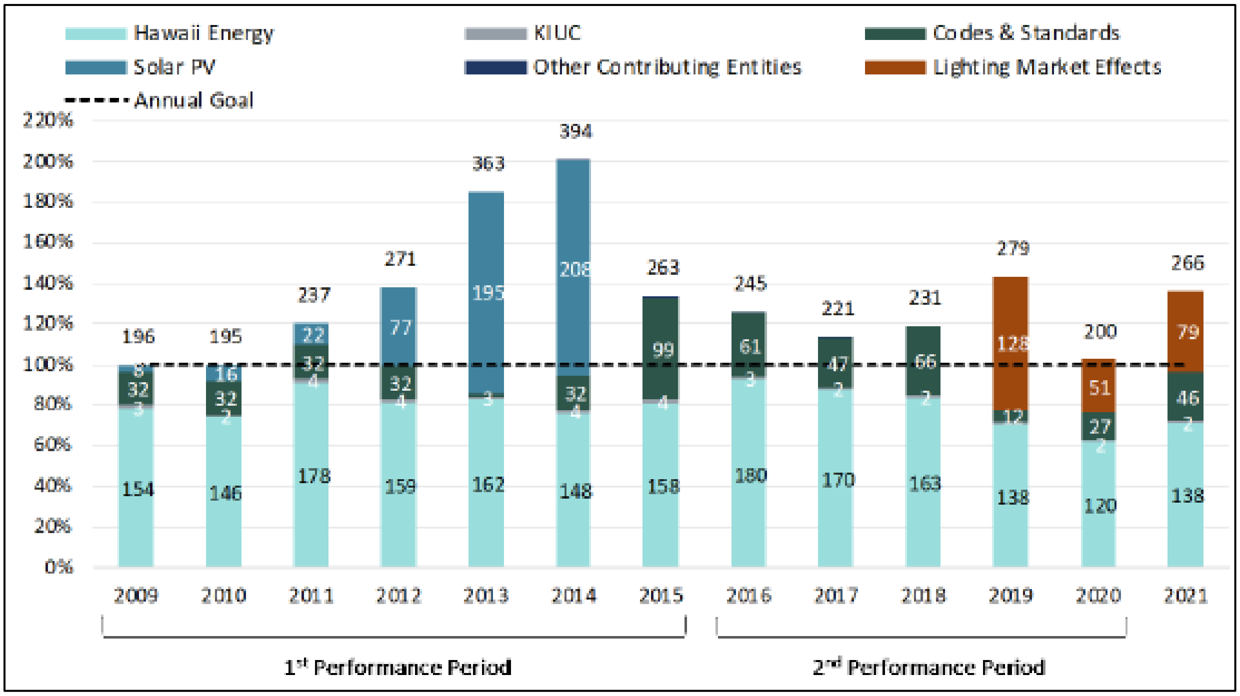

**Figure 2.2-3** Annual Statewide First-Year Energy Efficiency Accomplishments towards EEPS Goals (GWh system level savings)

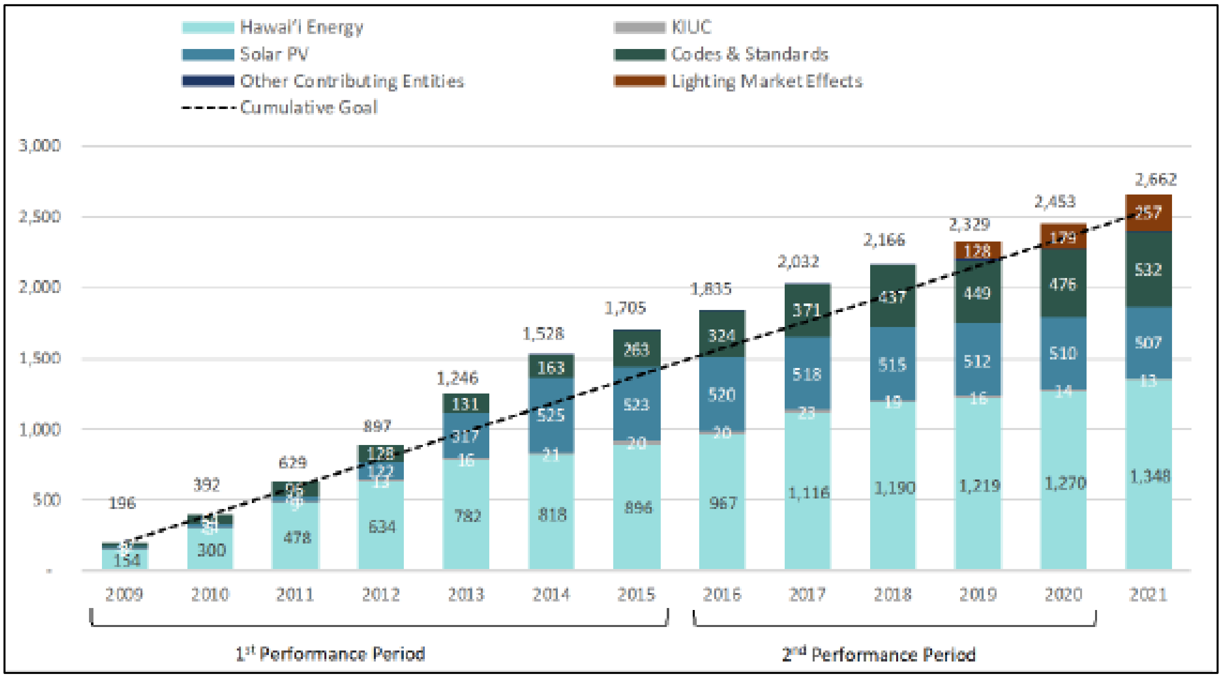

**Figure 2.2-4** Annual Statewide Cumulative Persisting Energy Efficiency Accomplishments towards EEPS Goals (GWh system level savings)

Despite some shortcomings when considering the cumulative persisting energy efficiency accomplishments, the Hawaii Energy program portfolio was successful in delivering substantial energy savings during the First and Second EEPS Performance Periods. Table 2.2-3 below highlights the total program impacts by year. Between program year ("PY") 09 and PY21, Hawaii Energy was able to provide customers with around 2,000 GWh of first year energy savings. Despite first year energy savings declining slightly, 1,350 GWh of program savings persisted in PY21.

**Table 2.2-3** Hawaii Energy System-Level Savings by Program Year

| Program Year | Peak Demand Reduction (MW) | First Year Savings (GWh) | Lifetime Savings (GWh) | Cumulative Persisting Savings (GWh) |
|---|---|---|---|---|
| 2009 | 31.1 | 153.7 | 1,342.7 | 153.7 |
| 2010 | 23.3 | 546.0 | 1,430.0 | 299.7 |
| 2011 | 23.6 | 178.2 | 1,507.3 | 477.9 |
| 2012 | 20.7 | 158.6 | 1,507.1 | 633.8 |
| 2013 | 23.9 | 162.2 | 1,746.4 | 781.5 |
| 2014 | 26.2 | 148.2 | 1,508.3 | 817.8 |
| 2015 | 28.0 | 457.8 | 1,764.3 | 895.5 |
| 2016 | 25.7 | 180.1 | 2,245.0 | 966.7 |
| 2017 | 25.0 | 170.2 | 2,298.6 | 1,115.5 |
| 2018 | 26.0 | 162.9 | 2,248.8 | 1,190.0 |
| 2019 | 24.1 | 137.6 | 1,842.8 | 1,218.8 |
| 2020 | 22.0 | 120.0 | 1,497.4 | 1,269.6 |
| 2021 | 23.5 | 138.4 | 1,549.9 | 1,348.4 |

North American Emissions Control Area (NA ECA)

On March 26, 2010, the International Maritime Organization (IMO) officially designated waters off North American coasts as an area in which stringent international emission standards shall apply to all ships. This area, called the North American Emissions Control Area (NA ECA), includes waters adjacent to the Pacific coast, the Atlantic/Gulf coast, and the eight main Hawaiian Islands. A map showing the NA ECA is depicted below in Figure 2.2-5. Phase one fuel sulfur standards of the NA ECA became enforceable beginning in 2012. The second phase, which introduced more stringent regulations on fuel sulfur, began in 2015, with stringent $NO_x$ engine standards beginning the following year in 2016.[17]

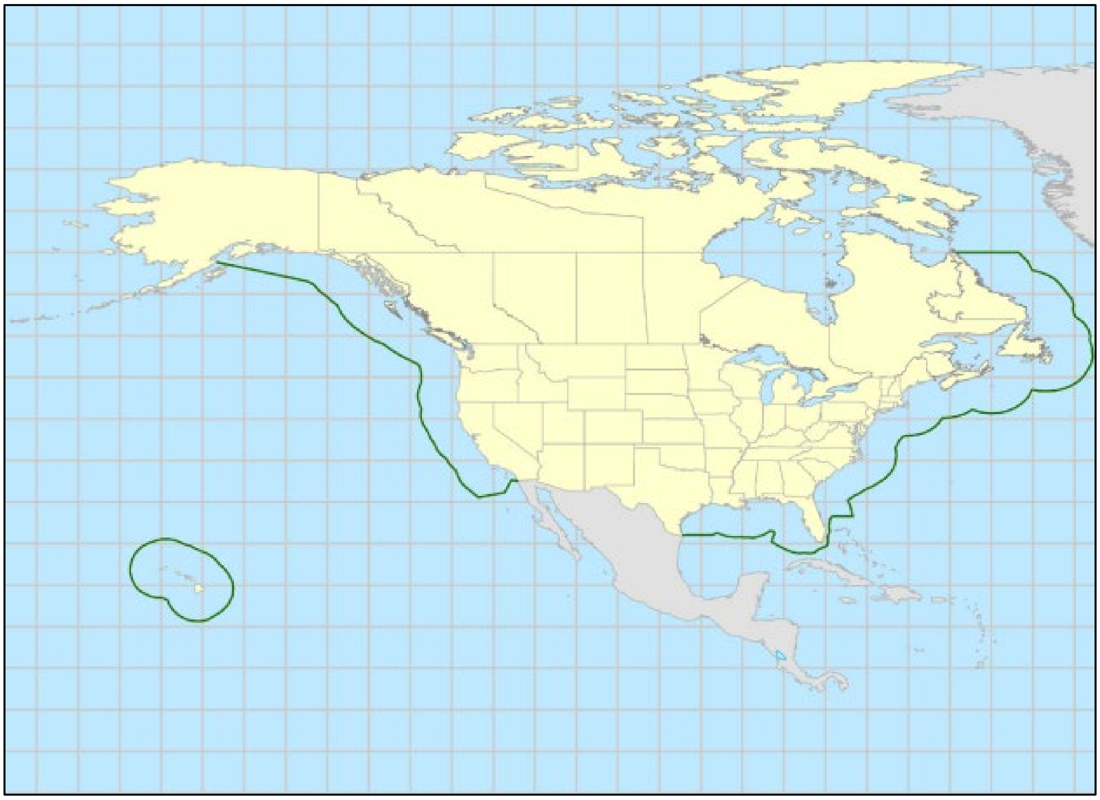

**Figure 2.2-5** Area of the North American Emission Control Area17

The NA ECA regulations, and when they went into effect, are listed in Table 2.2-4 below. These regulations govern nitrogen oxides ($NO_x$), sulfur dioxide ($SO_2$), and fine particulate matter ($PM_{2.5}$) emissions from ships. Emission control area standards involved massive reductions in fuel sulfur content from 15,000 ppm (1.5%) in March of 2010 to 10,000 ppm (1.0%) by June of 2010. Further reductions to 1,000 ppm (0.1%) were put into effect in 2015. An additional Tier III $NO_x$ standard took effect in 2016. The Tier I $NO_x$ standards range from 9.8 to 17 g/kW-hr, depending on engine size. The Tier III standards produced an 80% NOx reduction below the Tier I standards. Ship operators may also equip their vessels with exhaust gas cleaning devices as an option to meet the lower sulfur emission standards for complying with the NA ECA.[17]

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[17] See https://www.epa.gov/regulations-emissions-vehicles-and-engines/designation-north-american-emission-control-area-marine

**Table 2.2-4a** International Ship Engine and Fuel Standards (MARPOL Annex VI)

| | Year | Fuel Sulphur | NOx |
|---|---|---|---|
| Emission Control Area | March 2010 to July 2010 | 15,000 ppm | |
| | 2010 | 10,000 ppm | |
| | 2015 | 1,000 ppm | |
| | 2016 | | Tier III (Aftertreatment-forcing) |
| Global | Today to January 2011 | | Tier I (Engine-based controls) |
| | 2011 | | Tier II (Engine-based controls) |
| | Today to January 2012 | 45,000 ppm | |
| | 2012 | 35,000 ppm | |
| | 2020[a] | 5,000 ppm | |

In 2020, combined emissions from ships operating in the ECA are expected to yield a massive reduction in annual emissions. The expected emission reductions are as follows[18]:

- $NO_X$: 320,000 tons (23%)
- $SO_X$: 920,000 tons (86%)
- $PM_{2.5}$: 90,000 tons (74%)

Federal Mobile Source Regulations and State Mobile Source Programs

The Federal Clean Air Nonroad Diesel Rule was announced in 2004 to reduce emissions from nonroad diesel engines by more than 90 percent by the year 2016. The rule integrates engine and fuel controls as a system to gain emissions reductions and adds new fuel requirements for decreasing sulfur levels in fuel used for nonroad diesel engines, locomotives, and marine vessels by more than 99 percent. The new emissions standards from this rule apply to diesel engines in most construction, agricultural, industrial, and airport equipment. The emission standards, however, do not apply to diesel engines used in locomotives and marine vessels. The emission standards took effect for new engines beginning in 2008 and were fully phased in by 2014.

Federal control measures for Heavy-Duty Highway Vehicles are specified in 40 CFR, Part 86, Subpart P. The current mandatory emission standards for heavy-duty engines were phased-in from 2007-2010 and included a $NO_X$ emission standard of 0.20 g/bhp-hr. The regulation also reduced sulfur content for on-highway diesel fuel from 500 ppm to 15 ppm. Refineries were required to produce 15 ppm ULSD fuel beginning in June 2006 to enable the use of control technologies such as catalytic diesel particulate filters and $NO_X$ catalysts for compliance with the 2007/2010 emission limits.

The Federal Tier II Vehicle and Gasoline Sulfur Program has reduced the sulfur content of gasoline by up to 90 percent.[19] Low sulfur gasoline requirements have enabled the use of advanced emission control systems in cars, pickups, SUVs, and vans beginning in model year 2004. The new regulations have set an average standard of 0.07 grams per mile for $NO_X$ emissions for all classes of passenger vehicles beginning in 2004.[20]

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[18] See https://nepis.epa.gov/Exe/ZyPDF.cgi/P100AU0I.PDF?Dockey=P100AU0I.PDF

[19] See https://www.epa.gov/gasoline-standards/gasoline-sulfur.

[20] EPA Regulatory Announcement, EPA's Program for Cleaner Vehicles and Cleaner Gasoline, December 1999.

In March 2014, the EPA released a regulatory announcement about setting Tier 3 motor vehicle emission and fuel standards. The Federal Tier III gasoline sulfur regulations are in 40 CFR Part 80, Subparts D, E, H, and O. These regulations set new vehicle emission standards and lower the sulfur content in gasoline to a maximum level of 10 ppm by 2017. The gasoline sulfur standard will enable more stringent vehicle emission control measures and increase the effectiveness of air pollution control systems.

In October 2016, Volkswagen (VW) was charged with selling approximately 590,000 model year 2009 to 2016 diesel motor vehicles equipped with computer "defeat devices".[21] This enabled falsified emissions testing results thus allowing these vehicles to be non-compliant with the Clean Air Act (CAA) emission limits, with a primary concern for emissions of $NO_X$. Under the settlements, VW agreed to establish a $2.925 billion Environmental Mitigation Trust for its beneficiaries to pursue alternative transportation projects intended to fully mitigate the total excess $NO_X$ emitted by the non-compliant VW vehicles. As an eligible beneficiary, the State of Hawaii has been allocated $8.125 million, which in part, is helping the Hawaii State Energy Office (HSEO) in developing its green vehicle programs.[22]

With funds from the VW settlement, a statewide Vehicle Assistance Program (VAP) was established by the HSEO. The VAP offers financial assistance to private and/or public vehicle owners looking to replace medium/heavy duty vehicles or engines with clean alternatives. HSEO also recognizes that the program may need to evolve in response to market demand and economic conditions including disruptions such as COVID-19. Solicitations were opened by the City and County of Honolulu for two heavy duty low floor battery electric buses to replace two older diesel buses for city transit services dedicated to a loop of downtown medical facilities. These buses will service an area that could benefit roughly 20,000 residents and are estimated to mitigate 0.997 tons of $NO_X$ emissions annually. In addition, VW will pay for penalties, customer vehicle buyback, modification programs, and invest $2 billion over the next 10 years in zero emission vehicle infrastructure and education projects across the United States. Washington and Hawaii both earned a top-of-the-class, A+ for spending as much as the settlement allowed on electric vehicle charging infrastructure and electrified mass transit buses and ferries.

The Diesel Replacement Rebate (DRR) program provides rebates for the replacement of medium- and heavy-duty diesel vehicles with new, battery-electric equivalents. Presented by the Hawaiʻi State Energy Office in partnership with the Hawaiʻi Department of Health, who has been awarded federal grants through the Diesel Emissions Reduction Act (DERA) for each year from 2022 through 2024, to be matched by funds from the Volkswagen Environmental Mitigation Trust. The Diesel Replacement Rebate is one way that Hawaiʻi is supporting its community and encouraging the transition to zero-emission vehicles. Eligible diesel vehicles, engines and equipment may include buses, Class 5 – Class 8 heavy-duty highway vehicles, marine engines, locomotives and nonroad engines, equipment, or vehicles such as those used in construction, handling of cargo, agriculture, mining, or energy production.[23]

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[21] Volkswagen Settlement homepage at: https://energy.hawaii.gov/vw-settlement/vw

[22] See https://energy.hawaii.gov/what-we-do/financial-assistance-and-grants/volkswagen-settlement/environmental-mitigation-trust-hawaiis-beneficiary-mitigation-plan/#environmental-mitigation-trust

[23] See https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1017V7B.pdf

If a state provides a voluntary match equal to the base allocation offered by EPA, EPA will provide a matching incentive equal to 50 percent of the base allocation. For example: If EPA offers a base allocation of $200,000 to the state, the state could contribute $200,000 of state funding as a voluntary match and the state would receive an additional $100,000 in EPA funding as a matching incentive. The total project budget would then be $500,000, not including any mandatory cost-share funds. The voluntary match may be satisfied by allowable costs incurred by the state (including in kind contributions), or by cash donations of state funds or private funds. State voluntary matching funds included in the approved project budget are subject to the same terms and conditions and funding limits as the awarded DERA funds. A recipient is legally obligated to expend any voluntary match included in the approved project budget within the period of performance of that award.

On August 5, 2021, the EPA announced plans to further reduce greenhouse gas emissions and other harmful air pollutants from heavy-duty trucks through a series of three rulemakings. The first of the three rulemakings were signed on December 20, 2022 and titled “Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards.” This new rule sets stronger emissions standards for heavy-duty vehicles and engines starting in model year 2027. The new standards will cover a wider range of heavy-duty engine operating conditions and will be required to be met for longer periods of time.

On March 20, 2024, EPA issued new standards to reduce air pollution emissions from light-duty and medium-duty vehicles starting with model year 2027. The rules leverage advances in clean car technology to reduce smog, soot, and greenhouse gas forming pollution from vehicles. The Multi-Pollutant Standards for Model Years 2027 and Later Light-Duty and Medium Duty Vehicles phase in over model years 2027 through 2032.

### Construction Activity Mitigation

Rules of General Conformity: HAR §11-60.1-33(a) and §11-60.1-191 through §11-60.1-194 establish rules and citations that prohibits and enforces any person(s) from causing visible fugitive dust to become airborne when engaged in activities such as construction without taking reasonable precaution. Examples of reasonable precautions are:

i. Use of water or suitable chemicals for control of fugitive dust in the demolition of existing buildings or structures, construction operations, the grading of roads, or the clearing of land;
ii. Application of asphalt, water, or suitable chemicals on roads, material stockpiles, and other surfaces which may result in fugitive dust;
iii. Installation and use of hoods, fans, and fabric filters to enclose and vent the handling of dusty materials. Reasonable containment methods shall be employed during sandblasting or other similar operations;
iv. Covering all moving, open-bodied trucks transporting materials which may result in fugitive dust;
v. Maintenance of roadways in a clean manner; and
vi. Prompt removal of earth or other materials from paved streets which have been transported there by trucking, earth-moving equipment, erosion, or other means.

HAR §11-60.1-33(b) and §11-60.1-192(a) further prohibits and enforces any person from discharging visible fugitive dust beyond the property lot line on which the fugitive dust originates. Exceptions from these rules are persons engaged in agricultural operations or persons who can demonstrate to the director that the best practical operation or treatment is being implemented. HAR §11-60.1-34(c) prohibits any person(s) from exhausting emissions from idling vehicles and equipment in operation while the motor vehicle is stationary. Exception to this rule is equipment being operated as originally designed and intended, however, no visible discharge of smoke is allowed. Examples of this include operation of ready-mix trucks, cranes, hoists, and certain bulk carriers, or other auxiliary equipment built onto the vehicle or equipment that require power take-off from the engine.

Rules Specific to Persons Requiring a Permit: HAR §11-60.1-62 and 11-60.1-82 are provisions for determining which person(s) and activities require a state or federally enforceable permit. Construction activities requiring a permit are subject to additional state and federal requirements that are beyond the general rules of conformity. Person(s) or activities not in compliance are subject to enforcement action(s) pursuant to HAR f§11-60.1-192(a) for operating without a permit.

Rules of General Conformity: HAR §11-60.1-33(a) and §11-60.1-191 through §11-60.1-194 establish rules and citations that prohibits and enforces any person(s) from causing visible fugitive dust to become airborne when engaged in activities such as construction without taking reasonable precaution. Please refer to Appendix H. Examples of reasonable precautions are:

i. Use of water or suitable chemicals for control of fugitive dust in the demolition of existing buildings or structures, construction operations, the grading of roads, or the clearing of land;
ii. Application of asphalt, water, or suitable chemicals on roads, material stockpiles, and other surfaces which may result in fugitive dust;
iii. Installation and use of hoods, fans, and fabric filters to enclose and vent the handling of dusty materials. Reasonable containment methods shall be employed during sandblasting or other similar operations;
iv. Covering all moving, open-bodied trucks transporting materials which may result in fugitive dust;
v. Maintenance of roadways in a clean manner;
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## Hawaii's Open Burning Regulations

The State of Hawaii does not have a smoke management plan. Instead, planned open burning is regulated as codified in HAR §11-60.1 Subchapter 3 (please refer to Appendix H). Open burning includes agricultural, residential, and prescribed burning, and is prohibited with a few exceptions such as cooking, fire training, and agricultural burning with a valid permit. Other types of open burning require approval from DOH-CAB. Since January 2012, "backyard" burning of garbage and yard waste has been prohibited on all islands.

An Agricultural Burning Permit (AGP) program is administered for legitimate agricultural businesses to burn green waste (please refer to Appendix H). For these businesses to burn green waste, they must obtain an AGP, which imposes conditions (e.g., notification requirements, location where burning is allowed, when burning may occur, what materials can be burned, and other limitations) to minimize visible smoke impacts to schools, highways, airports, and other sensitive areas. Further restrictions such as "No-Burn" periods may be imposed in times of drought, or where other concerns may be prevalent.

## Best Available Retrofit Technology (BART)

BART regulations are applicable to certain large stationary sources that began operations between 1962 and 1977.[24] A large stationary source is BART eligible if 1) it belongs to one of the 26 BART source categories; 2) has emission units which were in existence on August 7, 1977, but not in operation before 1962; and 3) has total combined emission units with the potential to emit more than 250 tons per year of any single visibility impairing pollutant ($SO_2$, $NO_X$, and PM). The BART rule applies to any BART-eligible source that emits any air pollutant that which may reasonably be anticipated to cause or contribute to any impairment of visibility. The State of Hawaii chose to use the recommended 0.5 deciview threshold for BART determination.[10] The following facilities were identified as eligible under the rules: Hu Honua Bioenergy Pepeekeo facility and HL Kanoelehua Hill. However, the Hu Honua facility was issued a new permit, which included best available control technology (BACT), making it exempt from BART controls.[24]

## State Greenhouse Gas Regulation

Hawaii Administrative Rules (HAR), §11.60-1 Subchapter 11 was enacted to further implement the goals of Act 234, 2007 to effect policies on climate change within the State of Hawaii. The 2020 goal of reducing state-wide greenhouse gas emission levels to below 1990 levels was achieved. Under the law, carbon dioxide equivalent ($CO_2e$) emissions shall be reduced from large stationary sources with a 16% GHG emission cap from the established baseline level. The GHG cap applies to facilities with the potential to emit equal to or above 100,000 short tons of $CO_2e$ per year. Calendar year 2010 annual emissions were used as the baseline to calculate GHG emissions cap for each facility unless another baseline was approved. The emissions cap excludes biogenic $CO_2$ emissions.

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[24] See fact sheet at: https://www.epa.gov/visibility/fact-sheet-proposed-amendments-regional-haze-rule-and-proposed-guidelines-best-available

To further address the threat of climate change, the Hawaii State Legislature passed Act 15 of the 2018 which established a statewide carbon net-negative goal by the calendar year 2045 and Act 238 of the 2022 Legislature to add a GHG emissions limit that would reduce statewide GHG emissions to at least fifty percent 2005 levels by the year 2030. Reducing GHGs will reduce pollutants that cause visibility impairment as a co-benefit.

Plant Shut-Downs

Table 2.2-2 below shows point sources which have shut down on the Maui and Hawaii Islands. Source numbers 3 and 4 on Maui Island are shown on map in Figure 2.0-1. Source number 4 on Hawaii Island is shown on map in Figure 2.0-2.

**Table 2.2-4b** Point Source Shut Downs

| Source | Figure | Source Name | Island | Date Permit File Closed |
|---|---|---|---|---|
| 3 | 2.0-1 | HC&S Puunene Sugar Mill | Maui | 12-16-2016 |
| 4 | 2.0-1 | Maui Pineapple Company | Maui | 6-1-2010 |
| 4 | 2.0-2 | HL Shipman Power Plant | Hawaii | 12-31-2015 |

Best Available Retrofit Technology (BART) Determinations

For the RH-FIP, visibility modeling with CALPUFF was conducted by Alpine Geophysics on behalf of the DOH-CAB to determine which BART eligible sources were reasonably anticipated to cause or contribute to visibility impairment at any Class I area. Modeling determined that the Hu Honua Bioenergy facility (source #5 -now the Honua Ola Bioenergy facility) and Hawaii Electric Light Kanoelehua-Hill facility (source #5 in Figure 2.0-2) on the Big Island were subject to BART review since the visibility impacts from these sources were greater than the 0.5 deciview BART applicability threshold.[10]

The Hu Honua Bioenergy facility was originally constructed in 1971 and operated by Hilo Coast Processing Company starting in 1974 under Covered Source Permit No. 0229-02-C. Since 2004, ownership of the facility has been held by several companies. Covered Source Permit No. 0229-02-C that was transferred to Hu Honua Bioenergy, was replaced by Covered Source Permit No. 0724-01-C for a 407 MMBtu/hr biomass boiler. Controls for the boiler included lime injection to reduce $SO_2$, an SNCR system for $NO_X$ control, and an electrostatic precipitator and baghouse to remove particulate. As a result of the change to construct the new facility, which includes application of Best Available Control Technology (BACT), the Hu Honua Bioenergy was no longer BART eligible.[25]

The Hu Honua Bioenergy Plant is now the Honua Ola Bioenergy facility. The Hawaii PUC rejected an amended power purchase agreement between Honua Ola and Hawaiian Electric in 2022 despite previous approvals over agreements in 2013 and 2017. In its decision, the PUC cited concerns on combusting biomass and higher electricity bills. Honua Ola appealed to the PUC for reconsideration, but the bid was denied again. When the dispute came before the Hawaii Supreme Court, the Court upheld the PUC's decision. Honua Ola is currently evaluating its options moving forward.[26]

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[25] See https://www.epa.gov/sites/default/files/2016-09/documents/hu_honua_response2014_0.pdf

[26] See https://honuaolabioenergy.com/puc-denies-big-island-residents-renewable-energy-in-rejecting-power-purchase/

Although BART guidelines were not mandatory for the Kanoelehua-Hill Generating Station boilers because the total plant generating capacity is less than 750 MW, EPA evaluated this source for BART applicability anyway. Various measures for reducing $SO_2$, $NO_X$, and PM were considered including scrubbers, flue gas desulfurization, fuel switching, low $NO_X$ burners, and SCR. Taking into consideration Hawaii's renewable energy programs and the costs involved with using a lower sulfur fuel, EPA ultimately determined that BART for the Kanoelehua-Hill Generating Station was no controls.

# Chapter 3 Emission Reductions

## 3.0 Summary of Emission Reductions Achieved - 40 CFR §51.308(g)(2)

Section 3 provides actual emissions and emission projection from implementing control measures identified in Section 2.0. Control measures for establishing reasonable progress goals in the second planning period were based on four-factor analyses for facilities on Maui and Hawaii Islands. Unit shutdowns were also proposed for units instead implementing control measures selected from the four-factor analyses. Other programs for reducing emissions include the NA ECA; federal mobile source regulations; and Hawaii's fugitive dust, open burning, and GHG regulations.

## 3.1 Actual Emissions and Fuel Consumption (Maui Island RH-SIP Sources)

Maui Electric Kahului Plant

Actual, $NO_X$, $SO_2$, and $PM_{10}$ from the Kahului Power Plant over a 10-year period between 2012 and 2021 are shown in Figure 3.1-1. Emissions and fuel data were obtained from SLEIS[27] electronic receiving system for reporting to EPA's EIS. Figure 3.1-1 shows mostly $SO_2$ emissions that would be expected from this facility that burns residual fuel oil No. 6 as the primary fuel with significant amounts of sulfur. Between 2013 and 2016, emissions from the plant are lower than recent years between 2017 and 2021.

Hawaiian Electric has been planning to retire the Kahului Power Plant in 2024 but is pushing back the retirement of its fossil fuel-fired boilers as it works to get spare parts for four large Mitsubishi diesel engine generators (DEGs) operating at the Maalaea Power Plant on Maui.[28] As indicated by Hawaiian Electric, these Maalaea units provide 50 MW of generation to the Maui system and the Kahului boilers may not be able to shut down without jeopardizing the ability to serve Maui residents.[29] Spare parts are necessary approximately every two years to overhaul and continue operation of Maalaea DEGs M10 through M13.

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[27] SLEIS home page: https://eha-cloud.doh.hawaii.gov/sleis/

[28] See https://www.mauinews.com/news/local-news/2022/03/hawaiian-electric-mulls-later-shutdown-for-kahului-plant/

[29] Pages 141 and 142 of 745 of in Appendix P of the RH-SIP, Revision 1.

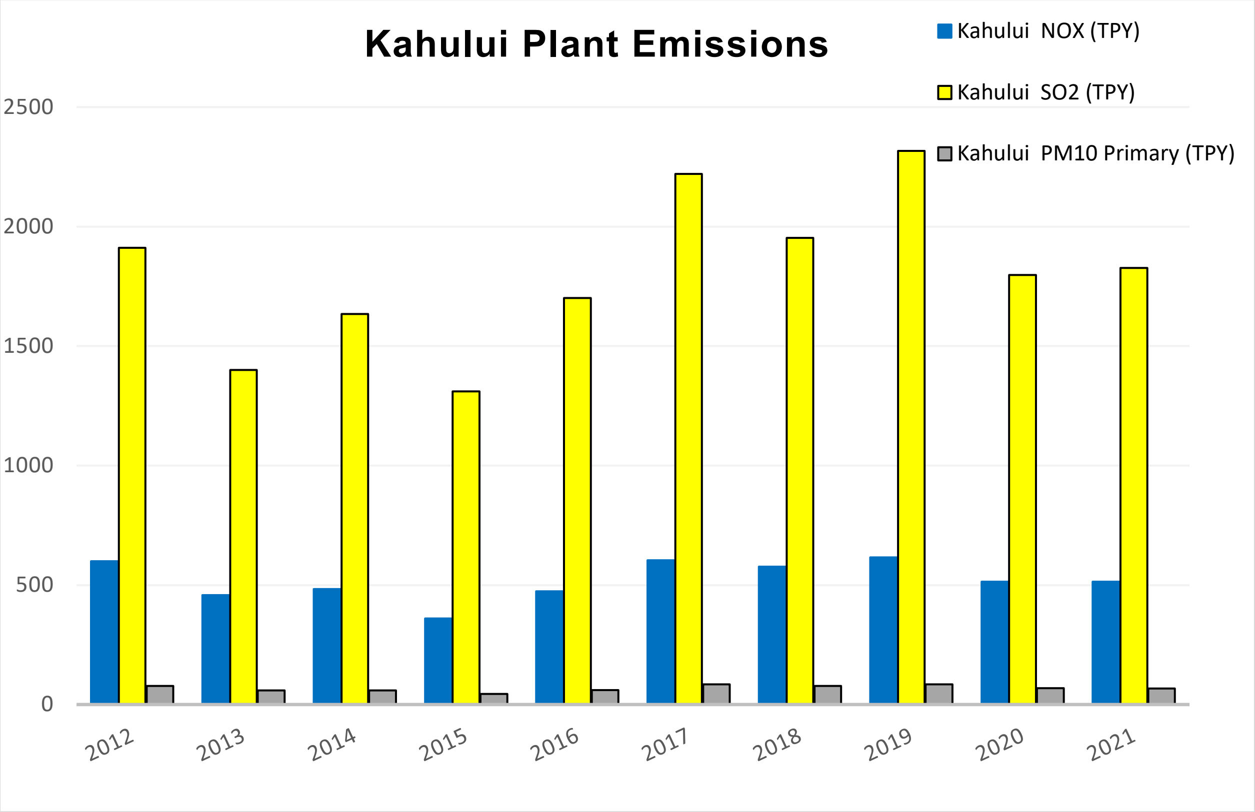
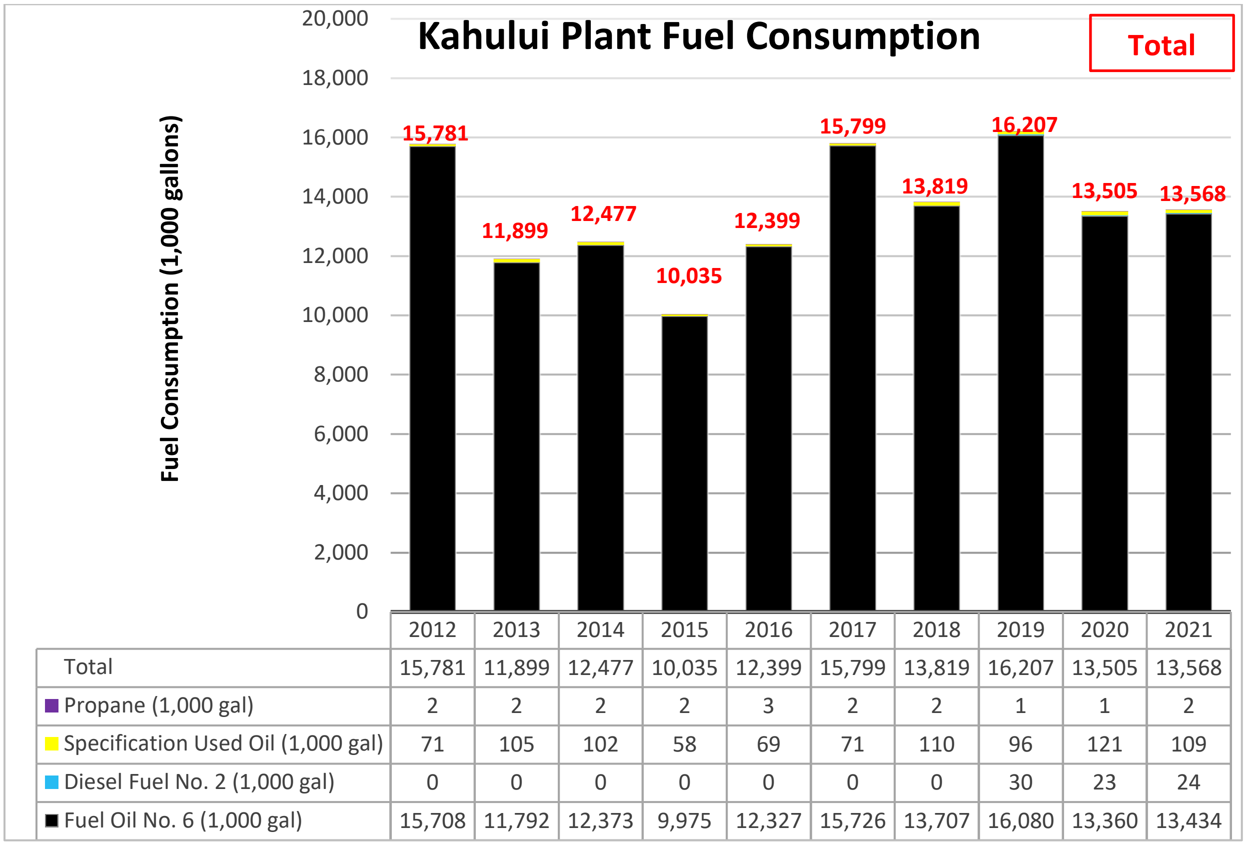


**Figure 3.1-1** Kahului Power Plant $NO_X$, $SO_2$, and $PM_{10}$ Emissions

The Kahului Power Plant's fuel consumption over a 10-year period between 2012 and 2021 is shown in Figures 3.1-2 for Boilers K-1 through K-4. Boilers K-2 through K-4 are equipped with gas igniters that burn propane as an igniter fuel. Boiler K-1 uses an electric igniter. Fuel oil No. 6 is the primary fuel for the boilers with a maximum sulfur content of 2.0%. The boilers are also permitted to burn fuel oil No. 2 with a maximum sulfur content of 0.5% and specification used oil with 2.0% maximum sulfur content.



| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 15,781 | 11,899 | 12,477 | 10,035 | 12,399 | 15,799 | 13,819 | 16,207 | 13,505 | 13,568 |
| 🟪 Propane (1,000 gal) | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 2 |
| 🟨 Specification Used Oil (1,000 gal) | 71 | 105 | 102 | 58 | 69 | 71 | 110 | 96 | 121 | 109 |
| 🟦 Diesel Fuel No. 2 (1,000 gal) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 23 | 24 |
| ■ Fuel Oil No. 6 (1,000 gal) | 15,708 | 11,792 | 12,373 | 9,975 | 12,327 | 15,726 | 13,707 | 16,080 | 13,360 | 13,434 |

**Figure 3.1-2** Kahului Power Plant Fuel Consumption

## Maui Electric Maalaea Plant

Actual $NO_X$, $SO_2$, and $PM_{10}$ emissions from the Maalaea Power Plant for 10-year period between 2012 and 2021 are shown in Figure 3.1-3. Emissions and fuel data were obtained from SLEIS electronic receiving system. Fuel oil No. 2 is the primary fuel for DEGs and combustion drones show operating at this plant. Figure 3.1-3 shows that emissions are primarily $NO_X$ which would be expected from this facility. Distillate fuel typically has a much lower sulfur content than residual oil, like that as the primary fuel for the Kahului boilers, and the internal combustion units (DEGs and CTs) at the Maalaea Generating Station form $NO_X$ from high pressures and temperatures during the combustion process.[30, 31] The principal mechanism of formation with distillate fuel is thermal $NO_X$.

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[30] AP-42, Chapter 3.1, Stationary Gas Turbines, April 2000

[31] AP-42, Chapter 3.4, Large Stationary Diesel and All Stationary Dual-Fuel Engines, October 1996.

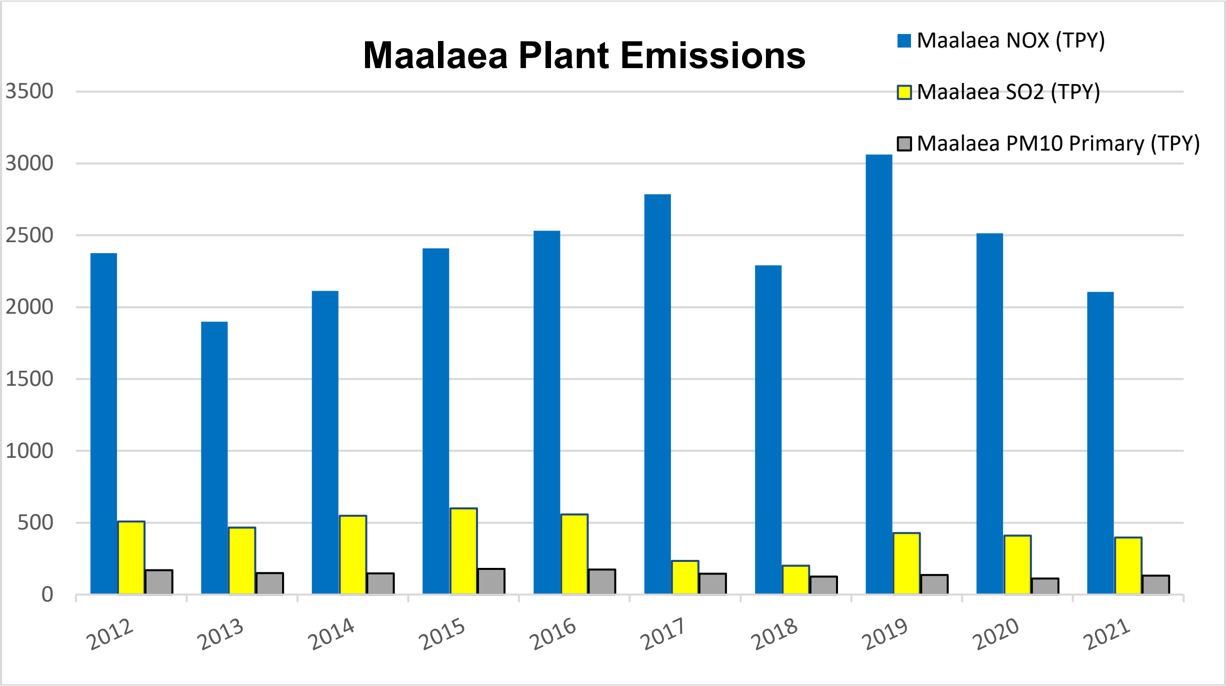
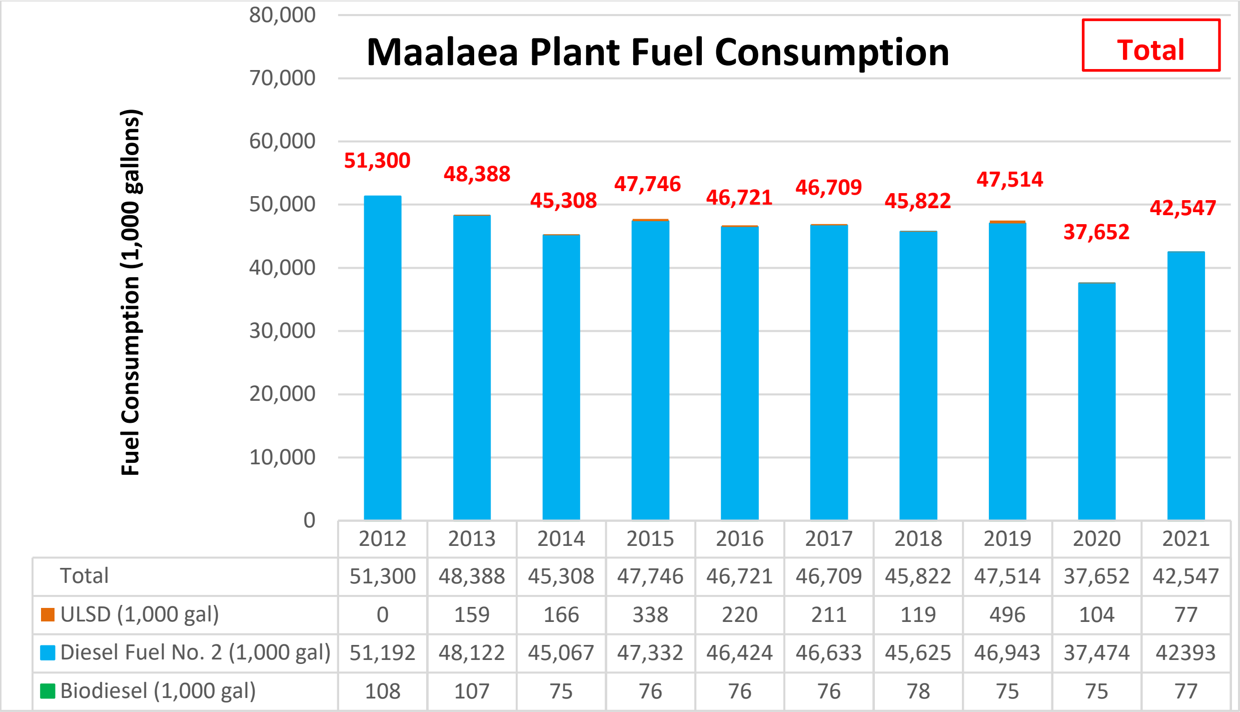


**Figure 3.1-3** Maalaea Power Plant $NO_X$, $SO_2$, and $PM_{10}$ Emissions

Fuel consumption of tis plant for 10-year period between 2012 and 2021 is shown in Figures 3.1-4. Diesel fuel oil No. 2 is overwhelmingly the primary fuel for DEGs and CTs at this facility with a maximum sulfur content of 2.0%. Ultra-low-sulfur diesel (ULSD) and biodiesel are also consumed, but at significantly less levels than fuel oil No. 2. Total fuel consumption has fluctuated between 2012 and 2021, with the highest fuel consumption in 2012 (51,300,000 gallons) and the lowest fuel consumption in 2020 (37,652,000 gallons).



| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 51,300 | 48,388 | 45,308 | 47,746 | 46,721 | 46,709 | 45,822 | 47,514 | 37,652 | 42,547 |
| 🟧 ULSD (1,000 gal) | 0 | 159 | 166 | 338 | 220 | 211 | 119 | 496 | 104 | 77 |
| 🟦 Diesel Fuel No. 2 (1,000 gal) | 51,192 | 48,122 | 45,067 | 47,332 | 46,424 | 46,633 | 45,625 | 46,943 | 37,474 | 42393 |
| 🟩 Biodiesel (1,000 gal) | 108 | 107 | 75 | 76 | 76 | 76 | 78 | 75 | 75 | 77 |

**Figure 3.1-4** Maalaea Power Plant Fuel Consumption

The federally enforceable regional haze control measure for the Maalaea Generation Station is the permanent shut down of boilers K-1 through K-4 by the end of 2028. After these boilers are shut down, there will be no emissions from the Kahului Power Plant.

## 3.2 Actual Emissions and Fuel Consumption (Hawaii Island RH-SIP Sources)

### Kanoelehua-Hill Power Plant

Actual $NO_X$, $SO_2$, and $PM_{10}$ emissions from the Kanoelehua-Hill Generating Station over a 10-year period between 2012 and 2021 are shown in Figure 3.2-1. Emissions and fuel data are from SLEIS electronic receiving systems for reporting to EPA's EIS. Figure 3.2-1 shows mostly $SO_2$ emissions. Highest emission of both $SO_2$ (2770 TPY) and $NO_x$ (806 TPY) from Kanoelehua-Hill plant were recorded in 2016.

Hawaiian Electric is investigating the possibility of an alternative to the control measures specified in Revision 1 of the RH-SIP for the Puna and Kanoelehua-Hill plants due to reliability issues with Hamakua Energy Partners that provides 21% of the firm capacity for Hawaii Island. Currently the RH-SIP requires a fuel switch for the Puna Boiler by August 10, 2026 and the permanent shut down of Boilers Hill 5 and Hill 6 by the end of 2028. The alternative control (depending on the status of power reserves on Hawaii Island) would involve a shut down of the Puna Boiler and Boiler Hill 5 by 2028, and an extended shut down and fuel switch to ULSD for Boiler Hill 6.

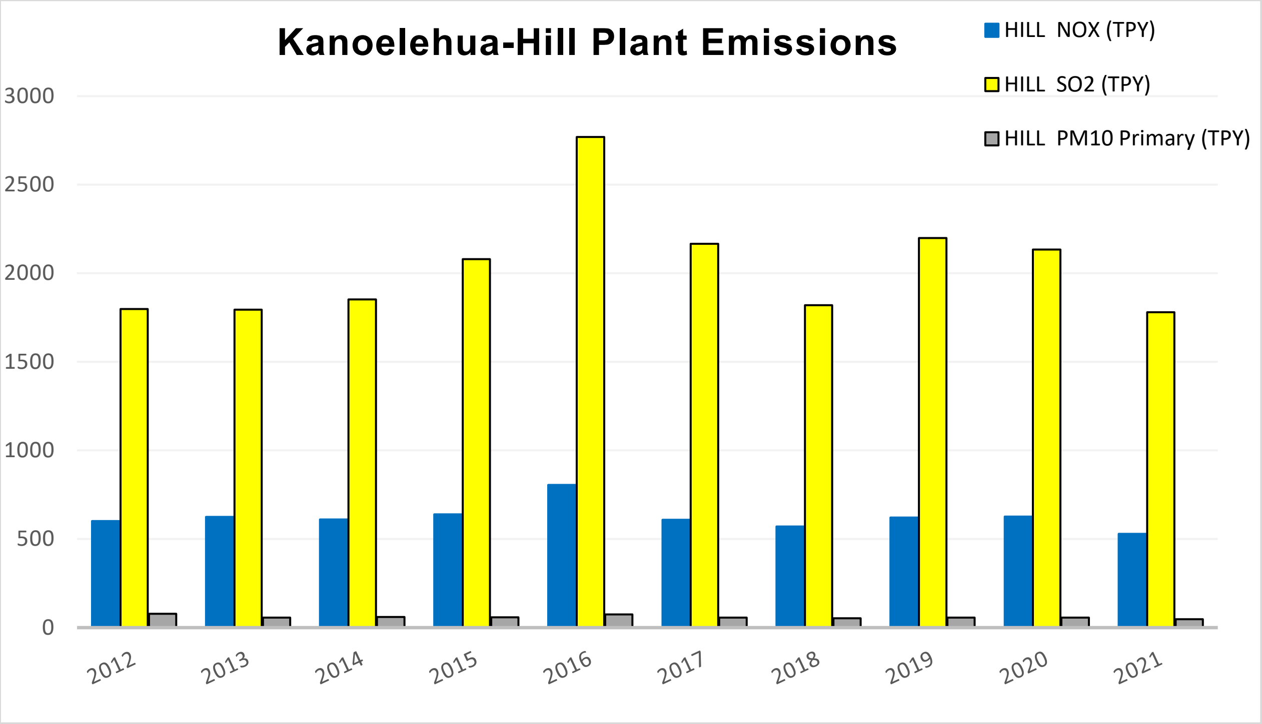
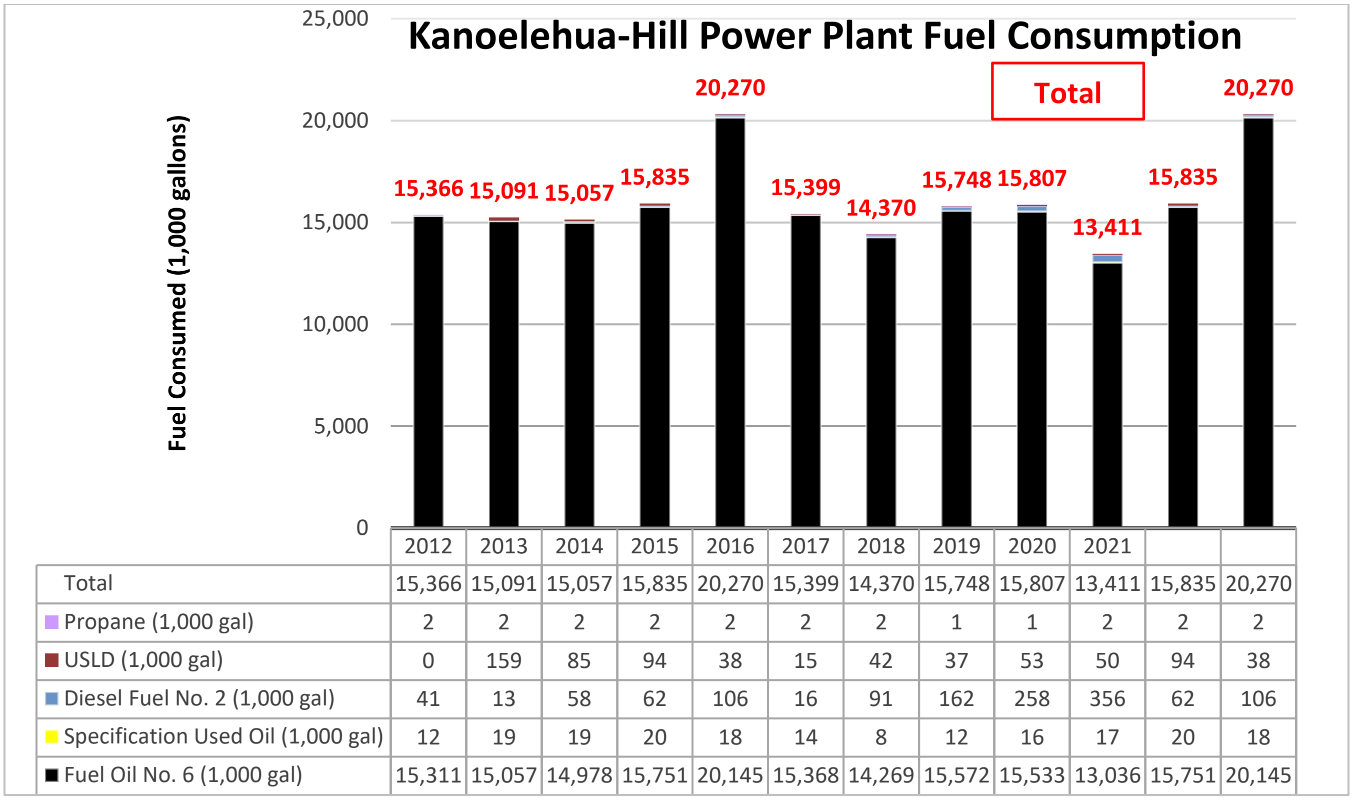


**Figure 3.2-1** Kanoelehua-Hill Power Plant $NO_X$, $SO_2$, and $PM_{10}$ Emissions

Fuel consumption from the Kanoelehua-Hill Generating Station over a 10-year period between 2012 and 2021 is shown in Figures 3.2-2. Fuel oil No. 6 is the primary fuel for two boilers operating at the facility with a maximum fuel sulfur content of 2.0%. In 2016, fuel consumption was highest at 20,270,000 gallons per year.



| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 15,366 | 15,091 | 15,057 | 15,835 | 20,270 | 15,399 | 14,370 | 15,748 | 15,807 | 13,411 | 15,835 | 20,270 |
| 🟪 Propane (1,000 gal) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 |
| 🟥 USLD (1,000 gal) | 0 | 159 | 85 | 94 | 38 | 15 | 42 | 37 | 53 | 50 | 94 | 38 |
| 🟦 Diesel Fuel No. 2 (1,000 gal) | 41 | 13 | 58 | 62 | 106 | 16 | 91 | 162 | 258 | 356 | 62 | 106 |
| 🟨 Specification Used Oil (1,000 gal) | 12 | 19 | 19 | 20 | 18 | 14 | 8 | 12 | 16 | 17 | 20 | 18 |
| ⬛ Fuel Oil No. 6 (1,000 gal) | 15,311 | 15,057 | 14,978 | 15,751 | 20,145 | 15,368 | 14,269 | 15,572 | 15,533 | 13,036 | 15,751 | 20,145 |

**Figure 3.2-2** Kanoelehua-Hill Power Plant Fuel Consumption

Puna Power Plant

Actual $NO_X$, $SO_2$, and $PM_{10}$ emissions from the Puna Generating Station over a 10-year period between 2012 and 2021 are shown in Figure 3.2-3. Emissions and fuel data were obtained from SLEIS. Figure 3.2-3 shows mostly $SO_2$ emissions. Overall emissions from Puna Power Plant were significantly higher between 2012 and 2014, before decreasing drastically to below 300 TPY between 2015 and 2018.

The $SO_2$ emissions increased to higher levels from 2018 to 2021 due to increased operation of the Puna plant after a geothermal facility temporarily shut down. Escalated volcanic activity in 2018 from the Kilauea eruption prompted the temporary shutdown of the nearby Puna Geothermal Venture (PGV) renewable energy plant. Approaching lava from the eruption inundated the main access road to PGV, the wellheads of two geothermal wells, the substation, and an adjacent warehouse storing a drilling rig. The Puna Generating Station had to significantly increase energy production to compensate for the loss of PGV, which provided 31% of Hawaii island's energy prior to the eruption.[32] Energy production from the Puna Generation Station and other diesel generators prevented blackouts on Hawaii island after the temporary shutdown of PGV.

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[32] See https://www.higp.hawaii.edu/hggrc/puna-geothermal-venture-is-hosting-community-meeting/

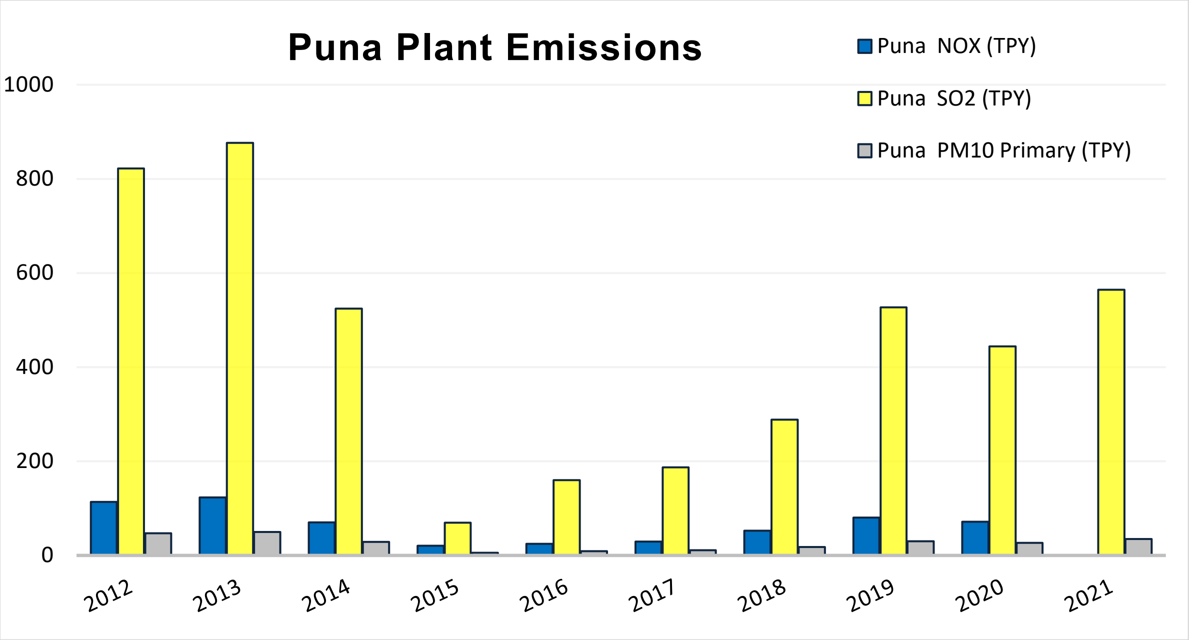
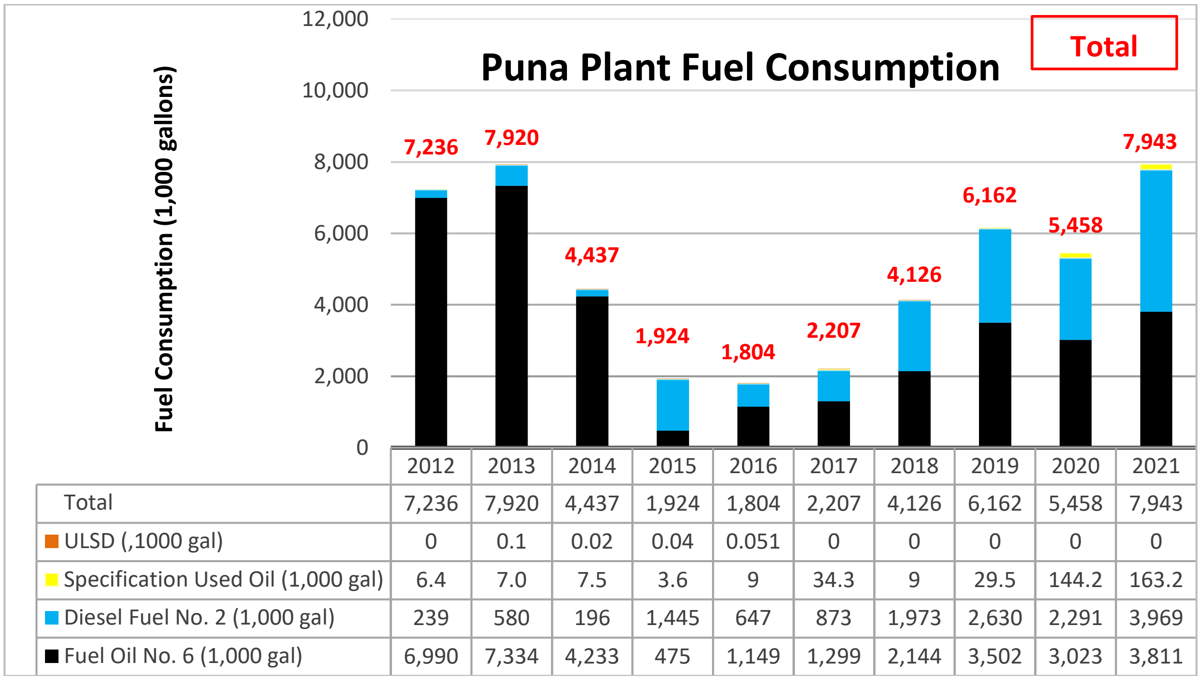


**Figure 3.2-3** Puna Power Plant $NO_X$, $SO_2$, and $PM_{10}$ Emissions

Fuel consumption from Puna Plant over a 10-year period between 2012 and 2021 is shown in Figure 3.2-4. Fuel oil No. 6 is the primary fuel for the Puna Boiler with a maximum sulfur content of 2.0%. The boiler is also permitted to burn fuel oil No. 2 with a maximum sulfur content of 0.5% and specification used oil with 2.0% maximum sulfur content. Total fuel consumption was higher between 2012 and 2013 as well as between 2019 and 2021. Between 2014 and 2018, fuel consumption never exceeded 5,000,000 gallons a year. Fuel oil No. 6 was overwhelmingly the primary fuel consumed between 2012 and 2014 until fuel No. 2 was consumed at higher rates than previously between 2015 and 2021.



| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 7,236 | 7,920 | 4,437 | 1,924 | 1,804 | 2,207 | 4,126 | 6,162 | 5,458 | 7,943 |
| ■ ULSD (,1000 gal) | 0 | 0.1 | 0.02 | 0.04 | 0.051 | 0 | 0 | 0 | 0 | 0 |
| ■ Specification Used Oil (1,000 gal) | 6.4 | 7.0 | 7.5 | 3.6 | 9 | 34.3 | 9 | 29.5 | 144.2 | 163.2 |
| ■ Diesel Fuel No. 2 (1,000 gal) | 239 | 580 | 196 | 1,445 | 647 | 873 | 1,973 | 2,630 | 2,291 | 3,969 |
| ■ Fuel Oil No. 6 (1,000 gal) | 6,990 | 7,334 | 4,233 | 475 | 1,149 | 1,299 | 2,144 | 3,502 | 3,023 | 3,811 |

**Figure 3.2-4** Puna Power Plant Fuel Consumption

Mauna Loa Macadamia Nut Power Plant

Actual $NO_X$, $SO_2$, and $PM_{10}$ emissions from the Mauna Loa Macadamia Nut Corporation Plant for a 10-year period between 2012 and 2021 are shown in Figure 3.2-5. Emissions and fuel data were obtained from SLEIS. This plant is emitting high percentage of NOx. However, over 10-year period, the $NO_X$ emissions have steadily declined from 111 TPY (2012) to 36 TPY (2021).

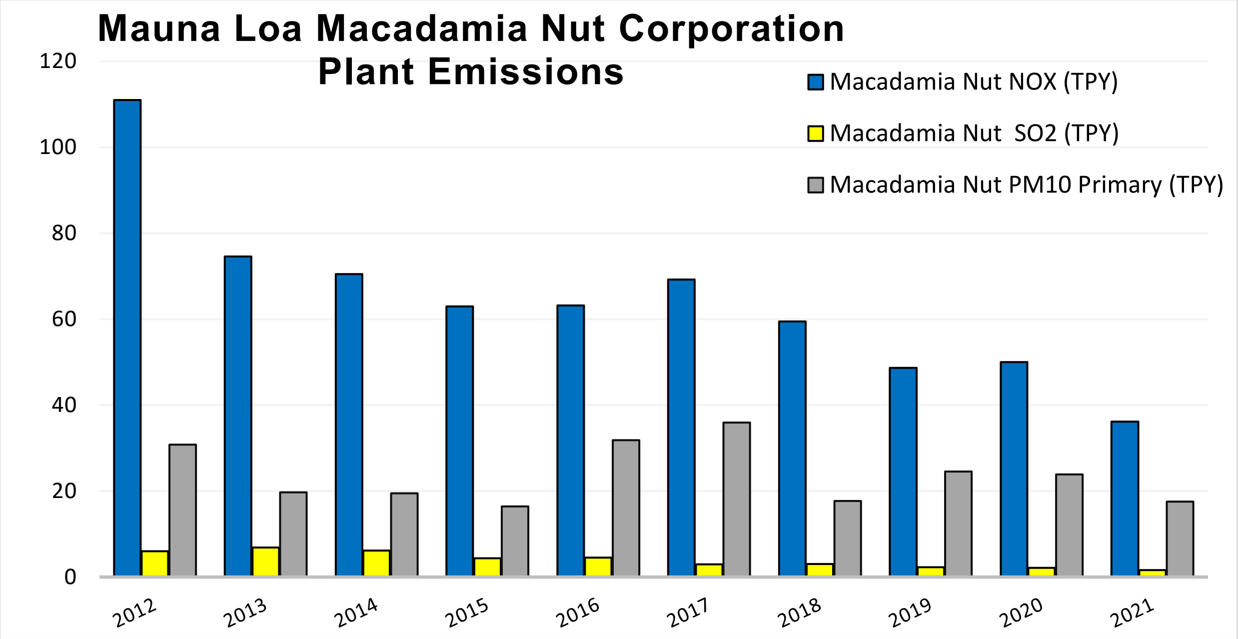
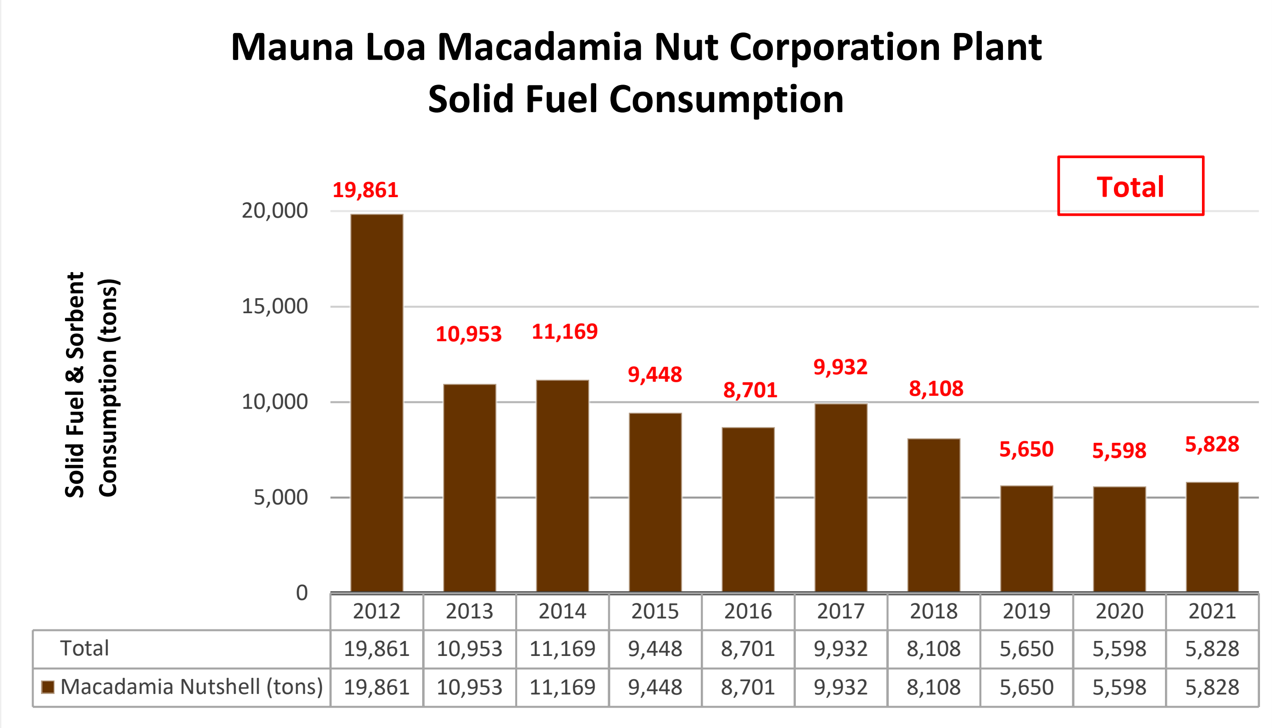


**Figure 3.2-5** Mauna Loa Macadamia Nut Corporation Plant $NO_X$, $SO_2$, and $PM_{10}$ Emissions

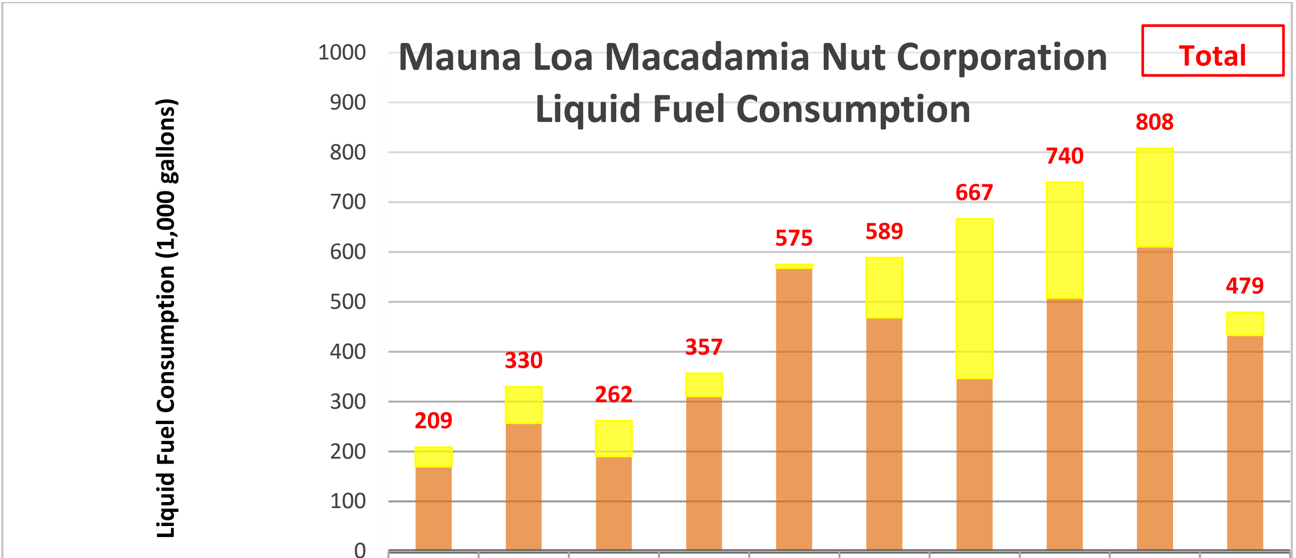
Solid fuel consumption over a 10-year period between 2012 and 2021 from Mauna Loa Plant is shown in Figure 3.2-6. Macadamia nutshell fuel is the only solid fuel used at the plant. Between 2012 and 2021, macadamia nutshell fuel declined from 19,861 tons in 2012 to 5,828 tons in 2021. Sudden decrease of macadamia nutshell consumption from 2012 to 2013 is due to the replacement of a biomass fired back-up boiler with a boiler using only ULSD in 2013.



| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 19,861 | 10,953 | 11,169 | 9,448 | 8,701 | 9,932 | 8,108 | 5,650 | 5,598 | 5,828 |
| ■ Macadamia Nutshell (tons) | 19,861 | 10,953 | 11,169 | 9,448 | 8,701 | 9,932 | 8,108 | 5,650 | 5,598 | 5,828 |

**Figure 3.2-6** Mauna Loa Macadamia Nut Corporation Plant Solid Fuel Consumption

Liquid fuel consumption for Mauna Loa Macadamia Nut Corporation Plant over a 10-year period between 2012 and 2021 is shown in Figure 3.2-7. ULSD is the primarily fuel consumption on this plant. However, specification used oil is also used, especially between 2018 and 2020. Although total fuel consumption has fluctuated over the years, it has increased from 208,938 gallons (2012) to 807,789 gallons (2020). This is likely due a back-up boiler switching from burning biomass to burning ULSD in 2013. However, total liquid fuel consumption dropped to 479,142 gallons in 2021.



| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 209 | 330 | 262 | 357 | 575 | 589 | 667 | 740 | 808 | 479 |
| 🟨 Specification Used Oil (1,000 gal) | 39 | 72 | 71 | 45 | 7 | 120 | 319 | 232 | 197 | 45 |
| 🟧 ULSD (1,000 gal) | 170 | 257 | 191 | 311 | 568 | 469 | 347 | 508 | 611 | 434 |

**Figure 3.2-7** Mauna Loa Macadamia Nut Corporation Plant Liquid Fuel Consumption

## 3.3 Emission Projections

Figure 3.3-1 shows total combined $SO_2$, $NO_X$, and $PM_{10}$ emission projections for Kahului and Maalaea RH-SIP sources on Maui Island. Actual emissions are shown for 2021 as a baseline. The emission projections were based on the following assumptions:

1) 2028 - The 2021 emissions were reduced by the amounts of $NO_X$ control achieved by scenario of installing SCR for Maalaea DEGs M7 and M10 - M13 and FITR for Maalaea DEGs M1 and M3 by the beginning of 2028.
2) 2029 - The 2021 emissions were reduced by the amount of control achieved for shutting down Kahului Boilers K1 - K4 by the beginning of 2029 plus the amount of $NO_X$ control achieved from installing SCR for Maalaea M7 and M10 - M13 and FITR for Maalaea M1 and M3 by the beginning of 2028.
3) 2031 - The 2021 emissions were reduced by the amount of control achieved for shutting down Kahului K1 - K4 by the beginning of 2029 plus emission reductions from scenario of shutting down Maalaea M10 by the beginning of 2031 plus installation of FITR for Maalaea M1 and M3 by the beginning of 2029.
4) 2033 - The 2021 emissions were reduced by the amount of emission control from shutting down Kahului K1 - K4 plus the emission reduction from shutting down Maalaea M10 by the beginning of 2031 and Maalaea M11 by the beginning of 2033 plus the $NO_X$ reduction from installing FITR from Maalaea M1 and M3 by the beginning of 2028.
5) 2038 - The 2021 emissions were reduced by the amount of emissions control achieved from shutting down Kahului K1 - K4 by the beginning of 2029 plus the emissions reduction from shutting down Maalaea M10 by the beginning of 2031 plus the emission reductions from shutting down M11 by the beginning of 2033 plus the emission reductions from shutting down M7, M12, and M13 by the beginning of 2038 plus the $NO_X$ reduction from installing FITR for Maalaea M1 and M3 by the beginning of 2028.

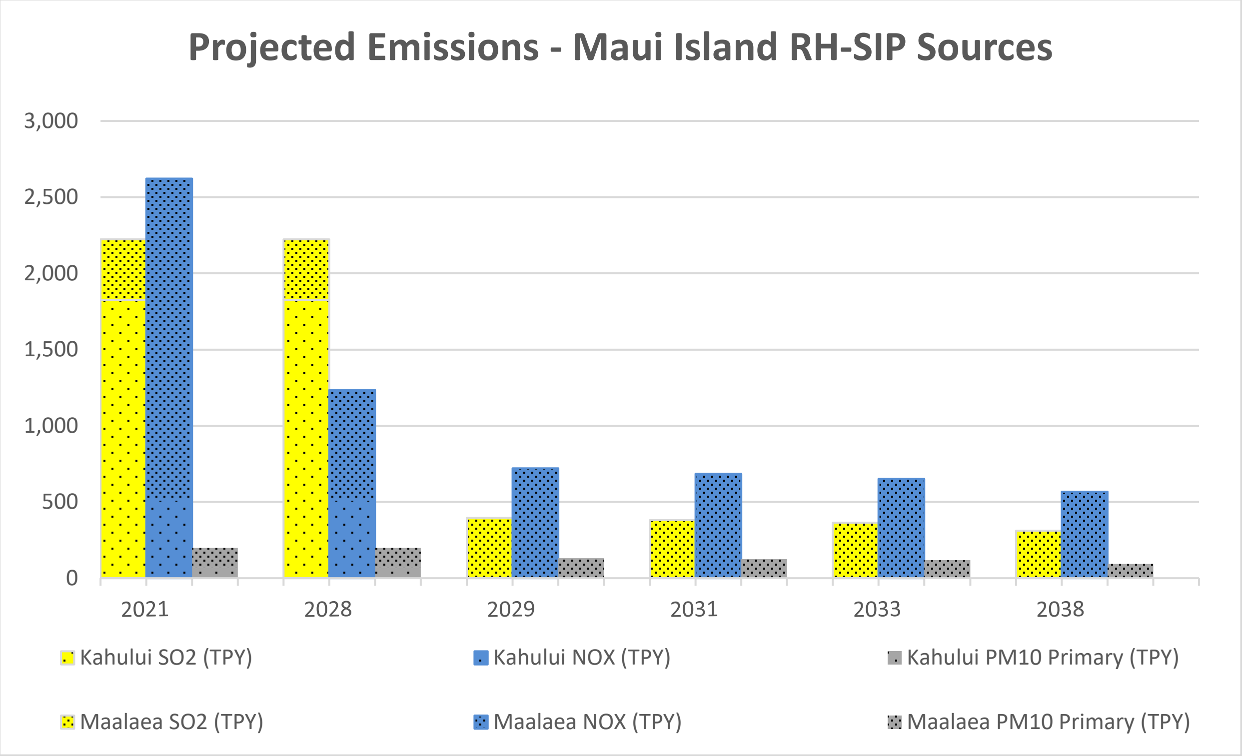


**Figure 3.3-1** Maui Island RH-SIP Source Projections

Figure 3.3-2 shows total combined $SO_2$, $NO_X$, and $PM_{10}$ emissions projections for the Kanoelehua-Hill, Puna, and Maun Loa Macadamia Nut Corporation RH-SIP sources on Hawaii Island. Actual emissions are shown for 2021 as a baseline. The emission projections are based on the following assumptions:

1) 2027 - The 2021 $SO_2$ emissions were reduced by the difference in emissions from the Puna Boiler fired fuel oil No. 6 with as much as 2.0% sulfur content before the fuel switch and the emissions after the fuel switch to ultra-low sulfur diesel fuel by August 10, 2026 with 0.0015% maximum sulfur content. The total yearly reduction would occur during calendar year 2027. Emissions factors were used to scale down actual 2021 emissions of $SO_2$, $NO_X$, and $PM_{10}$ by 0.0015/2.2 for $SO_2$, 0.171/0.767 for $NO_X$, and 0.014/0.287 for $PM_{10}$ to account for the fuel switch from fuel oil No. 6 to ULSD.
2) 2028 - The 2021 emissions were reduced by the amounts of emissions reduction achieved for shutting down Boilers Hill 5 and Hill 6 by the end of 2028.
3) No emission reductions were assumed for the Mauna Loa Macadamia Nut Corporation Plant since the type of boiler replacing the main boiler, as an RH-SIP control measure, is unknow at this time. The company may either replace the main boiler with an entirely new boiler or rebuild the old boiler. Emission data will need to be provided for the boiler replacement as part of the permitting process to modify the facility.

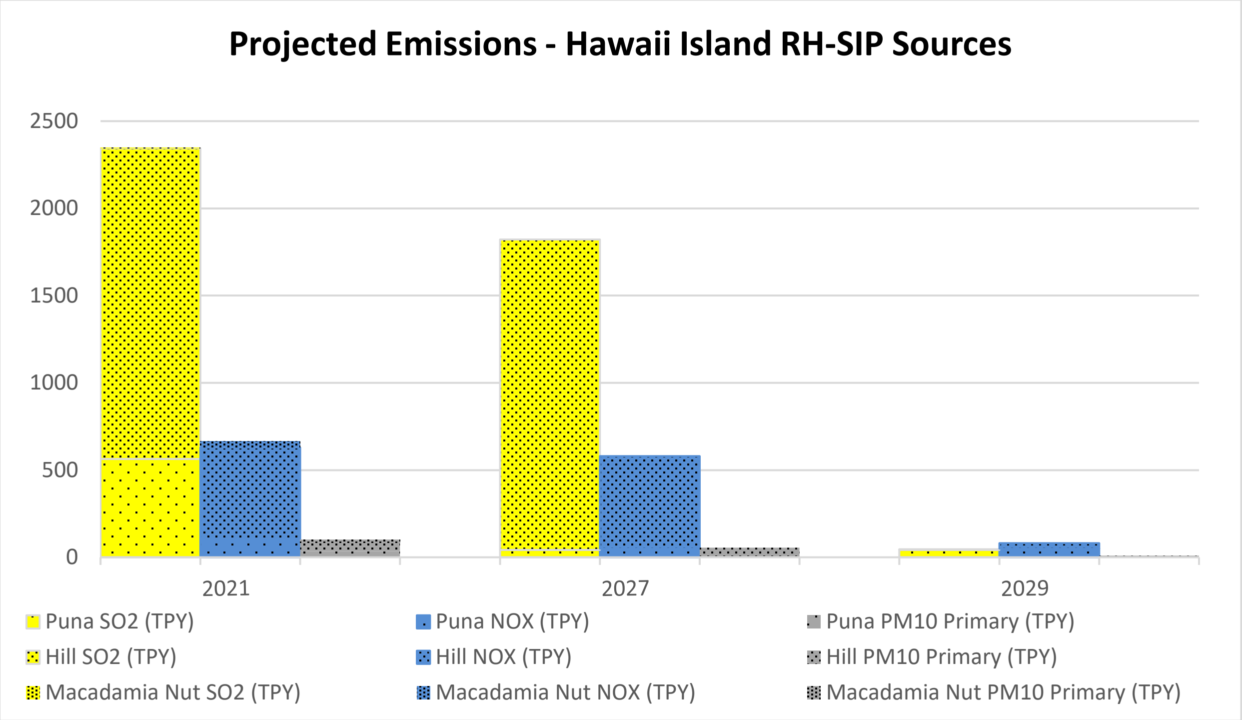


**Figure 3.3-2** Hawaii Island RH-SIP Source Projected Emissions

## 3.4 North American Emissions Control Area and Federal Mobile Source Regulations

Mobile source emissions are based on EPA's NEI data for years 2005 (base year), 2017, and 2020.[33] Mobile source emissions from Maui and Hawaii Islands are as follows:

<u>Maui Island:</u>

1) Table 3.4-1 provides summary of mobile source emissions for both on-road sources and non-road sources for Maui Island.
2) Figure 3.4-1 shows mobile source emissions trend for the specified years. Two figures include six different emitted sources in Table 3.4-1. Two figures have different y-axis range.
3) Overall, total emission of every source declined from 2005 to 2017, and to 2020.

<u>Hawaii Island:</u>

1) Table 3.4-2 provides summary of mobile source emissions for both on-road sources and non-road sources for Hawaii Island.
2) Figure 3.4-2 shows mobile source emissions trend for the specified years. Two figures include six different emitted sources in Table 3.4-2. Two figures have different y-axis range.
3) Overall, total emission of every source declined from 2005 to 2017, and to 2020.

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[33] EPA NEI Website: https://www.epa.gov/air-emissions-inventories

**Table 3.4-1** Mobile Source Emissions for Maui Island

| Sector On-Road | 2005 Total Emissions (TPY) | | | | | | 2017 Total Emissions (TPY) | | | | | | 2020 Total Emissions (TPY) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $SO_2$ | NOx | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ | $SO_2$ | NOx | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ | $SO_2$ | NOx | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ |
| Diesel Heavy Duty Vehicles | 14 | 491 | 17 | 15 | 36 | 1 | 1 | 343 | 34 | 21 | 36 | 1 | 0 | 285 | 24 | 13 | 23 | 2 |
| Diesel Light Duty Vehicles | 0 | 5 | 1 | 1 | 3 | 0 | 0 | 55 | 4 | 3 | 17 | 0 | 0 | 48 | 3 | 2 | 9 | |
| Non-Diesel Heavy Duty Vehicles | 1 | 97 | 2 | 2 | 74 | 1 | 0 | 14 | 2 | 0 | 10 | 0 | 0 | 10 | 2 | 1 | 11 | 1 |
| Non-Diesel Light Duty Vehicles | 31 | 1482 | 39 | 19 | 2583 | 149 | 6 | 1008 | 88 | 22 | 1045 | 43 | 3 | 431 | 60 | 15 | 577 | 31 |
| Sector Non-Road | $SO_2$ | NOx | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ | $SO_2$ | NOx | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ | $SO_2$ | NOx | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ |
| Aircraft | 26 | 289 | 38 | 31 | 88 | | 49 | 301 | 14 | 13 | 97 | | 18 | 129 | 13 | 12 | 113 | |
| Commercial Marine Vessel | 635 | 1787 | 99 | 93 | 37 | 0 | 21 | 760 | 17 | 16 | 33 | 0 | 2 | 132 | 3 | 3 | 5 | 0 |
| Equipment Diesel | 59 | 443 | 42 | 40 | 49 | | 0 | 198 | 14 | 13 | 18 | 0 | 0 | 159 | 10 | 10 | 14 | 0 |
| Equipment Gasoline | 1 | 109 | 23 | 21 | 927 | 0 | 1 | 104 | 23 | 21 | 521 | 0 | 0 | 99 | 23 | 21 | 432 | |
| Other | 0 | 29 | 0 | 0 | 7 | | 3 | 21 | 3 | 3 | 3 | | 1 | 8 | 1 | 1 | 2 | |
| Total | 769 | 4732 | 262 | 223 | 3805 | 152 | 81 | 2804 | 199 | 112 | 1780 | 44 | 24 | 1301 | 139 | 78 | 1186 | 34 |

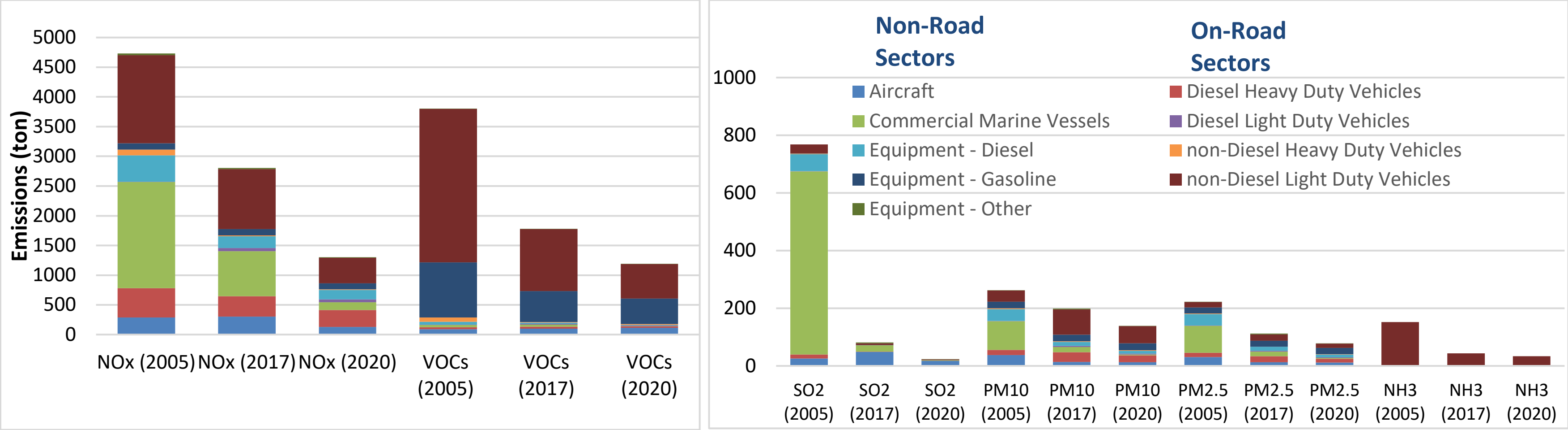

**Figure 3.4-1** Emission Trends on Mobile Source by Sector on Maui Island

**Table 3.4-2** Mobile Source Emissions for Hawaii Island

| Sector On-Road | 2005 Total Emissions (TPY) | | | | | | 2017 Total Emissions (TPY) | | | | | | 2020 Total Emissions (TPY) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $SO_2$ | NOx | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ | $SO_2$ | NOx | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ | $SO_2$ | NOx | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ |
| Diesel Heavy Duty Vehicles | 16 | 548 | 20 | 17 | 39 | 1 | 1 | 502 | 47 | 31 | 60 | 2 | 0 | 447 | 34 | 20 | 40 | 3 |
| Diesel Light Duty Vehicles | 0 | 6 | 1 | 1 | 4 | | 0 | 154 | 11 | 8 | 52 | 1 | 0 | 142 | 11 | 8 | 30 | 1 |
| Non-Diesel Heavy Duty Vehicles | 1 | 111 | 3 | 2 | 73 | 1 | 0 | 16 | 2 | 0 | 11 | 0 | 0 | 13 | 2 | 1 | 13 | 1 |
| Non-Diesel Light Duty Vehicles | 37 | 1793 | 46 | 22 | 2700 | 173 | 8 | 1480 | 110 | 32 | 1431 | 61 | 4 | 657 | 77 | 22 | 757 | 45 |
| Sector Non-Road | $SO_2$ | NOx | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ | $SO_2$ | NOx | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ | $SO_2$ | NOx | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ |
| Aircraft | 19 | 185 | 30 | 24 | 54 | | 55 | 407 | 32 | 29 | 182 | | 20 | 156 | 13 | 12 | 119 | |
| Commercial Marine Vessel | 829 | 1954 | 118 | 111 | 44 | 0 | 14 | 509 | 11 | 10 | 22 | 0 | 2 | 75 | 2 | 2 | 3 | |
| Equipment Diesel | 96 | 715 | 67 | 65 | 78 | 1 | 0 | 223 | 15 | 15 | 20 | 0 | 0 | 179 | 11 | 11 | 15 | 0 |
| Equipment Gasoline | 1 | 98 | 19 | 17 | 817 | | 1 | 103 | 17 | 15 | 459 | 0 | 0 | 101 | 16 | 15 | 360 | 0 |
| Other | 0 | 32 | 0 | 0 | 8 | | 2 | 15 | 2 | 2 | 3 | | 0 | 7 | 1 | 1 | 2 | |
| Total | 999 | 5442 | 303 | 259 | 3816 | 176 | 81 | 3409 | 247 | 142 | 2240 | 64 | 26 | 1777 | 167 | 92 | 1289 | 50 |

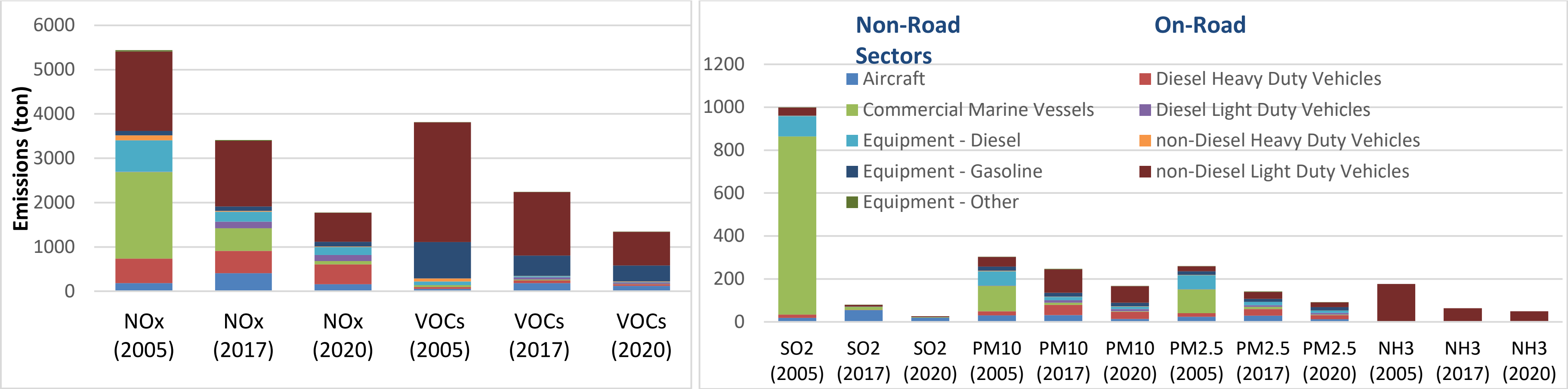

**Figure 3.4-2** Emission Trends on Mobile Source by Sector on Hawaii Island

## 3.5 Hawaii's Agricultural and Open Burning Regulations

Emissions from fires including agricultural burning, prescribed burning, and wildfires are based on EPA's NEI data for years 2005 (base year), 2017, and 2020. Fire emissions from Maui and Hawaii Islands are as follows:

<u>Maui Island:</u>

1) Table 3.5-1 is the summary table of the fire emission of six main sources on Maui Island for the years specified.
2) Figure 3.5-1 includes trend graph of the fire emission of every six source on Maui Island in specified years. Two figures include six different emitted sources in Table 3.5-1, but they have different y-axis range.
3) Data of prescribed burning in 2005, wildfires in 2017, and agricultural burning in 2017 and 2020 were not recorded.

<u>Hawaii Island:</u>

1) Table 3.5-2 is the summary table of the fire emission of six main sources on Hawaii Island for the years specified.
2) Figure 3.5-2 includes trend graph of the fire emission of every six source on Hawaii Island in specified years. Two figures include six different emitted sources in Table 3.5-2, but they have different y-axis range.
3) Data of prescribed burning in 2005, and agricultural burning in 2017 and 2020 were not recorded.

**Table 3.5-1** Fire Emissions for Maui Island

| Source | 2005 Emissions (TPY) | | | | | | 2017 Emissions (TPY) | | | | | | 2020 Emissions (TPY) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $SO_2$ | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ | $SO_2$ | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ | $SO_2$ | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ |
| Agricultural Burning | 132 | 297 | 1154 | 1060 | 391 | 108 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| Prescribed Burning | ----- | ----- | ----- | ----- | ----- | ----- | 31 | 51 | 462 | 391 | 1,093 | 76 | 25 | 57 | 253 | 215 | 540 | 38 |
| Wildfires | 14 | 52 | 234 | 201 | 113 | 11 | ----- | ----- | ----- | ----- | ----- | ----- | 86 | 199 | 844 | 716 | 1784 | 124 |
| Total | 146 | 349 | 1388 | 1261 | 504 | 119 | 31 | 51 | 462 | 391 | 1,093 | 76 | 111 | 256 | 1,097 | 931 | 2324 | 162 |

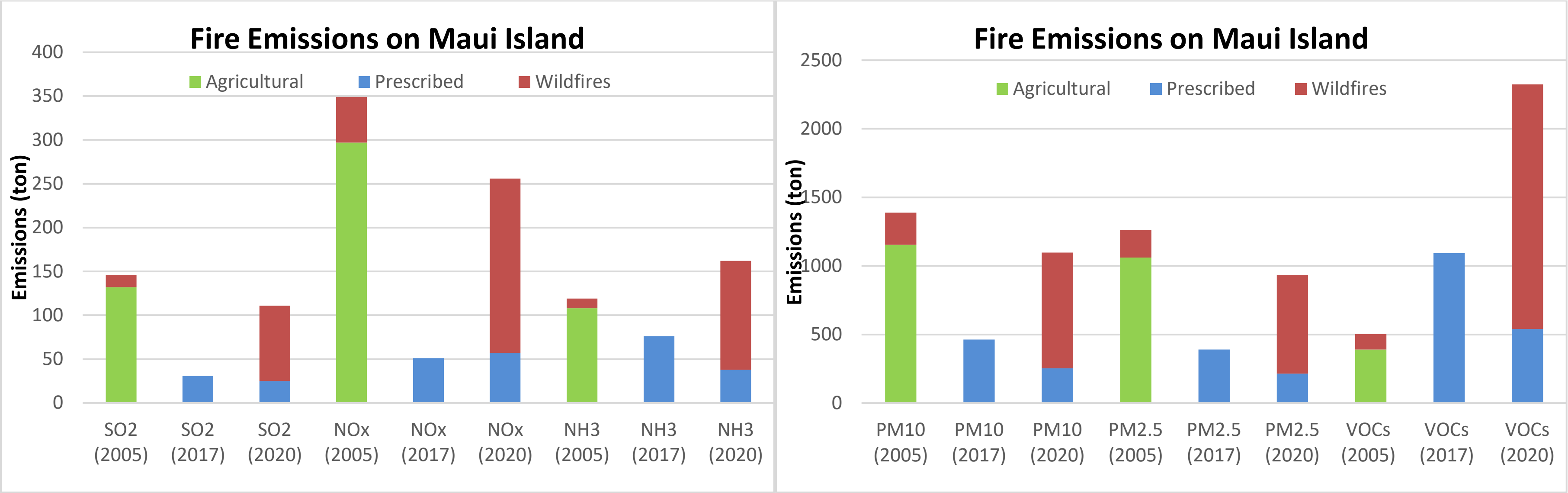

**Figure 3.5-1** Fire Emission Trends on Maui Island

**Table 3.5-2** Fire Emissions for Hawaii Island

| Source | 2005 Emissions (TPY) | | | | | | 2017 Emissions (TPY) | | | | | | 2020 Emissions (TPY) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $SO_2$ | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ | $SO_2$ | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ | $SO_2$ | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | VOCs | $NH_3$ |
| Agricultural Burning | 0 | 2 | 3 | 3 | 3 | 1 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| Prescribed Burning | ----- | ----- | ----- | ----- | ----- | ----- | 4 | 10 | 42 | 35 | 87 | 6 | 8 | 19 | 85 | 72 | 180 | 13 |
| Wildfires | 469 | 1712 | 7760 | 6655 | 3756 | 359 | 35 | 79 | 350 | 296 | 745 | 52 | 0 | 0 | 1 | 1 | 2 | 0 |
| Total | 469 | 1714 | 7763 | 6658 | 3759 | 360 | 39 | 89 | 392 | 331 | 832 | 58 | 8 | 19 | 86 | 73 | 182 | 13 |

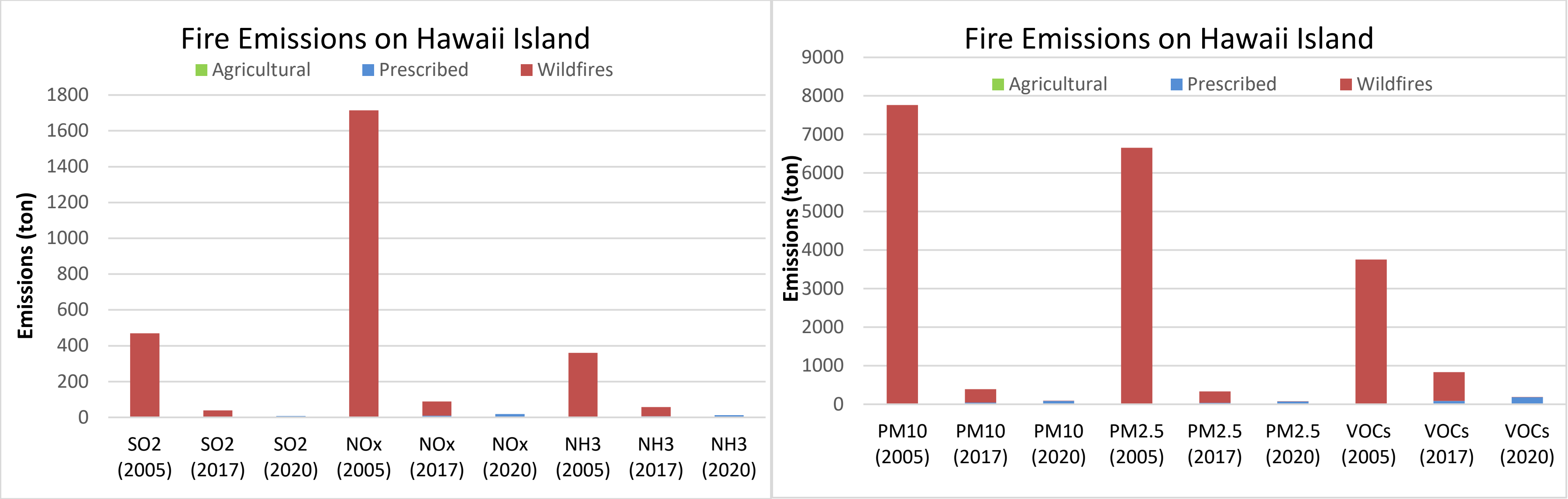

**Figure 3.5-2** Fire Emission Trends on Hawaii Island

## 3.6 Hawaii's Regulations to Mitigate Construction Activity Impacts

Maui Island:

1) Table 3.6-1 is the summary of the dust emissions on $PM_{10}$ and $PM_{2.5}$ on Maui Island from unpaved/paved roads and construction sites in the selected years: 2005 (base year), 2017, 2020.
2) Figure 3.6-1 shows the dust emission trends from Table 3.6-1.
3) Both $PM_{10}$ and $PM_{2.5}$ emissions decrease from 2005 to 2017. However, these emissions increase from 2017 to 2020.

**Table 3.6-1** Dust Emissions for Maui Island

| Source | 2005 Emissions (TPY) | | 2017 Emissions (TPY) | | 2020 Emissions (TPY) | |
|---|---|---|---|---|---|---|
| | $PM_{10}$ | $PM_{2.5}$ | $PM_{10}$ | $PM_{2.5}$ | $PM_{10}$ | $PM_{2.5}$ |
| Unpaved Road | 310 | 31 | 459 | 46 | 333 | 33 |
| Paved Road | 736 | 29 | 355 | 89 | 322 | 81 |
| Construction | 1734 | 174 | 842 | 84 | 1296 | 130 |
| Total | 2780 | 234 | 1656 | 219 | 1951 | 244 |

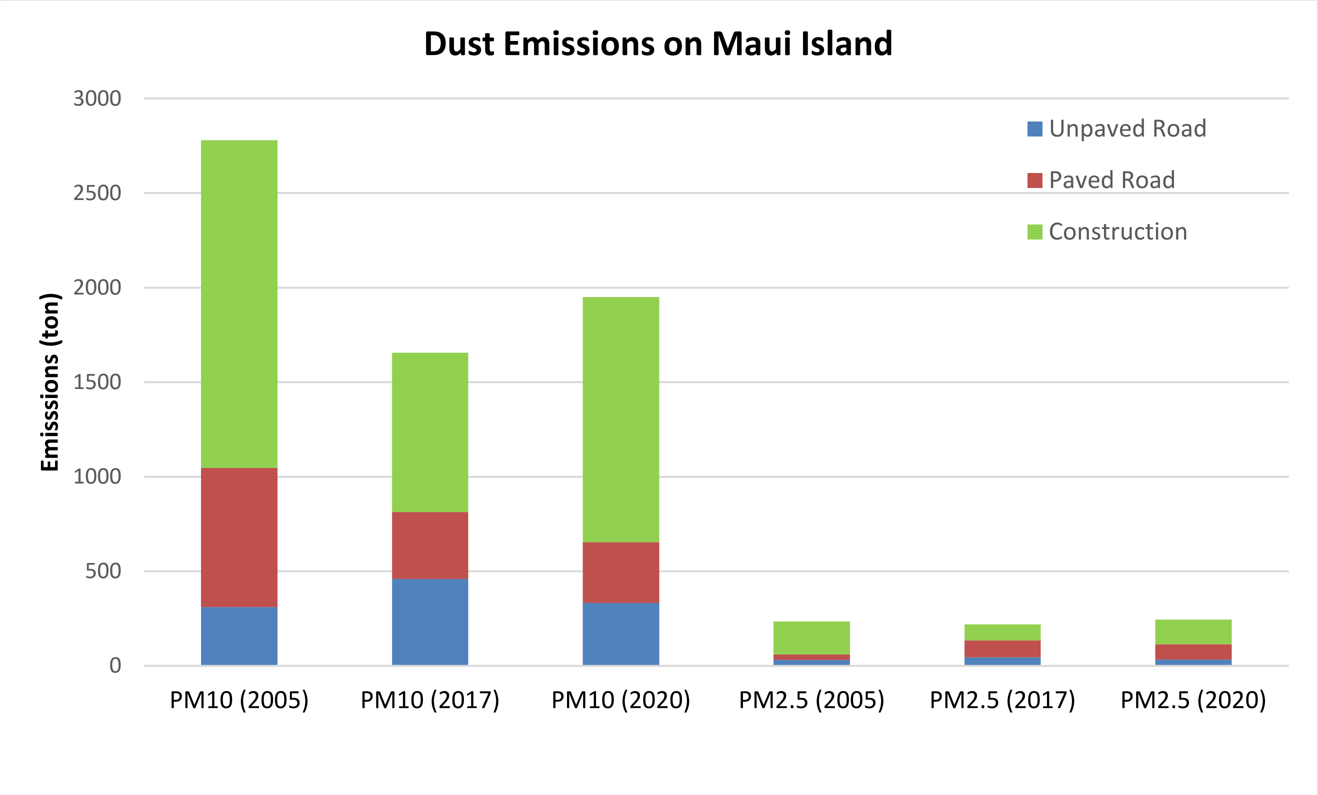

**Figure 3.6-1** Dust Emission Trends of the Particular Matter on Maui Island

Hawaii island:

1) Table 3.6-2 is the summary of the dust emissions on $PM_{10}$ and $PM_{2.5}$ on Hawaii Island from unpaved/paved roads and construction sites in the selected years: 2005 (base year), 2017, 2020.
2) Figure 3.6-2 shows the dust emission trends from Table 3.6-2.
3) Both $PM_{10}$ and $PM_{2.5}$ decrease in total emissions between 2005 and 2020.

**Table 3.6-2** Dust Emissions for Hawaii Island

| Source | 2005 Emissions (TPY) | | 2017 Emissions (TPY) | | 2020 Emissions (TPY) | |
|---|---|---|---|---|---|---|
| | $PM_{10}$ | $PM_{2.5}$ | $PM_{10}$ | $PM_{2.5}$ | $PM_{10}$ | $PM_{2.5}$ |
| Unpaved Road | 655 | 66 | 609 | 60 | 498 | 50 |
| Paved Road | 1170 | 49 | 296 | 74 | 290 | 72 |
| Construction | 2618 | 263 | 501 | 50 | 532 | 53 |
| Total | 4443 | 378 | 1406 | 184 | 1320 | 175 |

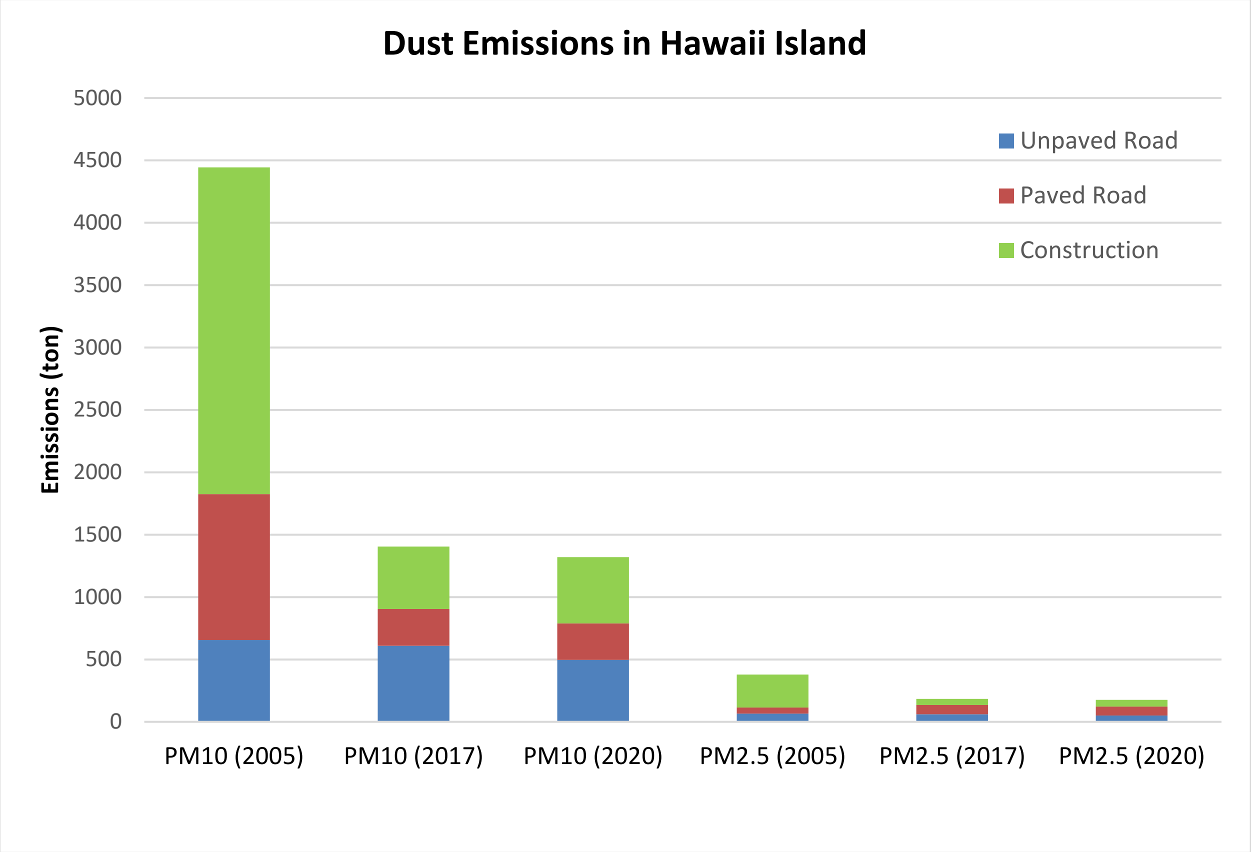

**Figure 3.6-2** Dust Emission Trends of the Particular Matter on Hawaii Island

# Chapter 4 Visibility Conditions

## 4.0 Visibility Progress – 40 CFR 51.308(g)(3)

Chapter 4.0 provides an evaluation of the progress towards the reasonable progress goals for Haleakala National Park on Maui and Hawaii Volcanoes National Park on the Big Island based on IMPROVE data from the WRAP TSS. The RHR requires an evaluation of baseline and current visibility conditions for the most impaired and clearest days in 5-year averages, measured in deciviews and light extinction.[34] A key development in the utilization of the IMPROVE data is the decision to not use the volcanic adjustment provided by the WRAP TSS. The purpose of the volcanic adjustment was to exclude emissions produced by the volcanic activity in Hawaii Volcanoes National Park. However, it was found that the resulting data still contained significantly high sulfate light extinction values due to impacts from natural volcanic $SO_2$ emissions. This resulted in an inaccurate picture of how anthropogenic emissions affect visibility in Hawaii's Class I areas. Therefore, for this progress report for the second implementation period, IMPROVE data from the WRAP TSS does not attempt to remove volcanic emissions, but instead operates under the assumption that volcanic emissions are not screened out which skews the overall trend for light extinction from sulfates.

Table 4.0-1 shows the site code, site name, and associated IMPROVE data files provided on the WRAP TSS for Haleakala National Park and Hawaii Volcanoes National Park.

**Table 4.0-1** Monitoring Site Codes and Descriptions

| Code | Name | Description |
|---|---|---|
| HACR1 | Haleakala Crater | Visibility monitoring station located in Haleakala Crater as shown in Figure 4.0-1. Data from the monitoring station is available up to 2022. The data set includes an adjustment for smoke and dust. However, it does not include an adjustment for monitor site relocation. Therefore, DOH-CAB established a 2000-2004 baseline visibility condition for HACR1 by using a scaling ratio from data on the WRAP TSS for HALE1. Data from HACR1 was used thereon to evaluate visibility conditions at Haleakala National Park. The HACR1 IMPROVE site is considered more representative of visibility conditions within Haleakala National Park. |
| HALE1 | Haleakala NP | Unadjusted data from the HALE1 monitoring site, shown in Figure 4.0-1, was utilized to adjust the baseline period (2000 – 2004) for HACR1. This data set from the original site includes an adjustment for smoke and dust. Data is available up to 2011. |
| HALE1_RHTS | Haleakala NP (RHTS) | HALE1 data set, adjusted for naturally occurring dust, wildfire smoke, and monitor site relocation. Data is available up to 2018. The WRAP TSS no longer provides updates to this data set. This data set was not used because adjustments for monitoring site relocation are no |

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[34] United States Environmental Protection Agency, General Principles for the 5-Year Regional Haze Progress Reports for the Initial Regional Haze State Implementation Plans, April 2013

**Table 4.0-1** Monitoring Site Codes and Descriptions

| | | |
|---|---|---|
| | | longer being made for updating the WRAP TSS. Data is available up to 2018. |
| HALE1_RHTS_VADJ | Haleakala NP (RHTS w/Volcanic Adjustments) | HALE1_RHTS_VADJ data set is adjusted to remove sulfates from volcanic activity as well as adjustments for smoke dust, and site relocation. Although this data set was developed for Hawaii's RH-SIP for second planning period, it did not effectively remove volcanic sulfates. Therefore, HACR1 is being used moving forward. |
| HAVO1 | Hawaii Volcanoes NP | Visibility monitoring station located in Volcanoes National Park. This data set is utilized for analysis for both the baseline and current visibility conditions and is adjusted for naturally occurring dust and wildfire smoke. |
| HAVO1_VADJ | Hawaii Volcanoes NP (w/Volcanic Adjustments) | HAVO1 data set, adjusted to remove sulfates from volcanic activity. Although this data set was developed for Hawaii's RH-SIP for the second planning period, it did not effectively remove volcanic sulfates. Therefore, HAVO1 is being used moving forward. |

For the "baseline visibility conditions" during the 2000-2004 baseline period, there is no visibility monitoring data for the HACR1 visibility monitoring site at Haleakala National Park. The HACR1 monitoring station began operation in 2007 and replaced the HALE1 monitoring station for Haleakala National Park in 2012. Figure 4.0-1 is a map showing the locations of the HALE1 and HACR1 visibility monitoring sites for Haleakala National Park.[9]

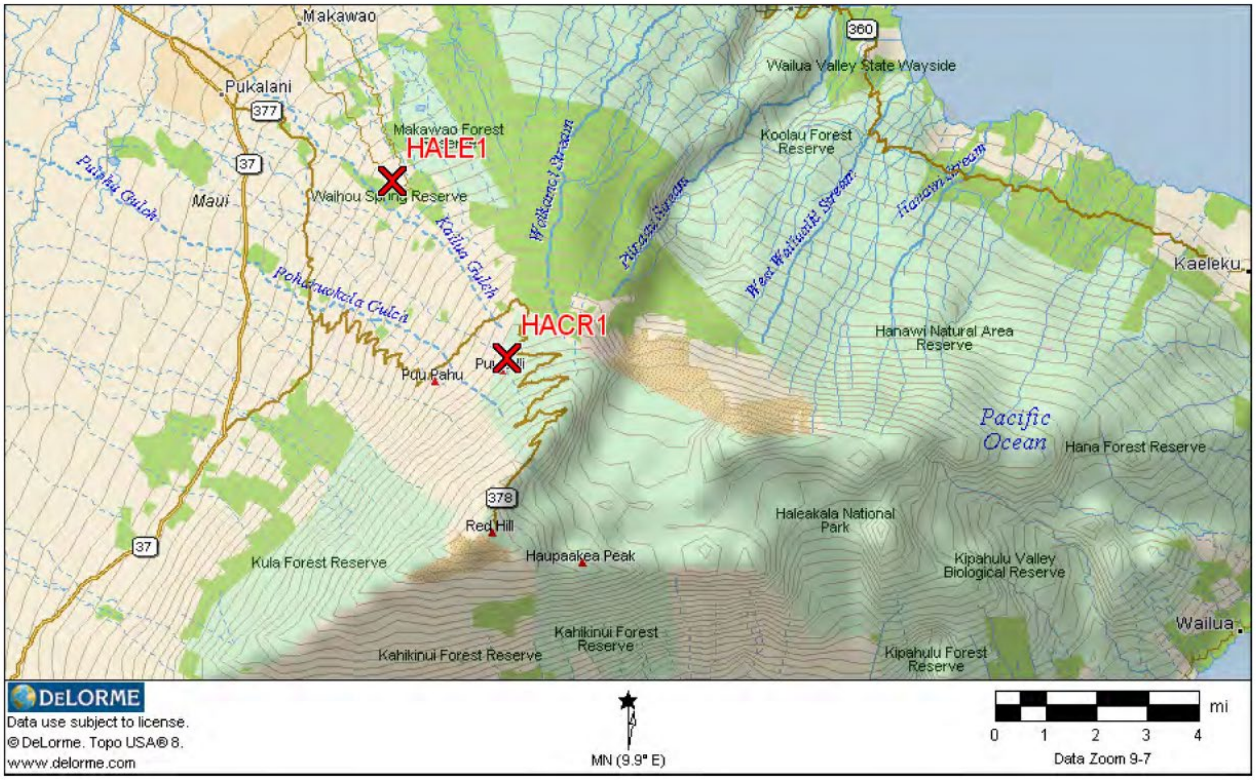

**Figure 4.0-1** Map of HALE1 and HACR1 Sites for Haleakala National Park[9]

Pursuant to 40 CFR §51.308(d)(2)(i), the WRAP established baseline visibility conditions for HACR1 at Haleakala National Park on Maui using a methodology developed in consultation with DOH-CAB, NPS, and EPA Region 9.[7] Visibility data for establishing baseline conditions was obtained from the Federal Land Manager Environmental Database.[14] The 2000-2004 baseline data and 2007-2011 data over the first progress period was available for the HALE1 monitor; however, visibility data for the HACR1 monitor was only available in the first progress period (2005-2009), since it started operation in 2007.[10] Therefore, ratios between the 2005-2009 progress period and the 2000-2004 baseline period for each aerosol species at the HALE1 were used to estimate visibility conditions for the HACR1 site.[10] For the 2000-2004 baseline period, 2000 data at the HALE1 monitor was not representative and unavailable for use in the 2000-2004 baseline period average. Averages for the 2000-2004 baseline were actually determined from visibility data between 2001 and 2004 for the HALE1 monitor. Progress period (2005-2009) to baseline (2000-2004) ratios for each species and haze index (HI) were determined as follows[10]:

$$\frac{\text{HACR1 Progress Period}}{\text{HALE } \frac{\text{Progress}}{\text{Baseline}} \text{ Average}} = \text{HACR1 Baseline Period Estimate}$$

Table 4.0-2 below shows light extinction averages from the progress to baseline ratios determined from data collected at the HALE1 station.

**Table 4.0-2** HALE1 Averages and Ratios

| Species | Group | HALE1 2000-2004 Baseline Period $b_{ext}$ (Mm$^{-1}$) | HALE1 2005-2009 Progress Period $b_{ext}$ (Mm$^{-1}$) | HALE1 Progress/Baseline Ratio |
|---|---|---|---|---|
| Ammonium Sulfate | Clearest Days | 2.1653 | 2.0886 | 0.9646 |
| | Haziest Days | 17.5323 | 26.4876 | 1.5108 |
| | Most Impaired Days | 18.3698 | 27.1418 | 1.4775 |
| Ammonium Nitrate | Clearest Days | 0.5570 | 0.4298 | 0.7716 |
| | Haziest Days | 2.6635 | 2.1132 | 0.7934 |
| | Most Impaired Days | 2.1553 | 1.6754 | 0.7774 |
| Particulate Organic Mass | Clearest Days | 0.6715 | 0.52 | 0.7744 |
| | Haziest Days | 2.8905 | 2.4848 | 0.8596 |
| | Most Impaired Days | 2.0780 | 1.547 | 0.7445 |
| Elemental Carbon | Clearest Days | 0.2040 | 0.165 | 0.8088 |
| | Haziest Days | 1.3953 | 1.2168 | 0.8721 |
| | Most Impaired Days | 1.0923 | 0.9246 | 0.8465 |
| Soil | Clearest Days | 0.0998 | 0.0896 | 0.8982 |
| | Haziest Days | 0.3490 | 0.373 | 1.0688 |
| | Most Impaired Days | 0.2593 | 0.2942 | 1.1348 |
| Coarse Mass | Clearest Days | 1.0435 | 0.864 | 0.8280 |
| | Haziest Days | 2.6280 | 1.9114 | 0.7273 |

**Table 4.0-2** HALE1 Averages and Ratios

| Species | Group | HALE1 2000-2004 Baseline Period $b_{ext}$ (Mm$^{-1}$) | HALE1 2005-2009 Progress Period $b_{ext}$ (Mm$^{-1}$) | HALE1 Progress/Baseline Ratio |
|---|---|---|---|---|
| | Most Impaired Days | 2.0708 | 1.545 | 0.7461 |
| Sea Salt | Clearest Days | 1.0870 | 1.5076 | 1.3869 |
| | Haziest Days | 1.2878 | 1.9816 | 1.5388 |
| | Most Impaired Days | 0.5408 | 1.1304 | 2.0904 |

Table 4.0-3 below shows the baseline estimates for HACR1 determined from the 2005-2009 HACR1 progress period and the progress period/baseline ratios for the HALE1 IMPROVE monitor. For the HACR1 monitor, data for the 2005-2009 first regional haze progress period was from 2007 through 2009 because this visibility monitor was installed in 2007. Scaling values in Table 4.0-3 for establishing the HACR1 baseline are shown in blue.

**Table 4.0-3** Baseline $b_{ext}$ Estimates

| Species | Group | HACR1 2005-2009 Progress Period $b_{ext}$ (Mm$^{-1}$) | HALE1 Progress/Baseline Ratio | HACR1 2000-2004 Baseline Period $b_{ext}$ (Mm$^{-1}$) Estimate |
|---|---|---|---|---|
| Ammonium Sulfate | Clearest Days | 1.0343 | 0.9646 | 1.0723 |
| | Haziest Days | 16.5050 | 1.5108 | 10.9247 |
| | Most Impaired Days | 16.9060 | 1.4775 | 11.4421 |
| Ammonium Nitrate | Clearest Days | 0.1430 | 0.7716 | 0.1853 |
| | Haziest Days | 1.1013 | 0.7934 | 1.3881 |
| | Most Impaired Days | 0.7603 | 0.7774 | 0.9781 |
| Particulate Organic Mass | Clearest Days | 0.0687 | 0.7744 | 0.0887 |
| | Haziest Days | 1.8323 | 0.8596 | 2.1315 |
| | Most Impaired Days | 0.5840 | 0.7445 | 0.7845 |
| Elemental Carbon | Clearest Days | 0.0407 | 0.8088 | 0.0503 |
| | Haziest Days | 0.6383 | 0.8721 | 0.7319 |
| | Most Impaired Days | 0.4200 | 0.8465 | 0.4962 |
| Soil | Clearest Days | 0.0730 | 0.8982 | 0.0813 |
| | Haziest Days | 0.4407 | 1.0688 | 0.4123 |
| | Most Impaired Days | 0.2767 | 1.1348 | 0.2438 |
| Coarse Mass | Clearest Days | 0.3130 | 0.8280 | 0.3780 |
| | Haziest Days | 1.6973 | 0.7273 | 2.3337 |
| | Most Impaired Days | 1.2617 | 0.7461 | 1.6910 |
| Sea Salt | Clearest Days | 0.3113 | 1.3869 | 0.2245 |
| | Haziest Days | 0.7423 | 1.5388 | 0.4824 |
| | Most Impaired Days | 0.4523 | 2.0904 | 0.2164 |

Table 4.0-4 provides baseline haze index (HI) estimates for the HACR1 monitor from Appendix I. The baseline HI was determined by scaling each HACR1 species for each of the most impaired and clearest days by the HALE1 scaling ratio, summing the scaled $b_{ext}$ for each species for each day, calculating the HI from summed $b_{ext}$ values with the deciview equation (i.e., $dv = 10 \ln(b_{ext} / 10)$), averaging the deciview values for each year, and averaging the yearly deciview values over the years representing the baseline period.

**Table 4.0-4** HACR1 Baseline HI (dv) Estimates [a]

| HI (dv) | Group | HACR1 2000-2004 Baseline HI (dv) Estimate |
|---|---|---|
| Deciviews | Clearest Days | 1.0027 |
| | Haziest Days | 9.4150 |
| | Most Impaired Days | 8.3780 |

a) Calculations are provided in Appendix I.

## 4.1 Current Visibility Conditions – 40 CFR 51.308(g)(3)(i)

Section 4.1 provides current visibility conditions for the most impaired and clearest days. Current visibility conditions should include the 5-year average with the most recent data at the time the state submits its 5-year progress report.[34] At this time the most recent five years of visibility data is from 2018 to 2022.

Tables 4.1-1 and 4.1-2 provide the annual visibility conditions from years 2018 to 2022 for the HACR1 IMPROVE monitor representing current visibility conditions at Haleakala National Park for the most impaired days and clearest days, respectively.

**Table 4.1-1** Current Annual Average Visibility Conditions (2018-2022) at HACR1 from Haleakala National Park for Most Impaired Days

| Year | HI | Aerosol Extinction by Species ($Mm^{-1}$) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (dv) | Sulfate | Nitrate | POM | EC | Soil | CM | Sea Salt |
| 2018 | 10.0 | 19.4 | 0.6 | 0.8 | 0.4 | 0.2 | 0.6 | 0.6 |
| 2019 | 6.1 | 5.5 | 1.2 | 0.5 | 0.2 | 0.2 | 1.0 | 0.9 |
| 2020 | 5.7 | 5.5 | 0.7 | 0.7 | 0.3 | 0.2 | 0.7 | 0.8 |
| 2021 | 5.7 | 5.9 | 0.8 | 0.4 | 0.2 | 0.2 | 0.8 | 0.8 |
| 2022 | 7.4 | 8.8 | 0.9 | 0.6 | 0.3 | 0.2 | 0.7 | 0.8 |
| Average | **7.0** | **9.0** | **0.8** | **0.6** | **0.3** | **0.2** | **0.8** | **0.8** |

**Table 4.1-2** Current Annual Average Visibility Conditions (2018-2022) at HACR1 from Haleakala National Park for Clearest Days

| Year | HI | Aerosol Extinction by Species ($Mm^{-1}$) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (dv) | Sulfate | Nitrate | POM | EC | Soil | CM | Sea Salt |
| 2018 | 0.4 | 0.7 | 0.1 | 0.2 | 0.07 | 0.03 | 0.2 | 0.1 |
| 2019 | 0.7 | 0.8 | 0.2 | 0.08 | 0.06 | 0.04 | 0.2 | 0.3 |
| 2020 | 0.4 | 0.6 | 0.1 | 0.2 | 0.08 | 0.03 | 0.2 | 0.2 |
| 2021 | 0.3 | 0.6 | 0.1 | 0.1 | 0.09 | 0.03 | 0.2 | 0.2 |
| 2022 | 0.6 | 0.9 | 0.1 | 0.2 | 0.07 | 0.04 | 0.2 | 0.2 |
| Average | **0.5** | **0.7** | **0.1** | **0.1** | **0.07** | **0.04** | **0.2** | **0.2** |

Tables 4.1-3 and 4.1-4 provide the annual visibility conditions between years 2018 and 2022 at the HAVO1 IMPROVE monitor representing current visibility conditions at Hawaii Volcanoes National Park for the most impaired days and clearest days, respectively.

**Table 4.1-3** Current Annual Average Visibility Conditions (2018-2022)
at HAVO1 from Hawaii Volcanoes National Park
for Most Impaired Days

| Year | HI (dv) | Aerosol Extinction by Species ($Mm^{-1}$) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Sulfate | Nitrate | POM | EC | Soil | CM | Sea Salt |
| 2018 [a] | Data not available. | | | | | | | |
| 2019 | 10.5 | 14.7 | 0.7 | 1.2 | 0.3 | 0.08 | 0.9 | 1.6 |
| 2020 | 9.7 | 10.2 | 1.1 | 1.6 | 0.4 | 0.1 | 1.3 | 2.5 |
| 2021 | 11.7 | 20.9 | 0.5 | 1.1 | 0.4 | 0.06 | 0.8 | 1.4 |
| 2022 | 14.8 | 32.9 | 0.6 | 1.1 | 0.6 | 0.08 | 1.5 | 1.0 |
| Average | **11.7** | **19.7** | **0.7** | **1.3** | **0.4** | **0.1** | **1.1** | **1.6** |

a) The HAVO1 IMPROVE monitor was compromised during the significant eruption event in 2018, and therefore 2018 data is not available. Even though it is located on a separate island, 2018 values for monitoring site HACR1 show uncharacteristically elevated sulfate levels.

**Table 4.1-4** Current Annual Average Visibility Conditions (2018-2022)
at HAVO1 from Hawaii Volcanoes National Park
for Clearest Days

| Year | HI (dv) | Aerosol Extinction by Species ($Mm^{-1}$) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Sulfate | Nitrate | POM | EC | Soil | CM | Sea Salt |
| 2018 [a] | Data not available. | | | | | | | |
| 2019 | 3.8 | 2.0 | 0.3 | 0.5 | 0.1 | 0.05 | 0.7 | 1.0 |
| 2020 | 2.8 | 1.2 | 0.2 | 0.7 | 0.2 | 0.01 | 0.4 | 0.7 |
| 2021 | 3.0 | 1.4 | 0.2 | 0.5 | 0.1 | 0.03 | 0.6 | 0.8 |
| 2022 | 3.0 | 1.3 | 0.3 | 0.4 | 0.2 | 0.03 | 0.5 | 0.8 |
| Average | **3.1** | **1.4** | **0.2** | **0.5** | **0.1** | **0.03** | **0.5** | **0.8** |

a) The HAVO1 IMPROVE monitor was compromised during the significant eruption event in 2018, and therefore 2018 data is not available. Even though it is located on a separate island, 2018 values for monitoring site HACR1 show uncharacteristically elevated sulfate levels.

## 4.2 Difference Between Current and Baseline Visibility Conditions – 40 CFR 51.308(g)(3)(ii)

Section 4.2 provides the difference between current visibility conditions for the most impaired and clearest days and baseline visibility conditions. Visibility displays for this section include the difference between the current and baseline conditions, as well as rolling five-year average plots for four rolling average periods preceding the current five-year rolling average.

Tables 4.2-1 and 4.2-2 below provide the haze index and extinction values by species for the most impaired and clearest visibility days at Haleakala National Park, respectively. The haze index and light extinction values are five-year averages based on annual average visibility data from the baseline period (2000-2004) to the five-year period with most recent data (2018-2022). The tables also show the difference between the baseline and current visibility conditions at Haleakala National Park. Red values, representing an increase, indicate more haze (impairment). Negative values in blue indicate less haze (improvement).

| **Table 4.2-1** Difference in Aerosol Extinction by Species and Haze Index<br>2000-2004 Baseline to 2018-2022 Current Period<br>Haleakala National Park HACR1 Monitor Most Impaired Days | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Progress Period | HI (dv) | Extinction by Species (Mm$^{-1}$) | | | | | | |
| | | Sulfate | Nitrate | POM | EC | Soil | CM | Sea Salt |
| **2000-2004** [a] | **8.4** | **11.4** | **1.0** | **0.8** | **0.5** | **0.2** | **1.7** | **0.2** |
| 2014-2018 | 8.6 | 13.6 | 0.6 | 0.6 | 0.2 | 0.2 | 0.7 | 0.6 |
| 2015-2019 | 8.2 | 12.5 | 0.7 | 0.6 | 0.3 | 0.1 | 0.8 | 0.7 |
| 2016-2020 | 7.8 | 11.5 | 0.8 | 0.7 | 0.3 | 0.2 | 0.7 | 0.7 |
| 2017-2021 | 7.2 | 9.8 | 0.8 | 0.6 | 0.3 | 0.2 | 0.7 | 0.7 |
| **2018-2022** | **7.0** | **9.0** | **0.9** | **0.7** | **0.3** | **0.2** | **0.8** | **0.8** |
| **Difference** [b] | **-1.4** | **-2.4** | **-0.1** | **-0.1** | **-0.2** | **0** | **-0.9** | **+0.6** |

a. Baseline values were adjusted for site relocation in Appendix I. Values are the average from adjustments for years 2007 to 2009 since HACR1 monitor started operation in 2007 and is the only data available for the 2005-2009 first implementation period.

b. Difference is current five-year period (2018-2022) value minus baseline (2000-2004) value.

| **Table 4.2-2** Difference in Aerosol Extinction by Species and Haze Index<br>2000-2004 Baseline to 2018-2022 Current Period<br>Haleakala National Park HACR1 Monitor Clearest Days | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Progress Period | HI (dv) | Extinction by Species (Mm$^{-1}$) | | | | | | |
| | | Sulfate | Nitrate | POM | EC | Soil | CM | Sea Salt |
| **2000-2004** [a] | **1.0** | **1.1** | **0.2** | **0.09** | **0.05** | **0.08** | **0.4** | **0.2** |
| 2014-2018 | 0.5 | 0.7 | 0.1 | 0.2 | 0.05 | 0.03 | 0.2 | 0.2 |
| 2015-2019 | 0.5 | 0.7 | 0.2 | 0.2 | 0.06 | 0.03 | 0.2 | 0.2 |
| 2016-2020 | 0.5 | 0.7 | 0.2 | 0.2 | 0.07 | 0.04 | 0.2 | 0.2 |
| 2017-2021 | 0.5 | 0.7 | 0.1 | 0.2 | 0.08 | 0.03 | 0.2 | 0.2 |
| **2018-2022** | **0.5** | **0.7** | **0.1** | **0.1** | **0.07** | **0.04** | **0.2** | **0.2** |
| **Difference** [b] | **-0.5** | **-0.4** | **-0.1** | **0** | **+0.02** | **-0.04** | **-0.2** | **0** |

a. Baseline values were adjusted for site relocation in Appendix I. Values are the average from adjustments for years 2007 to 2009 since HACR1 monitor started operation in 2007 and is the only data available for the 2005-2009 first implementation period.

b. Difference is current five-year period (2018-2022) value minus baseline (2000-2004) value.

Tables 4.2-3 and 4.2-4 below provide the haze index and light extinction by species for the clearest and most impaired visibility days at Hawaii Volcanoes National Park, respectively. The haze index and light extinction values are five year rolling annual averages from the baseline period (2000-2004) to the five-year period with most recent data (2018-2022). The tables also show the difference between the baseline and current visibility conditions for Hawaii Volcanoes National Park. Red values, representing an increase, indicate more haze (impairment). Negative values in blue indicate less haze (improvement).

**Table 4.2-3** Difference in Aerosol Extinction by Species and Haze Index
2000-2004 Baseline to 2018-2022 Current Period
Hawaii Volcanoes National Park HAVO1 Monitor
Most Impaired Days

| Progress Period | HI (dv) | Extinction by Species ($Mm^{-1}$) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Sulfate | Nitrate | POM | EC | Soil | CM | Sea Salt |
| **2000-2004** [a] | **18.7** | **60.3** | **0.8** | **2.3** | **1.0** | **0.3** | **0.7** | **0.5** |
| 2014-2018 [b] | 19.3 | 58.3 | 0.5 | 1.5 | 0.7 | 0.1 | 0.7 | 1.4 |
| 2015-2019 | 17.1 | 48.3 | 0.5 | 1.3 | 0.6 | 0.1 | 0.7 | 1.4 |
| 2016-2020 | 14.8 | 36.8 | 0.7 | 1.7 | 0.5 | 0.1 | 0.9 | 1.7 |
| 2017-2021 | 12.7 | 25.4 | 0.7 | 1.3 | 0.5 | 0.1 | 0.9 | 1.7 |
| **2018-2022** | 11.7 | 19.7 | 0.7 | 1.3 | 0.4 | 0.1 | 1.1 | 1.6 |
| **Difference** [c] | **-7.0** | **-40.6** | **-0.1** | **-1.1** | **-0.6** | **-0.2** | **+0.4** | **+1.1** |

a) Baseline values are four-year average from years 2001 through 2004, since 2000 data is invalid.
b) Data is not available for 2018 due to active eruption near the HAVO1 monitoring station.
c) Difference is current five-year period (2018-2022) value minus baseline (2000-2004) value.

**Table 4.2-4** Difference in Aerosol Extinction by Species and Haze Index
2000-2004 Baseline to 2018-2022 Current Period
Hawaii Volcanoes National Park HAVO1 Monitor
Clearest Days

| Progress Period | HI (dv) | Extinction by Species ($Mm^{-1}$) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Sulfate | Nitrate | POM | EC | Soil | CM | Sea Salt |
| **2000-2004** [a] | **4.1** | **2.2** | **0.3** | **1.1** | **0.2** | **0.06** | **0.4** | **0.9** |
| 2013-2017 | 3.6 | 1.8 | 0.3 | 0.3 | 0.08 | 0.03 | 0.6 | 1.3 |
| 2014-2018 | 3.5 | 1.8 | 0.3 | 0.3 | 0.08 | 0.03 | 0.6 | 1.2 |
| 2015-2019 | 3.6 | 1.8 | 0.3 | 0.4 | 0.1 | 0.04 | 0.6 | 1.2 |
| 2016-2020 | 3.3 | 1.6 | 0.3 | 0.5 | 0.1 | 0.03 | 0.5 | 1.0 |
| 2017-2021 [b] | 3.3 | 1.6 | 0.3 | 0.5 | 0.1 | 0.03 | 0.5 | 1.0 |
| **2018-2022** [b] | 3.2 | 1.4 | 0.2 | 0.5 | 0.2 | 0.03 | 0.5 | 0.8 |
| **Difference** [c] | **-0.9** | **-0.8** | **-0.1** | **-0.6** | **0** | **-0.03** | **+0.1** | **-0.1** |

a) Baseline values are four-year average from years 2001 through 2004, since 2000 data is invalid.
b) Data is not available for 2018 due to active eruption near the HAVO1 monitoring station.
c) Difference is current five-year period (2017-2021) value minus baseline (2000-2004) value.

Visibility conditions are shown in Figures 4.2-1 and 4.2-2 for Haleakala National Park and in Figures 4.2.3 and 4.2-4 for Hawaii Volcanoes National Park from years 2000 to 2022. The plots provide actual visibility, skewed by volcanic sulfate impacts, in comparison to baseline and natural visibility for the most impaired and clearest days in units of deciview.

Baseline visibility conditions are represented by a solid green line from 2000 to 2004. Baseline conditions for Haleakala National Park were determined in Section 4.0 of this progress report and are provided in Table 4.0-4 for the most impaired and clearest days. Most impaired and clearest day baseline visibility conditions for Hawaii Volcanoes National Park were from the WRAP TSS version 3 and is the average of the yearly average deciview values from 2001 to 2004.

Solid orange lines are natural visibility conditions.  Natural visibility conditions for Haleakala National Park and Hawaii Volcanoes National Park are from the WRAP TSS for the most impaired days.  For the clearest days, natural visibility conditions were from EPA's white paper regarding IMPROVE monitoring site adjustments for Hawaii's Class I areas.[35]

Dashed green curves with solid dots are plots of the average annual haze index.  There is a large amount of variability in haze index due to variability in sulfate impacts from volcanic activity.  For the most impaired days at Haleakala National Park, the increase in haze index occurs at time when there was increased volcanic activity from the 2018 Kilauea eruption. There is no data in 2018 from the Hawaii Volcanoes National Park visibility monitor during time of increased volcanic eruption activity.  Please note that adjustments for episodic events (volcanic activity, dust, and smoke) are not made for the clearest days.  However, for the white paper, adjustments were made to account for changes in HALE-HACR1 site relocation of the visibility monitor servicing Haleakala Nation Park for both the most impaired and clearest days.

Solid green curves with x's are five-year rolling average plots of haze index. For HACR1, the five-year rolling average haze index starts from a 2009 center point (i.e., 2007-2011 for 2009, 2008-2012 for 2008, etc.) since data is not available for this monitor from 2004 to 2007. Also note that there is no data in 2018 from the Hawaii Volcanoes National Park visibility monitor during time of increased volcanic eruption activity.  Impacts from volcanic sulfates affect monitors at both national parks.  Five-year rolling averages of the haze index show slight visibility improvements at both national parks for the most impaired days.  There are more significant improvements in the visibility conditions at both national parks for the clearest days.

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[35] EPA White Paper: Recommendations for the HALE-HACR1 IMPROVE Monitoring Site Combination and Volcano Adjustment for Sites Representing Hawaii Class I Areas for the Regional Haze Rule (https://www.epa.gov/system/files/documents/2021-08/white_paper_for_regional_haze_hi_volcano_adjust_final.pdf)

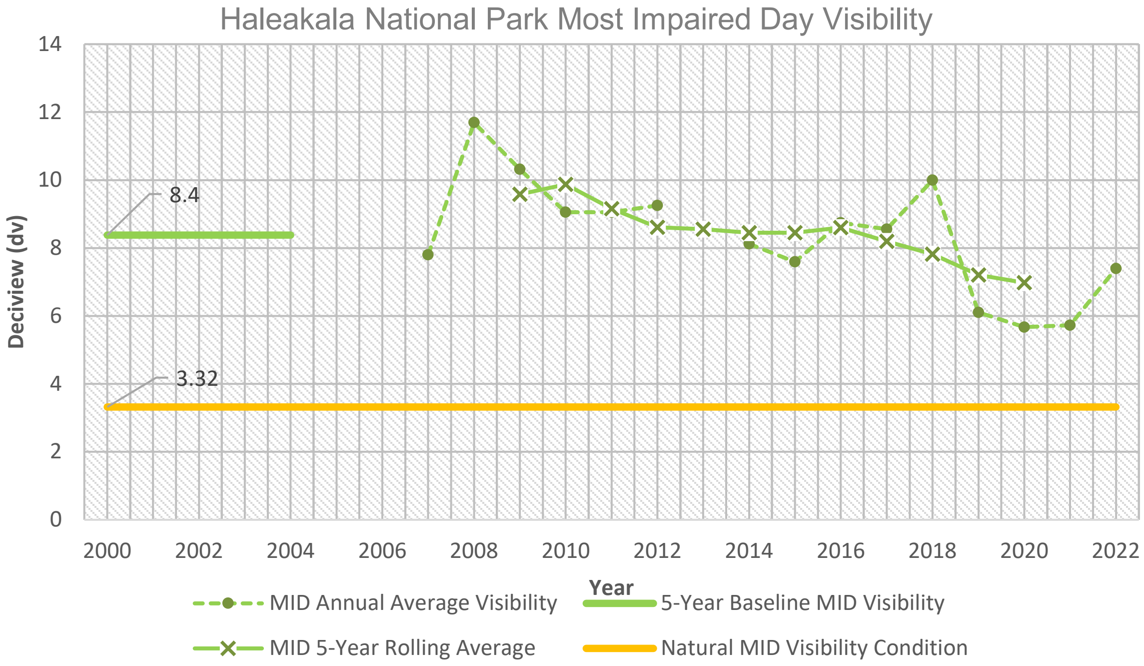

**Figure 4.2-1** Haleakala National Park, Most Impaired Day Visibility

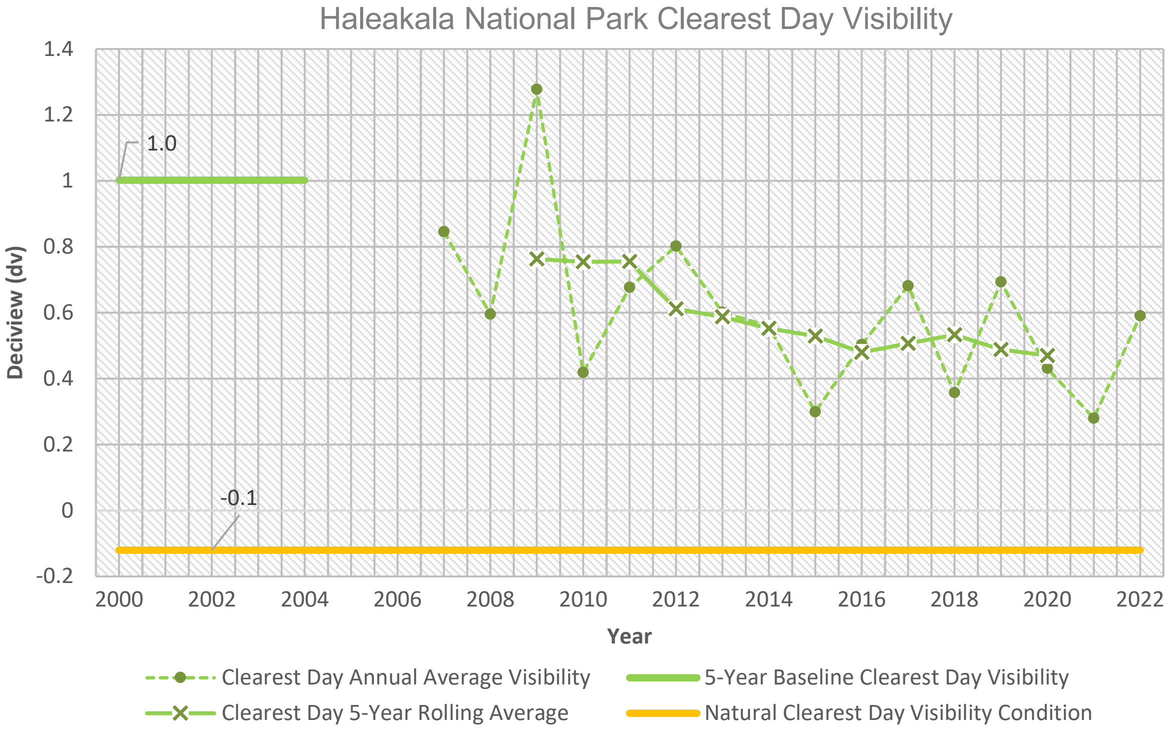

**Figure 4.2-2** Haleakala National Park, Clearest Day Visibility

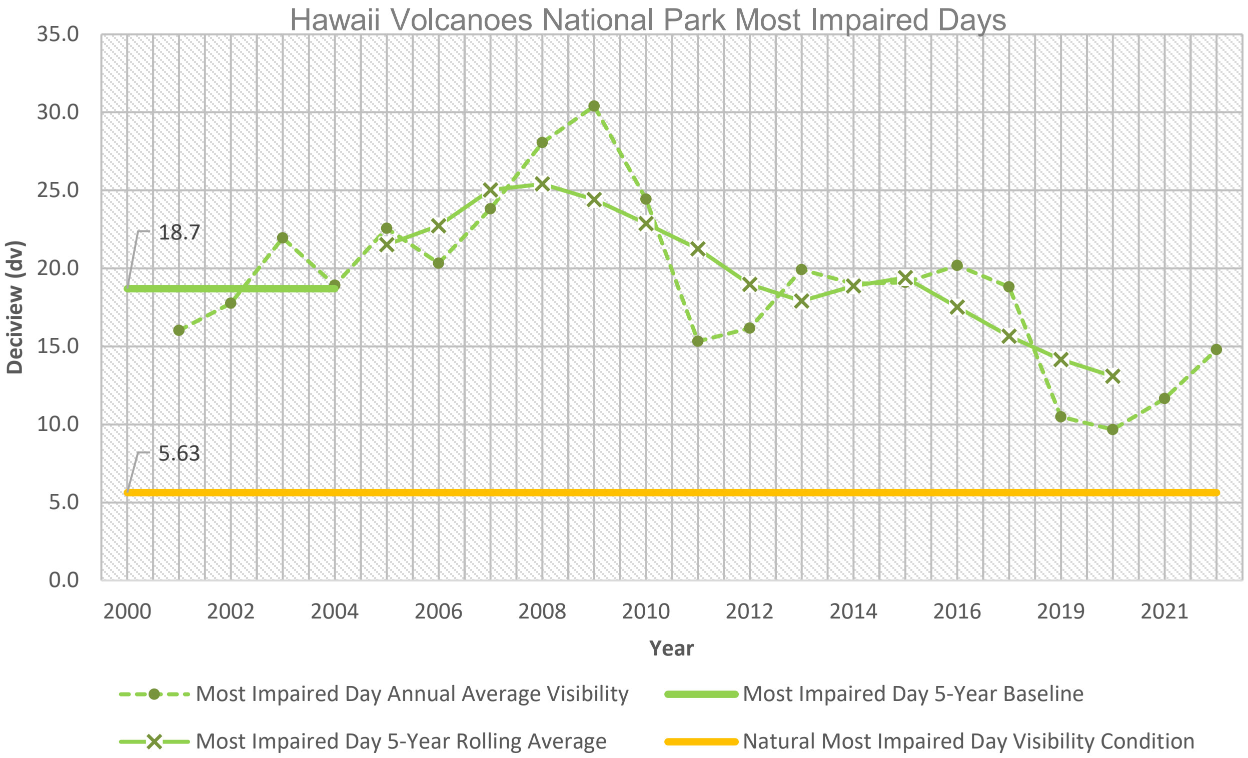

**Figure 4.2-3** Hawaii Volcanoes National Park, Most Impaired Day Visibility

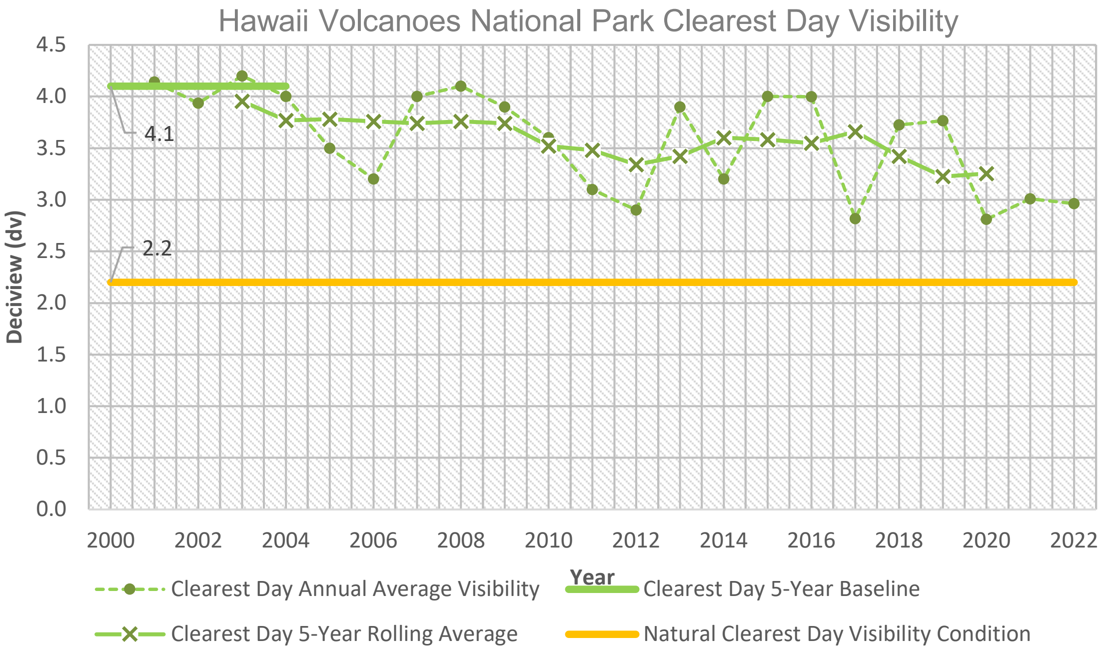

**Figure 4.2-4** Hawaii Volcanoes National Park, Clearest Day Visibility

Figures 4.2-5 to 4.2-6 and 4.2-7 to 4.2-9 present 5-year average light extinction between 2000 and 2022 for Haleakala National Park and Volcanoes National Park, respectively. Figures 4.2-5, 4.2-7, 4.2-9, and 4.2-11 include light extinction for all aerosol species. Figures 4.2-6, 4.2-8, 4.2-10, and 4.2-12 exclude sulfate to magnify contributions to light extinction from other aerosol species on the most impaired days for the most impaired and clearest days for both national parks.

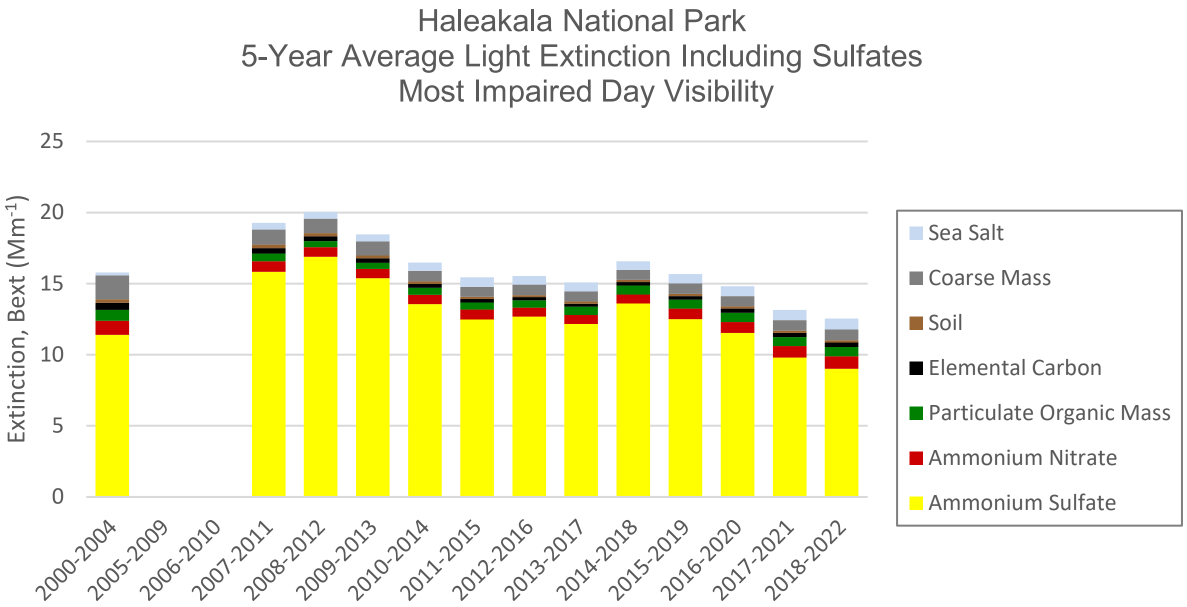

**Figure 4.2-5** Haleakala National Park Light Extinction Including Sulfates, Most Impaired Day Visibility

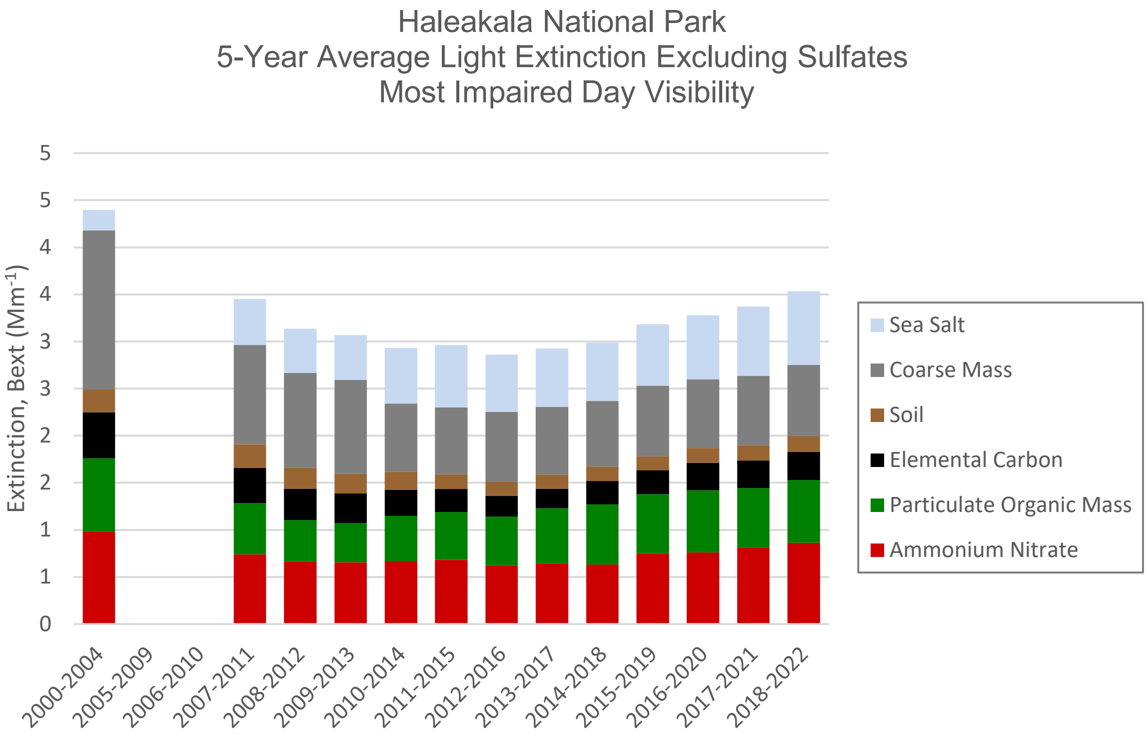

**Figure 4.2-6** Haleakala National Park Light Extinction Excluding Sulfates, Most Impaired Day Visibility

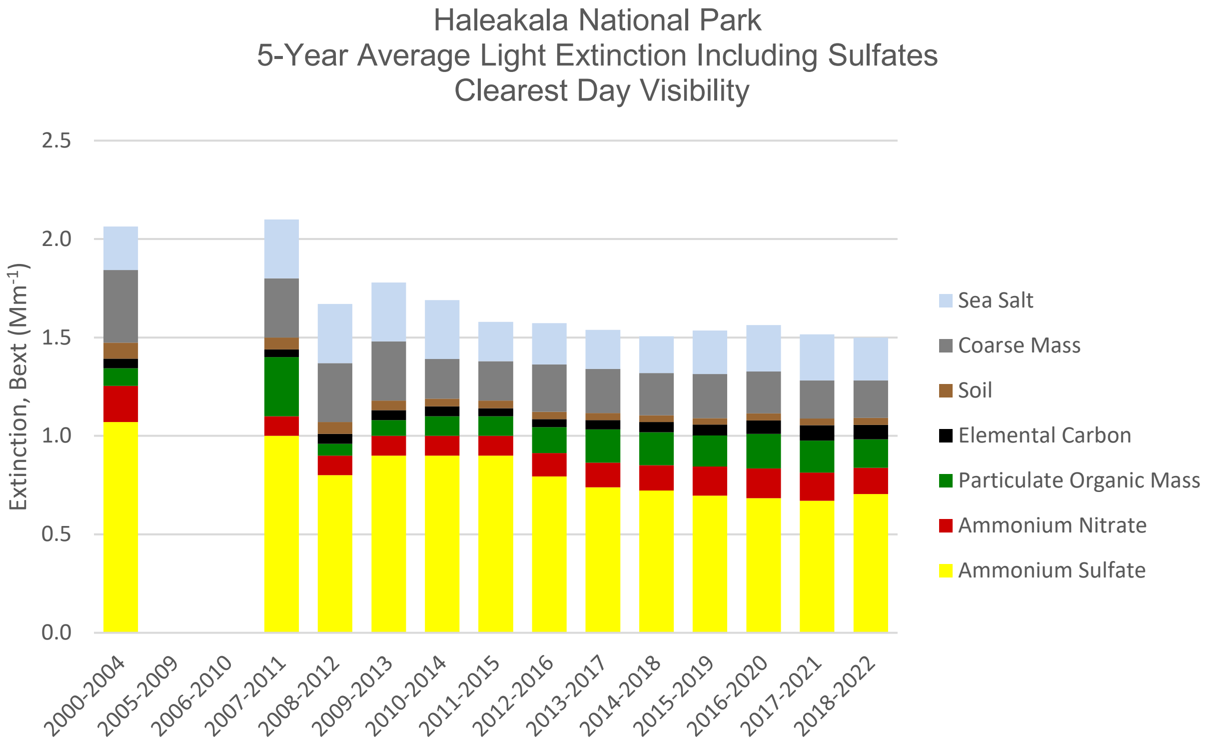

**Figure 4.2-7** Haleakala National Park Light Extinction Including Sulfates, Clearest Day Visibility

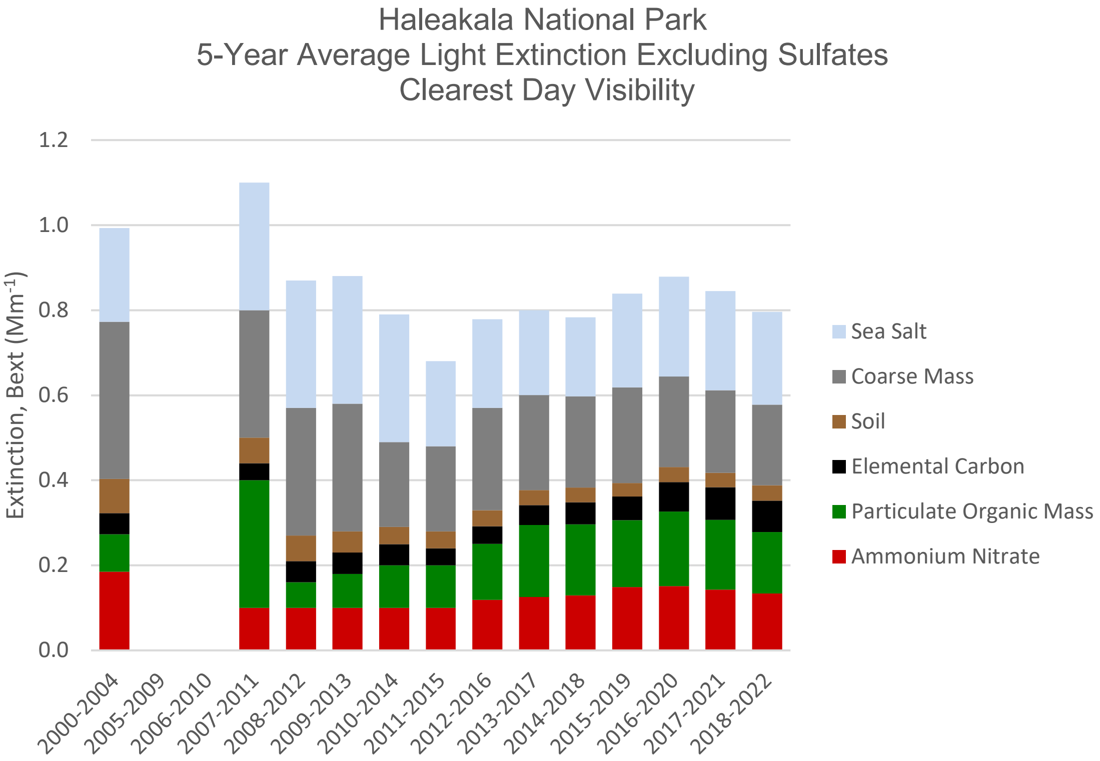

**Figure 4.2-8** Haleakala National Park Light Extinction Excluding Sulfates, Clearest Day Visibility

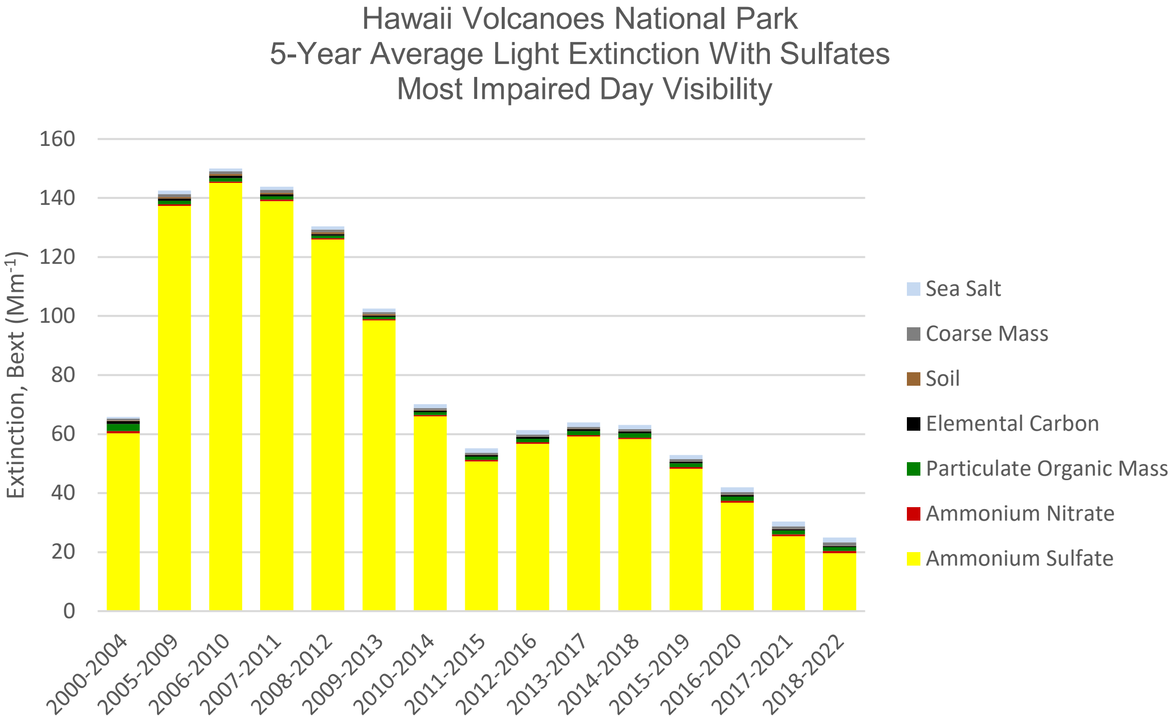

**Figure 4.2-9** Hawaii Volcanoes National Park Light Extinction Including Sulfates, Most Impaired Day Visibility

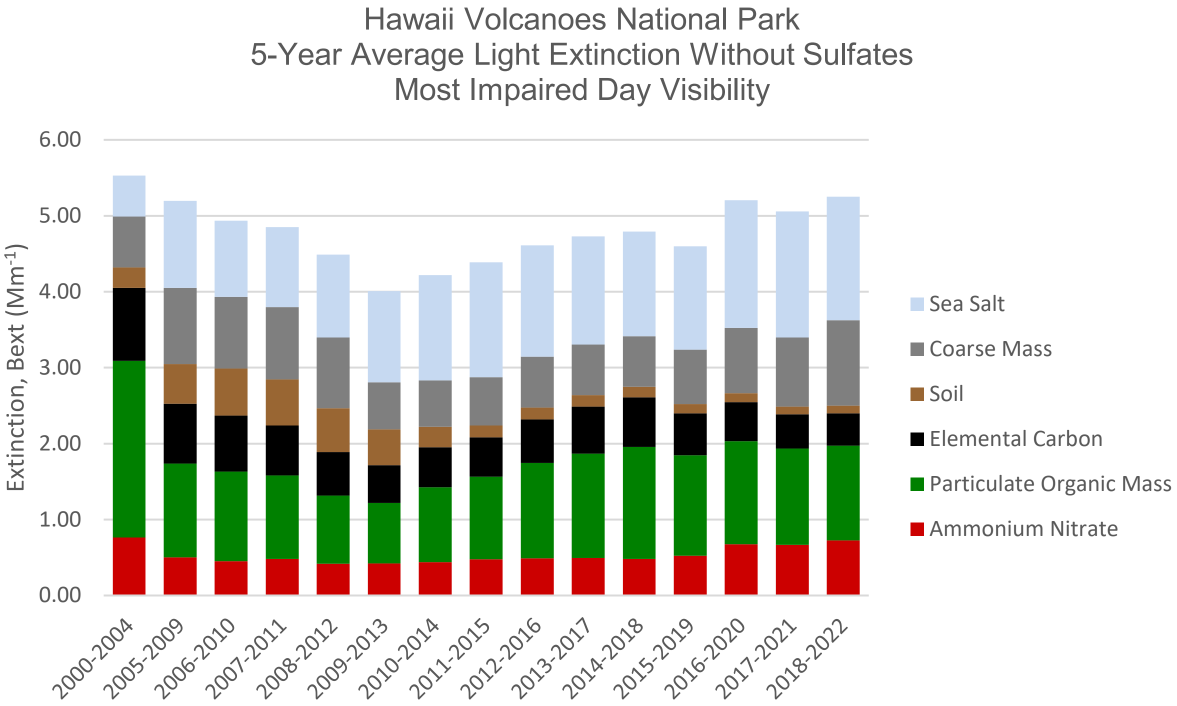

**Figure 4.2-10** Hawaii Volcanoes National Park Light Extinction Excluding Sulfates, Most Impaired Day Visibility

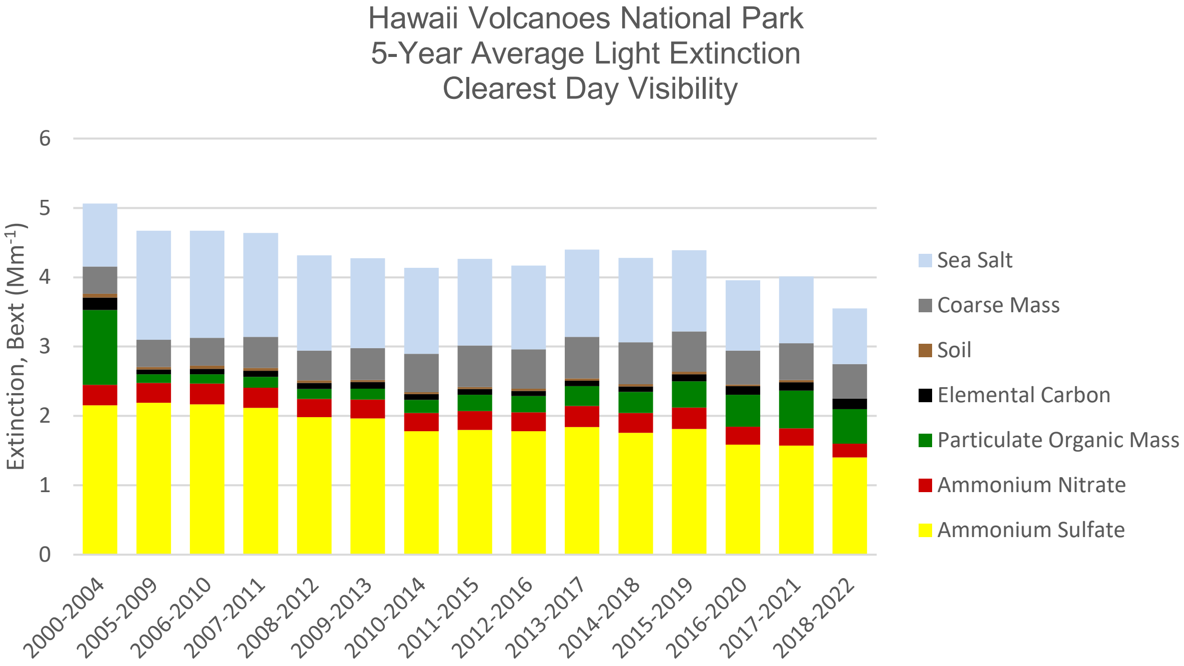

**Figure 4.2-11** Hawaii Volcanoes National Park Light Extinction Including Sulfates, Clearest Day Visibility

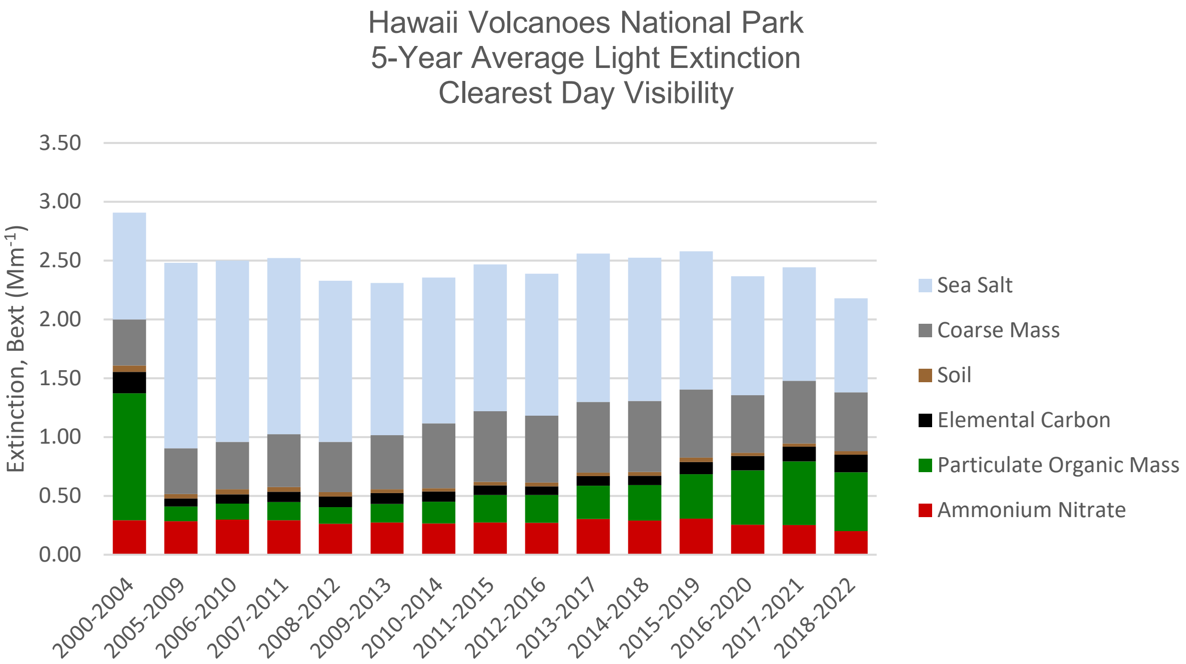

**Figure 4.2-12** Hawaii Volcanoes National Park Light Extinction Excluding Sulfates, Clearest Day Visibility

Figures 4.2-13 and 4.2-14 show changes in speciated light extinction between the five-year baseline period (2000-2004) and current 5-Year progress period (2011-2021) for Haleakala National Park (HACR1) and Hawaii Volcanoes National Park (HAVO1), for the clearest and most impaired visibility days, respectively.

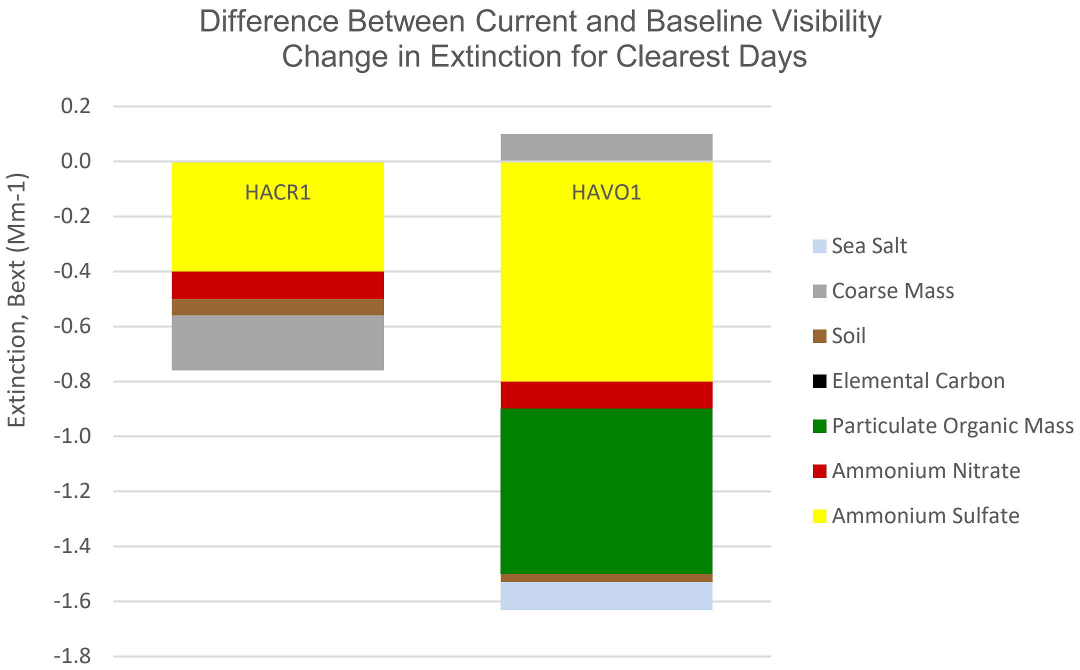

**Figure 4.2-13** Change in Extinction for Clearest Days at HACR1 and HAVO1

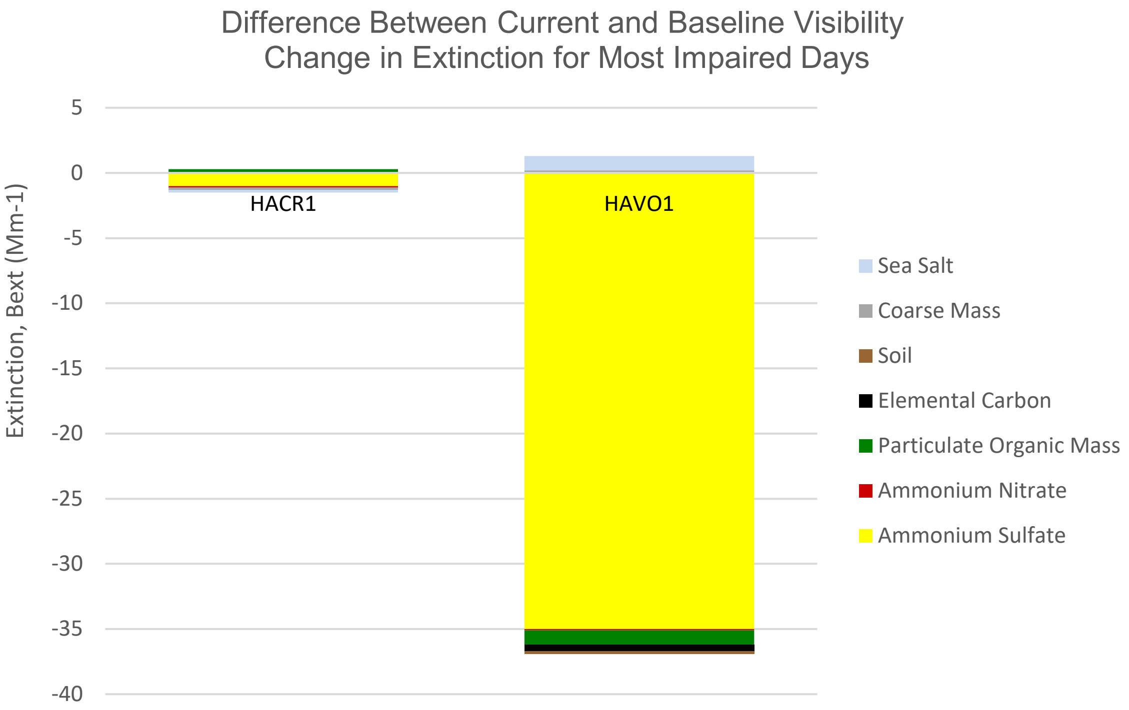

**Figure 4.2-14** Change in Extinction for Most Impaired Days at HACR1 and HAVO1

## 4.3 Change in Visibility for Clearest and Most Impaired Days – 40 CFR §51.308(g)(3)(iii)(B)

This section addresses the change in visibility impairment characterized by annual average trend statistics for HACR1 and HAVO1. Although 40 CFR §51.308(g)(3)(iii) specifies an evaluation of changes over the most current 5-Year progress period, as indicated in the WRAP Regional Haze Progress Report,[9] trend analysis is better suited to longer periods of time. Therefore DOH-CAB evaluated trends over the entire time of monitor operation. Data for the HACR1 was available from 2007 to 2022. For HAVO1, data was available from 2001 to 2022, which excludes 2018 when the monitoring station was compromised by an active eruption. Additional analysis is provided in the WRAP Regional Haze Progress Report.[9]

Tables 4.3-1 and 4.3-2 provide trend statistics for light extinction ($b_{ext}$) and haze index (dv) for HACR1 and HAVO1 at Haleakala and Volcanoes National Parks, respectively. Light extinction was evaluated for each species, and trends in $b_{ext}$ and haze index were determined using a linear Theil regression for each site. The Theil regression is known as a robust linear regression method that is resistant to the effect of outliers in the dataset. The slope, or trend, of the Theil regression is calculated as the median of all possible slopes from one point to another. The intercept of the Theil regression is calculated such that the slope will run through the median of the data points.[36] The correlation between the change in light extinction, or haze index, and time was evaluated by calculating the p-value for the

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[36] Granato, G.E., Kendall-Theil Robust Line (KTRLine—version 1.0)—A Visual Basic Program for Calculating and Graphing Robust Nonparametric Estimates of Linear-Regression Coefficients Between Two Continuous Variables. USGS, 2006. From: https://pubs.usgs.gov/tm/2006/tm4a7/

data assuming a two-sided test to ensure that we account for both positive and negative slopes in the probability.[37] Only trends for aerosol species and haze index with p-value statistics less than 0.15 (85% confidence level) are provided, with increasing slopes in red and decreasing slopes in blue.

A more comprehensive list of trends for all species, including the associated p-values, and a percent change per year, are provided in Appendix J. The percent change per year is calculated by dividing the slope from the Theil regression by the value of the trend line on the first year that data was available (i.e., 2007 for HACR1 and 2001 for HAVO1) and multiplying by 100%.

**Table 4.3-1** 2007-2022 Annual Average Trends in Aerosol Extinction by Species (HACR1)

| Group | HI Trend (dv/yr) | Trend ($Mm^{-1}$/yr) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Ammonium Sulfate | Ammonium Nitrate | POM | EC | Soil | CM | Sea Salt |
| Clearest | -0.024 | -0.028 | ----- | 0.009 | 0.003 | -0.002 | ----- | -0.007 |
| Most Impaired | -0.233 | -0.758 | ----- | ----- | ----- | -0.008 | ----- | 0.027 |
| All Days | -0.099 | -0.081 | ----- | ----- | ----- | -0.003 | -0.016 | ----- |

**Table 4.3-2** 2007-2022 Annual Average Trends in Aerosol Extinction by Species (HAVO1)

| Group | HI Trend (dv/yr) | Trend ($Mm^{-1}$/yr) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Ammonium Sulfate | Ammonium Nitrate | POM | EC | Soil | CM | Sea Salt |
| Clearest | -0.047 | -0.035 | ----- | ----- | ----- | -0.001 | 0.009 | -0.022 |
| Most Impaired | -0.345 | ----- | ----- | ----- | -0.024 | ----- | ----- | 0.042 |
| All Days | -0.080 | ----- | -0.007 | -0.020 | -0.005 | -0.002 | 0.006 | 0.022 |

# Chapter 5 Emissions Analysis

## 5.0 Statewide Emissions Inventory Changes – 40 CFR 51.308(g)(4)

Section 5 provides statewide emissions inventory data for tracking the change over the past five (5) years in emissions of pollutants contributing to visibility impairment from all sources and activities within the state. For Hawaii, year 2005 was selected as the baseline emissions inventory because it was the most complete inventory available at the time technical work commenced for the RH-SIP. The most recent statewide emissions inventory data for tracking changes in emissions were from EPA's 2020 NEI. Table 5.0-1 lists the major emitted pollutants inventoried, the related aerosol species, and some of the major sources for each pollutant.[9] Statewide emissions inventories for $SO_2$, $NO_X$, $PM_{10}$, $PM_{2.5}$, $NH_3$, and VOC are provided in Tables 5.0-2 through 5.0-6 for the 2005 baseline, 2011, 2014, 2017, and 2020 inventory years. The 2005 emissions inventory was derived from a

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[37] What are the Differences between One-Tailed and Two-Tailed Tests?. UCLA: Statistical Consulting Group. From https://stats.oarc.ucla.edu/other/mult-pkg/faq/general/faq-what-are-the-differences-between-one-tailed-and-two-tailed-tests/

2010 study conducted by the consulting firm Environ on behalf of the Hawaii DOH-CAB that provided Hawaii's statewide emissions for 2002, 2005, and projected 2018.[10, 38] The emission inventory numbers developed by Environ Corporation were refined, as applicable, by the Hawaii DOH-CAB.[10] The EPA also worked with the University of North Carolina and consulting firm ICF International to develop new emission inventories for on-road vehicles after finalizing a new model MOVES for estimating emissions from on-road vehicles.[10] The Hawaii emission inventories provided by Environ were updated with estimations using the MOVES model.

**Table 5.0-1** Hawaii Pollutants, Aerosol Species, and Major Sources [a]

| Emitted Pollutant | Related Aerosol | Major Sources | Notes |
|---|---|---|---|
| $SO_2$ | Ammonium Sulfate | Point Sources; On- and Off-Road Mobile Sources; Volcanic Emissions<br>(see note b) | $SO_2$ emissions are generally associated with anthropogenic sources such as fuel oil fired power plants, large commercial operations such aggregate processing or sugar cane processing, and both on- and off-road diesel engines.<br><br>Also, in Hawaii, volcanic activity contributes significantly to natural emissions of $SO_2$, and it is possible that some of these emissions are transported to the contiguous states. |
| $NO_X$ | Ammonium Nitrate | On- and Off-Road Mobile Sources; Point Sources; Area Sources | $NO_X$ emissions are generally associated with anthropogenic sources. Common sources include virtually all combustion activities, especially those involving cars, trucks, power plants, and other industrial processes. |
| $NH_3$ | Ammonium Sulfate & Ammonium Nitrate | Area Sources; On-Road Mobile Sources | Gaseous $NH_3$ has implications in particulate formation because it can form particulate ammonium. Ammonium is not directly measured by the IMPROVE program but affects formation potential of ammonium sulfate and ammonium nitrate. All measured nitrate and sulfate are assumed to be associated with ammonium for IMPROVE reporting purposes. |
| VOCs | Particulate Organic Mass (POM) | Biogenic Emissions; Vehicle Emissions; Area Sources | VOCs are gaseous emissions of carbon compounds, which are often converted to POM through chemical reactions in the atmosphere.<br><br>Estimates for biogenic emissions of VOCs have undergone significant updates since 2002, so changes reported here are more reflective of methodology changes than actual changes in emissions (see Section 3.2.1 of Reference 6). |
| Fine Soil | Soil | Windblown Dust;<br>Fugitive Dust;<br>Road Dust;<br>Area Sources | Fine soil is reported here as the crustal or soil components of $PM_{2.5}$. |

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[38] Final Emission Inventory Report: Data Population of Air System for Hawaii's Emissions Data (AirSHED), Prepared for Hawaii Department of Health by ENVIRON International Corporation.

| **Table 5.0-1** Hawaii Pollutants, Aerosol Species, and Major Sources [a] | | | |
|---|---|---|---|
| Emitted Pollutant | Related Aerosol | Major Sources | Notes |
| Coarse Mass (PMC) | Coarse Mass | Windblown Dust; Fugitive Dust | Coarse mass is reported by the IMPROVE Network as the difference between $PM_{10}$ and $PM_{2.5}$ mass measurements. Coarse mass is not separated by species in the same way that $PM_{2.5}$ is speciated, but these measurements are generally associated with crustal components. Similar to crustal $PM_{2.5}$, natural windblown dust is often the largest contributor to PMC. |

a. From Table 6.5-7 on Page 6-131 of Reference 9.

b. Point sources include emissions from EGUs, non-EGUs, and airports.

**Table 5.0-2** Statewide Emissions Inventory 2005[a]

| Source Category | $SO_2$ | $NO_X$ | VOC | $PM_{10}$ | $PM_{2.5}$ | $NH_3$ |
|---|---|---|---|---|---|---|
| **Anthropogenic Sources (TPY)** | | | | | | |
| Point Sources | 27,072 | 22,745 | 2,695 | 3,536 | 2,900 | 12 |
| Area Sources | 3,716 | 1,509 | 16,920 | 33,408 | 1,245 | 11,136 |
| Agricultural Burning | 178 | 406 | 535 | 1,567 | 1,379 | 60 |
| Other Fire | 0 | 1 | 7 | 7 | 6 | 0 |
| On-Road Mobile Sources | 321 | 20,642 | 12,066 | 638 | 379 | 1,085 |
| Non-Road Mobile Sources [b] | 669 | 6,296 | 6,383 | 649 | 620 | 0 |
| Marine [c] | 3,619 | 5,624 | 209 | 398 | 262 | 0 |
| **Total Anthropogenic** | **35,575** | **57,223** | **38,815** | **40,203** | **6,791** | **12,298** |
| **Natural Sources (TPY)** | | | | | | |
| Volcano | 961,366 | 0 | 0 | 0 | 0 | 0 |
| Sea Spray | 0 | 0 | 0 | 382,637 | 10,714 | 0 |
| Windblown Dust | 0 | 0 | 0 | 46,808 | 4,681 | 0 |
| Wildfire | 591 | 2,156 | 4,729 | 9,771 | 8.305 | 540 |
| Biogenic | 0 | 4,617 | 130,153 | 0 | 0 | 0 |
| **Total Natural** | **961,957** | **6,773** | **134,882** | **439,216** | **23,700** | **540** |
| **All Sources (TPY)** | | | | | | |
| **Total Overall Emissions** | **997,532** | **63,996** | **173,697** | **479,419** | **30,491** | **12,838** |

a) Based on emission inventory work from ENVIRON International Corporation[12]
b) Non-Road Mobile totals include aircraft and locomotive emissions.
Marine totals include in/near/underway emissions.

**Table 5.0-3** Statewide Emissions Inventory 2011[a]

| Source Category | $SO_2$ | $NO_X$ | VOC | $PM_{10}$ | $PM_{2.5}$ | NH3 |
|---|---|---|---|---|---|---|
| **Anthropogenic Sources (TPY)** | | | | | | |
| Point Sources | 22,047 | 28,982 | 3,059 | 2,813 | 2,458 | 1,031 |
| Area Sources [b] | 3,331 | 1,176 | 18,425 | 34,803 | 4,409 | 7,547 |
| Agricultural Burning | 178 | 405 | 535 | 1,567 | 1,441 | 148 |
| Prescribed Burning | 36 | 389 | 1,672 | 853 | 674 | 59 |
| On-Road Mobile Sources | 102 | 15,503 | 11,180 | 305 | 277 | 412 |
| Non-Road Mobile Sources | 7 | 3,842 | 5,428 | 403 | 383 | 6 |
| Marine [c] | 2,037 | 4,895 | 154 | 338 | 313 | 3 |
| **Total Anthropogenic** | **27,738** | **55,192** | **40,453** | **41,420** | **9,955** | **9,749** |
| **Natural Sources (TPY)** | | | | | | |
| Volcano [d] | 447,566 | 0 | 0 | 0 | 0 | 0 |
| Sea Spray [e] | 0 | 0 | 0 | 382,637 | 10,714 | 0 |
| Windblown Dust [e] | 0 | 0 | 0 | 46,808 | 4,681 | 0 |
| Wildfire | 9 | 99 | 390 | 162 | 127 | 12 |
| Biogenic [e] | 0 | 4,617 | 130,153 | 0 | 0 | 0 |
| **Total Natural** | **447,566** | **4,716** | **130,543** | **429,607** | **15,522** | **12** |
| **All Sources (TPY)** | | | | | | |
| **Total Overall Emissions** | **475,304** | **59,808** | **170,996** | **471,027** | **25,477** | **9,761** |

a) Based on 2011 NEI at: https://www.epa.gov/air-emissions-inventories/2011-national-emissions-inventory-nei-data.
b) Area source emissions exclude agricultural burning and marine.
c) Marine totals include diesel port diesel underway, residual port and residual underway.
d) Based on $SO_2$ emission rates reported by USGS for Kilauea volcano that was reported in Reference **Error! Bookmark not defined.**.

e) Based on emission inventory work from ENVIRON International Corporation for 2005 and 2008 (Ref. 21).

**Table 5.0-4** Statewide Emissions Inventory 2014[a]

| Source Category | $SO_2$ | $NO_X$ | VOC | $PM_{10}$ | $PM_{2.5}$ | $NH_3$ |
|---|---|---|---|---|---|---|
| **Anthropogenic Sources (TPY)** | | | | | | |
| Point Sources | 19,543 | 26,163 | 4,117 | 2,583 | 2,259 | 247 |
| Area Sources [b] | 98 | 463 | 15,162 | 54,626 | 7,547 | 3,884 |
| Agricultural Burning | 197 | 359 | 534 | 583 | 515 | 2,551 |
| Prescribed Burning | 534 | 6,153 | 29,665 | 14,086 | 11,150 | 951 |
| On-Road Mobile Sources | 104 | 12,077 | 10,383 | 770 | 300 | 338 |
| Non-Road Mobile Sources | 9 | 3,228 | 4,313 | 356 | 337 | 6 |
| Marine [c] | 229 | 1,131 | 35 | 37 | 35 | 0.4 |
| **Total Anthropogenic** | **20,714** | **49,574** | **64,209** | **73,041** | **22,143** | **7,977** |
| **Natural Sources (TPY)** | | | | | | |
| Volcano [d] | 2,062,813 | - | - | - | - | - |
| Sea Spray [e] | - | - | - | 382,637 | 10,714 | - |
| Windblown Dust [e] | - | - | - | 46,808 | 4,681 | - |
| Wildfire | 258 | 3,374 | 14,437 | 11,340 | 9,607 | 838 |
| Biogenic [e] | - | 237 | 31,842 | - | - | - |
| **Total Natural** | **2,063,071** | **3,611** | **46,279** | **440,785** | **25,002** | **838** |
| **All Sources (TPY)** | | | | | | |
| **Total Overall Emissions** | **2,083,785** | **53,185** | **110,489** | **513,826** | **47,146** | **8,815** |

a. Emissions are from the 2014 NEI (https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data) unless noted otherwise below.

b. Area source emissions include emissions from all sectors in the non-point data category (NP) of 2014 NEI except for agricultural field burning and commercial marine vessels as emissions from these categories are reported separately here (Agricultural Burning and Marine, respectively).

c. Based on $SO_2$ emission rates reported by USGS for Kilauea volcano (USGS DailyAves_720pts.xlsx file provided by Tamar Elias, USGS)

d. Sea spray and windblown dust emissions were estimated for Hawaii as part of emission inventory work by ENVIRON International Corporation for the years 2002 and 2005 (ENVIRON, 2010). These emissions are reported here and are assumed to be representative of all years. Sea spray and windblown dust PM2.5 emissions are derived from PM10 emissions along with Environ 2005 PM2.5/PM10 ratios.

e. No wildfire or biogenic emissions were included in the 2014 NEI for Hawaii. Emissions from the EPA" 2016 modeling platform (EPA, 2020) are reported here as 2016 is the closest year with available emissions estimates for these sectors. Wildfire PM2.5 emissions are based on 2014 PM10 emissions along with 2017 EPA NEI PM2.5/PM10 ratio.

**Table 5.0-5** Statewide Emissions Inventory 2017[a]

| Source Category | $SO_2$ | $NO_X$ | VOC | $PM_{10}$ | $PM_{2.5}$ | $NH_3$ |
|---|---|---|---|---|---|---|
| **Anthropogenic Sources (TPY)** | | | | | | |
| Point Sources [b] | 17,265 | 21,596 | 3,519 | 2,108 | 1,857 | 232 |
| Area Sources [c] | 1,141 | 807 | 14,387 | 18,908 | 3,991 | 1,583 |
| Agricultural Burning [d] | - | - | - | - | - | - |
| Prescribed Burning | 50 | 90 | 1,562 | 673 | 571 | 109 |
| On-Road Mobile Sources | 52 | 9,327 | 8,109 | 841 | 308 | 332 |
| Non-Road Mobile Sources | 5 | 3,288 | 4,454 | 327 | 309 | 7 |
| Marine | 110 | 4,401 | 276 | 102 | 96 | 2 |
| **Total Anthropogenic** | **18,624** | **39,509** | **32,307** | **22,959** | **7,132** | **2,265** |
| **Natural Sources (TPY)** | | | | | | |
| Volcano [e] | 1,925,614 | - | - | - | - | - |
| Sea Spray [f] | - | - | - | 382,637 | 10,714 | - |
| Windblown Dust [f] | - | - | - | 46,808 | 4,681 | - |
| Wildfire | 43 | 100 | 916 | 432 | 366 | 64 |
| Biogenic | - | 1,422 | 128,061 | - | - | - |
| **Total Natural** | **1,925,657** | **1,522** | **128,977** | **429,877** | **15,7 60** | **64** |
| **All Sources (TPY)** | | | | | | |
| **Total Overall Emissions** | **1,944,281** | **41,031** | **161,284** | **452,835** | **22,891** | **2,328** |

a) Emissions are from the 2017 NEI (https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data) unless noted otherwise below.

b) Point source emissions are from the June 2020 update to the point sources of the 2017 NEI (2017NEI_June2020_PT), which is only available in the EIS gateway.

c) Area source emissions include emissions from all sectors in the non-point data category (NP) of 2017 NEI except for biogenic and commercial marine vessels as emissions from these categories are reported separately here (Biogenic and Marine, respectively).

d) No emissions are reported for the agricultural field burning sector in the 2017 NEI data for HI.

e) Based on 2017 $SO_2$ emission rates reported by USGS for Kilauea volcano (USGS DailyAves_720pts.xlsx file provided by Tamar Elias, USGS).

f) Sea spray and windblown dust emissions were estimated for Hawaii as part of emission inventory work by ENVIRON International Corporation for the years 2002 and 2005 (ENVIRON, 2010). These emissions are reported here and are assumed to be representative of all years. Sea spray and windblown dust PM2.5 emissions are derived from $PM_{10}$ emissions along with Environ 2005 $PM_{2.5}/PM_{10}$ ratios.

| **Table 5.0-6** Statewide Emissions Inventory 2020[a] | | | | | | |
|---|---|---|---|---|---|---|
| Source Category | $SO_2$ | $NO_X$ | VOC | $PM_{10}$ | $PM_{2.5}$ | $NH_3$ |
| **Anthropogenic Sources (TPY)** | | | | | | |
| Point Sources | 16,453 | 18,464 | 2,369 | 1,647 | 1,446 | 205 |
| Area Sources [b] | 164 | 775 | 20,526 | 19,800 | 5,017 | 879 |
| Agricultural Burning [c] | - | - | - | - | - | - |
| Prescribed Burning | 70 | 161 | 1,500 | 705 | 597 | 104 |
| On-Road Mobile Sources | 24 | 5,840 | 4,684 | 593 | 217 | 263 |
| Non-Road Mobile Sources | 3 | 2,827 | 3,595 | 283 | 267 | 8 |
| Marine | 27 | 1,753 | 63 | 41 | 39 | 1 |
| **Total Anthropogenic** | **16,741** | **29,820** | **32,737** | **23,069** | **7,583** | **1,460** |
| **Natural Sources (TPY)** | | | | | | |
| Volcano [d] | 17,301 | - | - | - | - | - |
| Sea Spray [e] | - | - | - | 382,637 | 10,714 | - |
| Windblown Dust [e] | - | - | - | 46,808 | 4,681 | - |
| Wildfire | 94 | 219 | 1,976 | 934 | 792 | 137 |
| Biogenic | - | 1,427 | 130,594 | - | - | - |
| **Total Natural** | **17,395** | **1,646** | **132,570** | **430,379** | **16,187** | **137** |
| **All Sources (TPY)** | | | | | | |
| **Total Overall Emissions** | **34,136** | **31,466** | **165,307** | **453,448** | **23,770** | **1,597** |

a) Emissions are from the 2020 NEI (https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-nei-data) unless noted otherwise below.

b) Area source emissions include emissions from all sectors in the non-point data category (NP) of 2020 NEI except for biogenic and commercial marine vessels as emissions from these categories are reported separately here (Biogenic and Marine, respectively).

c) No emissions are reported for the agricultural field burning sector in the 2020 NEI data for HI.

d) Based on 2019 $SO_2$ emission rates reported by USGS for Kilauea volcano (USGS DailyAves_720pts.xlsx file provided by Tamar Elias, USGS). Volcanic emissions data was limited for 2020 due to measuring equipment being down. Therefore, 2019 $SO_2$ emissions data was used for volcanic emissions.

e) Sea spray and windblown dust emissions were estimated for Hawaii as part of emission inventory work by ENVIRON International Corporation for the years 2002 and 2005 (ENVIRON, 2010). These emissions are reported here and are assumed to be representative of all years. Sea spray and windblown dust PM2.5 emissions are derived from PM10 emissions along with Environ 2005 PM2.5/PM10 ratios.

## 5.1 Anthropogenic Versus Natural Emissions

Figures 5.1-1 through 5.1-7 are based on emissions data from Tables 5.0-2 and 5.0-6, volcanic $SO_2$ emissions data from USGS. Figures 5.1-1, 5.1-2, 5.1-4, 5.1-5, and 5.1-6 show that nonanthropogenic (natural) emissions are significant for $SO_2$, $PM_{10}$, and VOCs. However, in 2019 when there were no volcanic eruptions, emission rates reported by USGS for Kilauea volcano (USGS DailyAves_720pts.xlsfile provided by Tamar Elias, USGS) show that anthropogenic $SO_2$ is a more significant contributor to statewide $SO_2$ emissions.

As shown in Figure 5.1-1, $SO_2$ from the volcano overwhelms statewide anthropogenic sources of $SO_2$. Volcanic $SO_2$ emissions are 96% of total $SO_2$ emissions (statewide anthropogenic $SO_2$ + volcanic $SO_2$). Also, $SO_2$ emissions would have been higher for 2005 if updated methods were used to measure emissions. In 2014 USGS-HAVO began using more accurate techniques to measure emissions rates at the Halemaumau summit vent using a fixed array of ten (10) upward-facing ultraviolet spectrometers that replaced measurement of $SO_2$ with vehicle-based ultraviolet light spectrometer for the Halemaumau vent. According to USGS-HAVO, the numbers increased from the vehicle-based measuring method by a factor of two (2) to four (4).

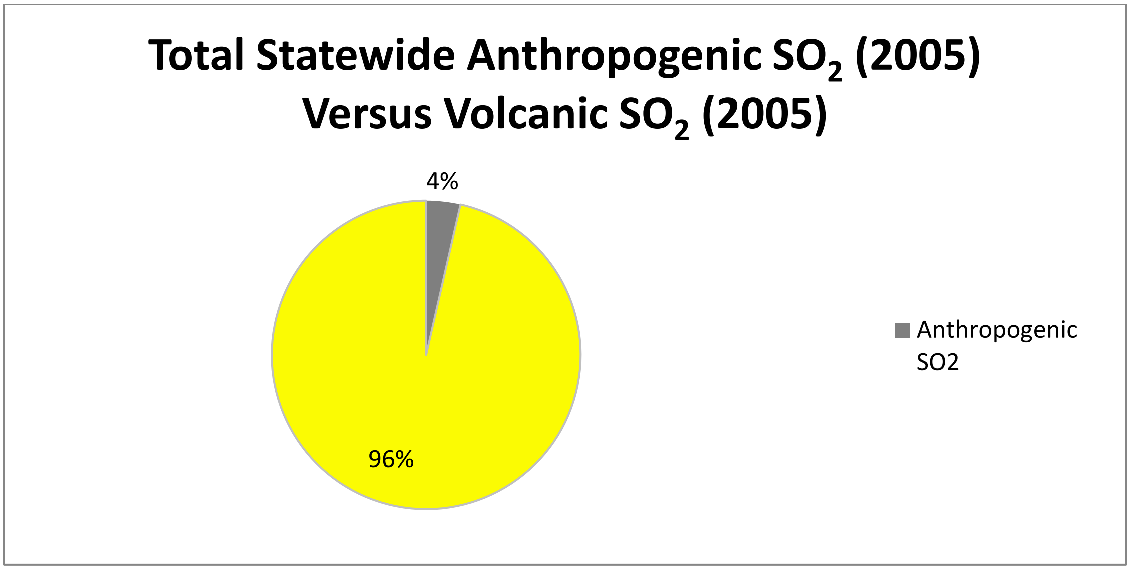

**Figure 5.1-1** Baseline Statewide Anthropogenic and Volcanic $SO_2$

In 2020, data shown in Figure 5.1-2 shows that the ratio of total statewide anthropogenic SO2 emissions to 2005 Volcanic $SO_2$ emissions further decreased, so that anthropogenic emissions accounted for only 2%.

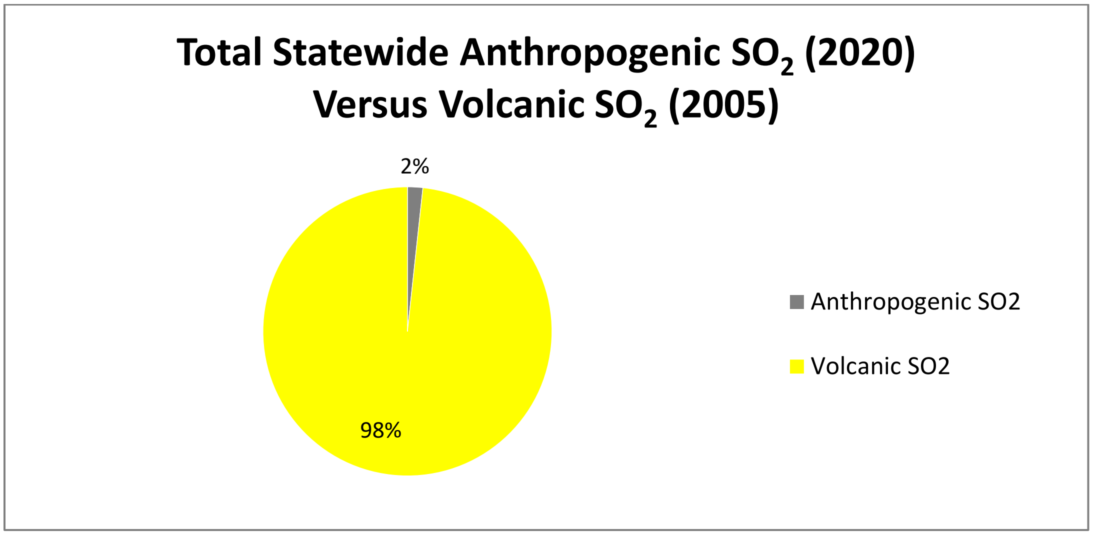

**Figure 5.1-2** Total Statewide Anthropogenic $SO_2$ (2020) and Volcanic $SO_2$ (2005)

In early 2018, Kīlauea's $SO_2$ emission rates were stable at both the summit, where a lava lake had been present for a decade, and the middle East Rift Zone (MERZ), where Puʻuʻōʻō vent had been erupting almost continuously for 35 years. The 2018 lower East Rift Zone (LERZ) eruption and the simultaneous summit caldera collapse from May to September 2018 led to unprecedentedly high $SO_2$ emissions at the LERZ fissures and temporary increased at both the summit and Puʻuʻōʻō. By late summer 2018, emissions at all three sites had drastically decreased, with LERZ and MERZ emissions dropping to below-detection and near-negligible levels, respectively.

In 2019 and 2020, MERZ emissions remained below detection limits, and Kīlauea summit emissions were near detection levels. 2019 also marked the appearance of the first summit water lake in Kīlauea's crater in recorded history, though Hawaiian oral tradition and analysis of erupted materials suggest past water bodies in the crater. The extremely low $SO_2$ emissions during this period raised questions about possible $SO_2$ scrubbing by the lake, but this was ultimately ruled out as a significant factor.

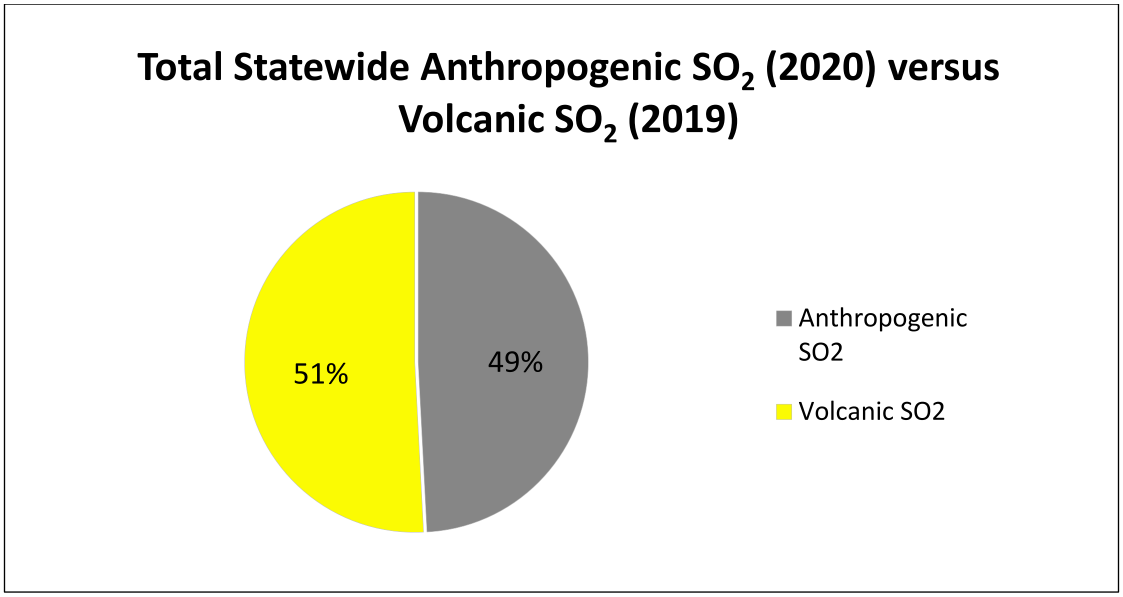

**Figure 5.1-3** Total Statewide Anthropogenic $SO_2$ (2020) and Volcanic $SO_2$ (2019)

a. Limited data on Volcanic $SO_2$ is available for 2020 due to measurement equipment being down, and 2019 is the most recent year to 2020 with a complete emissions data.

High $SO_2$ emissions returned in late December 2020 when lava erupted from the summit crater walls, evaporating the lake and forming a new lava lake. Emissions decreased as the eruption progressed, returning to low levels by mid-2021 when the eruption ceased. Another summit eruption began in September 2021, bringing high $SO_2$ emissions again. This activity continued through much of 2022, with brief pauses during which emissions dropped to near-background levels, only to increase again when lava returned to the summit crater.

In late 2022, just before the end of Kīlauea's 2021–2022 eruption, Mauna Loa erupted for the first time since 1984. The eruption began in the summit caldera and quickly moved to fissures on the Northeast Rift Zone (NERZ). $SO_2$ emission rates from Mauna Loa were very high, comparable to those during Kīlauea's 2018 LERZ eruption. However, Mauna Loa's eruption was shorter, with activity ceasing and $SO_2$ emissions dropping to below-detection levels just two weeks after it started.

Comparing the total 2020 statewide anthropogenic $SO_2$ to the 2022 volcanic $SO_2$ further corroborates that the vast majority of $SO_2$ emissions in our state come from volcanic emissions, which can be significant during both active and non-active eruption periods.

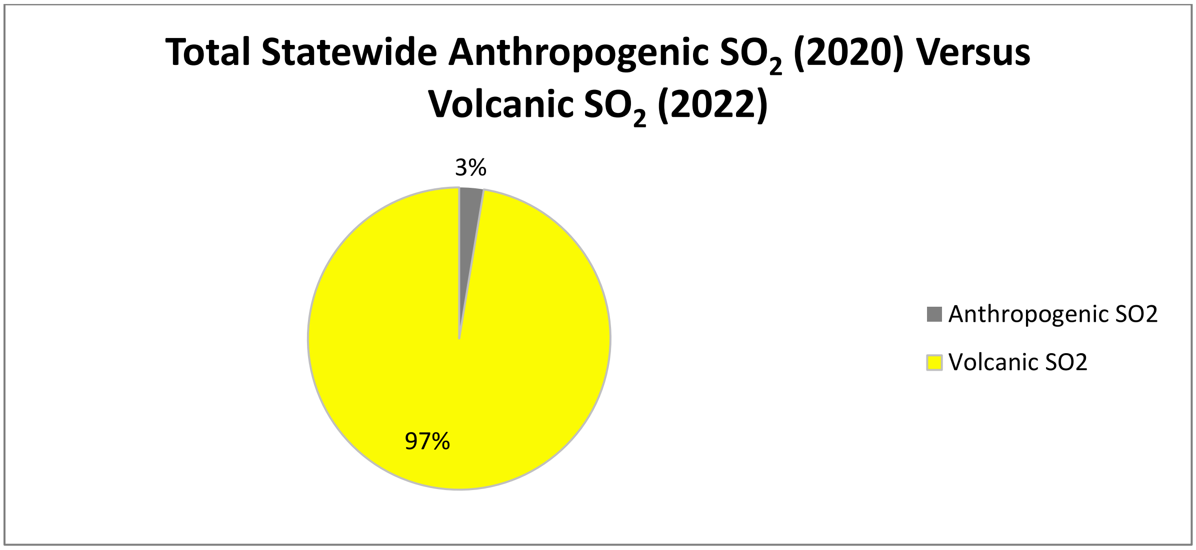

**Figure 5.1-4** Total Statewide Anthropogenic $SO_2$ (2020) and Volcanic $SO_2$ (2022)

In Figure 5.1-5 statewide, $PM_{10}$ emissions from sea spray, accounting for 94% of the total statewide emissions, dominate anthropogenic $PM_{10}$.

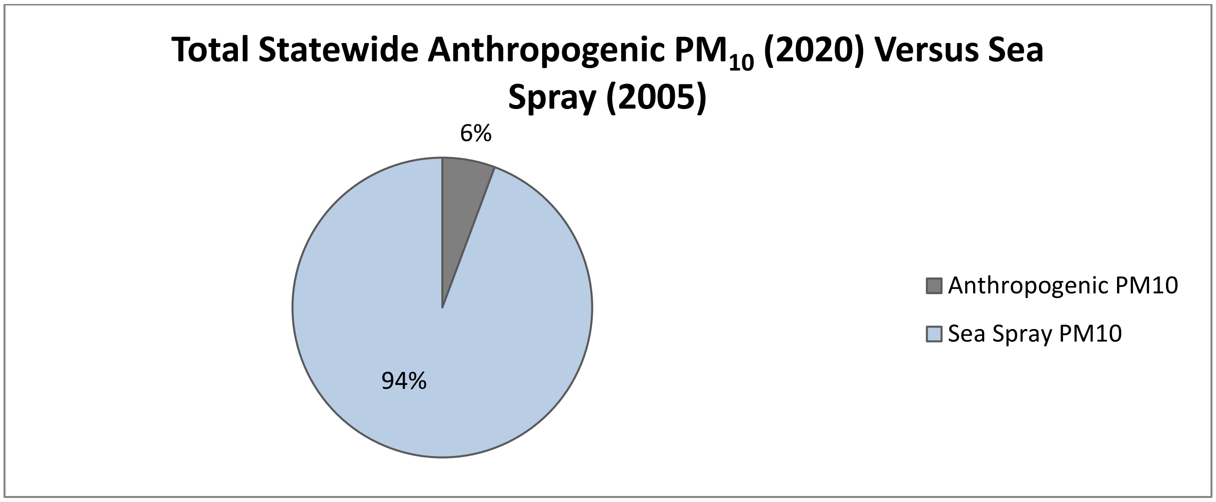

**Figure 5.1-5** Total Statewide Anthropogenic $PM_{10}$ (2020) Versus Sea Spray (2020)

Figure 5.1-6 shows that natural emissions from plants and soils are a dominate source of VOC, accounting for 77% of the total statewide VOC emissions.

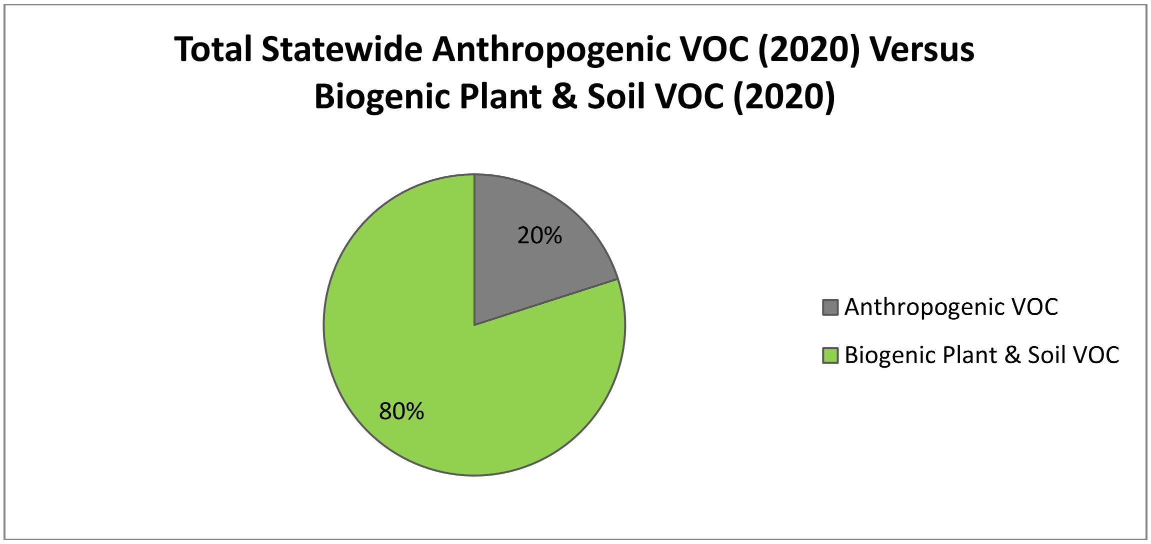

**Figure 5.1-6** Average Statewide Anthropogenic and Biogenic Plant & Soil VOC

# Chapter 6 Significant Changes in Anthropogenic Emissions

## 6.0 Changes in Emissions – 40 CFR 51.308(g)(5)

The Regional Haze Rule requires an assessment of any significant changes in anthropogenic emissions within or outside the state that have occurred since the period addressed in Hawaii's RH-SIP, Revision 1, including whether or not these changes in anthropogenic emissions were anticipated in the state plan and whether they have limited or impeded progress in reducing pollutant emissions and improving visibility.

For the RH-SIP, $SO_2$, $NO_X$, and $PM_{10}$/$PM_{2.5}$ were the primary anthropogenic pollutants affecting visibility in Hawaii's Class I areas. Tables 6.0-1 through 6.0-3 and associated figures show that statewide emissions have decreased significantly for these pollutants between 2014 and 2020. Emission reductions from control measures specified in Hawaii's RH-SIP will ensure future reductions of theses pollutants from facilities identified in the screening process to have the highest potential to impair visibility in the national parks.

Tables 6.0-4 and 6.0-5 and associated figures show that statewide emissions have significantly decreased between 2014 and 2020 for VOCs and $NH_3$ which are other pollutants that can affect visibility in the national parks. Emission reductions in Revision 1 of the RH-SIP will also reduce VOCs and $NH_3$ from the affected facilities.

The difference in statewide $SO_2$ emission inventory totals for the 2014 to 2020 progress period in Table 6.0-1 and Figure 6.0-1 show an overall decrease of 19% in $SO_2$ emissions. The only increases in $SO_2$ emissions are from the area source category. Although there was an increase of 166% in area source $SO_2$ from the 2014 to 2020 emission years, it is still a relatively small output when compared to the reduction in $SO_2$ emissions from point sources.

**Table 6.0-1** Difference in Statewide Anthropogenic $SO_2$ Emissions

| Source Category | Statewide Sulfur Dioxide (TPY) | | | | |
|---|---|---|---|---|---|
| | 2014 | 2017 | 2020 | Total Difference (2014 – 2020) | Percent Change (2014 – 2020) |
| Point Sources | 19,543 | 17,265 | 16,453 | -3,090 | -16% |
| Area Sources | 98 | 1,141 | 234 | 136 | 139% |
| Agricultural Burning | 197 | - | - | - | - |
| Other Fire/Prescribed Burning | 534 | 50 | 70 | -464 | -87% |
| On-Road Mobile Sources | 104 | 52 | 28 | -76 | -73% |
| Non-Road Mobile Sources | 9 | 5 | 3 | -6 | -67% |
| Marine | 229 | 110 | 27 | -202 | -88% |
| **Total Anthropogenic** | **20,714** | **18,624** | **16,815** | **-3,899** | **-19%** |

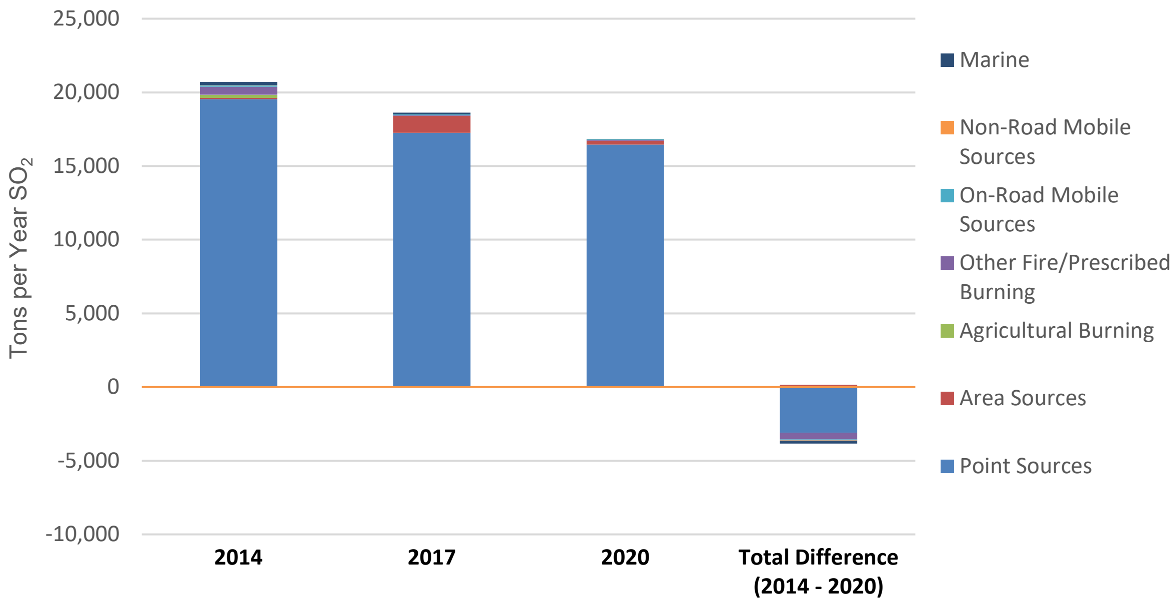

**Figure 6.0-1** 2014, 2017 and 2020 Emissions and Difference in Emission Inventory Totals for Sulfur Dioxide by Source Category for Hawaii

The difference in $NO_X$ emission inventory totals from the 2014 to 2020 progress period in Table 6.0-2 and Figure 6.0-2 show an overall decrease of 33% in $NO_X$ emissions. The only increases in $NO_X$ are from the area source category. For point sources, the largest source of $NO_X$ emissions, there was a decrease of 29%.

**Table 6.0-2** Difference in Statewide Anthropogenic $NO_x$ Emissions

| Source Category | Statewide Nitrogen Oxide (TPY) | | | | |
|---|---|---|---|---|---|
| | 2014 | 2017 | 2020 | Total Difference (2014 – 2020) | Percent Change (2014 – 2020) |
| Point Sources | 26,163 | 21,596 | 18,464 | -7,699 | -29% |
| Area Sources | 463 | 807 | 937 | 474 | 102% |
| Agricultural Burning | 359 | - | - | - | - |
| Other Fire/Prescribed Burning | 6,153 | 90 | 161 | -5,992 | -97% |
| On-Road Mobile Sources | 12,077 | 9,327 | 5,840 | -6,237 | -52% |
| Non-Road Mobile Sources | 3,228 | 3,288 | 2,827 | -401 | -12% |
| Marine | 1,131 | 4,401 | 1,753 | 622 | 55% |
| **Total Anthropogenic** | **49,574** | **39,509** | **29,982** | **-19,233** | **-40%** |

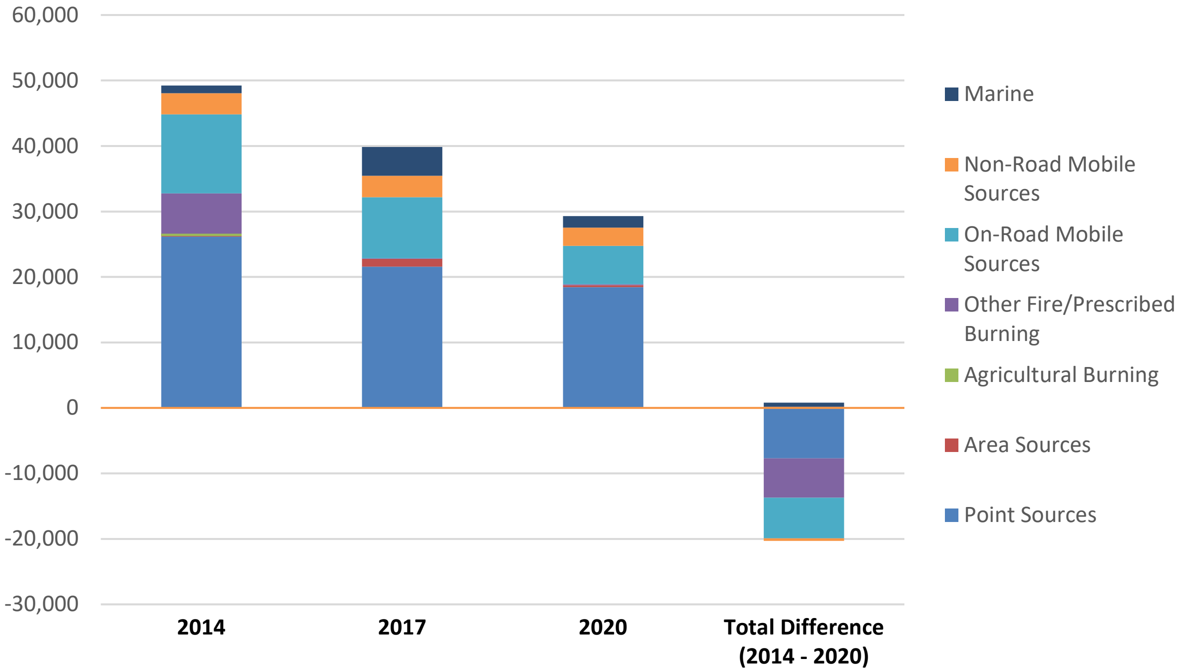

**Figure 6.0-2** 2014, 2017 and 2020 Emissions and Difference in Emission Inventory Totals for Nitrogen Oxide by Source Category for Hawaii

The difference in $PM_{10}$ emission inventory totals for the 2014 to 2020 progress period in Table 6.0-3 and Figure 6.0-3 show an overall decrease of 67% in statewide $PM_{10}$ emissions. Increases in $PM_{10}$ emissions from 2014 to 2020 are shown for only the marine source category, by 8%. The largest decrease was in PM10 from area sources, with a 62 percent decrease from 2014 to 2020.

**Table 6.0-3** Difference in Statewide Anthropogenic $PM_{10}$ Emissions

| Source Category | Statewide $PM_{10}$ (TPY) | | | | |
|---|---|---|---|---|---|
| | 2014 | 2017 | 2020 | Total Difference (2014 – 2020) | Percent Change (2014 – 2020) |
| Point Sources | 2,583 | 2,108 | 1,647 | -936 | -36% |
| Area Sources | 54,626 | 18,908 | 20,505 | -34,121 | -62% |
| Agricultural Burning | 583 | - | - | N/A | N/A |
| Other Fire/Prescribed Burning | 14,086 | 673 | 705 | -13,381 | -95% |
| On-Road Mobile Sources | 770 | 841 | 593 | -177 | -23% |
| Non-Road Mobile Sources | 356 | 327 | 283 | -73 | -21% |
| Marine | 37 | 102 | 40 | 3 | 8% |
| **Total Anthropogenic** | **73,041** | **22,959** | **23,773** | **-49,268** | **-67%** |

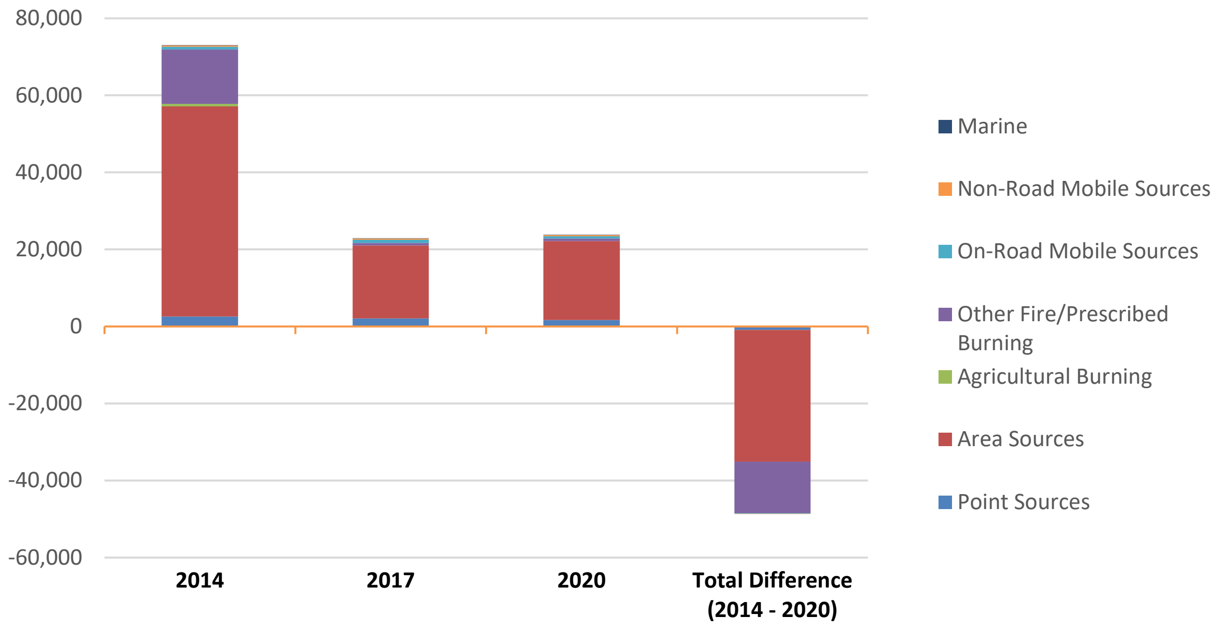

**Figure 6.0-3** 2014, 2017, and 2020 Emissions and Difference in Emission Inventory Totals for $PM_{10}$ by source category for Hawaii

The difference in VOC emission inventory totals for the 2014 to 2020 progress period in Table 6.0-4 and Figure 6.0-4 show an overall decrease of 47% in statewide VOC emissions. Increases in VOC emissions from 2014 to 2020 are shown for area and marine source categories.

**Table 6.0-4** Difference in Statewide Volatile Organic Compound Emissions

| Source Category | Statewide Volatile Organic Compound (TPY) | | | | |
|---|---|---|---|---|---|
| | 2014 | 2017 | 2020 | Total Difference (2014 – 2020) | Percent Change (2014 – 2020) |
| Point Sources | 4,117 | 3,519 | 2,369 | -1,748 | -42% |
| Area Sources | 15,162 | 14,387 | 22,026 | 6,864 | 45% |
| Agricultural Burning | 534 | - | - | - | - |
| Other Fire/Prescribed Burning | 29,665 | 1,562 | 1,500 | -28,165 | -95% |
| On-Road Mobile Sources | 10,383 | 8,109 | 4,684 | -5,699 | -55% |
| Non-Road Mobile Sources | 4,313 | 4,454 | 3,594 | -719 | -17% |
| Marine | 35 | 276 | 62 | 27 | 77% |
| **Total Anthropogenic** | **64,209** | **32,307** | **34,235** | **-29,440** | **-47%** |

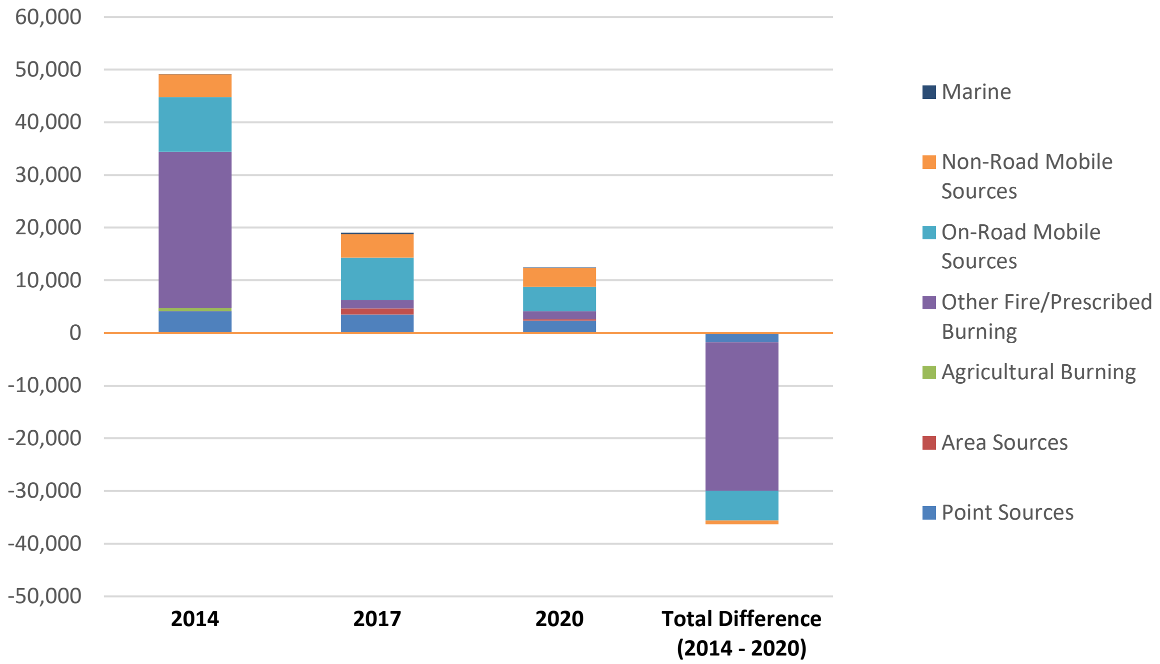

**Figure 6.0-4** 2014, 2017 and 2020 Emissions and Difference in Emission Inventory Totals for Volatile Organic Compound by Source Category for Hawaii

The difference in $NH_3$ emissions inventory totals for the 2014 to 2020 progress period in Table 6.0-5 and Figure 6.0-5 show an overall decrease of 80% in statewide $NH_3$ emissions. Increases in $NH_3$ emissions are shown for non-road mobile and marine source categories. For point sources, a majority of the $NH_3$ emissions are from sources on Oahu where prevailing trade winds would blow pollutants away from the Class I areas a majority of the time. The total combined increase in $NH_3$ emissions from non-road mobile, and marine source categories is less than 2% of the total $NH_3$ emitted by all sources statewide for both the 2014 to 2020 emission years.

**Table 6.0-5** Difference in Statewide Ammonia Emissions

| Source Category | Statewide Ammonia (TPY) | | | | |
|---|---|---|---|---|---|
| | 2014 | 2017 | 2020 | Total Difference (2014 – 2020) | Percent Change (2014 – 2020) |
| Point Sources | 247 | 232 | 205 | -42 | -17% |
| Area Sources | 3,884 | 1,583 | 984 | -2,900 | -75% |
| Agricultural Burning | 2,551 | - | - | - | - |
| Other Fire/Prescribed Burning | 951 | 109 | 104 | -847 | -89% |
| On-Road Mobile Sources | 338 | 332 | 263 | -75 | -22% |
| Non-Road Mobile Sources | 6 | 7 | 7 | 1 | 17% |
| Marine | 0.4 | 2 | 1 | 1 | 150% |
| **Total Anthropogenic** | **7,977** | **2,265** | **1,564** | **-3,862** | **-80%** |

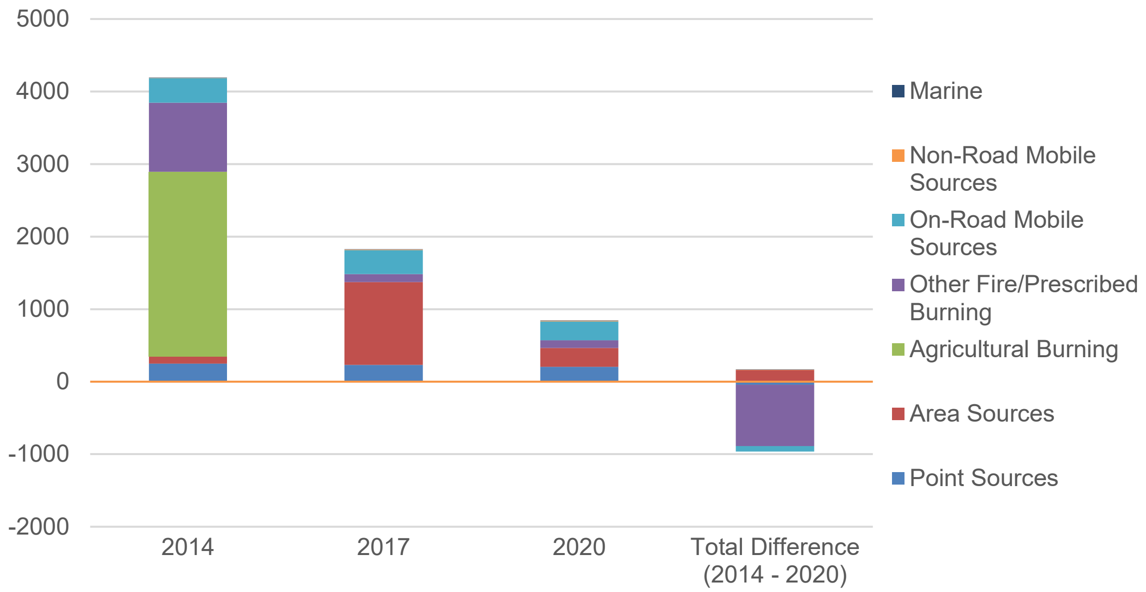

**Figure 6.0-5** 2014, 2017 and 2020 Emissions and Difference in Emission Inventory Totals for Ammonia by Source Category for Hawaii

## 6.1 Emission Inventory Trends

The charts below show statewide emission trends from National Emission Inventory (NEI) years 2014, 2017 and 2020 broken down by emission source categories for each visibility impairing pollutant. The charts show a downward trend in emissions from 2014 through 2020. Emission inventories for 2016 and 2028 were not included because these inventories are on a different basis and not needed for tracking purposes like the other NEI years. Assumptions for the 2016 and 2028 emission inventories used for the photochemical modeling assessment are provided in Section 8.1 from Chapter 8 of the RH-SIP. Figures

6.1-1 through 6.1-3 show the primary contributors are point sources for $SO_2$ and $NO_X$, and area sources for VOC's, $NH_3$, $PM_{10}$, and $PM_{2.5}$.

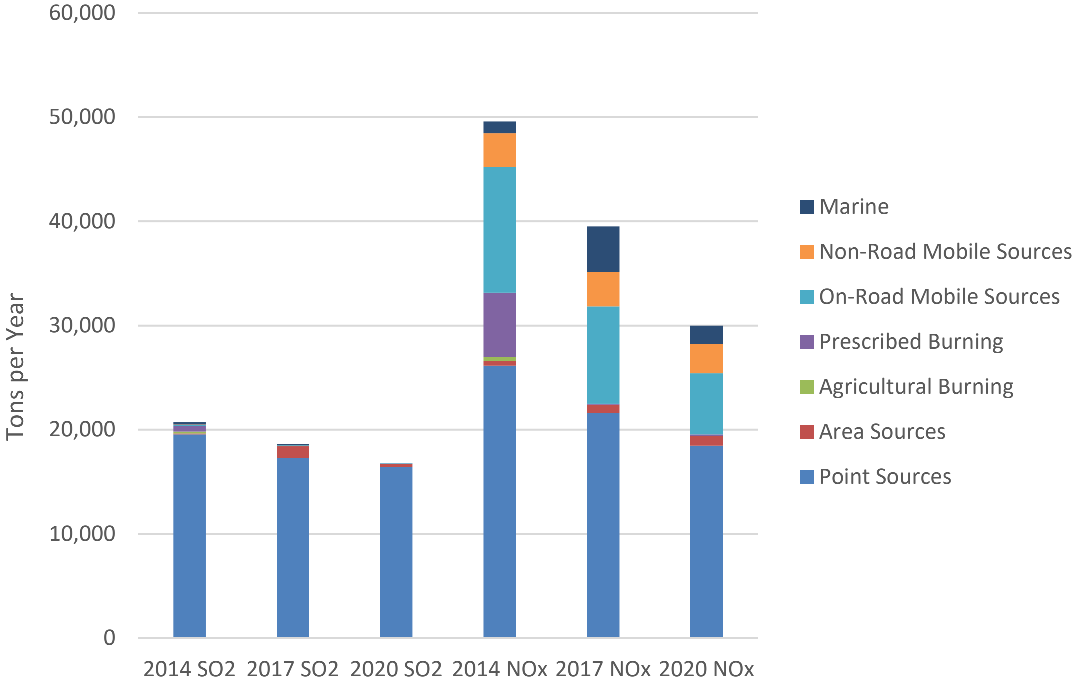

**Figure 6.1-1** Hawaii's 2014, 2017 and 2020 NEI $SO_2$ and $NO_X$ Emission Trends

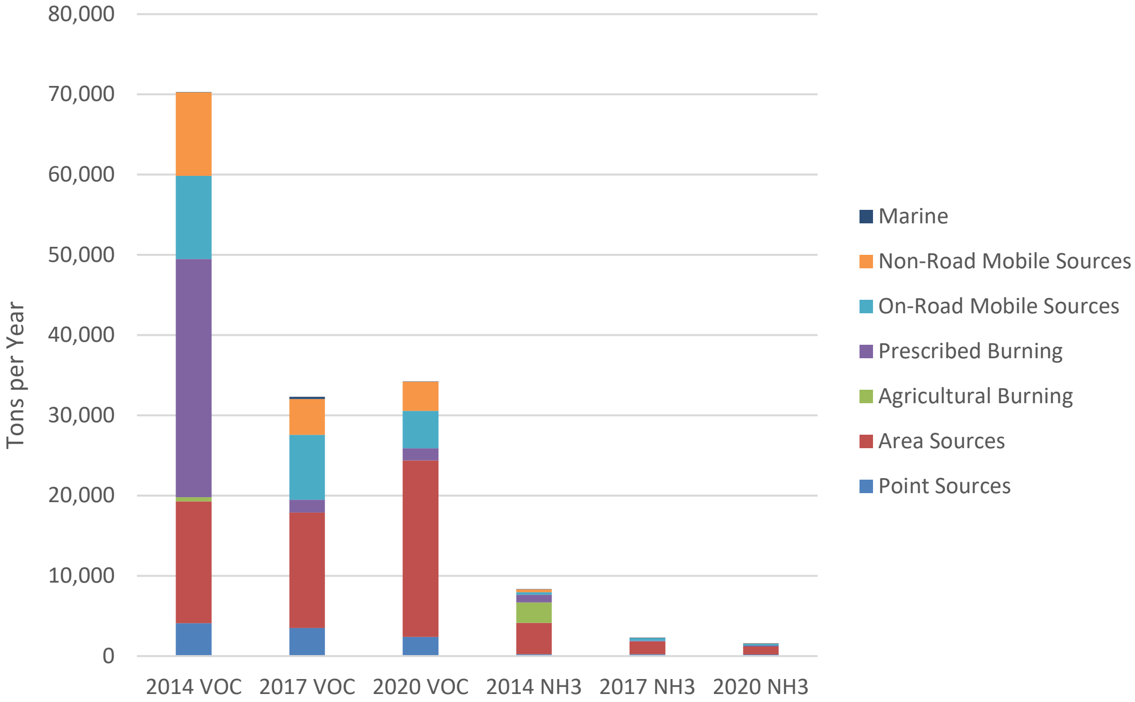

**Figure 6.1-2** Hawaii's 2014, 2017 and 2020 NEI VOC and $NH_3$ Emission Trends

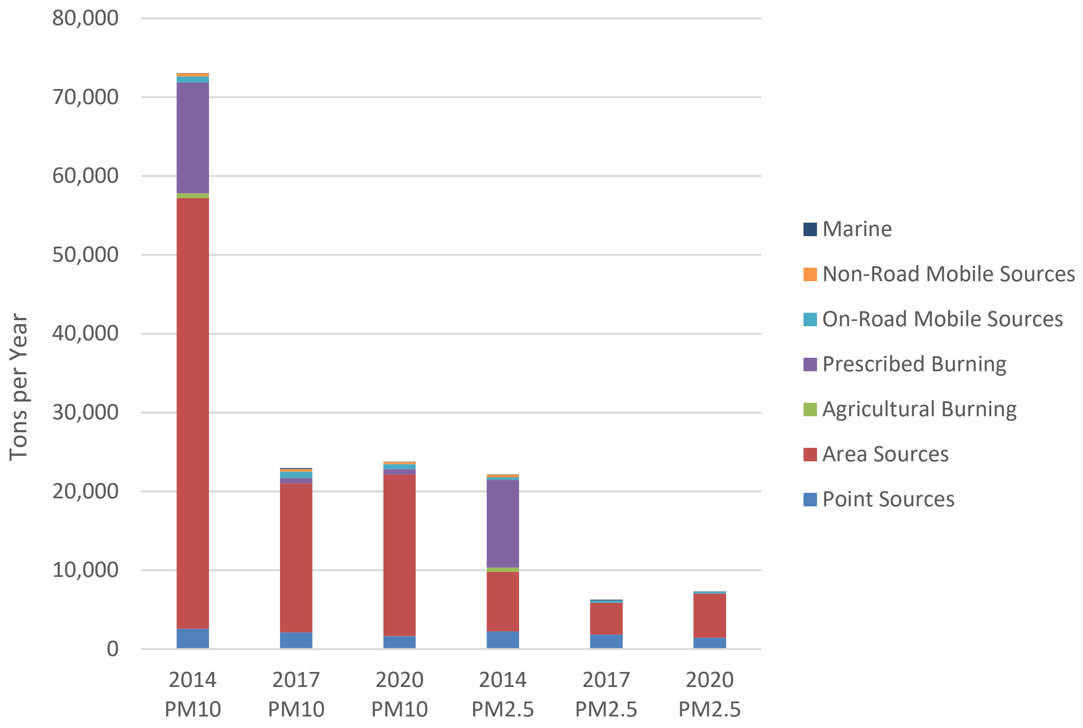

**Figure 6.1-3** Hawaii's 2014, 2017 and 2020 NEI $PM_{10}$ and $PM_{2.5}$ Emission Trends

# Chapter 7 Assessment of Current Implementation Plan Strategy

## 7.0 Assessment of Current Strategy – 40 CFR 51.308(g)(6)

Chapter 7 provides an assessment of whether the current implementation plan elements and strategies are sufficient to enable the state to meet all established reasonable progress goals. Tables 7.0-1 through 7.0-4 and Figures 7.0-1 through 7.0-8 show the visibility conditions for the most recent five-year current visibility conditions in comparison to the 2000 -2004 baseline and reasonable progress goals.

For Haleakala National Park, baseline light extinction and deciview values were from Appendix I, except for light extinction from sulfate that was adjusted to screen out high light extinction values due to volcanic $SO_2$ impacts. These were the average of the yearly average deciview values from 2007 to 2009 for the most impaired and clearest days. Note that the HACR1 monitor started in 2007. Please refer to Appendix K for the sulfate adjustments.

For Hawaii Volcanoes National Park, baseline light extinction and deciview values were from the WRAP TSS, except that light extinction from sulfate was adjusted to screen out volcanic $SO_2$ impacts. These were average values from 2001 to 2004 for the most impaired and clearest days.

Data from 2019 was used to screen out natural sulfate light extinction values due to the volcano since no volcanic eruptions occurred in 2019. Sulfate extinction was adjusted by ratios of 2005 $SO_2$/2019 $SO_2$ and 2028 $SO_2$/2019 $SO_2$ from sources contributing most to visibility impairment in each national park. Volcanic $SO_2$ from 2019 (17,301 TPY of $SO_2$), which was far less than that during eruptions, was also applied in factoring light extinction. Emissions from 2005 represented those from sources during the baseline period as this was the most complete inventory when regional haze work began. Emissions projected in Appendix V of the RH-SIP, Revision 1, based on regional haze control measures, were used in the adjustment for sulfate extinction by the 2019 $SO_2$/2028 $SO_2$ ratio for the reasonable progress goals.

Sources for factoring sulfate extinction were those with the highest potential to impair visibility based on WEP/AOI rankings (see Tables 5.10-3 and 5.10-4 of the RH-SIP, Revision 1 for Haleakala National Park and Hawaii Volcanoes National Park, respectively). Highest sulfate impacts for Haleakala National Park included those from Kahului Power Plant (3,198 TPY $SO_2$ in 2005, 2,316 TPY $SO_2$ in 2019), Maalaea Generating Station (913 TPY $SO_2$ in 2005 and 428 TPY of $SO_2$ in 2019), and Kanoelehua-Hill Power Plant (2,822 TPY of $SO_2$ in 2005 and 2,199 TPY $SO_2$ in 2019). Sources with highest potential to impact visibility in Hawaii Volcanoes National Park from sulfates included Kanoelehua-Hill Power Plant and Puna Power Plant (1,345 TPY of $SO_2$ in 2005 and 527 TPY of $SO_2$ in 2019).

Current visibility conditions from years 2018 to 2022 were from the WRAP TSS for all haze species, except for sulfate. Sulfate light extinction was held constant using 2019 WRAP TSS data when no volcanic eruptions occurred.

**Table 7.0-1** Haleakala National Park RPG (Most Impaired Days)

| | $B_{ext}$ ($Mm^{-1}$) | | |
|---|---|---|---|
| Species | 2000-2004 Baseline | Current Visibility 2018-2022 | 2028 Reasonable Progress Goal |
| Ammonium Nitrate | 0.97 | 0.86 | 0.60 |
| Ammonium Sulfate | 5.96[a] | 5.47[b] | 4.39[c] |
| Coarse Mass | 1.69 | 0.75 | 0.70 |
| Elemental Carbon | 0.50 | 0.30 | 0.21 |
| Particulate Organic Mass | 0.78 | 0.63 | 0.60 |
| Sea Salt | 0.22 | 0.78 | 0.64 |
| Soil | 0.24 | 0.17 | 0.16 |
| dv (units in deciviews) | 6.51 | 5.23 – 6.33 | 4.89 |

a. The 2000-2004 baseline light extinction for ammonium sulfate is adjusted based on the following equation:

$$2000 - 2004\ Baseline\ Value = 5.47 * \frac{(3{,}198_{TPY} + 913_{TPY} + 2{,}822_{TPY}) + 17{,}301_{TPY}}{(2{,}316_{TPY} + 428_{TPY} + 2{,}199_{TPY}) + 17{,}301_{TPY}}$$

b. An ammonium sulfate light extinction value of 5.47 $Mm^{-1}$ was assumed for the current visibility condition because there were no volcanic eruptions in 2019.

c. The projected light extinction for ammonium sulfate is adjusted based on the following equation:

$$2028\ Projected\ Value = 5.47 * \frac{(0\ _{TPY} + 557\ _{TPY} + 0_{TPY}) + 17{,}301_{TPY}}{(2{,}316_{TPY} + 428_{TPY} + 2{,}199_{TPY}) + 17{,}301_{TPY}}$$

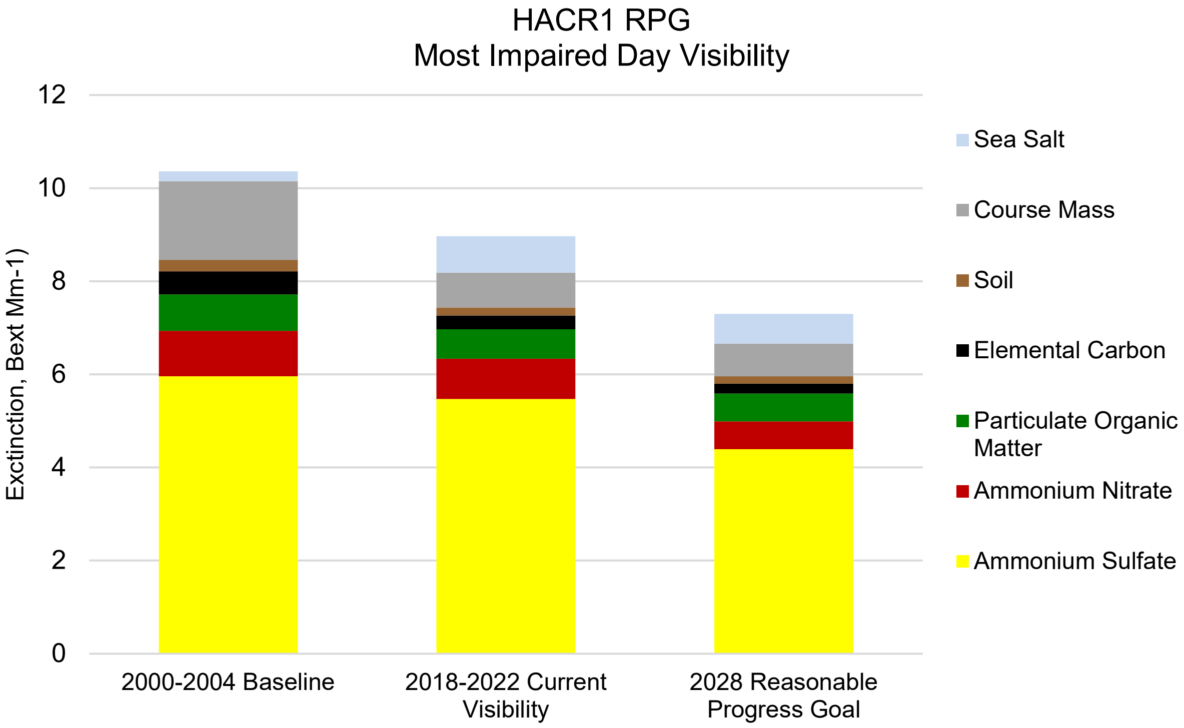

**Figure 7.0-1** Haleakala National Park Reasonable Progress Goal for Most Impaired Day Visibility

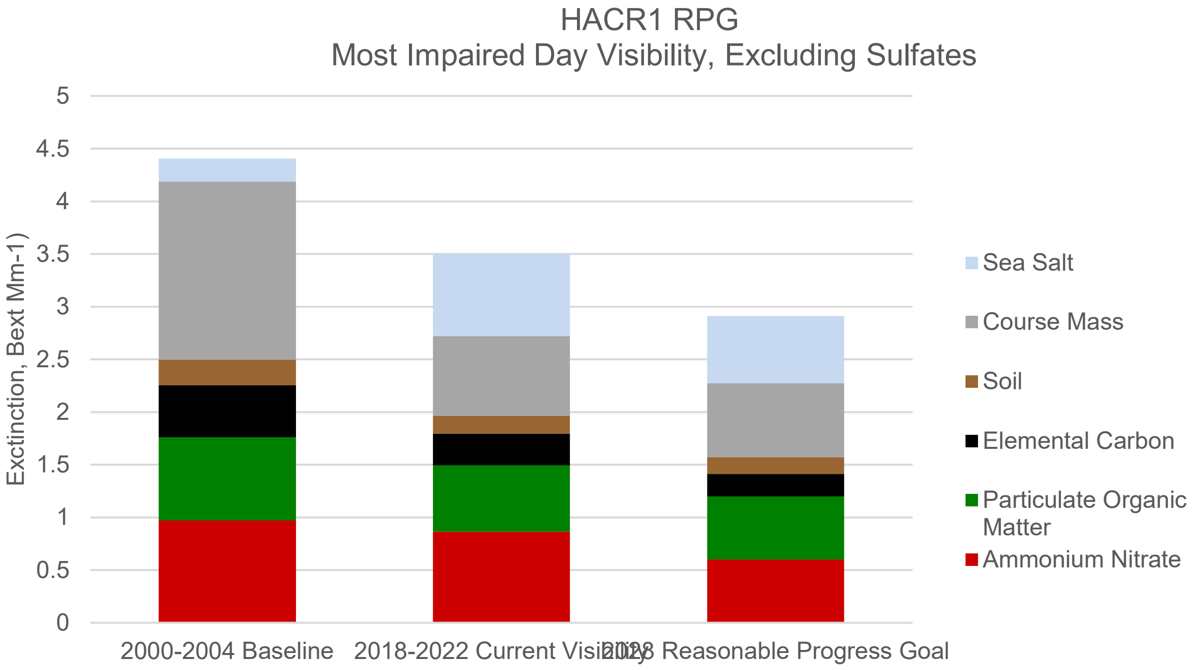

**Figure 7.0-2** Haleakala National Park Reasonable Progress Goal for Most Impaired Day Visibility, Excluding Sulfates

**Table 7.0-2** Haleakala National Park RPG (Clearest Days)

| | $B_{ext}$ ($Mm^{-1}$) | | |
|---|---|---|---|
| Species | 2000-2004 Baseline | Current Visibility 2018-2022 | 2028 Reasonable Progress Goal |
| Ammonium Nitrate | 0.19 | 0.13 | 0.12 |
| Ammonium Sulfate | 0.85[a] | 0.78[b] | 0.63[c] |
| Coarse Mass | 0.38 | 0.19 | 0.21 |
| Elemental Carbon | 0.05 | 0.07 | 0.04 |
| Particulate Organic Mass | 0.09 | 0.14 | 0.17 |
| Sea Salt | 0.22 | 0.22 | 0.19 |
| Soil | 0.08 | 0.04 | 0.04 |
| dv (units in deciviews) | 0.81 | 0.46 – 1.10 | 0.39 |

a. The 2000-2004 baseline light extinction value for Ammonium Sulfate is based on the following equation:

$$2000 - 2004\ Baseline\ Value = 0.78 * \frac{(3{,}198_{TPY} + 913_{TPY} + 2{,}822_{TPY}) + 17{,}301_{TPY}}{(2{,}316._{TPY} + 428_{TPY} + 2{,}199_{TPY}) + 17{,}301_{TPY}}$$

b. For ammonia sulfate, the light extinction value of 0.78 $Mm^{-1}$ was assumed for the current visibility conditions because there were no volcanic eruptions in 2019.

c. The projected light extinction for ammonium sulfate is based on the following equation:

$$2028\ Projected\ Value = 0.78 * \frac{(0\ _{TPY} + 557\ _{TPY} + 0_{TPY}) + 17{,}301_{TPY}}{(2{,}316_{TPY} + 428_{TPY} + 2{,}199_{TPY}) + 17{,}301_{TPY}}$$

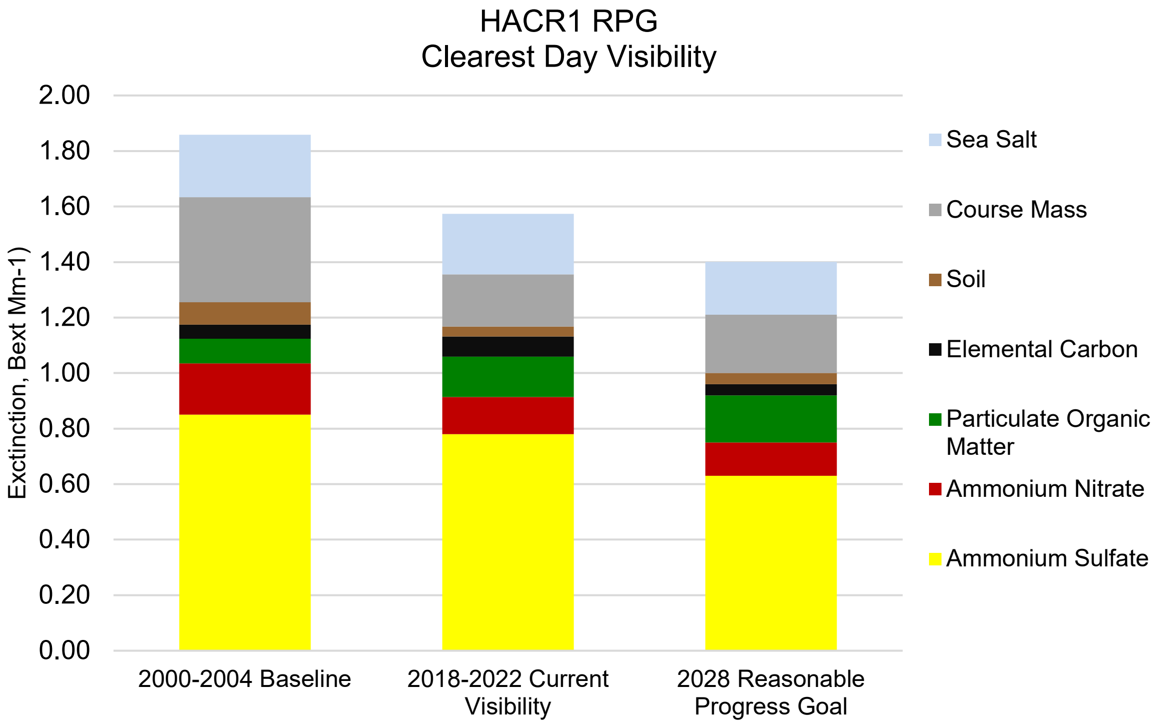

**Figure 7.0-3** Haleakala National Park Reasonable Progress Goal for Clearest Day Visibility

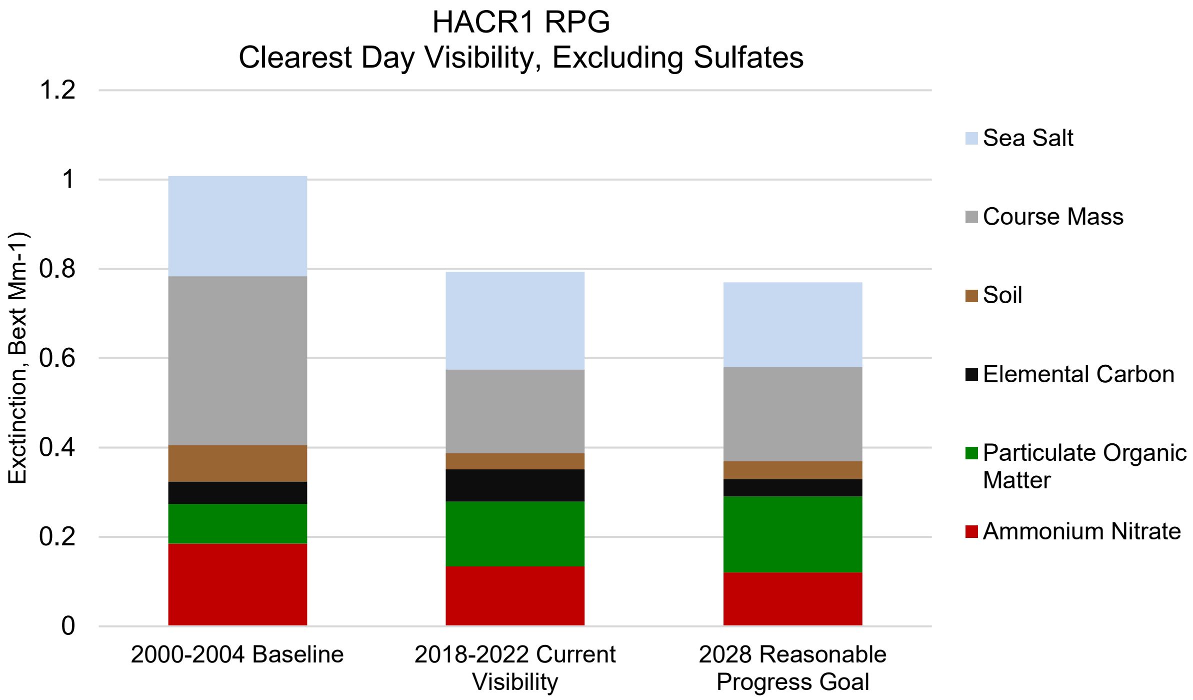

**Figure 7.0-4** Haleakala National Park Reasonable Progress Goal for Clearest Day Visibility, Excluding Sulfates

**Table 7.0-3** Hawaii Volcanoes National Park RPG (Most Impaired Days)

| Species | $B_{ext}$ ($Mm^{-1}$) | | |
|---|---|---|---|
| | 2000-2004 Baseline | Current Visibility 2018-2022 | 2028 Reasonable Progress Goal |
| Ammonium Nitrate | 0.77 | 0.65 | 0.42 |
| Ammonium Sulfate | 15.78[a] | 14.72[b] | 12.72[c] |
| Coarse Mass | 0.67 | 1.02 | 0.67 |
| Elemental Carbon | 0.96 | 0.48 | 0.52 |
| Particulate Organic Mass | 2.33 | 1.23 | 1.21 |
| Sea Salt | 0.54 | 1.53 | 1.44 |
| Soil | 0.27 | 0.09 | 0.09[d] |
| dv (units in deciviews) | 11.39 | 10.68 – 11.47 | 9.93 |

a. The 2000-2004 baseline light extinction value for ammonium sulfate is based on the following equation:

$$2000 - 2004\ Baseline\ Value = 14.72 * \frac{(1{,}345_{TPY} + 2{,}822_{TPY}) + 17{,}301_{TPY}}{(527_{TPY} + 2{,}199_{TPY}) + 17{,}301_{TPY}}$$

b. For ammonia sulfate, the light extinction value of 14.72 $Mm^{-1}$ was assumed for the current visibility conditions because there were no volcanic eruptions in 2019.

c. The projected light extinction for ammonium sulfate is adjusted based on the following equation:

$$2028\ Projected\ Value = 14.72 * \frac{(0_{TPY} + 2_{TPY}) + 17{,}301_{TPY}}{(527_{TPY} + 2{,}199_{TPY}) + 17{,}301_{TPY}}$$

d. Soil light extinction reported in Appendix V of RH-SIP should be 0.09 $Mm^{-1}$ instead of 1.00 $Mm^{-1}$.

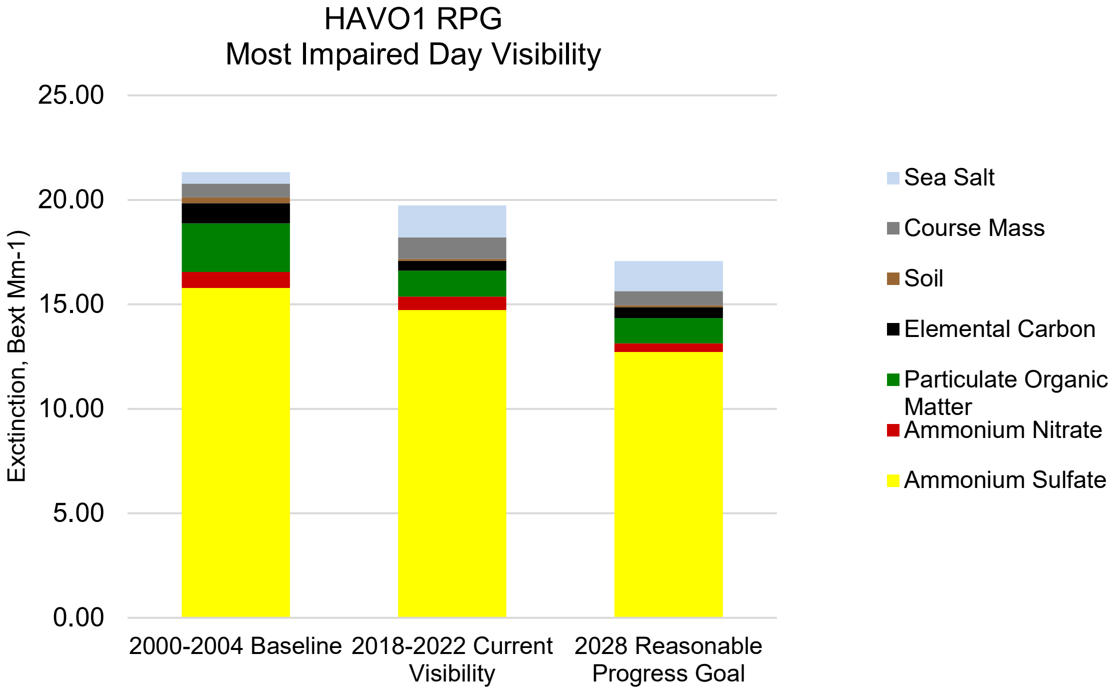

**Figure 7.0-5** Hawaii Volcanoes National Park Reasonable Progress Goal for Most Impaired Day Visibility

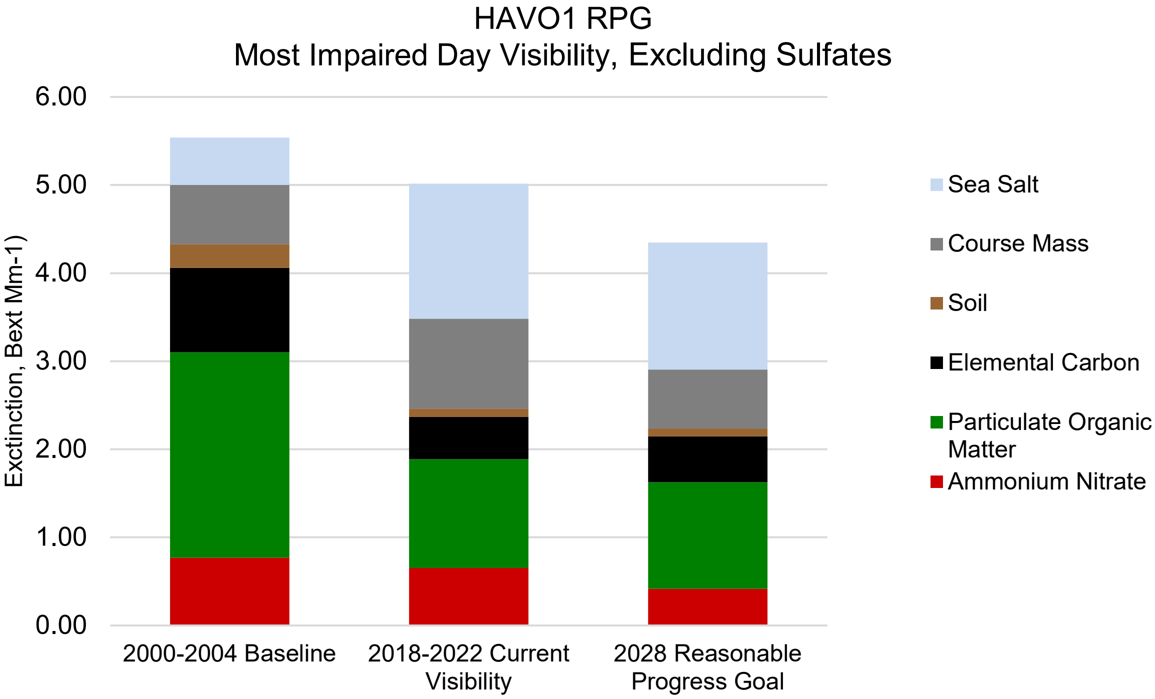

**Figure 7.0-6** Hawaii Volcanoes National Park Reasonable Progress Goal for Most Impaired Day Visibility, Excluding Sulfates

**Table 7.0-4** Hawaii Volcanoes National Park RPG (Clearest Days)

| Species | $B_{ext}$ ($Mm^{-1}$) | | |
|---|---|---|---|
| | 2000-2004 Baseline | Current Visibility 2018-2022 | 2028 Reasonable Progress Goal |
| Ammonium Nitrate | 0.30 | 0.26 | 0.28 |
| Ammonium Sulfate | 2.11[a] | 1.97[b] | 1.70[c] |
| Coarse Mass | 0.39 | 0.53 | 0.60 |
| Elemental Carbon | 0.18 | 0.13 | 0.07 |
| Particulate Organic Mass | 1.08 | 0.51 | 0.30 |
| Sea Salt | 0.91 | 0.94 | 1.22 |
| Soil | 0.06 | 0.03 | 0.03[d] |
| dv | 4.05 | 3.42 – 3.78 | 3.51 |

a. The 2000-2004 baseline light extinction value for Ammonium Sulfate is adjusted based on the following equation:

$$2000 - 2004\ Baseline\ Value = 1.97 * \frac{(1{,}345_{TPY} + 2{,}822_{TPY}) + 17{,}301_{TPY}}{(527_{TPY} + 2{,}199_{TPY}) + 17{,}301_{TPY}}$$

b. For ammonia sulfate, the light extinction value of 5.47 $Mm^{-1}$ was assumed for the current visibility conditions because there were no volcanic eruptions in 2019.

c. The projected light extinction for ammonium sulfate is adjusted based on the following equation:

$$2028\ Projected\ Value = 1.97 * \frac{(0_{TPY}+2_{TPY})+17{,}301_{TPY}}{(527_{TPY}+2{,}199_{TPY})+17{,}301_{TPY}} \text{o}$$

d. Soil light extinction reported in Appendix V of RH-SIP should be 0.03 $Mm^{-1}$ instead of 1.00 $Mm^{-1}$.

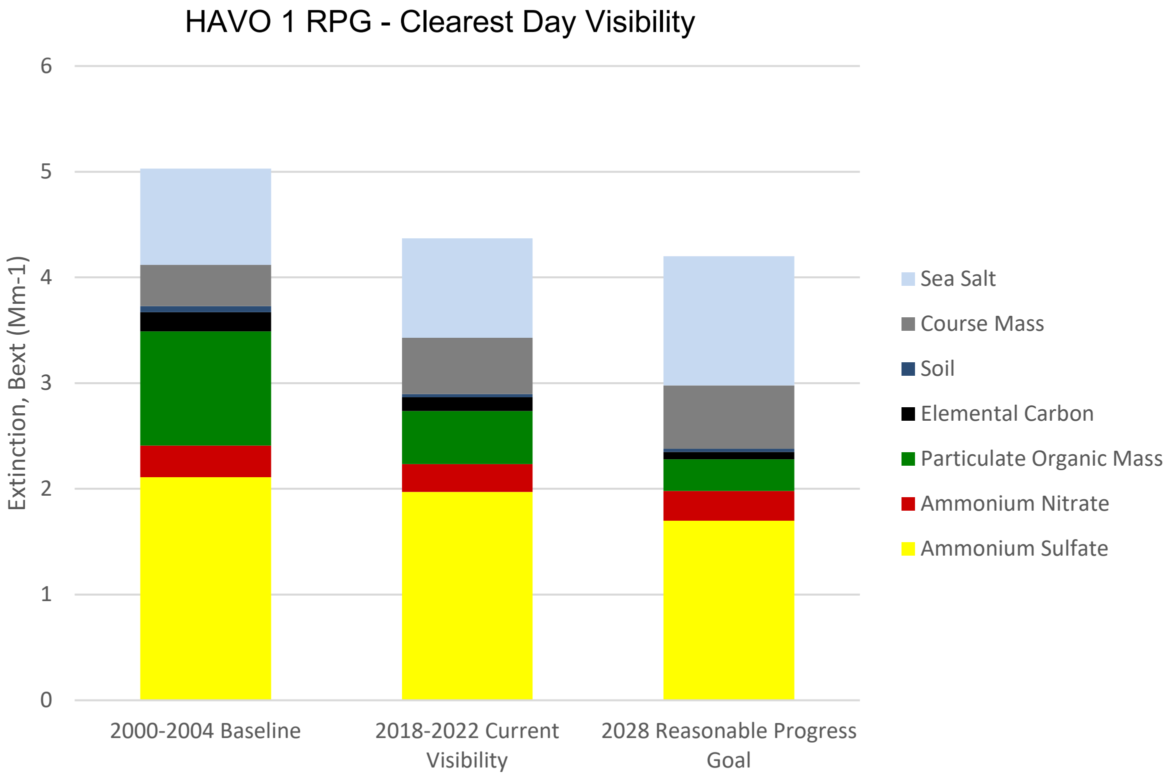

**Figure 7.0-7** Hawaii Volcanoes National Park Reasonable Progress Goal for Clearest Day Visibility

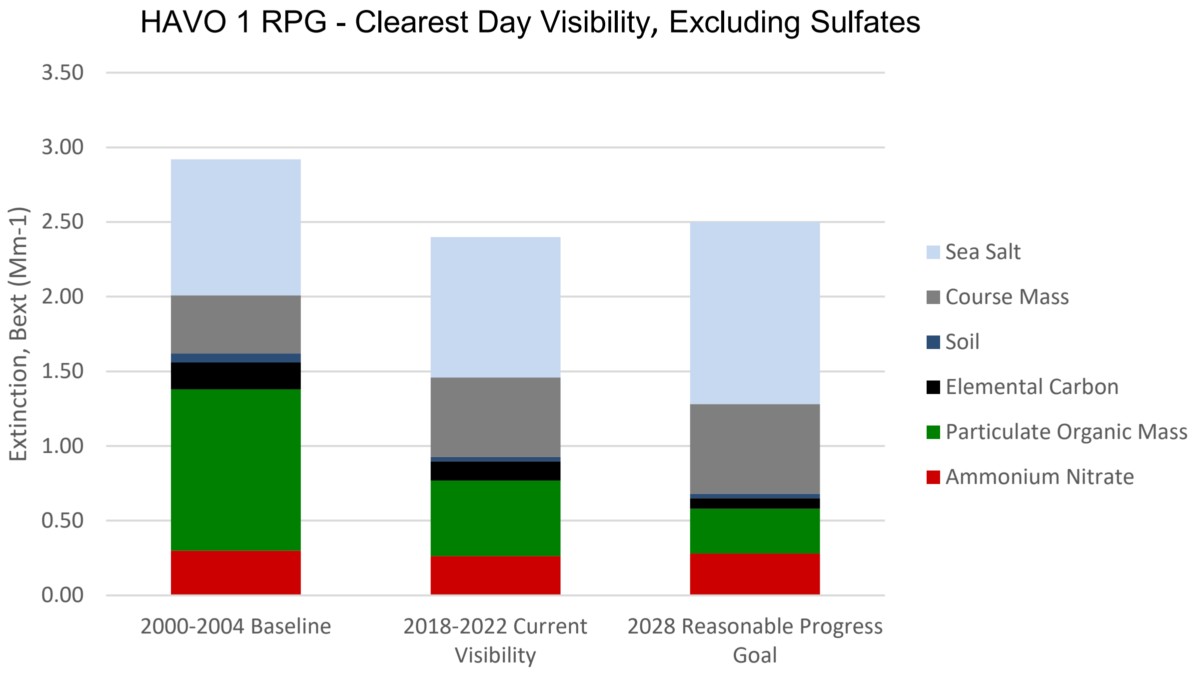

**Figure 7.0-8** Hawaii Volcanoes National Park Reasonable Progress Goal for Clearest Day Visibility, Excluding Sulfates

<u>HACR1 (Most Impaired and Clearest Visibility Days)</u>

Current visibility conditions for the most impaired and clearest days indicate sulfates as the primary contributor to haze at the HACR1 IMPROVE monitors. Please refer to Figures 7.0-1 through 7.0-4. This is evident even after screening out high light extinction values for sulfate with data from 2019 when there were no volcanic eruptions. After applying sulfate adjustments for the current visibility period, light extinction from sulfates accounted for about 61 percent of total light extinction on the most impaired days and 50 percent on the clearest days. On the most impaired days, there's been a noticeable decrease in sulfates course mass, elemental carbon, particulate organic mass, and nitrates between the 2000-2004 baseline and 2022, and an increase in only sea salt during that same period. On the clearest days there is a decrease in course mass, soil, sulfates, and nitrates, and an increase in elemental carbon and particulate organic mass.

<u>HAVO1 (Most Impaired and Clearest Visibility Days)</u>

Current visibility conditions for the most impaired and clearest days show sulfates as the primary contributor to haze at the HAVO IMPROVE monitor. Please refer to Figures 7.0-3 and 7.0-5 through 7.0-8. It is worth noting that over the most recent 5 year period, sulfates account for about 75 percent of the light extinction recorded at HAVO1. For the clearest days during the same period, sulfates account for about 44 percent of visible haze. While 2022 shows no reductions from the baseline for the most impaired days for course mass, there are notable reductions in soil, elemental carbon, and particular organic matter. On the clearest days, there is a decrease in light extinction from sulfates and an increase in course mass, elemental carbon, and nitrate. Please refer to Chapter 8 of this progress report for evaluation of the IMPROVE monitoring data.

## 7.1 Haleakala National Park Visibility Goals

The URP is drawn from the baseline to the natural 2064 endpoint for the most impaired visibility days only, while the line of no degradation is only for comparison with the clearest days. The value of the 2000-2004 baseline was determined in Appendix K for the HALE1-HACR1 site combination plus volcano adjustment for sulfate light extinction. Data from Appendix I was used for the site combination adjustment. The 2007 to 2022 visibility conditions were also determined in Appendix K for the volcano adjustment to sulfates. Figures 7.1-1 and 7.1-2 are glidepath graphs without and with volcanic adjustments, respectively. Figure 7.7-1 shows that the most impaired days increased to above the URP in 2022, largely due to increased sulfate composition due to increased volcanic activity from the eruption in Hawaii Volcanoes National Park on the Big Island which is uncontrollable and unpreventable. Figure 7.1-2 with volcanic adjustment shows a spike in 2019 for the most impaired days due to increased light extinction from nitrates. It is interesting to note that 2019 was a year with highest $NO_X$ emissions from 2012 to 2021 from both the Kahului and Maalaea Generating stations on the island of Maui which are about 20 miles from the HACR1 monitor. Please refer to Figures 3.1-1 through 3.1-4 for graphs of emissions and fuel consumption. Regional haze control measures will significantly reduce $NO_X$, $SO_2$, and $PM_{10}$ emissions from these facilities. Reduction measures include a shut down of boilers K-1 through K-4 by the end of 2028 for the Kahului Generating Station, FITR for Diesel Engine Generators M1 and M3 by the end of 2027 for the Maalaea Generating Station, and SCR or shut downs after 2028 for Diesel Engine Generators M7, M10, M11, M12, and M13 at the Maalaea Generating Station. The reasonable progress goal, adjusted for volcanic activity, is shown with a blue triangle In Figure 7.1-2.

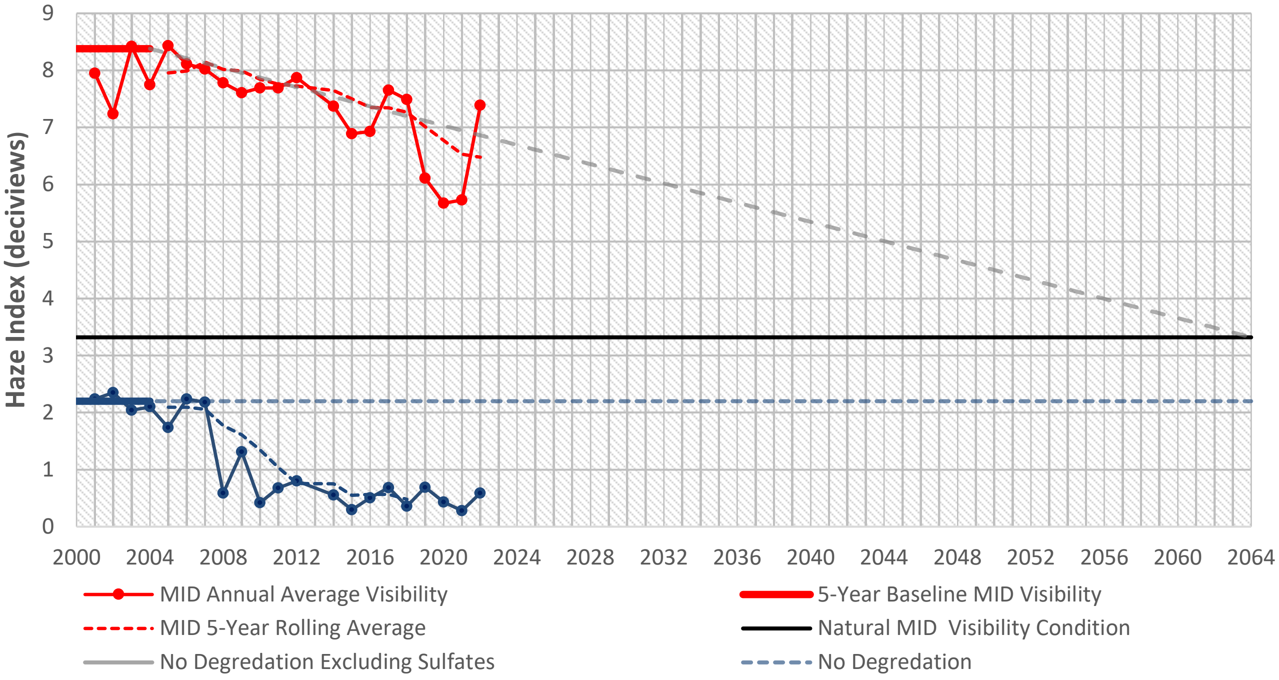

**Figure 7.1-1** Visibility Levels at Haleakala National Park

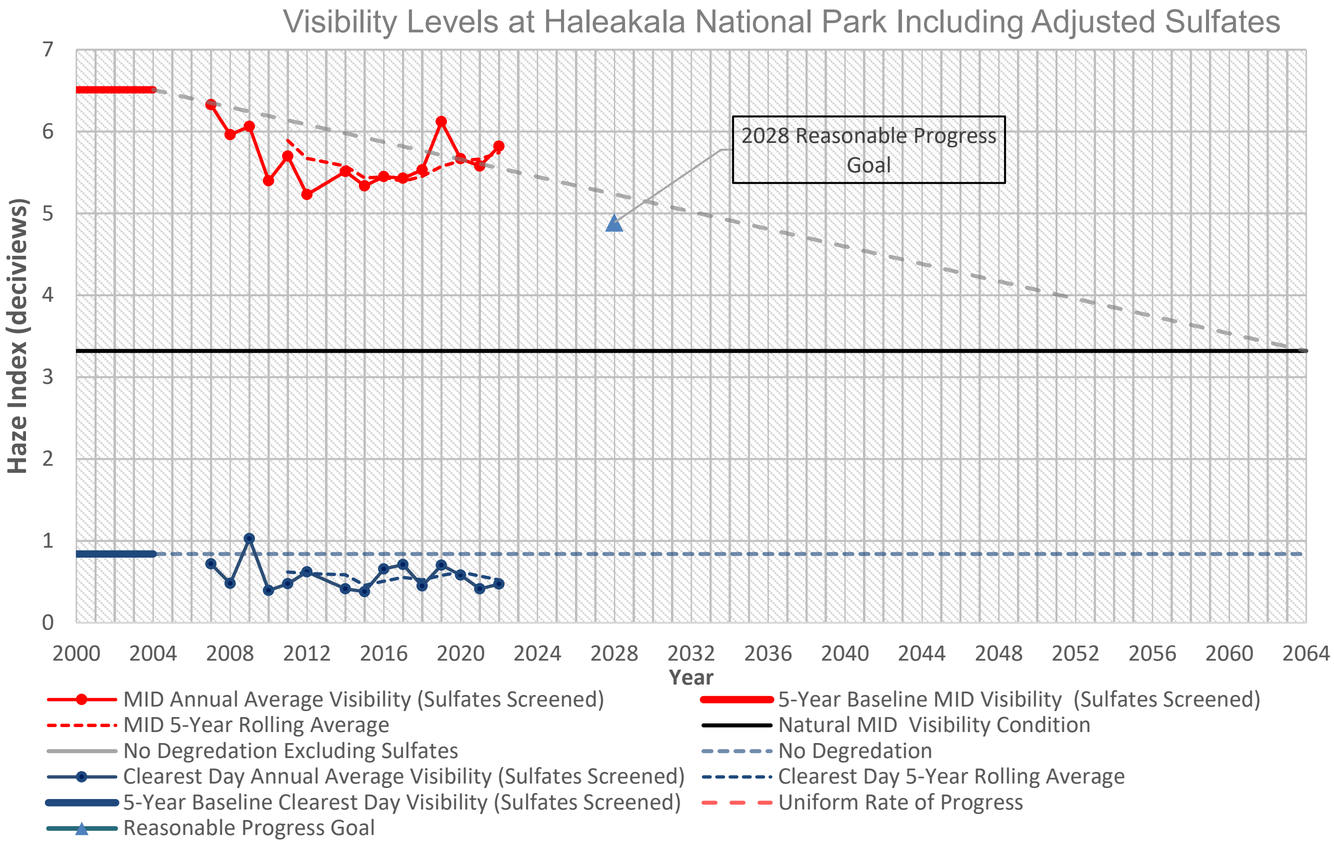

**Figure 7.1-2** Visibility Levels at Haleakala National Park, with Adjusted Sulfates

## 7.2 Hawaii Volcanoes National Park Visibility Goals

As with Haleakala National Park, the URP is drawn from the baseline to the 2064 end point for the most impaired visibility days only, and the line of no degradation is only for reference to the clearest days. The value of the 2000-2004 baseline and 2005 – 2022 visibility conditions were determined in Appendix K for the HAVO1 site with volcano adjustment for sulfate light extinction. Data from the WRAP TSS was used to determine visibility conditions. Figures 7.2-1 and 7.2-2 are glidepath graphs without and with volcanic adjustments, respectively. The impact of the 2022 Kilauea and Mauna Loa eruptions can be seen in Figure 7.2-1, showing a dramatic increase in haze from 2020 to 2022 due to high light extinction from sulfates. In Figure 7.2-2, a spike is seen for the most impaired days in 2020 due to an increase in light extinction from nitrates. Note that regional haze control measures for the Kanoelehua-Hill and Puna power plants on the island of Hawaii will significantly reduce emissions of $NO_X$, $SO_2$, and $PM_{10}$ from these power plants. Reduction measures include permanent shut down of Boilers Hill 5 and Hill 6 by the end of 2028 at the Kanoelehua-Hill Generating Station and a fuel switch from fuel oil No. 6 to ULSD for the boiler at the Puna Power Plant by the middle of August 2026. The reasonable progress goal, adjusted for volcanic activity, is shown with a blue triangle in Figure 7.2-2.

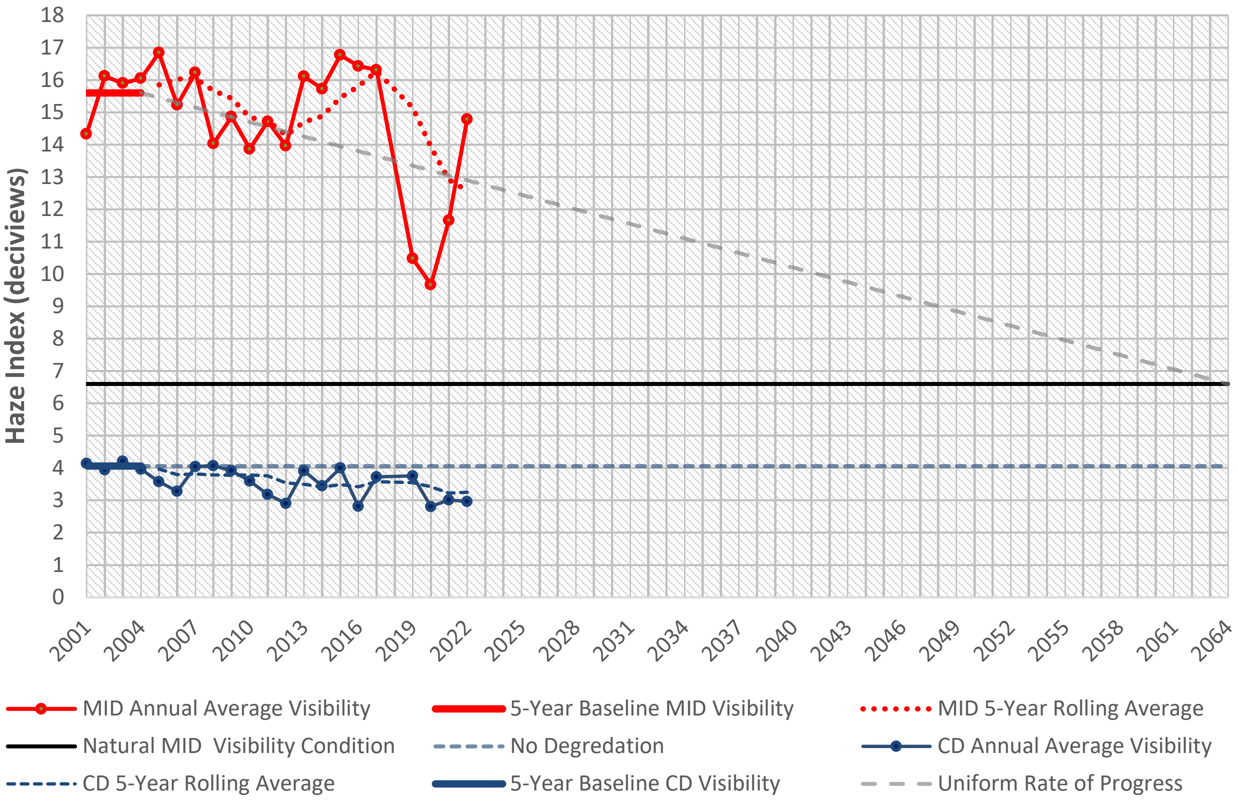

**Figure 7.2-1** Visibility Levels at Hawaii Volcanoes National Park

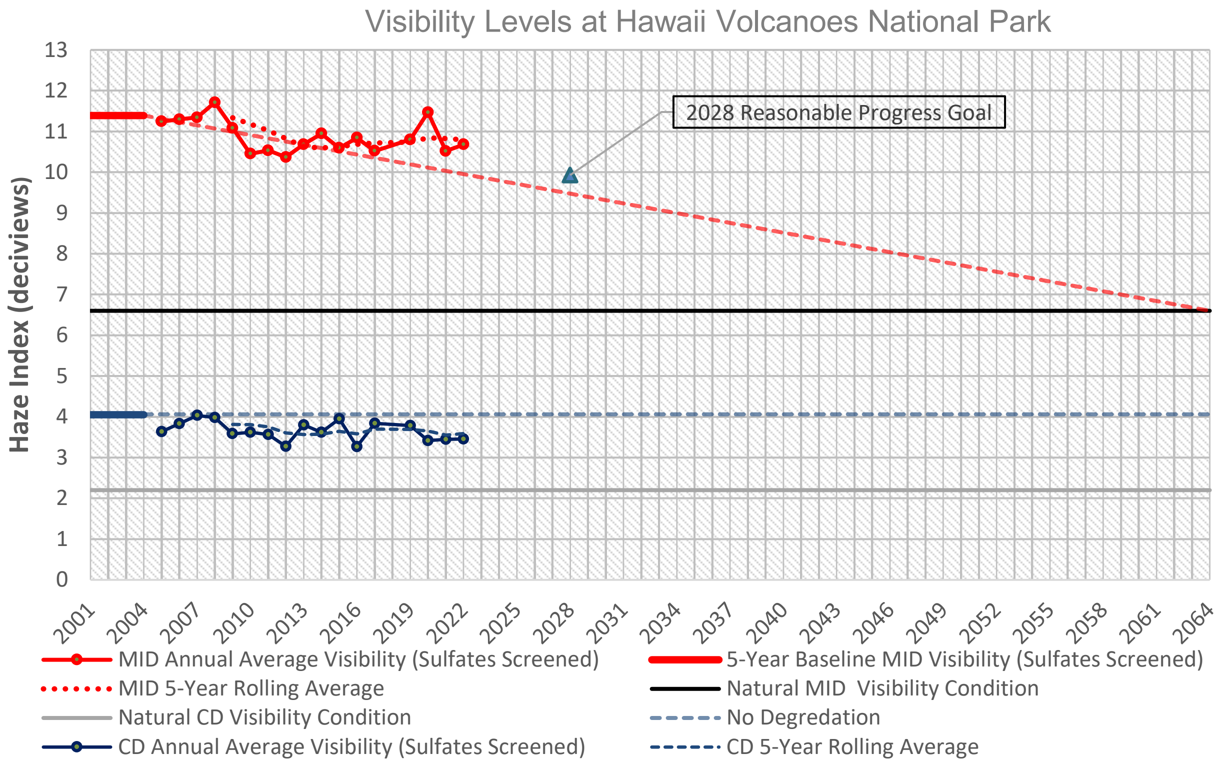

**Figure 7.2-2** Visibility Levels at Hawaii Volcanoes National Park, with Adjusted Sulfates

# Chapter 8 Visibility Monitoring Strategy

## 8.0 Visibility Monitoring Strategy – 40 CFR § 51.308(g)(7)

Although EPA guidance states that a review of a state's visibility monitoring strategy is only necessary for the first implementation period progress report, the national parks in Hawaii have additional characteristics which require further consideration. Visibility is measured at Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring sites to track regional haze progress. The locations of these monitoring sites and the methodology used for their implementation are described in Chapter 1. IMPROVE data is generated and for all fifteen (15) WESTAR states, but the inclusion of impacts from active volcanoes in Hawaii's Class I areas presents additional challenges when interpreting the data trends. Sulfur dioxide ($SO_2$) emissions from the volcanoes in Hawaii Volcanoes National Park can vary from hundreds to thousands of tons per day while not erupting, to hundreds of thousands of tons per day during periods of active eruption. Although efforts were taken to adjust Hawaii's IMPROVE data to account for impacts from volcanic emissions, the team of data analysts stated at a meeting with DOH-CAB that their methodology does not screen out all volcanic $SO_2$ emissions. This is particularly true during times of less volcanic activity, when there are less dramatic, although still significant and consistent, emission rates. Because the IMRPOVE data for Hawaii still captures a sizeable percentage of biogenic $SO_2$, the resulting data trends in units of deciview do not accurately show how the implemented regional haze control measures impact visibility.

The WRAP TSS provides a variety of charts and graphs for analyzing visibility impairment using the data reported by the IMPROVE program. Hawaii has and will continue to use the regional technical support analysis tools found on the WRAP TSS, as well as other analysis tool and efforts sponsored by the WESTAR/WRAP. The State will continue to participate in the regional analysis activities of the WESTAR/WRAP to collectively assess and verify the progress toward reasonable progress goals, as the RHR continues to be implemented.

Hawaii IMPROVE monitoring data from the HACR1, HALE1, and HAVO1 monitoring sites are obtained from the WRAP TSS, visibility impacting parameters (e.g., ammonium nitrate extinction) are listed in Table 8.0-1.

**Table 8.0-1** Visibility Impacting Parameter from the IMPROVE DataWizard

| Visibility Impacting Parameter | Unit | IMPROVE DataWizard Code |
|---|---|---|
| Ammonium Nitrate Extinction | 1/Mm | ammNO3f_bext |
| Ammonium Sulfate Extinction | 1/Mm | ammSO4f_bext |
| Elemental Carbon Extinction | 1/Mm | ECf_bext |
| Coarse Mass Extinction | 1/Mm | CM_bext |
| Organic (Carbon) Mass Extinction | 1/Mm | OMCf_bext |
| Sea Salt Extinction | 1/Mm | SeaSaltf_bext |
| Soil Extinction | 1/Mm | SOILf_bext |
| Total Aerosol Extinction | 1/Mm | aerosol_bext |
| Standard Visibility Range | km | SVR |
| Haze Index | 1 | dv |
| Total Extinction | 1/Mm | total_bext |

## 8.1 IMPROVE Monitors

There is currently one IMPROVE site on Maui Island (HACR1) which replaced the HALE1 IMPROVE monitor. This site represents Haleakala National Park and sits on the north-west slopes of mount Haleakala in between the national park and the more industrial and populated areas of Maui. It has been gathering data since 2017. Figure 8.1-1 shows the monitoring station, located on the slopes of the Haleakala crater. Haleakalā Crater is a large topographic depression that occupies the summit region of Haleakalā volcano in Maui, Hawaii. The crater is an erosional feature and opens at its northwest and southeast corners forming large valleys that drain to the north and south coasts, respectively. The crater is approximately 11 km long, 3.5 km wide, and 300 m deep at the volcano's summit. See section 1.3 for further details.

**Figure 8.1-1** HACR1 Monitoring Station

The Hawaii Volcanoes National Park IMPROVE site (HAVO1) sits on the northeastern edge of the Kīlauea Caldera on Hawaii Island. The site, in close proximity to the Kīlauea visitor center, the Volcano House Hotel, and the Halema'uma'u trail head, is located directly behind the Volcano Art Center Gallery, right off Crater Rim Drive. HAVO1 monitors visibility in Hawaii Volcanoes National Park's in the vicinity of the Kīlauea Volcano, one of two active volcanoes within the park. The site, sitting at 1258 meters above sea level, has been collecting data since March 2, 1988 and is shown in Figure 8.1-2. The Kīlauea Caldera, often referred to as the Kīlauea Crater, is located at the summit of the active Kīlauea Volcano. The caldera is approximately 4.72 km long, 3.14 km wide, with a circumference of 12.63 km, and has walls up to 120 m high, breached by consistent lava flows on the southwestern side. Kīlauea also features Halema'uma'u, a large and very active pit crater within the large caldera.

**Figure 8.1-2** HAVO1 Monitoring Station

# Chapter 9 Determination of Adequacy – 40 CFR §51.308(h)

## 9.0 Determination of Adequacy – 40 CFR §51.308(h)

40 CFR §51.308(h) requires the state to one of the following actions based upon information provided in the progress report:

- The state may declare that no further revisions are needed at this time in order to achieve established goals for visibility improvement and emission reductions.
- If the state determines the implementation plan may be inadequate to ensure reasonable progress due to emissions from another state(s), the state must collaborate with other state(s) through the regional haze planning process to develop additional strategies to address the deficiencies.
- Where the state determines that the implementation plan may be inadequate to ensure reasonable progress due to emissions from another country, the state must notify EPA and provide available information for the determination.
- If the state determines that the implementation plan may be inadequate to ensure reasonable progress due to emissions from sources within the state, the state must revise its implementation plan to address the deficiencies within one year.

Based on information contained in this progress report, DOH-CAB believes that control strategies in Revision 1 of Hawaii's RH-SIP are adequate for the state to meet its 2028 reasonable progress goals and has determined that no substantive revision of the plan is needed at this time. The four-factor analyses in Chapter 6 and Appendix P of the RH-SIP constitute the required robust demonstration for selecting regional haze control measures based on screening results in Chapter 5 of the RH-SIP. Regional haze control measures were incorporated into permits of the affected facilities as federally enforceable conditions.

# Chapter 10 Procedural Requirements

## 10.0 Consultation with Federal Land Managers – 40 CFR §51.308(i)

Hawaii provided an opportunity for consultation with the Federal Land Managers (FLMs) at least sixty (60) days prior to initiating the public comment period and providing the public the opportunity to request a public hearing on the Regional Haze Progress Report. The Regional Haze Progress Report was submitted to the FLMs on XXXX, 2024 for review and comments. The EPA was also notified on XXXX, 2024 and provided a copy of the report during the FLM review and comment period. The FLMs provided comments on XXXX, 2024. In accordance with 40 CFR §51.308(i)(3), comments from the FLMs are provided in Appendix L.

## 10.1 Public Comment Period

Pursuant to Hawaii Revised Statutes (HRS) Section 342B-13, a public notice for the Regional Haze Progress Report was published on XXXX with the public comment period commencing on XXXX and ending on XXXX. Since no request for a public hearing was received, a hearing was not held. The FLMs and EPA were notified on XXXX that the DOH-CAB was accepting comments and would hold a public hearing, if requested, on the draft 5-Year Regional Haze Progress Report. The DOH-CAB also posted the notice for the draft Regional Haze Progress Report on its website at: http://health.hawaii.gov/cab/clean-air-branch/notice-and-finding-of-violation-downloads-pdf/. Copies of the notice sent to the Star Advertiser, Hawaii Tribune-Herald, West Hawaii Today, The Garden Island, and Maui News are provided in Appendix M.

Prior to the close of the public comment period, EPA and FLMs provided comments on the draft Regional Haze Progress Report. Comments received and DOH-CAB's responses to the comments are provided in Appendix N.