Hawaii State Department of Health

Regional Haze
State Implementation Plan, Revision 1

Second Planning Period

Month X, 2024

Prepared by:
Clean Air Branch
Hawaii State Department of Health

1959

Josh Green, M.D.
Governor of Hawaii

Kenneth S. Fink, MD, MGA, MPH
Director of Health

Halema'uma'u Crater, from Crater Rim Trail, Hawaii Volcanoes National Park – Courtesy of Janice Wei, National Park Service

Volcanic Landscape, Haleakala National Park - Courtesy of Don Shephard, 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 §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. The rule was revised in 2017 to strengthen visibility protection and to emphasize that states reduce man-made emissions of air pollutants that impair visibility. States are required to prepare Regional Haze State Implementation Plans (RH-SIPs) that provide long-term strategies for Class I areas to comply 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).

The RHR divides the RH-SIP development process into ten-year periods to achieve gradual improvement in visibility. When the final planning period ends in 2064, the goal of the RHR is for visibility to be restored to natural conditions for each Class I area. The first RH-SIPs were due in 2007 and covered the 2008-2018 planning period.

Since Hawaii was unable to submit the initial RH-SIP, the EPA developed a Regional Haze Federal Implementation plan (RH-FIP) that was promulgated on October 9, 2012. The RH-FIP established a total combined SO_2 emissions cap of 3,550 tons per year for three electric power plants in Hilo on the Big Island by December 31, 2018. Since one of these power plants shut down (Shipman Generating Station), the SO_2 emissions cap applies to only two (2) plants (Kanoelehua-Hill and Puna Generating Stations).

The RH-SIP submittal deadline for this second 2018-2028 planning period was updated in the revised RHR from July 31, 2018, to July 31, 2021. The RH-SIP for this planning period establishes new reasonable progress goals (RPGs) for each of Hawaii's two (2) Class I areas.

Initial screening identified seven (7) electric plants with a Q/d threshold greater than ten (10) that were notified to provide a four-factor analysis to evaluate controls. These included three (3) power plants on Oahu, two (2) power plants on the island of Hawaii, and two (2) power plants on Maui. The Q/d surrogate for screening is the annual emissions in tons per year divided by the distance in kilometers between a source and Class I area. The four-factor analysis for selecting control measures considered cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts of compliance, and the remaining useful life of the affected anthropogenic source of visibility impairment.

A more sophisticated weighted emissions potential/area of influence (WEP/AOI) analysis ranked the relative potential of point sources to contribute to haze in Hawaii's Class I areas. The WEP/AOI analysis considered other factors that were not part of the Q/d screening, such as meteorology and light extinction from the specific haze species.

Due to the Hawaiian Island chain being subject to predominant North Easterly trade winds, it was found that Oahu-based sources had a very low relative potential to contribute to haze in the national parks. Therefore, only sources on the islands of Hawaii and Maui, where the national parks are located, were evaluated in the process to select controls.

A cost threshold floor of $5,800 per ton of pollutant was initially used to determine cost effective controls for the August 12, 2022 RH-SIP submittal using the Chemical Engineering Plant Cost Index (CEPCI); an index that tracks costs of equipment, construction labor, buildings, and supervision in chemical process industries. According to EPA's Control Cost Manual, the CEPCI is an index that has been used extensively by EPA for cost escalation purposes. The control cost manual states that the CEPCI is typically acceptable and most accurate when used over a 5-year-or-less time period. However, in consultation meetings between the DOH, EPA, and NPS it was concluded that the CEPCI is an acceptable guideline to determine reasonable progress for regional haze, and that $5,800 per ton of pollutant removed is a reasonable cost threshold. The cost for this threshold was escalated from the $5,000 per ton cost threshold used in the first regional haze planning period. For the RH-SIP Revision (2023 RH-SIP submittal), at a time with higher interest rates, a new cost threshold was established based on EPA's recommendation to escalate the cost from 2009 to 2021 dollars and use the prime interest rate to determine control costs. The new cost threshold in 2021 dollars was found to be $6,800/ton. The current prime interest rate (7.75% to 8.25%) was used for the four-factor analysis in this RH-SIP revision to determine the cost of controls.

Based on the four-factor analysis, WEP/AOI rankings, and source retirement commitments in place of controls selected from the four-factor analysis, the following federally enforceable conditions were ultimately established in permits for four facilities:

Hawaii Island Sources:

- Kanoelehua-Hill Power Plant – Permanent shut down of Boilers Hill 5 and Hill 6 by the end of 2028.
- Puna Power Plant – Fuel switch from fuel oil No. 6 to ULSD for the plant's boiler by four years from permit issuance. The permit was issued on August 10, 2022, for the boiler fuel switch.
- Mauna Loa Macadamia Nut Corporation Plant – Permanent shut down of main boiler by the end of 2026. The main boiler will be replaced with another unit after shut down of the existing unit.

Maui Island Sources:

- Kahului Power Plant – Permanent shut down of Boilers K-1, K-2, K-3, and K-4 by the end of 2028.
- Maalaea Power Plant:
  - Fuel injection timing retard (FITR) for Diesel Engine Generators M1 and M3 by the end of 2027.
  - DEGs M7, M10, M11, M12 and M13 – Selective catalytic reduction (SCR) installed or permanent shut down by end of:
    - 2037 for M7;

    - 2030 for M10 and/or M11;
    - 2032 for M10 or M11 if one of these units is shut down by the end of 2030 or installs SCR; and
    - 2037 for M12 and M13.
  - On and after December 31, 2027, the permittee must not operate M7, M10, M11, M12, and M13 without an SCR system fully installed, operational, and maintained or shut down according to the aforementioned staggered shut down schedule.

Interagency Monitoring of Protected Visual Environments (IMPROVE) data collected at visibility monitors servicing Hawaii's Class I areas was adjusted to screen out impacts from volcanic activity (sulfates) based on EPA's methodology for episodic events. However, not all impacts would be screened out due to the ongoing nature of the Kilauea eruption that releases extremely large amounts of sulfur dioxide (SO_2).

From 2008 to 2018 eruptive activity was almost continuous along the Kilauea Volcano's East Rift Zone, and the summit vent hosted an active lava lake and significant gas plume. After the eruption ended in 2018, the lava lake drained and a water lake formed in the crater, significantly decreasing the daily SO_2 emissions at the summit. There were multiple subsequent shorter eruption periods over the next years. According to information from United States Geological Survey (USGS) - Hawaii Volcanoes Observatory (HVO) personnel, on the onset of these eruptions, tens of thousands of tons of SO_2 per day is released by the volcano, but can decrease to hundreds of tons per day after the initial eruption.

Photochemical modeling was performed by EPA to estimate visibility conditions at the end of the second planning period in 2028 that were compared with the regional haze uniform rate of progress (URP) glidepath. Emissions from EPA's 2016 Hawaii modeling platform were used for the modeling. The modeling assumed no volcanic emissions. The RHR includes a provision that allows states to propose an adjustment to the glidepath to account for impacts from international anthropogenic sources and prescribed fires. Glidepaths in this RH-SIP were not adjusted for international contributions that are beyond the state's authority to control. Prescribed fires were also not considered in the adjustment.

Photochemical model results for 2028 indicate a rate of progress that is slower than the URP for Haleakala National Park and Hawaii Volcanoes National Park (the deciview value is above the glidepath for the most impaired days). Deciview values based on IMPROVE data for 2019, during a period with significant reduction in SO_2 venting after the Kilauea eruption had ceased, are below the glidepath for the most impaired days and no degradation level on the clearest days for both Haleakala National Park and Hawaii Volcanoes National Park. The 2019 IMPROVE data was adjusted for episodic volcanic events and the change in location of the Haleakala monitor.

The Hawaii Department of Health Clean Air Branch (DOH-CAB) has determined that control strategies in the RH-SIP are adequate for Hawaii to meet the 2028 reasonable progress goals (RPGs) based on four-factor analyses for selecting controls and enforceable commitments to shut down specific units if not implementing the controls selected. The RPGs provide an improvement in visibility on the most impaired days for the second implementation period and will help ensure no visibility degradation occurs on the clearest days over this implementation period at Hawaii's two (2) Class I areas. Air permits for the Kahului and Maalaea Generating Stations on Maui, the Kanoelehua-Hill and Puna Generating Stations on the Big Island, and the Mauna Loa Macadamia Nut Corporation Plant on the Big Island have been revised to incorporate the federally enforceable regional haze control measures.

Table of Contents

List of Figures

List of Tables

Appendices

Appendix A: 2018 Kilauea Volcanic Event – Eruption Summary
Appendix B: Notifications to Provide Four-Factor Analysis, August 12, 2022, RH-SIP Submittal
Appendix C: 2015 – 2019 Wind Rose Plots from Oahu, Molokai, and Maui Island
Appendix D Regional Haze Four-Factor Analysis, Kalaeloa Partners, L.P., August 12, 2022, RH-SIP Submittal
Appendix E: Regional Haze Four-Factor Analysis, Hawaiian Electric Company, Inc. Kahe Generating Station, August 12, 2022, RH-SIP Submittal
Appendix F: Regional Haze Four-Factor Analysis, Hawaiian Electric Company, Inc. Waiau Generating Station, August 12, 2022, RH-SIP Submittal
Appendix G: Regional Haze Four-Factor Analysis, Hawaii Electric Light Company, Inc. Kanoelehua-Hill Generating Station, August 12, 2022, RH-SIP Submittal
Appendix H: Regional Haze Four-Factor Analysis, Hawaii Electric Light Company, Inc. Puna Generating Station, August 12, 2022, RH-SIP Submittal
Appendix I:. Regional Haze Four-Factor Analysis, Maui Electric Light Company, Ltd. Kahului Generating Station, August 12, 2022, RH-SIP Submittal
Appendix J: Regional Haze Four-Factor Analysis, Maui Electric Light Company, Ltd. Maalaea Generating Station, August 12, 2022, RH-SIP Submittal
Appendix K: Regional Haze Control Measures Selected, August 12, 2022, RH-SIP Submittal
Appendix L: Renewable Portfolio Standards (HRS §269-92) and Energy-Efficiency Portfolio Standards (HRS §269-96)
Appendix M: PUC's Report to the 2019 Hawaii State's Legislature on RPS
Appendix N: PUC's Report to the 2019 Hawaii State's Legislature on EEPS
Appendix O: Fugitive Dust and Open Burning
Appendix P: Regional Haze Consultation, Draft Permits, Draft Permit Application Reviews, and Draft Technical Support Documents
Appendix Q: Demonstration Showing Historical Emissions are Less Than the PTE
Appendix R: Price on Carbon News Release by the Commission on November 28, 2018
Appendix S: Bicycling and Walking SB574 and SB1402
Appendix T: Income Taxation of Nonresidents Working Remotely
Appendix U: Teleworking HB567, SB1252, and HB936
Appendix V: Regional Haze Adjusted Reasonable Progress Goals
Appendix W: Public Notices of Draft RH-SIP, Draft RH-SIP, Revision 1, and Associated Draft Permit Amendments
Appendix X: Public Comments Received with DOH-CAB Responses and Final Permit Amendments, August 12, 2022 RH-SIP Submittal, 2024 RH-SIP, Revision 1 Submittal
Appendix Y: Legal Authority

List of Acronyms and Definitions	
AEO	Annual Energy Outlook
Aerosols	Suspensions of tiny liquid and/or solid particles in the air
AGP	Agricultural Burning Permit
AirSHED	Emissions Inventory System Software from Lakes Environmental
AOI	Area of Influence
Asian Dust	A meteorological phenomenon which affects most 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

List of Acronyms and Definitions	
b_{ext}	Reconstructed Light Extinction
CAA	Clean Air Act
CALPUFF	Transport and Dispersion Model
CDS	Circulating Dry Scrubber
CEPCI	Chemical Engineering Plant Cost Index
CFR	Code of Federal Regulations
CM	Coarse Mass
CMAQ	Community Multiscale Air Quality model
CMV	Commercial Marine Vessel
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CT	Combustion Turbine
CY	Cubic Yard
DBEDT	Department of Business, Economic Development and Tourism (State of Hawaii)
DEG	Diesel Engine Generator
DLIR	Department of Labor and Industrial Relations (State of Hawaii)
DOE	U.S. Department of Energy
DOH-CAB	Department of Health Clean Air Branch (State of Hawaii)
DOT	Department of Transportation (State of Hawaii)
DPF	Diesel Particulate Filter
Dv	Deciview, a measurement of visibility impairment
EC	Elemental Carbon
EEPS	Energy Efficiency Portfolio Standard
EGU	Electric Generating Unit
EIS	EPA’s Emissions Inventory System
EPA	US Environmental Protection Agency
ESP	Electrostatic Precipitator for particulate control
EWRT	Extinction Weighted Residence Time
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FGR	Flue Gas Recirculation
FIP	Federal Implementation Plan
FITR	Fuel Injection Timing Retard for NO_X control
Fka	Formerly Known As
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
HAVO1	Hawaii Volcanoes National Park Visibility Monitoring Site
Hawaiian Electric (HE)	Hawaiian Electric Company, Inc.
Hawaii Electric Light (HL)	Hawaii Electric Light Company, Inc.
HI	Haze Index
Hr	Hour

List of Acronyms and Definitions	
HRS	Hawaii Revised Statute
HVO	Hawaii Volcano Observatory
HYSPLIT	Hybrid Single Particle Lagrangian Integrated Trajectory model
IMPROVE	Interagency Monitoring of Protected Visual Environments
IPP	Independent Power Producer
Kw	Kilowatt
Laze	This is a local term that refers to lava haze. When lava flows into the ocean it reacts vigorously with seawater to create large acidic steam plumes, known as 'laze'. These plumes are laden with hydrochloric acid and volcanic glass particles.
LNB	Low NOx Burner for NOx control
M	Meter
Maui Electric (ME)	Maui Electric Company, Ltd
MID	Most Impaired Days
MOVES	Motor Vehicle Emissions Simulator
MVA	Megavolt Amp
MW	Megawatt
NA ECA	North American Emissions Control Area
NEI	National Emissions Inventory
NESHAP	National Emission Standards for Hazardous Air Pollutants
NH_3	Ammonia
NO_X	Nitrogen Oxides
NP	National Park
NPS	National Park Service
NSPS	New Source Performance Standard
OAQPS	Office of Air Quality Planning and Standards, US EPA
OC	Organic Carbon
OFA	Overfire Air
PBFA	Public Benefits Fee Administrator
PEC	Primary Elemental Carbon
$PM_{2.5}$	Particulate matter less than or equal to 2.5 micrometers in diameter
PMF	Positive Matrix Factorization
POA	Primary Organic Aerosols
POM	Particulate Organic Mass
PSIP	Power Supply Improvement Plan
PUC	State of Hawaii Public Utility Commission
Q/d	A surrogate for screening – annual emissions (in tons per year) divided by the distance in kilometers between a source and the nearest Class I Area.
RICE	Reciprocating Internal Combustion Engine
RH	Regional Haze
RHR	Regional Haze Rule
RPG	Reasonable Progress Goal
RPO	Regional Planning Organization
RPS	Renewable Portfolio Standard
RT	Residence Time
RWC	Residential Wood Combustion
SCR	Selective Catalytic Reduction for NO_X control
SIP	State Implementation Plan

List of Acronyms and Definitions	
SLEIS	State and Local Emissions Inventory System Software from Windsor Solutions
SMAT-CE	EPA Software for the Model Attainment Test – Community Edition
SO_2	Sulfur Dioxide Gas
SNCR	Selective Non-catalytic Reduction for NO_X control
SUV	Sport Utility Vehicle
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-HVO	United States Geological Survey – Hawaii Volcano Observatory
VMT	Vehicle Miles Traveled
VOC	Volatile organic compound
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.
WESTAR	Western States Air Resources Council
WEP/AOI	Weighted Emissions Potential/Area of Influence
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 absorbs and scatter light to cause haze include sulfates, nitrates, course mass, organic carbon, elemental carbon, soil dust, and sea salt. Sources of particulate can be manmade (anthropogenic) or from natural events. Anthropogenic emissions include primary (directly emitted) $PM_{2.5}$ such as fugitive dust (e.g., aggregate processing, vehicle travel on unpaved roads, etc.). Natural emissions of primary $PM_{2.5}$ include aerosolized salts from sea spray. Precursors of $PM_{2.5}$, such as SO_2, NO_X, NH_3, and VOCs, can also react to form secondary $PM_{2.5}$. Anthropogenic sources include primary and secondary particulate from combustion (e.g., electric plants, motor vehicles, agricultural burning, etc.). Kilauea Volcano on the Big Island (Hawaii) is a large source of natural SO_2 that forms secondary $PM_{2.5}$. Volcanic SO_2 emissions create vog when SO_2 reacts with sunlight and air constituents to form sulfate aerosols that cause haze on the Big Island and on other islands hundreds of miles away.

The Kilauea Volcano has erupted almost continuously since 1983 causing considerable property damage and vog from sulfates.[1] On May 3, 2018 volcanic activity started to escalate and continued for about three (3) and a half months before substantially subsiding.[1] This powerful eruptive event destroyed more than 600 homes and made Kilauea the most destructive volcano in the United States since 1980 when Mount St. Helens erupted in Washington State.[2] On December 5, 2018, after ninety (90) days of inactivity from the volcano, the eruption that began in 1983 was declared to have ended.[1] A summary of the 2018 Kilauea eruption event, based on summaries of articles from the Honolulu Star Advertiser and other information from USGS, is provided in Appendix A.

While volcanic SO_2 emissions from Kilauea Volcano have typically overwhelmed that from anthropogenic sources, volcanic SO_2 decreased significantly after the eruption ended in 2018. Actual combined SO_2 from power plants alone were higher than that measured from the volcano in 2019. Please refer to Chapter 4. The decrease in volcanic activity in 2019 made anthropogenic sources a more significant contributor to emissions that can cause haze.

On December 20, 2020, the Kilauea Volcano started another eruption. According to USGS, the SO_2 emission rate measurements from February 23, 2021, were about 800 tons per day. This rate is lower than the emission rates from the pre-2018 lava lake that were typically around 5,000 tons per day of SO_2. This eruption ended on May 26, 2021.[3]

On September 29, 2021, after earthquake activity increased abruptly beneath the crater, USGS declared that Kilauea was erupting again. This eruption event paused 24 times between December 2021 and March 2022. By September 2021, the crater floor of Kilauea had risen 140 meters (460 feet) with an added 111 million cubic meters (29.3 billion gallons) of lava.[4]

---

[1] See https://pubs.usgs.gov/fs/2012/3127/

[2] See https://www.popularmechanics.com/science/environment/a25471113/kilauea-hawaiian-volcano-eruption-geology/

[3] See Appendix A for new eruption that stated on September 29, 2021. See Executive Summary for additional information from phone conversation with HVO personnel.

[4] See https://www.usgs.gov/observatories/hvo/news/volcano-watch-how-kilauea-volcano-fills-its-craters

Mauna Loa, the largest volcano on the island of Hawaii, and approximately 30 miles from Kilauea, began erupting on November 27, 2022. This marked the first time since 1984 that both volcanoes had erupted simultaneously. The USGS estimated that Mauna Loa emitted 250,000 tons per day of SO_2, about 50 times greater than emission rates from Kilauea during its 2018 eruption.[5] Figure 1.1-1 below provides a map of Hawaii Volcanoes National Park and shows the relative locations of the volcanoes.

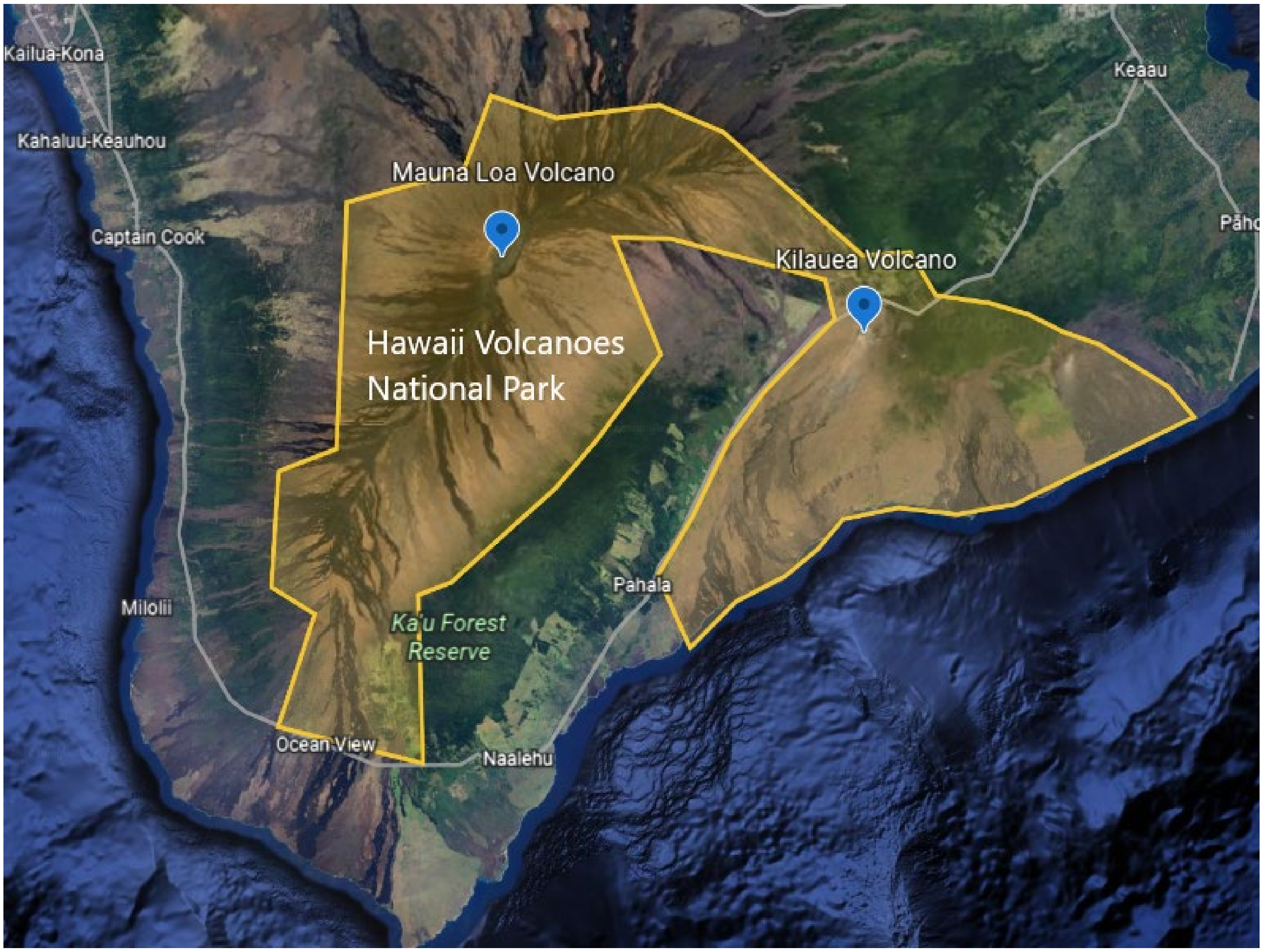


Figure 1.1-1 Detailed Map of Hawaii Volcanoes National Park

The summit eruption of Kilauea volcano has been paused since March 7, 2023, and Mauna Loa has been quiet since the eruption ended on December 13, 2022. Again, with the decrease in volcanic activity, anthropogenic sources are a more significant contributor to emissions that can cause haze.

Pursuant to §169A of the 1977 CAA amendments for addressing regional haze, goals were established to protect visibility from human-made air pollution 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 Class I areas. Emissions from volcanoes are unpredictable, uncontrollable, biogenic, and are outside of the scope of the RHR.

---

[5] See https://www.usgs.gov/news/featured-story/mauna-loa-has-begun-erupting

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

Figure 1.1-2 Mandatory Class I Areas within the United States[6]

1.1 Regional Haze Rule

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 manmade 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.[7] The objective is to improve the visibility on the most impaired days (twenty percent of monitored days in a calendar year with the highest anthropogenic visibility impairment) at each Class I area, and ensure no degradation in visibility in these areas on the clearest days (twenty percent of the monitored days in a calendar year with the lowest values of the deciview index). In accordance with 40 CFR §51.308(f), Hawaii must submit its Regional Haze implementation plan revision by July 31, 2021, July 31, 2028, and every ten (10) years thereafter. Another requirement is that progress reports are due by January 31, 2025, July 31, 2033, and every 10 years thereafter.[8]

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 pages 1-3 of Reference 7 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.[9] 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[10]	Acreage[10]
Haleakala National Park	Maui	NPS	33,265
Hawaii Volcanoes National Park	Hawaii	NPS	229,616

---

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

[8] Federal Register, Vol. 82, No. 6, January 10, 2017, 40 CFR Parts 51 and 52, Protection of Visibility: Amendments to Requirements for State Plans, Final Rule.

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

[10] Federal Land Manager Environmental Database: http://views.cira.colostate.edu/fed/DataWizard/Default.aspx.

1.3 Hawaii's IMPROVE Monitoring Sites

Visibility is measured at Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring sites to measure visibility impairment in mandatory Federal Class I areas throughout the United States. IMPROVE was initially established as a national visibility network in 1985 and consisted of 30 monitoring sites primarily located in national parks.[11] With implementation of the RHR, the IMPROVE network expanded, and 110 monitoring sites were identified that were deemed representative of the regional haze conditions for 155 of the 156 visibility-protected Federal Class I areas.[11] The Bearing Sea Wilderness was the exception.[11] Hawaii has IMPROVE monitors at Haleakala National Park (HACR1 and HALE1) and Hawaii Volcanoes National Park (HAVO1).

For Haleakala National Park, 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 this Federal Class I area.[10,12] 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.[12] The HACR1 IMPROVE site was considered more representative of visibility conditions within Haleakala National Park and replaced the HALE1 monitoring station in 2012.[12]

For Hawaii Volcanoes National Park, the HAVO1 IMPROVE monitor started operation on the Big Island in 1988 and is identified with yellow dot in Figure 1.3-2.

Table 1.3-1 below provides additional information on the IMPROVE monitoring sites.

Table 1.3-1 Hawaii's IMPROVE Monitoring Stations

Class I Area	IMPROVE Site	Island	Location[12]		Elevation[12]	
			Latitude	Longitude	M	Ft
Haleakala NP	HACR1*	Maui	20.7585	-156.2479	2,158	7,080
	HALE1**	Maui	20.8086	-156.2823	1,153	3,783
Hawaii Volcanoes NP	HAVO1	Hawaii	19.40309	-155.2579	1,259	4,130

* Monitoring at HACR1 began in 2007.

**Monitoring at HALE1 site was discontinued in 2012.

---

[11] https://vista.cira.colostate.edu/Improve/improve-program/

[12] WRAP Regional Haze Rule Reasonable Progress Summary Report, June 28, 2013.

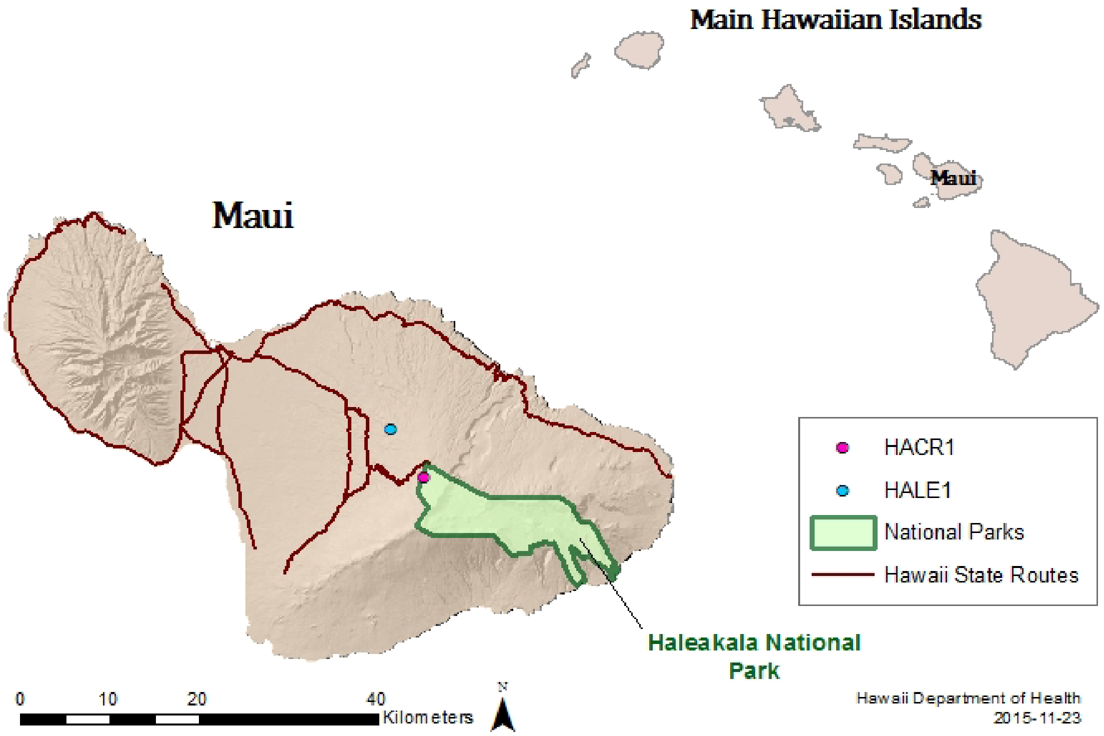


Figure 1.3-1 Haleakala National Park Visibility Monitoring Sites (IMPROVE Sites HALE1 & HACR1)

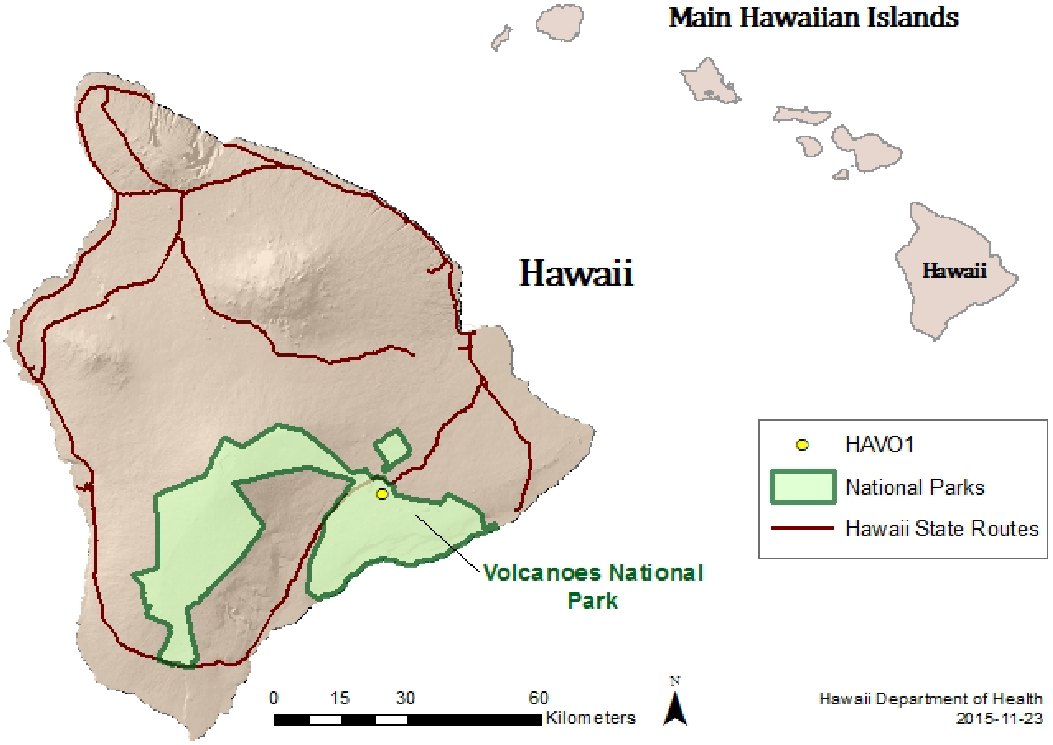


Figure 1.3-2 Volcanoes National Park Visibility Monitoring Sites (IMPROVE Site HAVO1)

1.4 Estimating Visibility Impairment

Particles and gases in the atmosphere can both absorb and scatter light. The absorption and scattering (i.e., extinguishing) of light result in light extinction (visibility impairment between the viewer and the light source) creating haze. The 2017 Regional Haze Rule defines visibility impairment or anthropogenic visibility impairment as "any humanly perceptible difference due to air pollution from anthropogenic sources between actual visibility and natural visibility on one or more days."[7]

To determine compliance under the RHR, each IMPROVE monitor collects 24 hour particulate samples every three (3) days on a set of particulate filters to identify the chemical constituents causing visibility impairment at the site.[13] The particulate concentration data is converted into reconstructed light extinction ("b_{ext}") in units of inverse mega meters (Mm^{-1}) with the IMPROVE equation.[14] 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.[14] The equation also accounts for the Rayleigh scattering that occurs in pure air. The IMPROVE equation, revised in December 2005, is listed below in Figure 1.4-1.[14]

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

Figure 1.4-1 Revised IMPROVE Equation[14]

Bracketed items in the IMPROVE equation are the measured concentrations in ug/m^3 of the particulate constituents collected by the IMPROVE monitoring station.[14] The f(RH) is a water growth factor for sulfate and nitrate, that are hygroscopic (these particles tend to attract water).[14] 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").[14]

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 14 disclosed the following information for these parameters:

---

[13] Guidance for Tracking Progress Under the Regional Haze Rule, U.S. EPA, September 2003.

[14] 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.

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.

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 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.

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

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:

$$HI(deciview) = 10 \ln(b_{ext}/10)$$

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

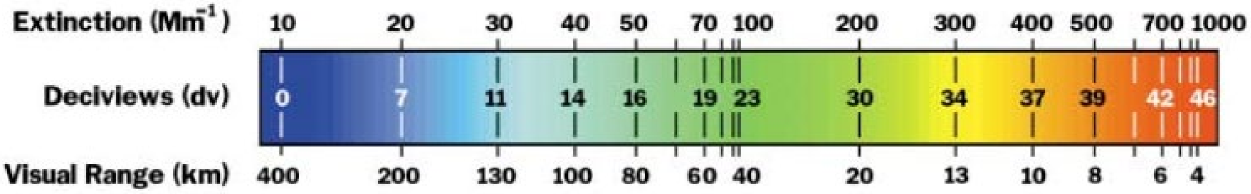


Figure 1.5-1 Comparison of Extinction, Deciview, and Visual Range[15]

1.6 Natural, Baseline, and Current Visibility Conditions

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

Natural Visibility – As defined in Reference 7, natural visibility conditions mean 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. 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.

---

[15] William C. Malm, Introduction to Visibility, May 1999.

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.[7] 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.[7]

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.[7] According to 40 CFR §51.308(f)(1)(iii) in Reference 5, 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. The most recent five (5)-year period for which data are available 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.[7]

Most Impaired Days – Means the twenty (20) percent of monitored days in a calendar year with the highest amounts of anthropogenic visibility impairment.[7]

Clearest Days – Means the twenty (20) percent of monitored days in a calendar year with the lowest values on the deciview index.[7]

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.

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.[16] 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.[17] It is unnecessary to assign extinction on the clearest days to anthropogenic and natural fractions.[17]

---

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

[17] 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.

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.[17] The WRAP TSS[18] provides annual average haze index in deciviews calculated by either the first planning period metric or the second planning period metric including adjustments for volcanic activity.

1.7 Uniform Rate of Progress (URP)

Pursuant to Reference 17, the URP is the calculation of the uniform slope, or glide path, of the line between baseline visibility conditions over a 60-year period.[19] By comparing baseline 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.[19] 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.

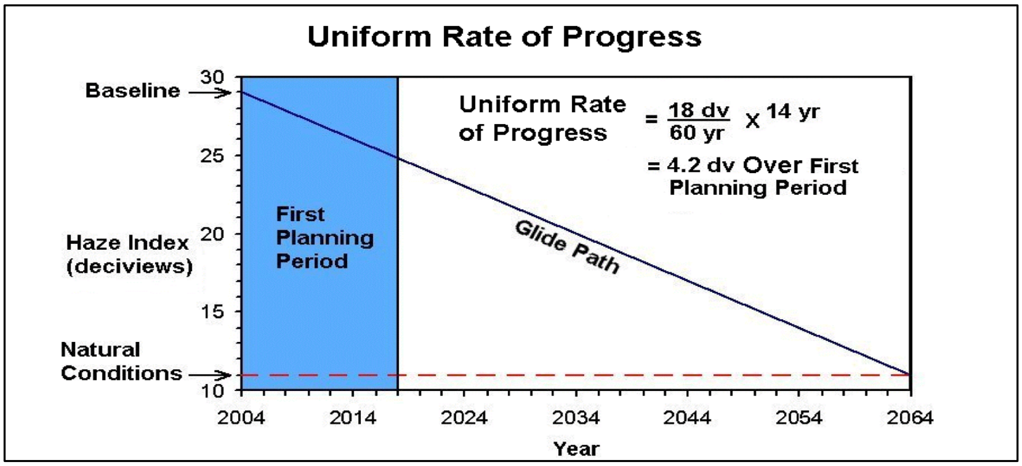


Figure 1.7-1 Uniform Rate of Progress Example[19]

The 2017 Regional Haze Rule:

(1) Provides a revised approach to tracking visibility improvements over time within the URP framework.[20] Under these rule revisions, in the second and future implementation periods, states must select the “twenty (20) percent most impaired days” each year at each Class I area based on daily anthropogenic impairment.[20]

---

[18] WRAP TSS at: https://views.cira.colostate.edu/tssv2/

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

[20] Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program, U.S. EPA, December 2018.

(2) Includes a provision that allows states to propose an adjustment to the URP to account for impacts from anthropogenic sources outside the United States, if the adjustment has been developed through scientifically valid data and methods.[20]

(3) Requires states to determine the baseline (2000-2004) visibility condition for the twenty (20) percent most anthropogenically impaired days and requires that the long-term strategy and reasonable progress goals (RPGs) must provide for improvement of visibility for the most anthropogenically impaired days, relative to baseline period.[20]

(4) Specifies that the URP is calculated according to the following formula:[20]

$$URP = [(2000\text{-}2004\ \text{visibility})_{20\%\ \text{most impaired}} - (\text{natural visibility})_{20\%\ \text{most impaired}}]/60$$

(5) Requires states to determine the baseline (2000-2004) visibility conditions for the 20 percent most impaired days and requires that the long-term strategy and RPG ensure no degradation in visibility for the most impaired days, relative to the baseline period.[20]

1.8 Regional Haze Rule State Implementation Plan

Core requirements for the implementation plan for regional haze are specified in 40 CFR §51.308(d). For the second planning period, the RH-SIP is due on July 31, 2021, pursuant to 40 CFR §51.308(f). As specified in Reference 5, to meet the core requirements for regional haze in the Class I areas, the State must submit an implementation plan containing the following plan elements and supporting documentation for all required analysis:

(ii) Reasonable progress goals – For each Class I area located within the State, the State must establish goals (expressed in deciviews) that provide for reasonable progress toward achieving natural visibility conditions. The RPGs must provide for an improvement in visibility for the most impaired days over the period of the implementation plan and ensure no degradation in visibility for the least impaired days over the same period.

In establishing the RPGs for each Class I Area within the State, the State must consider the cost of compliance, and the remaining useful life or any potentially affected sources and include a demonstration showing how these factors were taken in consideration in selecting the goal.

(2) Calculations of baseline and natural visibility conditions – For each Class I area, the State must determine the following visibility conditions:

ii. Baseline visibility conditions for the most impaired and clearest days for period 2000 to 2004; and

ii. Natural visibility conditions for the most impaired and clearest days.

(3) Long-term strategy for regional haze – A long-term strategy must be submitted that addresses visibility impairment for each Class I area. The long-term strategy must

include enforceable emission limitations, compliance schedules, and other measures as necessary to achieve the RPGs.

(4) Monitoring strategy and other plan requirements – The state must submit with the implementation plan a monitoring strategy for measuring, characterizing, and reporting of regional haze visibility that is representative of all Class I areas within the state.

The following are regional haze planning steps for completing the RH-SIP:

STEP 1 – Ambient data analysis to identify baseline, current and natural visibility conditions for the 20% most impaired days and 20% clearest days for each Class I area within the state.
STEP 2 – Determine which Class I areas in other states may be affected by the state's own emissions. This is not applicable to Hawaii due to its remote location. The closest states to Hawaii with Class I areas are Alaska and California that are over 2,000 miles away.
STEP 3 – Select the emission sources for which an analysis of emission control measures will be completed in the second implementation period and explain the bases for these selections.
STEP 4 – Characterize control measure factors for the selected sources pursuant to 40 CFR §51.308(f)(2).
STEP 5 – Select control measures for reasonable progress.
STEP 6 – Perform photochemical modeling of the long-term strategy to set reasonable progress goals for 2028.
STEP 7 – Progress, degradation, and URP glidepath checks to demonstrate that there will be an improvement in the 20% most impaired days in 2028 and there will be no degradation on the 20% clearest days in 2028 at the in-state Class I areas.
STEP 8 – Additional RH-SIP requirements to ensure the requirements of the Regional Haze Rule are met.

1.9 Description of Chapters for Hawaii's Regional Haze Rule State Implementation Plan

The RHR requires states to periodically submit RH-SIPs every ten (10) years. The first state plans were due in 2007 and covered the 2008 -2018 planning period. For the second 2018-2028 planning period, the due date for submitting the RH-SIP was extended from July 31, 2018, to July 31, 2021.

A brief description of each chapter for Hawaii's second planning period RH-SIP is as follows:

Chapter 1.0 is an overview, which describes the requirements of the RHR; Federal Class I areas located in the State of Hawaii; Hawaii's IMPROVE monitoring sites; measures of visibility including previously established baseline and natural visibility conditions (e.g., volcanic eruption); EPA's new algorithm to separate natural from anthropogenic fractions; uniform rate of progress (URP) or glide path; and brief description of the RH SIP.

Chapter 2.0 covers plan development, which describes RH planning, the Western Regional Air Partnership (WRAP), and consultation with both the Federal Land Manager (FLM) and the Environmental Protection Agency (EPA).
Chapter 3.0 (STEP 1) covers visibility conditions, which describes the RH program requirements in Title 40 Code of Federal Regulation (CFR) §51.308(f)(1) for the baseline, natural, and current visibility conditions; and the URP.

Chapter 4.0 (STEP 3) covers emissions inventory requirements in Title 40 CFR §51.308(1)(f)(6)(v) and (g)(4) and (5).

Chapter 5.0 (STEP 3) describes the screening process and criteria used to determine which point sources were included in the long-term strategy pursuant to Title 40 CFR §51.308(f)(2)(i). This chapter also provides the basis for evaluating point and area sources.

Chapter 6.0 (STEPS 4 and 5) evaluates enforceable emission control measures (i.e., emissions limitations, compliance schedules, and other measures) as determined pursuant to Title 40 CFR §51.308(f)(2)(i) through (iv) that provides for reasonable progress in each Federal Class I area. The RPGs, expressed in deciviews, are not directly enforceable and therefore, enforceable emission control measures are necessary to gauge reasonable progress. This section explains how the four-factor analysis takes into consideration selection of measures for inclusion in the State of Hawaii's long-term strategy pursuant to Title 40 CFR §51.308(f)(2)(i). The technical basis (such as documented modeling, monitoring, cost, engineering, and emissions data) that were used as basis for the selection are documented in this section pursuant to Title 40 CFR §51.308(f)(2)(iii).

Chapter 7.0 delineates the State of Hawaii's long-term strategy which addresses regional haze visibility impairment for each mandatory Federal Class I area pursuant to Title 40 CFR §51.308(f)(2)(i). Chapter 7.0 also includes enforceable emission control measures for making reasonable progress pursuant to Title 40 CFR §51.308(f)(2) as documented in Chapter 6.0 of this state implementation plan and consideration of additional factors as listed in Title 40 CFR §51.308(f)(2)(iv).

Chapter 8.0 (STEP 6 and 7) describes the RPG requirements for regional haze in Title 40 CFR §51.308(f)(3), establishes PRGs for 2028 (in deciviews), demonstrates the adequacy of emission control measures to effectively achieve projected natural visibility during both the most impaired and clearest days, and compares improvements in visibility to the URP.

Chapter 9.0 (STEP 8) describes the requirements for issuing periodic progress reports to the EPA, updates the status of all measures towards the RPGs, summarizes emissions reductions, assess changes in visibility conditions relative to previously established natural and baseline visibility conditions and any significant changes in anthropogenic emissions since the previous progress report pursuant to Title 40 CFR §51.308(g). In addition, Section 9.0 does the following:

a. Reviews and assess the Visibility Monitoring Strategy, identifies any planned changes, and provides recommended actions;

b. Evaluates the adequacy of control strategies in the existing RH plan pursuant to Title 40 CFR §51.308(h); and

c. Describes the requirements for the State and Federal Land Manager (FLM) coordination in Title 40 CFR §51.308(i) and the interactions that transpired between Hawaii and the EPA and FLMs in consultation with developing this RH-SIP.

1.10 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.

Chapter 2 Regional Haze State Implementation Plan Development

2.0 Regional Haze Planning

There are five reginal planning organizations (RPOs) across the United States that include the Western Regional Air Partnership (WRAP), Central States Air Resource Agencies (CENSARA), Lake Michigan Air Directors Consortium (LADCO), Mid-Atlantic/Northeast Visibility Union (MANE-VU), and Southeastern Air Pollution Control Agencies (SESARM). The five (5) RPOs are shown in Figure 2.0-1.[21]

Hawaii is a member of the Western Regional Air Partnership (WRAP) that works in cooperation with the Western States Air Resources Council (WESTAR). Members of WESTAR/WRAP include the states of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming. Federal WRAP/WESTAR partners include the NPS, Fish and Wildlife Service, Bureau of Land Management, and U.S. Forest Service.

---

[21] See https://www.epa.gov/visibility/visibility-regional-planning-organizations

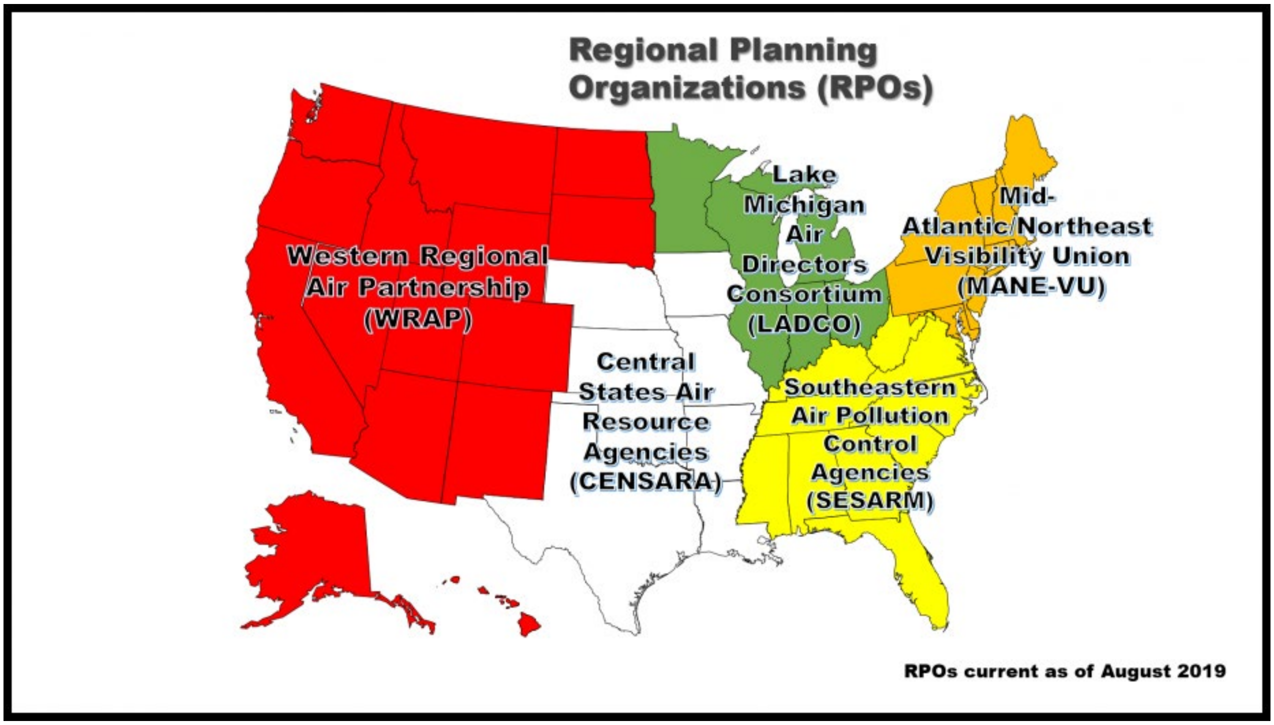


Figure 2.0-1 Regional Planning Organizations

2.1 Western States Air Resources Council (WESTAR) / Western Regional Air Partnership (WRAP)

The WESTAR/WRAP is a voluntary partnership of states, tribes, federal land managers, local air agencies and the U.S. EPA whose purpose is to understand current and evolving air quality issues in the West.[22] During this second regional haze planning period, WRAP in cooperation with WESTAR provided the following technical support for developing Hawaii's RH-SIP:

- Planning support and coordination from Regional Haze Planning Work Group (RHPWG) calls and webex recordings. The "Coordination and Glide Path", "Emissions Inventory and Modeling Protocol", and "Control Measures" subcommittees of the RHPWG addressed key technical issues for RH-SIP development. The DOH-CAB attended most of the RHPWG calls/webexs.
- Ramboll US. Corporation, in coordination with WRAP, assisted DOH-CAB with emission inventories of visibility impairing pollutants. Chapter 4 provides additional information on state-wide emissions and trends.
- A screening tool was developed by Ramboll US. Corporation in coordination with WRAP to determine sources with greatest visibility impacts on Hawaii's two (2) Class I areas. Sources selected from this screening step were required to submit a four-factor analysis to evaluate regional haze control measures. Please refer to Chapter 5 for source screening which used a Q/d threshold of ten (10) to select point sources for four-factor analysis.

---

[22] See https://www.westar.org/

- A weighted WEP/AOI analysis was provided by Ramboll US. Corporation, in coordination with WRAP, to further screen sources using HYSPLIT back trajectories to regional haze monitoring sites on the most impaired days. An extinction weighted residence time analysis is overlaid with gridded emissions and point source emissions to obtain a WEP that rank source regions and point sources for probability to visibility impairment at Class I areas on the most impaired days.

2.2 Federal Land Manger Coordination – 40 CFR §51.308(i)

The DOH-CAB consulted with FLMs in accordance with the provisions of 40 CFR §51.308(i)(2). These provisions require the State to provide the FLMs with an opportunity for consultation, in person at a point early enough in developing the long-term strategy, but not less than one hundred and twenty (120) days prior to holding a public hearing on the implementation plan. These provisions also require the opportunity for consultation on the implementation plan be provided to the FLMs no less than sixty (60) days prior to a public hearing or public comment opportunity. This consultation must include an opportunity for FLMs to discuss their:

(1) Assessment of impairment of visibility in any mandatory Class I Federal area; and
(2) Recommendations on the development and implementation of strategies to address visibility impairment.

Pursuant to 40 CFR §51.308(i)(3), the DOH-CAB provides the following descriptions of how comments from the FLMs were addressed:

- In accordance with 40 CFR §51.308(i)(4), the RH-SIP must provide procedures for continuing consultation between the State and FLMs on the implementation of the visibility protection program, including development and review of implementation plan revisions and progress reports, and on implementation of other programs having the potential to contribute to visibility impairment in Federal Class I areas.
- The DOH-CAB engaged in consultation with FLMs from the National Park Service in developing strategies to address visibility impairment and review of the four-factor analyses provided. Conference calls between DOH-CAB and the National Park Service are documented in Section 9.5, Federal Land Manager Consultation – 40 CFR 51.308(h). The DOH-CAB provided four-factor analyses from the seven (7) power plants and one industrial source screened to evaluate regional haze control measures. Comments from the NPS on the four-factor analyses from the power plants are provided in Appendices D through J. NPS comments on the Mauna Loa Macadamia Nut Corporation Plant analysis were addressed at meetings.
- Hawaii provided the draft RH-SIP to the NPS, U.S. Fish and Wildlife Service, and the U.S. Forest Service on March 24, 2022, for their review and comments prior to initiating the public comment period pursuant to 40 CFR §51.308(i)(2). A regional haze consultation meeting was held on May 19, 2022, to discuss comments from the FLMs on Hawaii's draft RH-SIP. The NPS Air Resources Division, NPS Interior Regions 8, 9, 10, and 12; and several national park units in Hawaii hosted the RH-SIP consultation meeting with DOH-CAB. Representatives from the U.S. Fish and Wildlife Service and EPA (Region 9) also attended the meeting. The FLMS provided their written comments on May 26, 2022. In accordance with 40 CFR §51.308(i)(3), comments from the FLMs and DOH-CAB's responses to these

comments are provided in Section 9.5, Federal Land Manager Consultation– 40 CFR 51.308(h). A summary of the conclusions and recommendations from the FLMS is also provided in the public notice for accepting comments on Hawaii's draft RH-SIP.

- Continued coordination and consultation will occur, as needed, through WRAP/WESTAR business meetings and conference calls that discuss regional haze issues that include FLMs as participants. The DOH-CAB will continue to consult with the FLMs directly.

2.3 EPA Guidance, Photochemical Modeling, and IMROVE Data Adjustment

The DOH-CAB had extensive consultation with EPA for developing the RH-SIP in this second planning period. The EPA provided feedback on four-factor analyses from facilities screened for further evaluation. Conference calls between DOH-CAB and EPA are documented in Section 9.6.

The Office of Air Quality, Permitting and Standards (OAQPS) of EPA conducted photochemical modeling for Hawaii to determine visibility impacts from anthropogenic sources. Emissions for the model were from EPA's 2016 emissions modeling platform. Photochemical modeling was used to determine visibility conditions without SO_2 impacts from the Kilauea Volcano that mask anthropogenic impacts at the IMPROVE monitors since the Kilauea Volcano was erupting in 2016.

The OAQPS adjusted IMPROVE data for Haleakala NP and Hawaii Volcanoes NP to account for visibility impacts from volcanic activity at both Class I areas and the change in location of the visibility monitor servicing Haleakala National Park. A white paper provides the methodology for the adjustments that were made to the IMPROVE data that was use for the photochemical modeling assessment.[23]

Chapter 3 Visibility Conditions

3.0 Baseline, Current, and Natural Visibility – 40 CFR §51.308(f)(1)(i-iii)

40 CFR §51.308(f)(1)(i-iii) requires states to address regional haze in each Mandatory Federal Class I area within the state for the most impaired and clearest days. States must evaluate current visibility conditions relative to a five (5)-year baseline from 2000 to 2004 and natural visibility conditions as they were before human activity in accordance with the RHR. Baseline, natural, and current visibility conditions for Haleakala National Park and Hawaii Volcanoes National Park are based on IMPROVE monitoring station data. IMPROVE monitors collect 24-hour particulate samples every three (3) days to identify haze constituents (e.g., sulfates, nitrates, coarse mass, organic mass, and sea salt) causing visibility impairment. Improve monitors servicing Haleakala National Park and Hawaii Volcanoes National Park are designated HACR1

---

[23] White paper is at following site: https://www.epa.gov/system/files/documents/2021-08/white_paper_for_regional_haze_hi_volcano_adjust_final.pdf

and HAVO1, respectively. Visibility conditions, based on IMPROVE data, are provided on the WRAP TSS.[18]

On April 13, 2020, EPA issued a memorandum on the use of patched and substituted data and data completeness for tracking visibility with the IMPROVE data.[24] The TSS was updated using IMPROVE data meeting EPA's recommended completeness criteria for tracking visibility. Adjustments were also made to the IMPROVE data to screen out impacts from natural episodic events with high haze levels related to wildfire (based on organic and elemental carbon) or dust storms (based on fine crustal and coarse mass) that only apply to the most impaired days. In Appendix A of the EPA memorandum, baseline, current, and natural visibility conditions were provided for the most impaired days; however, EPA did not provide results for the clearest days.

On June 3, 2020, EPA issued a memorandum that updated Appendix A of its April 13, 2020, memorandum to include visibility conditions for the clearest days. Tables 3.0-1 and 3.0-2 below provide visibility conditions established by EPA for the HACR1 and HAVO1 monitors based on the technical addendum referenced in EPA's June 3, 2020, memorandum. Baseline visibility conditions for Haleakala National Park, however, were not adjusted consistently with the methodology established in Hawaii's Regional Haze Progress Report for incidences when one monitoring station replaces another.

Table 3.0-1 Baseline, Current, and Natural Visibility Conditions for Clearest and Most Impaired Days at Haleakala National Park

20% Days of Calendar Year	Baseline (2000-2004) (dv)	Current (2014-2018) (dv) [a]	Natural (2064) (dv)	
			Clearest Days	Most Impaired Days
Clearest	4.55	0.48	2.66	4.77
Most Impaired	12.67	8.60		

a. HACR1 data combined with HALE1 data starting 01-01-08.

Table 3.0-2 Baseline, Current, and Natural Visibility Conditions for Clearest and Most Impaired Days at Hawaii Volcanoes National Park

20% Days of Calendar Year	Baseline (2000-2004) (dv)	Current (2014-2018) (dv)	Natural (2064) (dv)	
			Clearest Days	Most Impaired Days
Clearest	4.06	3.50	2.20	5.63
Most Impaired	18.66	19.28		

In the July 2020 Technical Support Document for EPA's "Updated 2028 Regional Haze Modeling for Hawaii, Virgin Islands, and Alaska", the IMPROVE data was adjusted to

---

[24] EPA Memorandum, Recommendation for the Use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program, April 13, 2020.

screen out impacts from volcanic activity (sulfates) with the same method used for wildfires and dust storms (episodic threshold determined by the lowest annual 95th percentile daily extinction) for the most impaired days only. IMPROVE data was, therefore, adjusted for volcanic activity as well as wildfires and dust storms in the EPA modeling assessment.

The DOH-CAB raised concerns with EPA's methodology to determine baseline visibility conditions for Haleakala National Park because it was inconsistent with the methodology used in Hawaii's Regional Haze Progress Report. An alternative approach for the Haleakala National Park baseline was provided by EPA in discussions with DOH-CAB and WRAP.

On August 5, 2021, EPA issued a white paper titled "Recommendations for the HALE1-HACR1 Site Combination and Volcano Adjustment for Sites Representing Hawaii Class I areas for the Regional Haze Rule".[23] The white paper builds upon the recommendations in the 2018 Technical Guidance and June 2020 Memo with additional recommendations for combining visibility data for IMPROVE sites representing the Haleakala National Park Class I area and an adjustment of visibility data at sites representing Haleakala National Park and Hawaii Volcanoes National Park Class I areas to account for episodic volcanic events.[23]

For the Haleakala National Park combined site (HALE1-HACR1), EPA's calculation methodology to determine visibility conditions was similar to the ratio-based approach used in Hawaii's Regional Haze Progress Report with some major modifications: 1) ratios between the two sites for the same time period were calculated rather than the same site over two time periods, 2) data for all years where both sites were complete during the overlap period (2007-2011) was utilized, 3) the analysis was limited to days where both sites had concentration measurements for all chemical components, and 4) the median rather than the average ratio was used. To screen out volcanic impacts on the most impaired days for the combined HALE1-HACR1 site and the Hawaii Volcanoes National Park monitor (HAVO1), EPA identified the 95th percentile 24-hour ammonium sulfate extinction value for each year between 2000 and 2014 and selected the year with the lowest value.

While Hawaii's 2017 Regional Haze Progress Report states that a majority of the visibility degradation in Hawaii's National Parks was due to the ongoing release of SO_2 from the Kilauea Volcano, SO_2 emissions significantly decreased after the Kilauea eruption ended in September 2018. The USGS stated, that in 2019, the Kilauea summit was the only source releasing enough SO_2 emissions to be quantified using ultra-violet spectroscopy. Preliminary USGS results for 2019 indicated an average summit daily SO_2 emission rate of about 43 metric tons per day (47 short tons per day) and an average annual total SO_2 emission rate of about 15,695 metric tons per year (17,301 short tons per year) which is far lower than the SO_2 emissions reported in the progress report of around two (2) million tons per year. The total combined SO_2 emissions from point sources screened for four-factor analysis were estimated to be about 18,058 tons per year in 2017 which is 939 tons higher than preliminary USGS estimates of volcanic SO_2 for 2019. After the Kilauea eruption activity ended in September 2018, point sources played a more significant part in SO_2 visibility impacts. On December 20, 2020, the Kilauea Volcano started another eruption. According to USGS-HVO personnel, on the onset of these eruptions, tens of thousands of tons of

SO_2 per day is released by the volcano. By February 23, 2021, SO_2 emissions had decreased to about 800 tons per day that would correlate to an annual emission rate of 292,000 tons per year. This rate is lower than the emission rates from the pre-2018 lava lake that were typically around 5,000 tons per day of SO_2 or around 1,825,000 tons per year. The December 20, 2020, eruption ended on May 26, 2021. See Page 1 of Chapter 1 for information on new eruption that started on September 29, 2021.

The potential for haze from NO_X emissions may be considered low in Hawaii due to warm weather conditions year-round. However, data from the NPS shows that temperatures in Haleakala National Park can vary widely from 80 degrees Fahrenheit (F) to 30 degrees F and at the Mauna Loa summit of Hawaii Volcanoes National Park, winter temperatures and snow are a possibility during any season.

IMPROVE data for both of Hawaii's national parks indicates the impact of nitrate is much lower than that at many monitors in other Class I areas around the country. However, EPA guidance notes that because regional haze results from a multitude of sources over a broad geographic area, progress may require addressing many relatively small contributions to impairment. Thus, a measure may be necessary for reasonable progress even if that measure in isolation does not result in perceptible visibility impairment.

A comparison of baseline visibility conditions to the current and natural visibility conditions are shown in Tables 3.0-3 and 3.0-4 for Haleakala National Park and Hawaii Volcanoes National Park, respectively, based on EPA's calculation methodology. IMPROVE data with adjustments for volcanic activity, wildfires, dust storms, and the combined HALE1-HACR1 site was provided to WRAP for updating the TSS.

Table 3.0-3 Comparison of Baseline, Current, and Natural Visibility Conditions for Clearest and Most Impaired Days at Haleakala National Park [a]

20% Days of Calendar Year	Baseline (2000-2004) (dv)	Current (2014-2018) (dv)	Natural (2064) (dv)	
			Clearest Days	Most Impaired Days
Clearest	2.18	0.48	-0.12	4.22
Most Impaired	7.84	7.27		

a: IMPROVE data adjusted for HALE1-HACR1 site combination and episodic events that include volcanic activity, wildfires smoke, and dust storms.

Table 3.0-4 Comparison of Baseline, Current, and Natural Visibility Conditions for Clearest and Most Impaired Hawaii Volcanoes National Park [a]

20% Days of Calendar Year	Baseline (2000-2004) (dv)	Current (2014-2018) (dv)	Natural (2064) (dv)	
			Clearest Days	Most Impaired Days
Clearest	4.06	3.50	2.20	6.62
Most Impaired	15.60	16.31		

a: IMPROVE data adjusted for episodic events that include volcanic activity, wildfires smoke, and dust storms.

Figure 3.0-1 shows the average annual contributions of haze species to light extinction and average annual deciview index for the clearest days at Haleakala National Park representing current visibility conditions. Most impairment is from sulfates that average (48% - 0.722 Mm^{-1}) of the total light extinction over the five (5) year period (2014-2018) which would be expected since Kilauea Volcano was erupting and emitting extremely large quantities of SO_2 over this five-year period. The next highest contributor is coarse mass (14% - 0.215 Mm^{-1}). Sea salt is another large contributor after sulfates (12% - 0.186 Mm^{-1}), due to costal influences, followed by organic mass (11% -0.160 Mm^{-1}), and nitrates (9% - 0.129 Mm^{-1}).

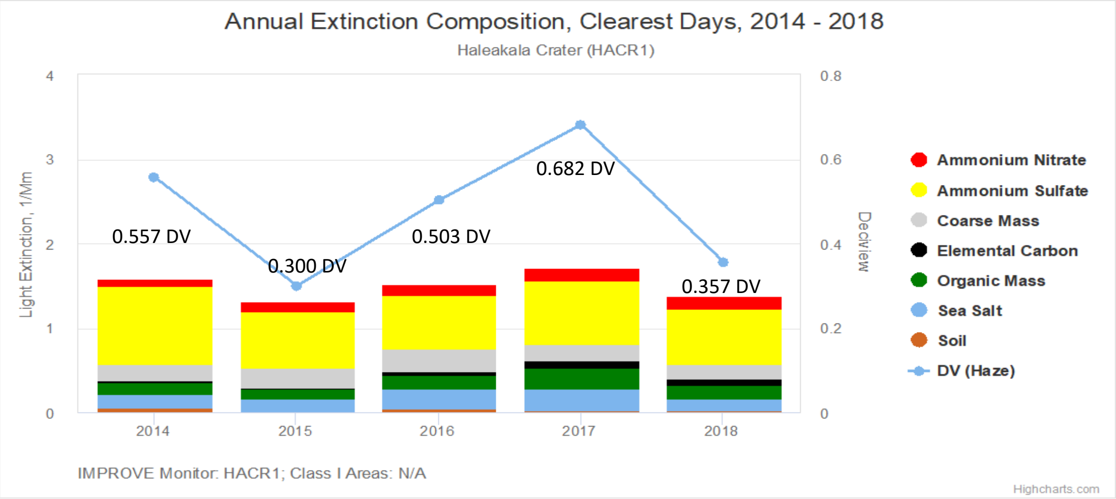


Figure 3.0-1 Visibility Conditions at Haleakala NP for Clearest Days

Figure 3.0-2 shows the average annual contributions of haze species to light extinction and average annual deciview index for the most impaired days at Haleakala National Park representing current visibility conditions based on IMPROVE data adjusted to screen sulfates from volcanic activity. Most impairment is from sulfates that average (75.49%; 9.24 Mm^{-1}) of the total light extinction over the five (5) year period (2014-2018). Next highest contributor to light extinction is coarse mass (5.78%; 0.70 Mm^{-1}) followed by nitrates (5.44%; 0.67 Mm^{-1}), sea salt (5.13%; 0.63 Mm^{-1}), organic mass (4.91% -0.60 Mm^{-1}), and soil (1.32%; 0.16 Mm^{-1}).

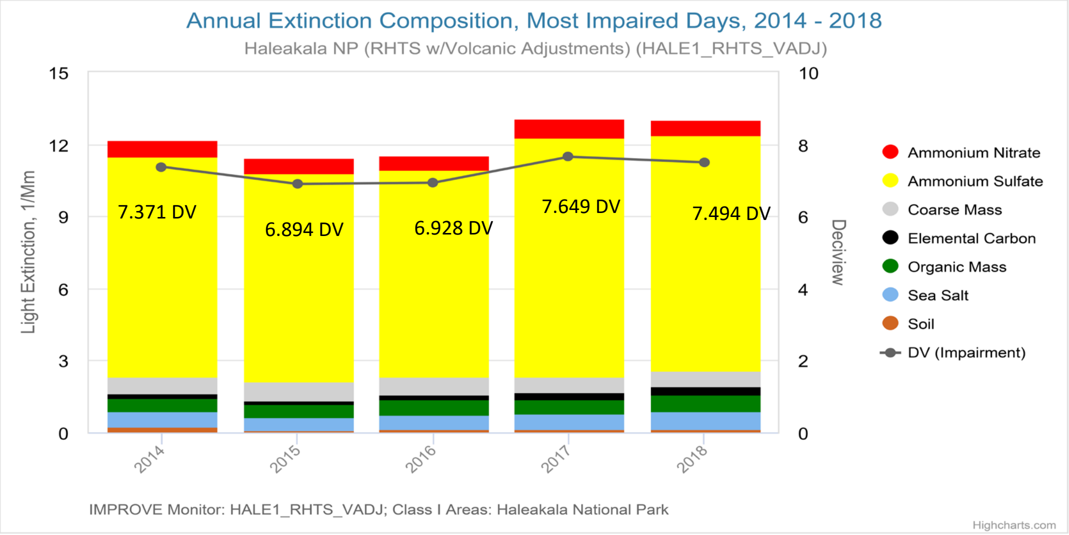


Figure 3.0-2 Visibility Conditions at Haleakala NP for Most Impaired Days

Figure 3.0-3 shows the average annual contributions of haze species to light extinction and average annual deciview index for the clearest days at Hawaii Volcanoes National Park representing current visibility conditions. Most visibility impairment is from sulfates that average (41%; 1.755 Mm^{-1}) over the most recent 5-year period (2014-2018) of available data. Next highest contributor to light extinction is sea salt (29%; 1.219 Mm^{-1}) followed by coarse mass (14%; 0.603 Mm^{-1}), organic mass (6.9% - 0.302 Mm^{-1}), and nitrates (6.7% - 0.290 Mm^{-1}). There is no data for year 2018.

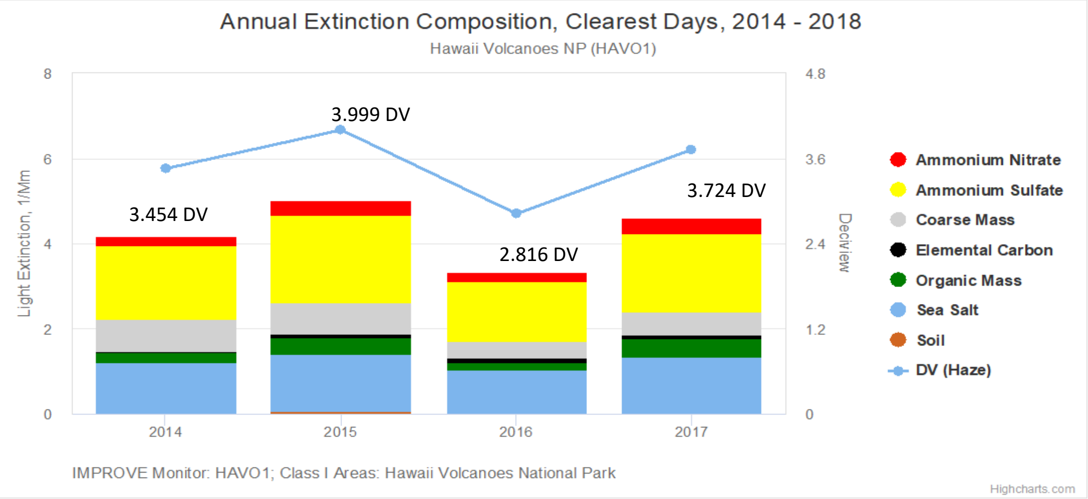


Figure 3.0-3 Visibility Conditions at Hawaii Volcanoes NP for Clearest Days

Figures 3.0-4 and 3.0-5 show the average contributions of haze species to light extinction and average annual deciview index for the most impaired days at Hawaii Volcanoes National Park representing current visibility conditions based on IMPROVE data adjusted to screen sulfates from volcanic activity. Figure 3.0-5 excludes sulfate to magnify light extinction contributions from other aerosol species. Most impairment is from sulfates that average (86.65%; 32.90 Mm^{-1}) over the most recent 5-year time frame (2014-2018) of available data. Next highest contributors are sea salt (4.03%; 1.45 Mm^{-1}) and organic mass (3.57%; 1.21 Mm^{-1}), followed by coarse mass (2.45%; 0.85 Mm^{-1}), elemental carbon (1.54%; 0.54 Mm^{-1}), and nitrates (1.44%; 0.50 Mm^{-1}).

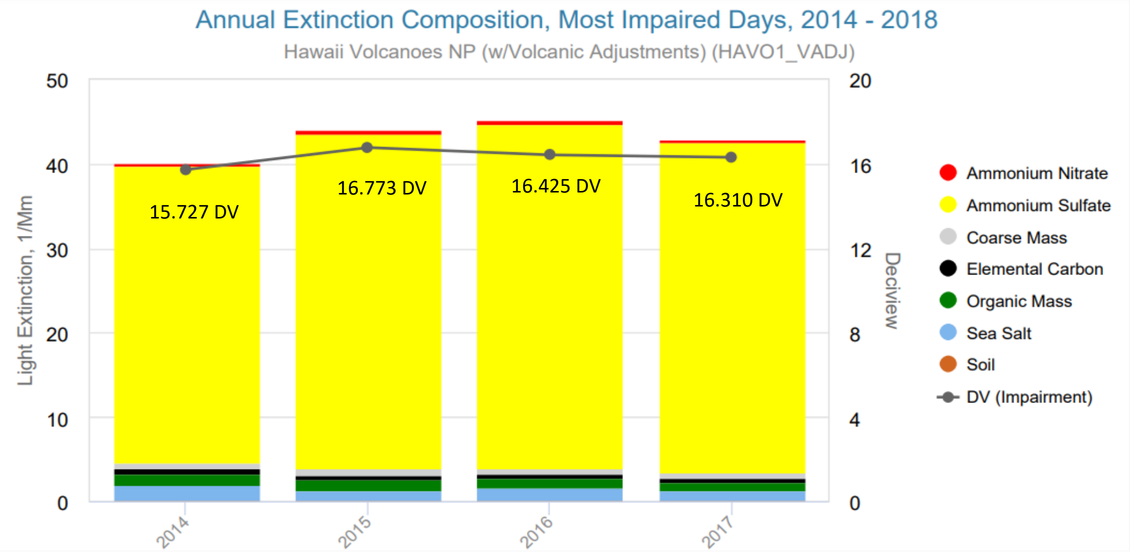


Figure 3.0-4 Visibility Conditions at Hawaii Volcanoes NP for Most Impaired Days

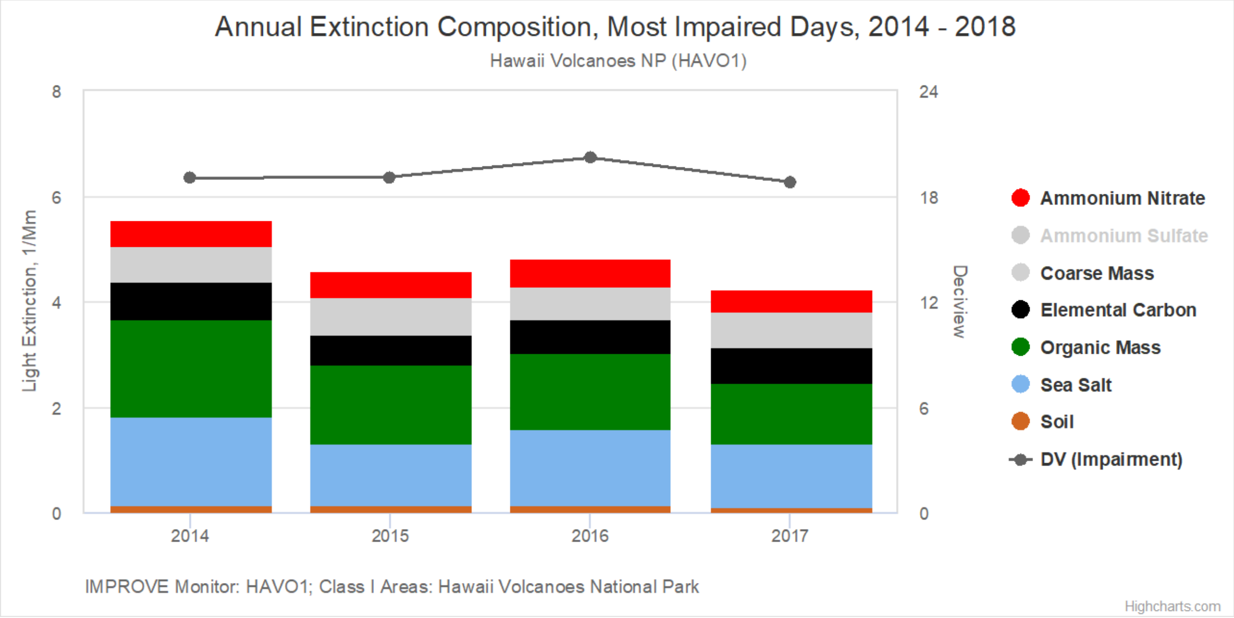


Figure 3.0-5 Visibility Conditions at Hawaii Volcanoes NP for Most Impaired Days

Evaluation of IMPROVE data over the current visibility period from 2014 to 2018 for Haleakala National Park and Hawaii Volcanoes National Park disclosed the following:

Ammonium Sulfate is the largest cause of visibility degradation, contributing from 48%-clearest days to 75%-most impaired days of the light extinction at Haleakala National Park and from 41%-clearest days to 87%-most impaired days of the light extinction at Hawaii Volcanoes National Park.

Natural causes of sulfate include SO_2 from the Kilauea Volcano located in Hawaii Volcanoes National Park.[14] There is significant variability in light extinction from sulfates due to SO_2 emissions that vary from year to year by hundreds of thousands of tons from the Kilauea eruption. The Kilauea Volcano, however, stopped erupting after the extreme volcanic event from May to September 2018. Figure 3.0-6 shows a significant reduction in light extinction from sulfates on the haziest days in the month of September when the eruption was winding down. The light extinction from sulfates on the haziest days at Haleakala National Park was as high as 34.026 Mm^{-1} in June 2018 and decreased to a level of 3.907 Mm^{-1} in September 2018. The change in light extinction from sulfates at Haleakala National Park is far less significant for the clearest days in months after the Kilauea eruption. Figure 3.0-7 shows light extinction from sulfates on the clearest days ranging from 0.323 Mm^{-1} to 0.996 mM^{-1} when the volcano was erupting from January to September 2018. Sulfate light extinction on the clearest days ranged from 0.515 Mm^{-1} to 0.717 Mm^{-1} between October and December 2018 after the eruption ended in September 2018. Sulfate from volcanic SO_2 emissions is expected to significantly increase, however, because the Kilauea Volcano started erupting again. Please see Chapter 1, Introduction for details on new eruptions.

Point sources that combust fuel oil are anthropogenic emitters of SO_2 that cause sulfate. A majority of these sources are power plants on the islands of Oahu, Maui, and Hawaii that combust fuel oil No. 6 with as much as 2.0% sulfur content.

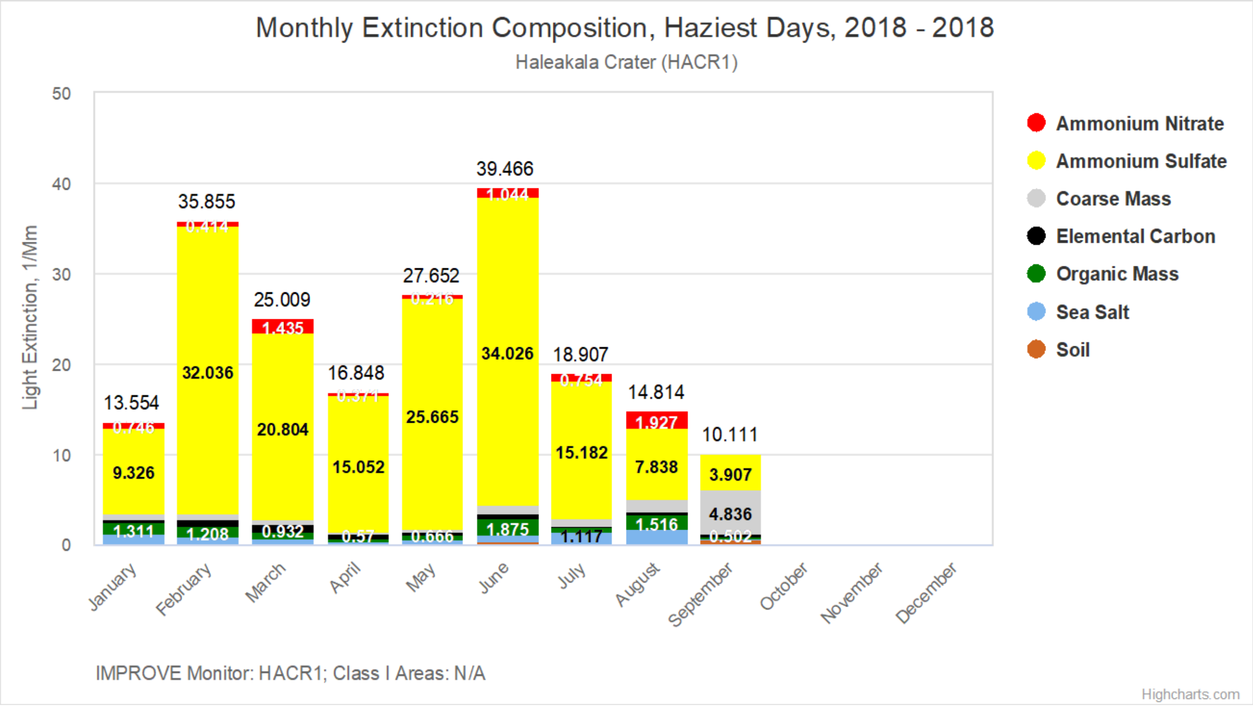


Figure 3.0-6 Monthly Visibility Conditions at Haleakala NP for Haziest Days

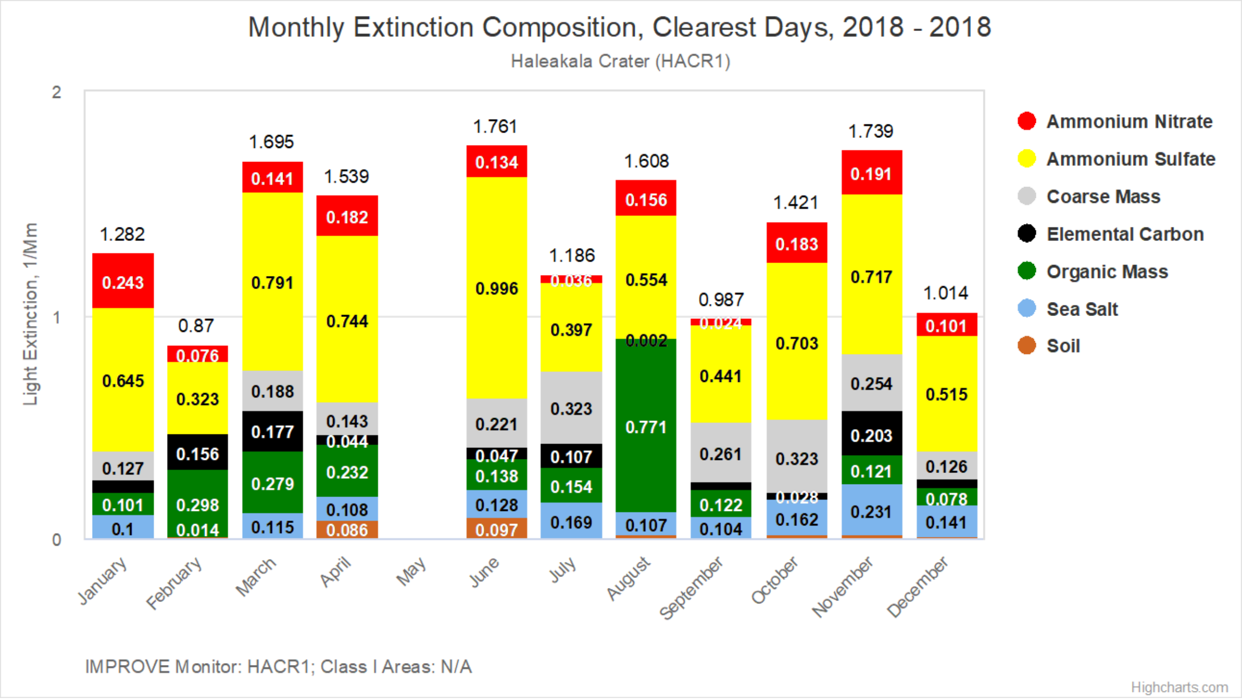


Figure 3.0-7 Monthly Visibility Conditions at Haleakala NP for Clearest Days

Sea salt, due to the natural marine environment, contributes from 5.8%-most impaired days to 12%-clearest days of the light extinction at Haleakala National Park and from 4%-most impaired days to 29%-clearest days of the light extinction at Hawaii Volcanoes National Park. Sea spray was found to be 90% of total statewide PM_{10} emissions (anthropogenic PM_{10} + biogenic PM_{10}) in Hawaii's 2017 Regional Haze Progress Report.

Coarse mass contributes from 6%-most impaired days to 14%-clearest days of the light extinction at Haleakala National Park and from 5.8%-most impaired days to 14%-clearest days of the light extinction at Hawaii Volcanoes National Park. Sulfates, ranging from 75% to 87% of the light extinction at the two national parks on the most impaired days, overwhelm light extinction from coarse mass on these days. Anthropogenic sources of coarse mass include fugitive dust from unpaved roads, aggregate processing, and construction activities. Natural sources of coarse mass include windblown dust.

Organic mass contributes from 4.9%-most impaired days to 11%-clearest days of the light extinction at Haleakala National Park and from 3.6%-most impaired days to 6.9%-clearest days of the light extinction at Hawaii Volcanoes National Park. Sources of organic mass include agricultural burning, wildfires, oil combustion, and international transport.[14] Organic mass can also be formed from biogenic plant and soil VOC. Biogenic VOC from plants and soil were found to be 77% of the total statewide VOC emissions (anthropogenic VOC + biogenic VOC) in Hawaii's 2017 Regional Haze Progress Report.

Ammonium Nitrates contribute from 5.4%-most impaired days to 9.0%-clearest days of the light extinction at Haleakala National Park and from 1.4%-most impaired days to 6.7%-clearest days of the light extinction at Hawaii Volcanoes National Park. Point sources that combust fuel oil are major anthropogenic emitters of NO_X that cause nitrates. A majority of these sources are power plants on the islands of Oahu, Maui, and Hawaii that combust fuel oil No. 6 (residual oil).

Because residual oils are produced from residue remaining after lighter fractions (gasoline, kerosene, and distillate oils) have been removed from the crude oil, they contain significant quantities of ash, nitrogen, and sulfur.[25] Fuels that contain nitrogen create "fuel NO_X".[26]

Elemental Carbon contributes from 1.4%-most impaired days to 3.3%-clearest days of the light extinction at Haleakala National Park and from 1.0%-most impaired days to 1.8%-clearest days of the light extinction at Hawaii Volcanoes National Park. Sources of elemental carbon include fossil fuel combustion and biomass combustion (e.g., wildfires and agricultural burning).

Soil contributes from 0.2%-most impaired days to 3.3%-clearest days of the light extinction at Haleakala National Park and from 0.2%-most impaired days to 0.5%-clearest days at Hawaii Volcanoes National Park. Sources of soil include wind-blown dust, fugitive dust from construction activities, and road dust.

---

[25] AP-42 VOL1:1.3 Fuel Oil Combustion

[26] Nitrogen Oxides, Why and How They Are Controlled, U.S. EPA, November 1999

3.1 Progress to Date and Visibility Differences for Most Impaired and Clearest Days – 40 CFR §51.308(f)(1)(iv-v)

40 CFR §51.308(f)(1) requires states to address visibility progress and differences between current and natural visibility conditions. 40 CFR §51.308(f)(1)(iv) requires an evaluation of progress to date towards the natural visibility since the baseline period, actual progress made towards the natural visibility condition since the baseline period, and actual progress made during the previous implementation period up to and including the period for calculating current visibility conditions for the most impaired and clearest days. 40 CFR §51.308(f)(1)(v) requires an evaluation of the number of deciviews by which the difference between current visibility conditions exceed the natural visibility conditions, for the clearest and most impaired days.

Figure 3.1-1 compares baseline, current, and natural visibility conditions at Haleakala National Park for the clearest and most impaired days.

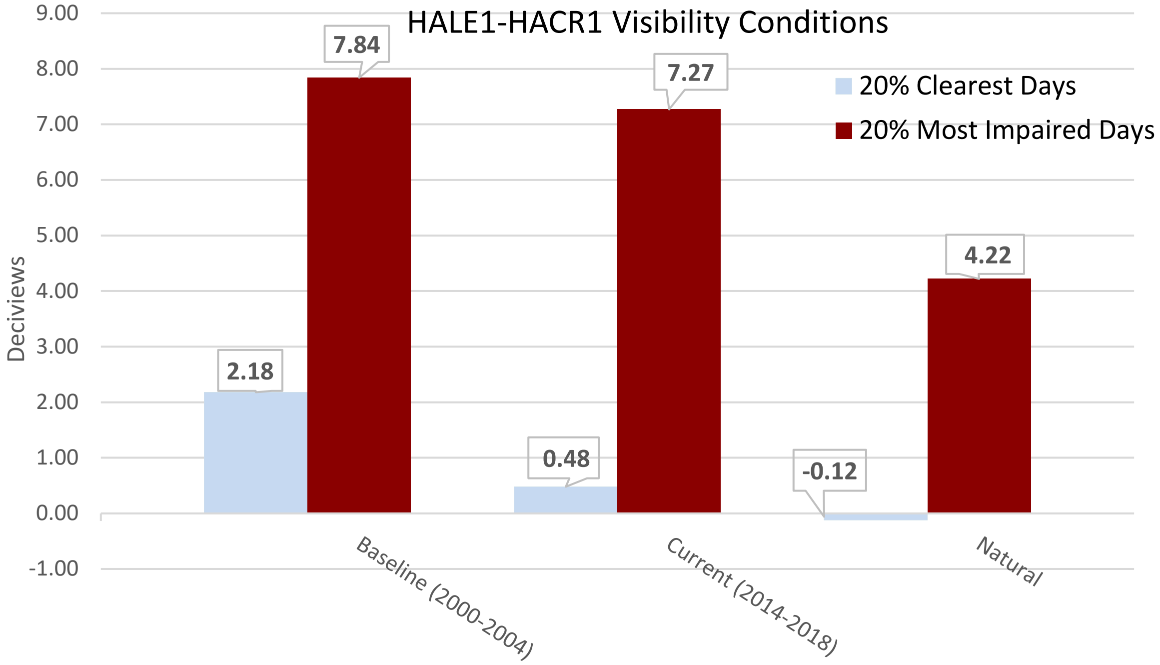


Figure 3.1-1 Progress for Baseline, Current, and Natural Visibility Conditions at Haleakala NP for Clearest and Most Impaired Days

Table 3.1-1 below provides the difference between current and natural visibility conditions for Haleakala National Park.

Table 3.1-1 Current Versus Natural Visibility Conditions at Haleakala NP

Current Visibility (2014-2018)		Natural Visibility (2064)		Difference	
Clearest Days (dv)	Most Impaired Days (dv)	Clearest Days (dv)	Most Impaired Days (dv)	Clearest Days (dv)	Most Impaired Days (dv)
0.48	7.27	-0.12	4.22	0.60	3.05

Figure 3.1-2 compares baseline, current, and natural visibility conditions at Hawaii Volcanoes National Park for the clearest and most impaired days.

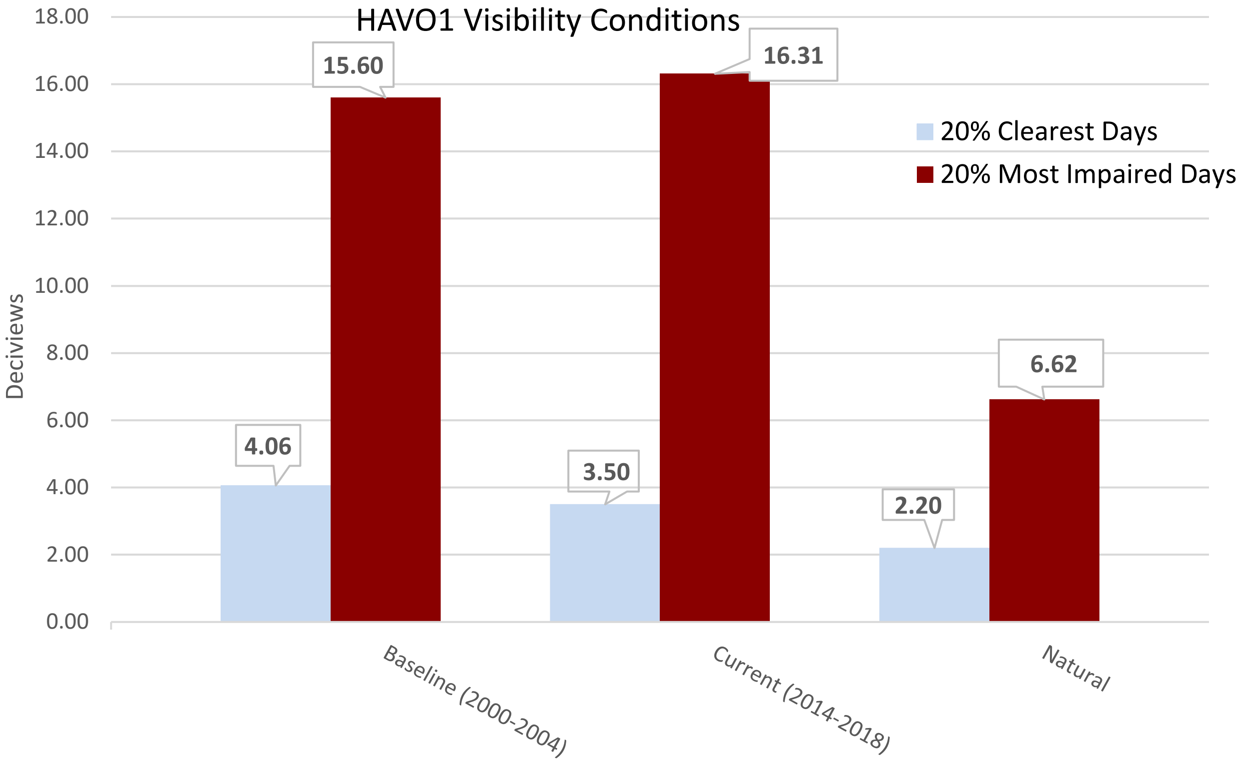


Figure 3.1-2 Progress for Baseline, Current, and Natural Visibility Conditions at Hawaii Volcanoes NP for Clearest and Most Impaired Days

Table 3.1-2 below provides the difference between current and natural visibility conditions for Haleakala National Park.

Table 3.1-2 Current Versus Natural Visibility Conditions at Hawaii Volcanoes NP

Current Visibility (2014-2018)		Natural Visibility (2064)		Difference	
Clearest Days (dv)	Most Impaired Days (dv)	Clearest Days (dv)	Most Impaired Days (dv)	Clearest Days (dv)	Most Impaired Days (dv)
3.50	16.31	2.20	6.62	1.30	9.69

3.2 Uniform Rate of Progress (URP) – 40 CFR §51.308(f)(1)(vi)

The URP is defined, in deciviews per year, the rate of visibility improvement that would be maintained to reach the natural visibility condition by the end of 2064. The URP or glidepaths are shown in Figures 3.2-1 and 3.2-2 as straight lines between the baseline visibility condition for the 20% most impaired days and natural visibility condition for 2064 based on the 20% most impaired days for Haleakala NP and Hawaii Volcanoes NP, respectively.

Calculations in Table 3.2-1 show the URP is 0.060 dv/yr for Haleakala National Park.

Table 3.2-1 URP for Haleakala National Park

2000-2004 Baseline 20% Most Impaired (dv)	2064 Natural 20% Most Impaired (dv)	Total Improvement Needed (dv)		URP (dv/yr) [a]
		2028 [a]	2064 [a]	
7.84	4.22	1.44	3.62	0.060

a. 7.84 dv -–4.22 dv = 3.62 dv; 2064-2004 = 60 yrs; 3.62 dv/60 yrs = 0.060 dv/yr; 2028-2004=24 yrs; = (24 yrs)(0.060 dv/yr) = 1.44 dv by 2028.

The calculated URP is drawn from the most impaired visibility days only. The value of the 2000-2004 baseline was based on that provided in EPA's white paper "Recommendations for the HALE1-HACR1 Site Combination and Volcano Adjustment for Sites Representing Hawaii Class I areas for Regional Haze Rule".[23] Figure 3.2-1 shows that the most impaired day 5-year rolling average for Haleakala National Park is slightly above the URP level for the first RH-SIP planning period (2001-2018). However, most of the visibility degradation is due to natural sulfates formed from SO_2 as a result of the Kilauea eruption in Hawaii Volcanoes National Park on the Big Island which is uncontrollable and unpreventable.

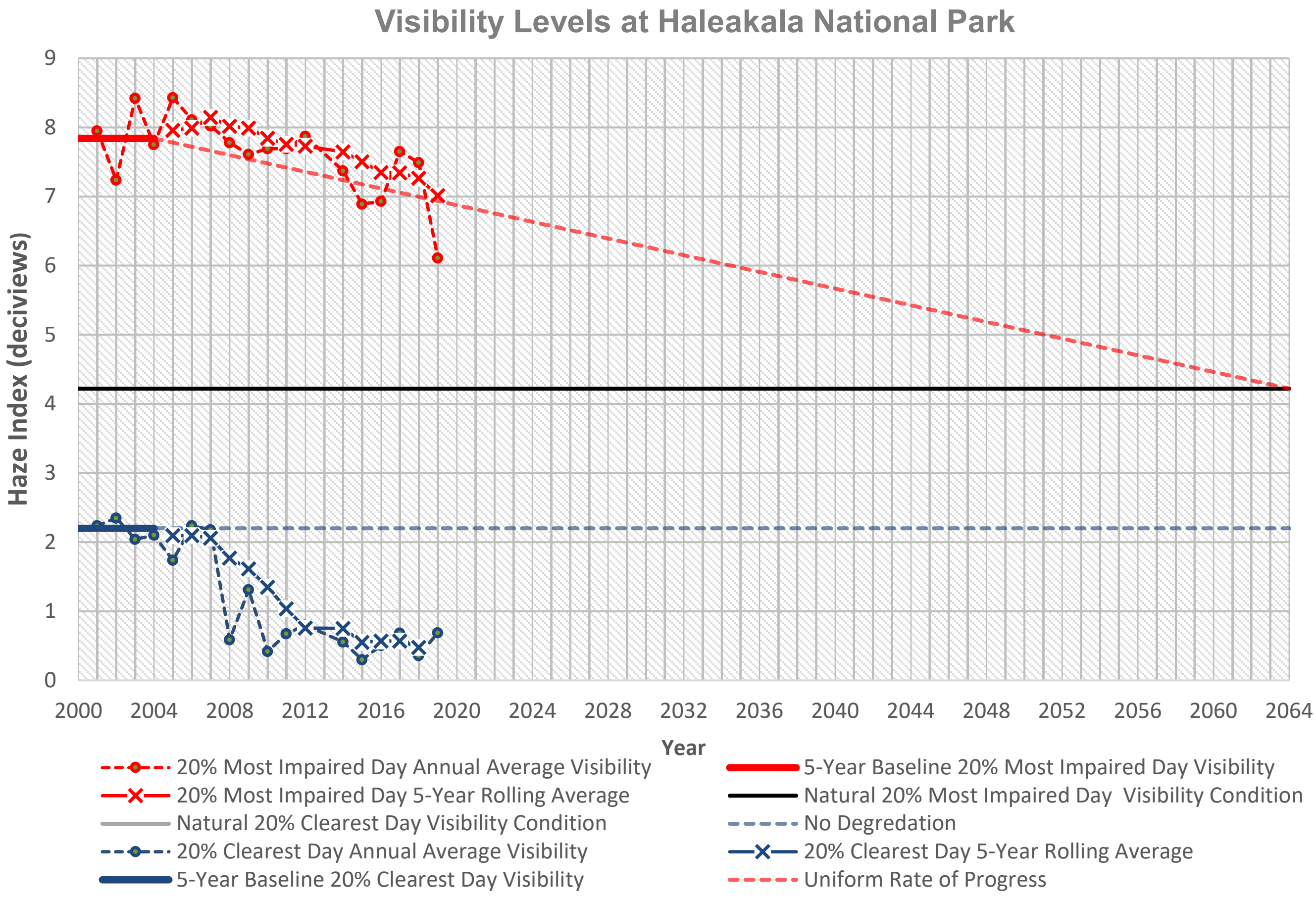


Figure 3.2-1 Visibility Levels at Haleakala National Park

Calculations in Table 3.2-2 show the URP is 0.150 dv/yr for Hawaii Volcanoes National Park.

Table 3.2-2 URP for Hawaii Volcanoes National Park

2000-2004 Baseline 20% Most Impaired (dv)	2064 Natural 20% Most Impaired (dv)	Total Improvement Needed (dv)		URP (dv/yr)
		2028	2064	
15.60	6.62	3.60	8.98	0.150

a. 15.60 dv -–6.62 dv = 8.98 dv; 2064-2004 = 60 yrs; 8.98 dv/60 yrs = 0.150 dv/yr; 2028-2004=24 yrs, (24 yrs)(0.150 dv/yr) = 3.60 dv by 2028.

The calculated URP is drawn from the most impaired visibility days only. Figure 3.2-2 shows that the most impaired day 5-year rolling average for Hawaii Volcanoes National Park is above the URP level for the first RH-SIP planning period (2001-2018). However, most of the visibility degradation is due to natural sulfates formed from SO_2 as a result of the Kilauea eruption in Hawaii Volcanoes National Park on the Big Island which is uncontrollable and unpreventable.

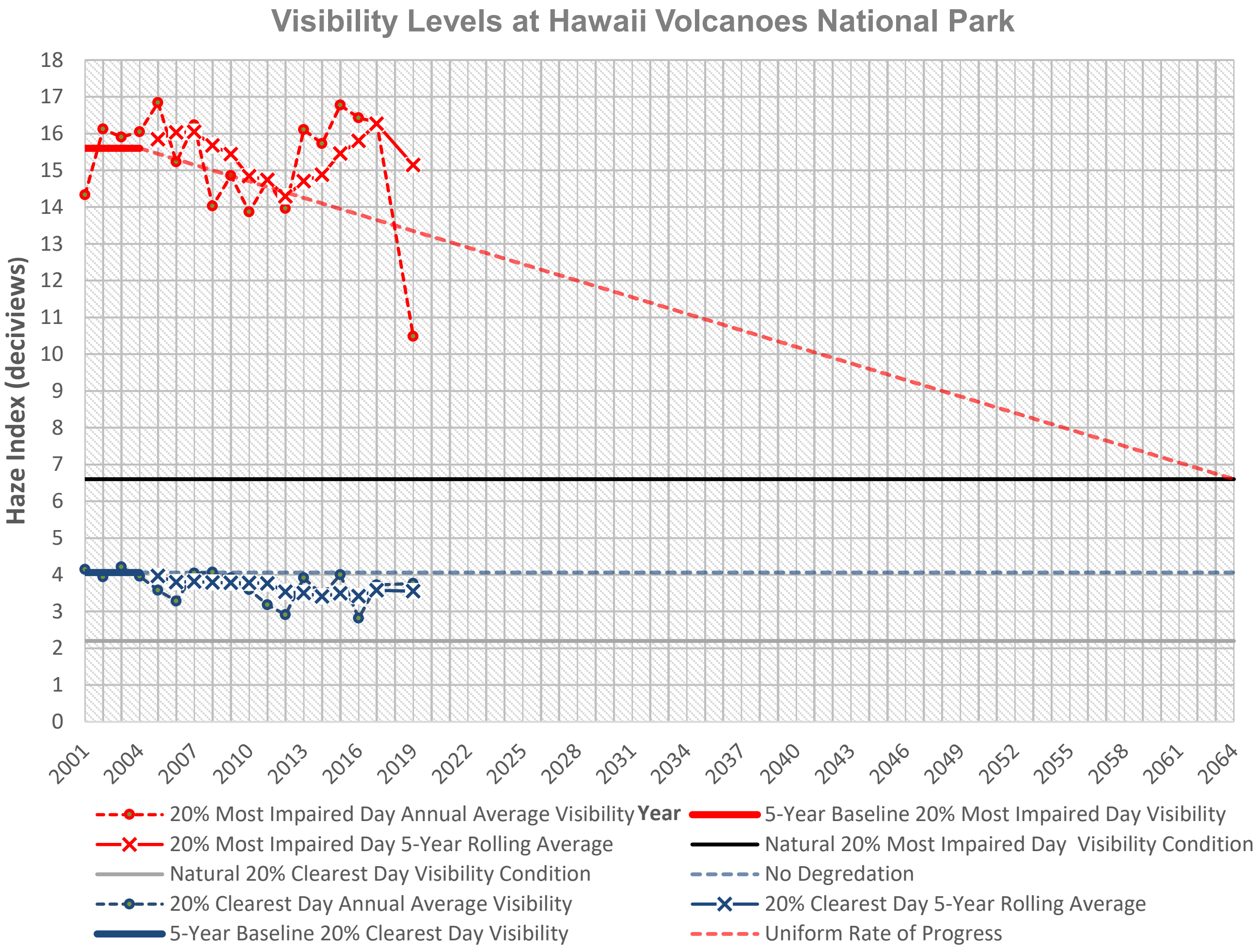


Figure 3.2-2 Visibility Levels at Hawaii Volcanoes National Park

Chapter 4 Statewide Emissions Inventory

4.0 Statewide Emissions Inventory – 40 CFR §51.308(f)(6)(v)

Section 51.308(f)(6)(v) of EPA's Regional Haze Rule (RHR) requires the establishment of a statewide emission inventory of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any mandatory Class I Federal area. Hawaii's air emissions inventory includes sulfur dioxide (SO_2), nitrogen oxides (NO_X), particulate matter less than 10 microns in diameter (PM_{10}), volatile organic compounds (VOCs), and ammonia (NH_3). This section provides information on the development of baseline and future emission inventories that were used in SIP visibility modeling. This section is also intended to satisfy 40 CFR 51.308(g)(4) and 40 CFR 51.308(g)(5) of the RHR.

4.1 Trends in Emissions of Visibility Impairing Pollutants – 40 CFR §51.308(g)(4)

40 CFR §51.308(g)(4) of the RHR requires periodic progress towards the reasonable progress goals and must contain:

An analysis tracking the change over the period since the period addressed in the most recent plan in emissions of pollutants contributing to visibility impairment from all sources and activities within the State. Emissions changes should be identified by type of source or activity. With respect to all sources and activities, the analysis must extend at least through the most recent year for which the state has submitted emission inventory information in accordance with EPA's triennial reporting requirements as of a date six (6) months preceding the required date of the progress report. With respect to sources that report directly to EPA's centralized emissions data system, the analysis must extend through the most recent year for which the Administrator has provided a State-level summary of such reported data or an internet-based tool by which the State may obtain such a summary as of a date six (6) months preceding the required date of the progress report. The State is not required to back cast previously reported emissions to be consistent with more recent emission estimates that may draw attention to actual or possible inconsistencies from changes in estimation procedures.

40 CFR §51.308(g)(5) of the RHR requires period progress towards the reasonable progress goals and must contain:

An assessment of any significant changes in anthropogenic emissions within or outside the State that have occurred since the period addressed in the most recent plan required under 40 CFR §51.308(f) including whether or not these changes in anthropogenic emissions were anticipated in that most recent plan and whether they have limited or impeded progress in reducing pollutant emissions and improving visibility.

Chapter 4 of this RH-SIP provides a summary of emissions of visibility impairing pollutants from all sources and activities within the state for the years 2005, 2011, 2014, 2016, & 2017. Data categories are separated into anthropogenic emissions and natural source emissions.

Anthropogenic source categories include point source, area (nonpoint) source, agricultural burning, other fire, nonroad mobile sources, on-road mobile sources, and marine. The natural sources of emissions are from volcanic activity, sea spray, windblown dust, wildfire, and biogenic sources.

Source categories represented in emissions summaries matching EPA's National Emissions Inventory (NEI) are described below:

Point Sources – include emissions estimates for larger sources that are located at a fixed, stationary location. Point sources in the NEI include large industrial facilities and electric power plants, airports, and smaller industrial, non-industrial and commercial facilities. A small number of portable sources such as some asphalt or rock crushing operations are also included. The emissions potential of stationary sources determines whether that facility should be reported as a point source, according to emissions thresholds set in the Air Emissions Reporting Rule (AERR). Emissions are calculated based on source specific factors and are reported to the state and NEI annually. As of 2008, mobile source nonroad emissions from airports, and railroad switch yards are included in the point source category in the NEI.

Area (Nonpoint) Sources – include emissions estimates for sources which individually are too small in magnitude to report as point sources. Examples include residential heating, commercial combustion, asphalt paving, and commercial and consumer solvent use. Beginning in 2008, the NEI includes emissions from the mobile source nonroad categories for commercial marine vessels and underway rail emissions. Prior to 2011, the NEI included vehicle refueling at gasoline service stations in the area sources sector and beginning in 2011 it is included in the on-road sector.

Nonroad Mobile Sources – include off-road mobile sources that use gasoline, diesel, and other fuels (e.g., LPG). Source types include construction equipment, lawn and garden equipment, aircraft ground support equipment, locomotives, and commercial marine vessels. For many nonroad sources, the EPA uses the MOVES-NONROAD model (which assumes that new EPA emissions standards will result in a certain number of off-road sources being replaced every year by new, less polluting off-road sources) and these sources are included in the EIS nonroad Data Category. Starting with the 2008 NEI, some nonpoint sources are included in other EIS Data Categories. Aircraft engine emissions (occurring during landing and takeoff operations) and the ground support and power unit equipment are included in the EIS Point Data Category at airport locations. Locomotive emissions at rail yards are also included in the EIS Point Data Category. Emissions of other locomotive emissions and of commercial marine vessel emissions (both underway and port emissions) are included in the NEI Nonpoint Data Category.

On-road Mobile Sources – include emissions from on-road vehicles that use gasoline, diesel, and other fuels. These sources include light duty and heavy-duty vehicle emissions from operation on roads, highway ramps, and during idling. The MOVES model also computes refueling emissions, which are included in the EIS Nonpoint Data Category. All other on-road source emissions are included in the EIS On-road Data Category.

For Hawaii, year 2005 was selected as the baseline inventory for the first regional haze planning period because it was the most complete inventory at the time technical work commenced for the RH-FIP. The most recent emissions inventory data for tracking the changes in emissions for the second regional haze planning period were obtained from EPA's 2017 NEI. Table 4.1-1 lists the major visibility impairing pollutants inventoried, the related aerosol species, and some of the major sources for each pollutant.

Statewide emissions inventories for SO_2, NO_X, NH_3, VOC, and PM_{10} and $PM_{2.5}$ are provided in Tables 4.1-2 through 4.1-6 for the 2005 baseline, 2011, 2014, 2016, and 2017 inventory years. The 2005 emissions inventory was derived from a 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.[27] The emission inventory numbers developed by Environ Corporation were refined, as applicable, by the Hawaii DOH-CAB. Updated numbers for the 2005 emission inventory are from Reference 25. The updated 2005 emission inventory numbers are also provided in Hawaii's 2017 Regional Haze Progress Report. In addition, the EPA 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. The Hawaii emission inventories provided by Environ were updated with estimations using the MOVES model.

Point source emissions include electric generating units (EGU) point sources, non-EGU point sources, and airport sources. Projected 2028 emissions from point sources account for regional haze control measures established in the second planning period and thus point source pollutants are reduced as reflected in Appendix V.

Table 4.1-1 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	SO_2 emissions are generally associated with anthropogenic sources such as fuel oil fired power plants, large commercial operations such as aggregate processing, and both on-road and off-road diesel engines. 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. 2019 volcanic activity has significantly decreased and led to significantly reduced volcanic SO_2 emissions after the Kilauea Volcano stopped erupting towards the end of 2018. Volcanic SO_2 emissions, however, are expected to increase significantly as the Kilauea Volcano started erupting again on December 20, 2020.

---

[27] 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 4.1-1 Hawaii Pollutants, Aerosol Species, and Major Sources [a]			
Emitted Pollutant	Related Aerosol	Major Sources	Notes
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. 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 10).[12]
Fine Soil	Soil	Windblown Dust; Fugitive Dust; Road Dust; Area Sources	Fine soil is reported here as the crustal or soil components of $PM_{2.5}$.
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 6.

Table 4.1-2 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**	**12,293**
Natural Sources (TPY)						
Volcano	961,366	-	-	-	-	-
Sea Spray	-	-	-	382,637	10,714	-
Windblown Dust	-	-	-	46,808	4,681	-
Wildfire	591	2,156	4,729	9,771	8,305	540
Biogenic	-	4,617	130,153	-	-	-
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 “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” and “Technical Support Document for the Proposed Action on the Federal Implementation Plan for the Regional Haze Program in the State of Hawaii” that updated emission inventory numbers from the final emissions inventory report from ENVIRON.

b. Non-Road Mobile totals include aircraft and locomotive emissions.

c. Marine totals include in/near/underway emissions.

Table 4.1-3 Statewide Emissions Inventory **2011** [a]

Source Category	SO_2	NO_X	VOC	PM_{10}	$PM_{2.5}$	NH_3
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**	**41,082**	**9,955**	**9,206**
Natural Sources (TPY)						
Volcano [d]	406,030	-	-	-	-	-
Sea Spray [e]	-	-	-	382,637	10,714	-
Windblown Dust [e]	-	-	-	46,808	4,681	-
Wildfire	9	99	390	162	127	12
Biogenic [e]	-	4,617	130,153	-	-	-
Total Natural	**406,039**	**4,716**	**130,543**	**429,607**	**15,522**	**12**
All Sources (TPY)						
Total Overall Emissions	**433,777**	**59,908**	**170,996**	**470,689**	**25,477**	**9,218**

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 (USGS DailyAves_720pts.xlsx file provided by Tamar Elias, USGS).
e. Based on emission inventory work from ENVIRON International Corporation for 2002 and 2005 (Reference 25).[27]
f. PM2.5 emissions from Area, Agricultural Burning, Prescribed Burning, On-Road Mobile Sources, Non-Road Mobile Sources, and Marine categories utilized PM2.5/PM10 ratio from 2011 NEI Version 2 emissions.

Table 4.1-4 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 4.1-5 Statewide Emissions Inventory **2016** [a]

Source Category	SO_2	NO_X	VOC	PM_{10}	$PM_{2.5}$	NH_3
Anthropogenic Sources (TPY)						
Point Sources	19,248	23,585	3,904	2,280	2,006	238
Area Sources [b]	98	464	14,556	37,780	7,934	1,579
Agricultural Burning [c]	30	55	77	93	82	391
Prescribed Burning [c]	-	-	-	-	-	-
On-Road Mobile Sources	63	10,387	9,072	630	233	316
Non-Road Mobile Sources	8	3,442	4,404	339	322	7
Marine [d]	267	8,984	443	185	174	2
Total Anthropogenic	**19,715**	**46,917**	**32,456**	**41,307**	**10,750**	**2,533**
Natural Sources (TPY)						
Volcano [e]	2,089,368	-	-	-	-	-
Sea Spray [f]	-	-	-	382,637	10,714	-
Windblown Dust [f]	-	-	-	46,808	4,681	-
Wildfire [c]	258	3,374	14,437	11,340	9,607	838
Biogenic	-	237	31,842	-	-	-
Total Natural	**2,089,626**	**3,611**	**46,279**	**440,785**	**25,002**	**838**
All Sources (TPY)						
Total Overall Emissions	**2,109,341**	**50,528**	**78,735**	**482,091**	**35,752**	**3,371**

a. Point source emissions are from the 2016 NEI data for Hawaii from the EPA" Emissions Inventory System (EIS) Gateway, which in 2016 only includes point sources. All other emissions are from the EPA 2016 Regional Haze Modeling v1 emissions platform (2016fh) for Hawaii (EPA, 2020) unless otherwise noted below. These emissions were extracted directly from the EPA model-ready emission files for the 3-kilometer resolution HI modeling domain, which were provided by Kirk Baker at the EPA on May 20, 2020.

b. Area sources include nonpoint sources (nonpt), fugitive dust (afdust_adj), agricultural ammonia sources (ag), and residential wood combustion (rwc).

c. The agricultural burning emissions reported here are the point source agricultural fires in the modeling platform (ptagfire). Wildland fire and prescribed burning emissions are provided in a single model emissions file (ptfire) and thus could not be disaggregated. The total wild and prescribed fire emissions are reported as wildfire emissions here. Agricultural burning PM2.5 emissions are based on 2016 PM10 emissions along with 2014 EPA NEI PM2.5/PM10 ratio, as no agricultural burning was reported in 2017 EPA NEI.

d. Marine emissions reported here are the domain-wide total from C1 and C2 (cmv_c1c2) and C3 (cmv_c3) commercial marine vessels in the model-ready emission files for the HI 3 km resolution modeling domain, including emissions from outside state waters. This is inconsistent with the emissions reported in the 2014 and 2017 NEI, and thus the 2016 and 2028 marine emissions should not be directly compared to emissions reported for 2014 and 2017.

e. Based on 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 PM10 emissions along with Environ 2005 PM2.5/PM10 ratios.

Table 4.1-6 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**	**15,760**	**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 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 PM10 emissions along with Environ 2005 PM2.5/PM10 ratios.

Table 4.1-7 Projected Statewide Emissions Inventory **2028** [a]						
Source Category	SO_2	NO_X	VOC	PM_{10}	$PM_{2.5}$	NH_3
Anthropogenic Sources (TPY)						
Point Sources [b]	14,619	22,304	3,903	2,136	1,862	225
Area Sources [c]	99	469	13,925	37,950	7,970	1,619
Agricultural Burning	30	55	77	93	82	391
Prescribed Burning	-	-	-	-	-	-
On-Road Mobile Sources	34	3,221	4,024	527	195	272
Non-Road Mobile Sources	6	2,086	3,016	212	201	8
Marine [d]	357	5,658	561	207	195	3
Total Anthropogenic	**15,146**	**33,792**	**25,507**	**41,125**	**10,504**	**2,518**
Natural Sources (TPY)						
Volcano [e]	2,089,368	-	-	-	-	-
Sea Spray [f]	-	-	-	382,637	10,714	-
Windblown Dust [f]	-	-	-	46,808	4,681	-
Wildfire [g]	258	3,374	14,437	11,340	9,607	838
Biogenic [g]	-	237	31,842	-	-	-
Total Natural	**2,089,626**	**3,611**	**46,279**	**440,785**	**25,002**	**838**
All Sources (TPY)						
Total Overall Emissions	**2,104,772**	**37,403**	**71,786**	**481,910**	**35,506**	**3,356**

a. Emissions are from the EPA 2028 Regional Haze Modeling v1 emissions platform (2028fh) for Hawaii (EPA, 2020) unless otherwise noted below. These emissions were extracted directly from the EPA model-ready emission files for the 3-kilometer resolution HI modeling domain, which were provided by Kirk Baker at the EPA on May 20, 2020. Natural (i.e., biogenic, wildland fire, etc.) and agricultural burning emissions were not projected and thus are the same as 2016.

b. Point source emissions include EGU point sources (ptegu), non-EGU point sources (ptnonipm) and airport sources (airport). Projected 2028 emissions from point sources reflect the designated control methodology from the second planning period and thus point source pollutants are reduced as reflected in Appendix V.

c. Area sources include nonpoint sources (nonpt), fugitive dust (afdust_adj), agricultural ammonia sources (ag), and residential wood combustion (rwc).

d. Marine emissions reported here are the domain-wide total from C1 and C2 (cmv_c1c2) and C3 (cmv_c3) commercial marine vessels in the model-ready emission files for the HI 3 km resolution modeling domain, including emissions from outside state waters. This is inconsistent with the emissions reported in the 2014 and 2017 NEI, and thus the 2016 and 2028 marine emissions should not be directly compared to emissions reported for 2014 and 2017.

e. Volcano emissions were not included in the EPA modeling platform. Emissions from 2016 are reported here to be consistent with the other natural source sectors.

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 PM10 emissions along with Environ 2005 PM2.5/PM10 ratios.

g. Wildfire and biogenic emissions were held at 2016 emission levels in the EPA 2028 modeling and so the same emissions are reported here. The agricultural burning emissions reported here are the point source agricultural fires in the modeling platform (ptagfire). Wildland fire and prescribed burning emissions are provided in a single model emissions file (ptfire) and thus could not be disaggregated. The total wild and prescribed fire emissions are reported as wildfire emissions here.

Figures 4.1-1 through 4.1-4, based on emissions inventory data for years 2005 and 2017 from Tables 4.1-2 and 4.1-6, respectively, show that nonanthropogenic (natural) emissions are significant for SO_2, PM_{10}, and VOCs.

As shown in Figure 4.1-1, the average volcanic SO_2 emissions from years 2005 and 2017 dwarf statewide anthropogenic sources of SO_2 from the volcano eruption. Average of years 2005 and 2017 volcanic SO_2 emissions (1,443,490 tons per year) equate to 98% of total statewide volcanic plus anthropogenic SO_2 emissions (27,100 tons per year) during those same years.

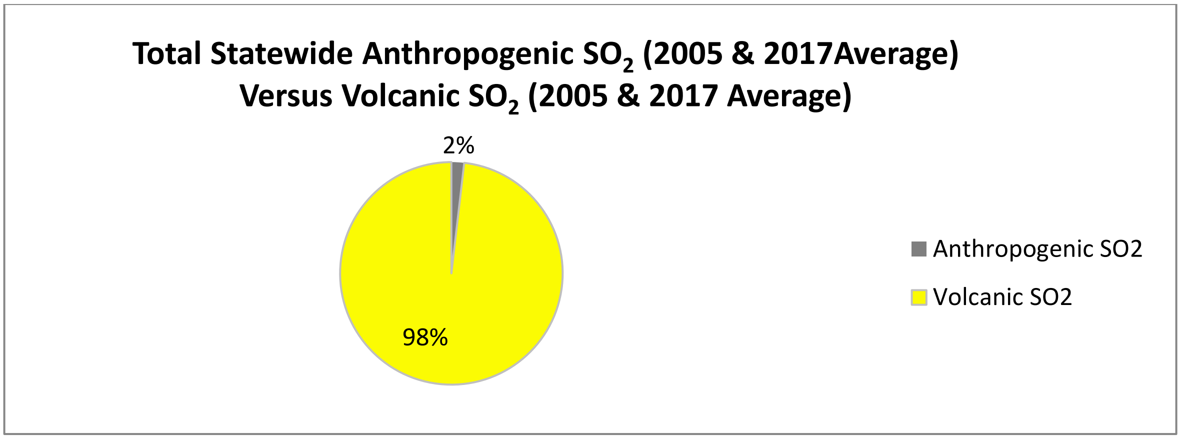


Figure 4.1-1 Average 2005 & 2017 Statewide Anthropogenic SO_2 Versus Average 2005 & 2017 Volcanic SO_2

Kilauea Volcano stopped erupting towards the end of 2018 and volcanic SO_2 decreased for a brief time until Kilauea started erupting again in 2020. Figure 4.1-2 shows that in 2019, SO_2 emissions from the volcano significantly decreased (17,301 tons per year) and would only equate to 39% of the total statewide average 2005 and 2017 volcanic SO_2 plus anthropogenic SO_2 (27,100 tons per year) based on USGS preliminary data. However, the volcano started erupting again in December 2020 which increased SO_2 from this uncontrollable source of emissions. This eruption ended on May 26, 2021, and another eruption started on September 29, 2021. According to USGS personnel, the 2021 eruption is characterized by SO_2 emission rates varying by hundreds to thousands of tons per day.

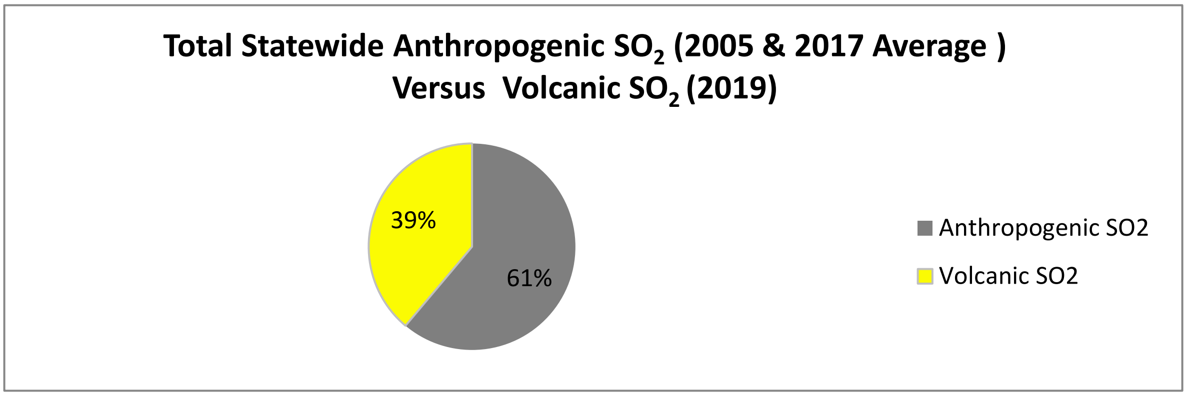


Figure 4.1-2 Average 2005 & 2017 Statewide Anthropogenic SO_2 Versus 2019 Volcanic SO_2 (shows how Hawaii anthropogenic SO_2 emissions are closer to volcanic SO_2 emissions when Kilauea is not actively erupting)

In Figure 4.1-3, statewide PM_{10} emissions from sea spray averaged during years 2005 & 2017 (383,637 tons per year) are significant and account for 92% of the total statewide average 2005 and 2017 sea spray PM_{10} plus anthropogenic PM_{10} emissions (31,581 tons per year).

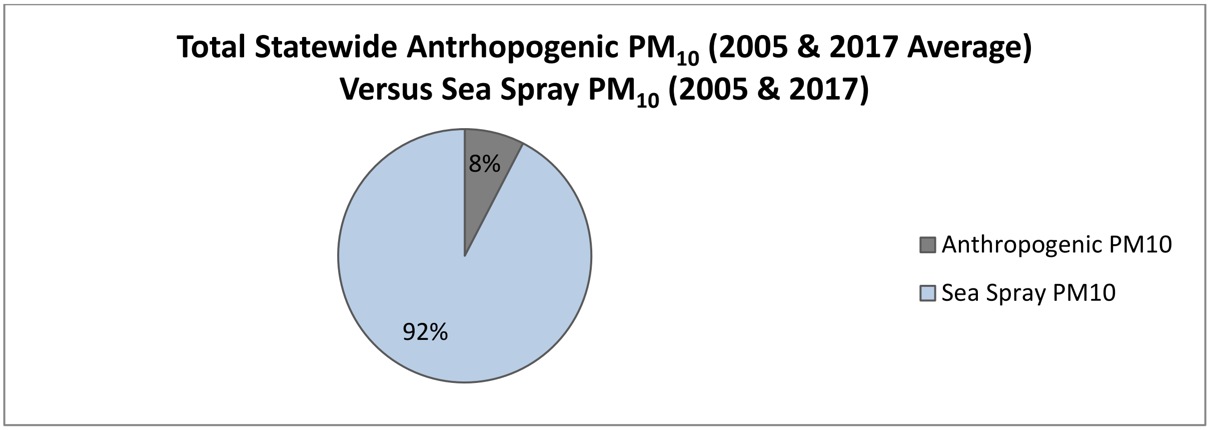


Figure 4.1-3 Average 2005 & 2017 Statewide Anthropogenic PM_{10} Versus Average 2005 & 2017 Sea Spray PM_{10}

Figure 4.1-4 shows that average natural biogenic emissions from plants and soils (129,107 tons per year) are a dominate source of VOC emissions, accounting for 78% of the average total statewide VOC anthropogenic emissions during the same average of years 2005 & 2017 (35,561 tons per year).

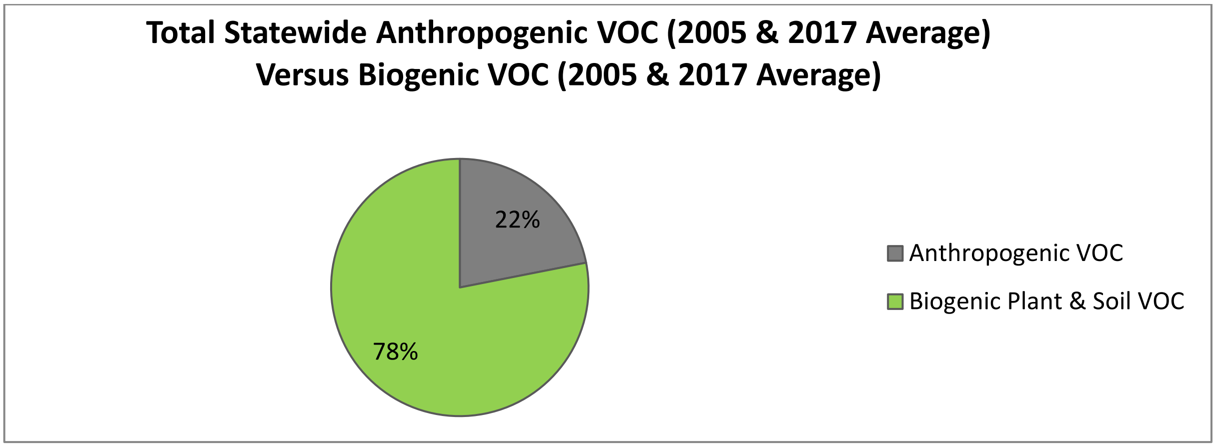


Figure 4.1-4 Average 2005 & 2017 Statewide Anthropogenic VOC Versus Average 2005 & 2017 Biogenic Plant & Soil VOC

4.2 Changes in Emissions – 40 CFR §51.308(g)(5)

This section provides an assessment for any significant changes in anthropogenic emissions in the state that have occurred over the years that have limited or impeded progress in reducing pollutant emissions and improving visibility. Anthropogenic emissions from Tables 4.2-1 to 4.2-5 and Figures 4.2-1 to 4.2-5 show changes in baseline emissions from the first and second planning periods for years 2005 and 2017, respectively. Tables 4.2-6 to 4.2-10 compares 2017 baseline emissions for the second regional haze planning period to projected 2028 emissions.

The difference in statewide SO_2 emission inventory totals from the 2005 and 2017 baselines of the first and second regional haze planning periods, respectively, in Table 4.2-1 and Figure 4.2-1 show an overall forty-eight percent (48%) decrease in SO_2 emissions from 35,575 tons per year in 2005 to 18,623 tons per year in 2017. The only increases in SO_2 is from the other fire/prescribed burning source category. The increase (50 tons per year of SO_2 in 2017 versus 0 tons per year of SO_2 in 2005) is less than one percent (1%) of the total average SO_2 emitted by all anthropogenic sources statewide in the 2005 and 2017 emission years. The largest reductions in terms of tons of SO_2 from 2005 to 2017 came from the point source category (-69%, - 9,807 tons), the commercial marine vessel (marine) category (-97%, - 3,509 tons), and the area source category (-69%, -2,575 tons). Reductions in fuel combustion source's fuel sulfur content have led to lower SO_2 emissions.

Table 4.2-1 Difference in Statewide Anthropogenic SO_2 Emissions

Source Category	Statewide SO_2 (TPY)						
	2005	2011	2014	2016	2017	Difference	Percent Change
Point Sources	27,072	22,047	19,543	19,248	17,265	-9,807	-36%
Area Sources	3,716	3,331	98	98	1,141	-2,575	-69%
Agricultural Burning	178	178	197	30	-	-178	-100%
Other Fire/Prescribed Burning	-	36	534	-	50	50	
On-Road Mobile Sources	321	102	104	63	52	-269	-84%
Non-Road Mobile Sources	669	7	9	8	5	-664	-99%
Marine	3,619	2,037	229	267	110	-3,509	-97%
Total Anthropogenic	**35,575**	**27,738**	**20,714**	**19,715**	**18,623**	**-16,952**	**-48%**

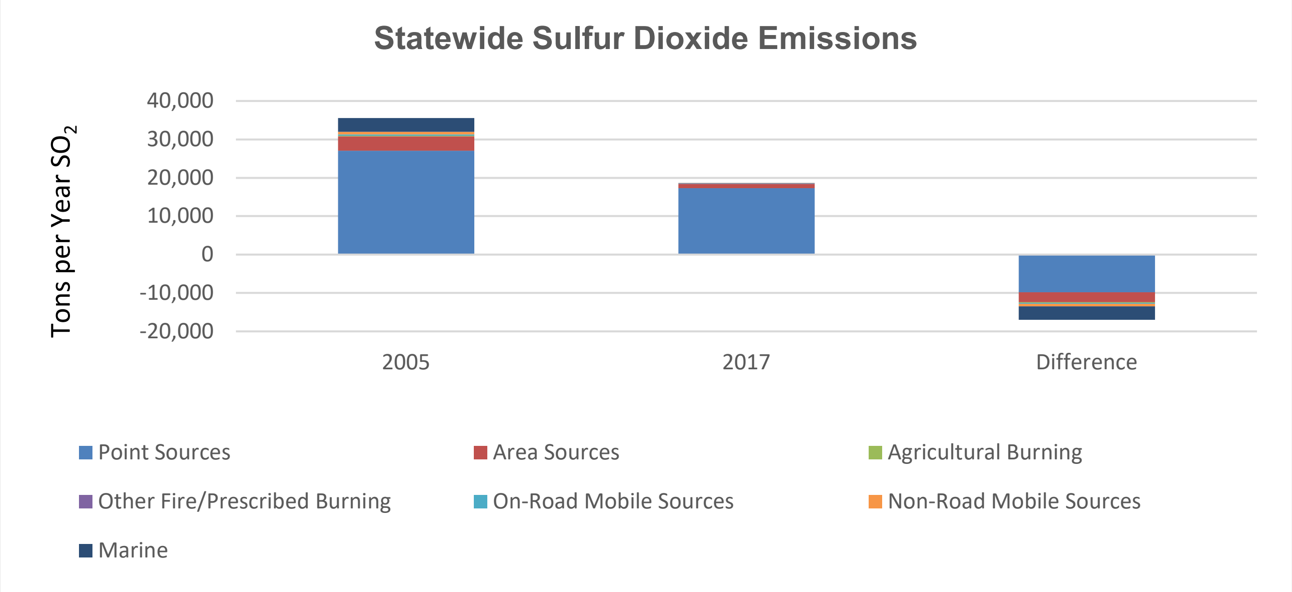


Figure 4.2-1 2005 & 2017 Statewide SO_2 Emissions and Difference

The difference in statewide NO_X emission inventory totals from the 2005 to 2017 baselines of the first and second regional haze planning periods, respectively, in Table 4.2-2 and Figure 4.2-2 show an overall decrease in NO_X emissions. The only increase in NO_X is from the other fire/prescribed burning data category. Overall, NO_X emissions from anthropogenic sources have decreased statewide by thirty-one percent (31%) from 57,223 tons per year in 2005 to 39,509 tons per year in 2017. The increase in NO_X emissions from 2005 to 2017 for the other fire/prescribed burning source category is less significant, accounting for less than 1% of the total NO_X emitted by all sources statewide for both the 2005 and 2017 emission years. NO_X emissions have declined in Hawaii from 2005 to 2017 particularly in the on-road (-55%, -11,315 tons per year) and non-road (-48%, -3,008 tons per year) mobile source categories. Reductions in on-road and non-road emissions are due to federal regulations resulting in emissions reductions from on-road/non-road vehicles and equipment. More efficient on-road/non-road equipment and engines have led to reductions in NO_X emissions, especially in the on-road source category.

Table 4.2-2 Difference in Statewide Anthropogenic NO_X Emissions

Source Category	Statewide NO_X (TPY)						
	2005	2011	2014	2016	2017	Difference	Percent Change
Point Sources	22,745	28,982	26,163	23,585	21,596	-1,149	-5%
Area Sources	1,509	1,176	463	464	807	-702	-46%
Agricultural Burning	406	405	359	55	-	-	
Other Fire/Prescribed Burning	1	389	6,153	-	90	89	>100%
On-Road Mobile Sources	20,642	15,503	12,077	10,387	9,327	-11,315	-55%
Non-Road Mobile Sources	6,296	3,842	3,228	3,442	3,288	-3,008	-48%
Marine	5,624	4,895	1,131	8,984	4,401	-1,223	-22%
Total Anthropogenic	**57,223**	**55,192**	**49,574**	**46,917**	**39,509**	**-17,714**	**-31%**

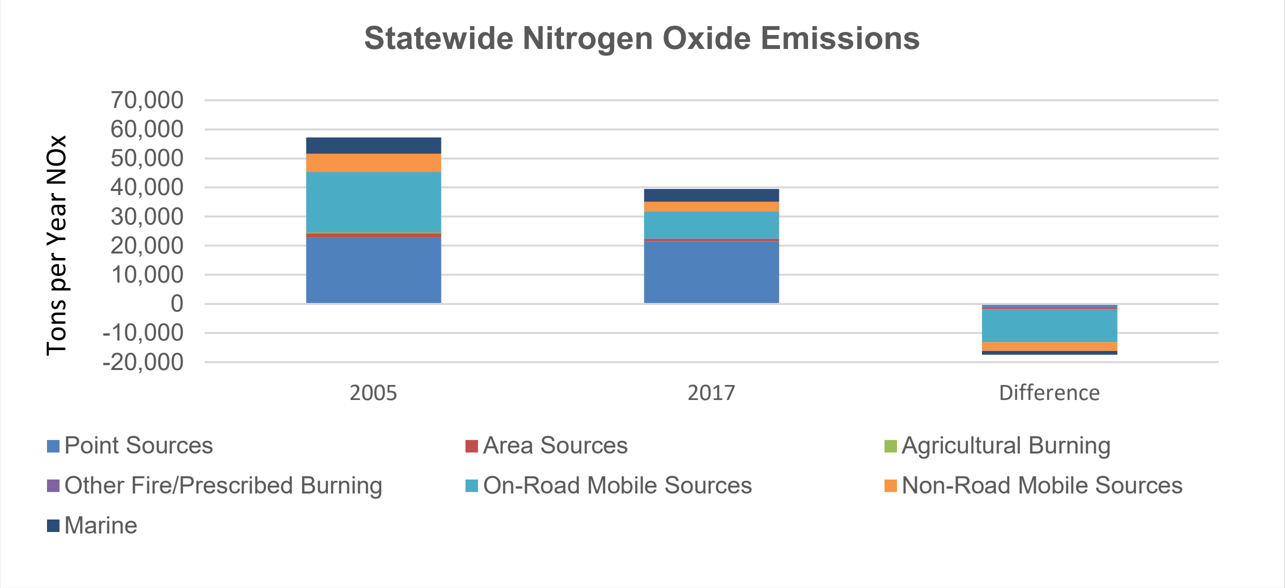


Figure 4.2-2 2005 & 2017 Statewide NO_X Emissions and Difference

The difference in VOC emission inventory totals from 2005 to 2017 baselines of the first and second regional haze planning periods, respectively, in Table 4.2-3 and Figure 4.2-3 show an overall 17% decrease in statewide VOC emissions from 38,815 tons per year in 2005 to 32,307 tons per year in 2017. Increases in VOC emissions from 2005 to 2017 are shown for point, other fire/prescribed fire, and marine source categories. For point and marine source categories, the change is consistent with an Environ 2010 Report that projected an increase in VOCs from these sources from 2005 to 2018. A majority of these point and area source emissions are on the Island of Oahu based on 2017 NEI data. These sources on Oahu would feature prevailing trade winds which would blow pollutants away from the Class I areas a majority of the time. A large increase in VOC emissions from 2005 to 2017 is attributed to the other fire/prescribed burning source category which is about 4% and 5% of the total VOCs emitted by all sources statewide for 2005 and 2017 emission years, respectively.

Table 4.2-3 Difference in Statewide Anthropogenic VOC Emissions

Source Category	Statewide VOC (TPY)						
	2005	2011	2014	2016	2017	Difference	Percent Change
Point Sources	2,695	3,059	4,117	3,904	3,519	824	31%
Area Sources	16,920	18,425	15,162	14,556	14,387	-2,533	-15%
Agricultural Burning	535	535	534	77	-	-535	-100%
Other Fire/Prescribed Burning	7	1,672	29,665	-	1,562	1,555	>100%
On-Road Mobile Sources	12,066	11,180	10,383	9,072	8,109	-3,957	-33%
Non-Road Mobile Sources	6,383	5,428	4,313	4,404	4,454	-1,929	-30%
Marine	209	154	35	443	276	67	32%
Total Anthropogenic	**38,815**	**40,453**	**64,209**	**32,456**	**32,307**	**-6,508**	**-17%**

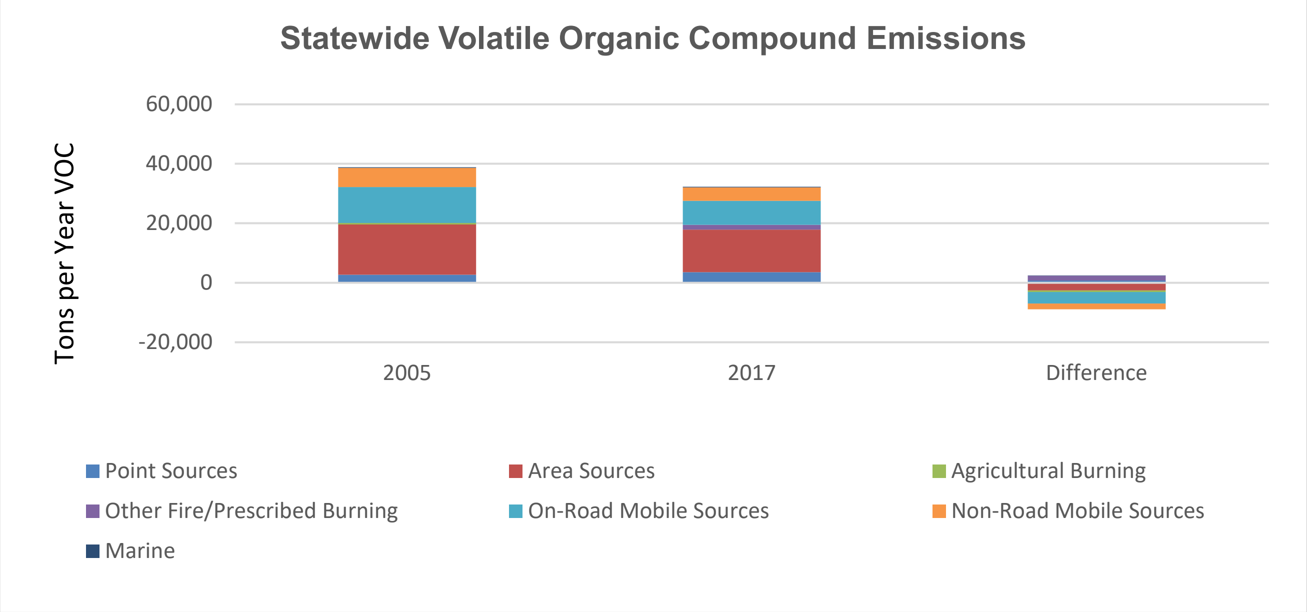


Figure 4.2-3 2005 & 2017 Statewide VOC Emissions and Difference

The difference in Particulate Matter less than 10 µm (PM_{10}) emissions inventory totals from the 2005 to 2017 baselines of the first and second regional haze planning periods, respectively, in Table 4.2-4 and Figure 4.2-4 show an overall 43% decrease in statewide PM_{10} emissions from 40,203 tons per year in 2005 to 22,958 tons per year in 2017. Increases in PM_{10} emissions are shown for other fire/prescribed burning and on-road mobile source categories. For the on-road mobile source category, a majority of the PM_{10} emissions are from Oahu where prevailing trade winds would blow pollutants away from the Class I areas a majority of the time. The total combined increase in PM_{10} emissions from other fire/prescribed burning and on-road mobile source categories is less than four percent 4% of the total PM_{10} emitted by all sources statewide for both the 2005 and 2017 emission years.

Table 4.2-4 Difference in Statewide Anthropogenic PM_{10} Emissions

Source Category	Statewide PM_{10} (TPY)						
	2005	2011	2014	2016	2017	Difference	Percent Change
Point Sources	3,536	2,813	2,583	2,280	2,108	-1,428	-40%
Area Sources	33,408	34,803	54,626	37,780	18,908	-14,500	-43%
Agricultural Burning	1,567	1,567	583	93	-	-1,567	-100%
Other Fire/Prescribed Burning	7	853	14,086	-	673	666	>100%
On-Road Mobile Sources	638	305	770	630	841	203	32%
Non-Road Mobile Sources	649	403	356	339	327	-322	-50%
Marine	398	338	37	185	102	-296	-74%
Total Anthropogenic	**40,203**	**41,082**	**73,042**	**41,307**	**22,958**	**-17,245**	**-43%**

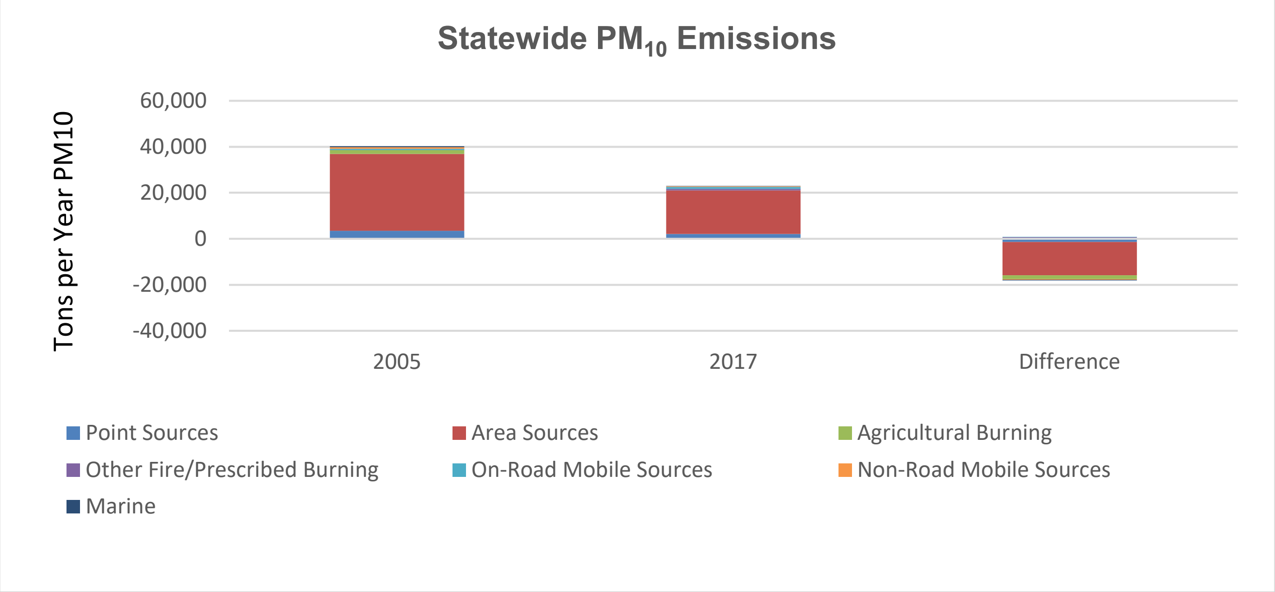


Figure 4.2-4 2005 & 2017 Statewide PM_{10} Emissions and Difference

The difference in Particulate Matter less than 2.5 µm ($PM_{2.5}$) emissions inventory totals from the 2005 to 2017 baselines of the first and second regional haze planning periods, respectively, in Table 4.2-5 and Figure 4.2-5 show an overall 5% increase in statewide $PM_{2.5}$ emissions from 6,791 tons per year in 2005 to 7,131 tons per year in 2017. Increases in $PM_{2.5}$ emissions are shown for other fire/prescribed burning and area source categories. For the area source category, a majority of the $PM_{2.5}$ emissions are from Oahu where prevailing trade winds would blow pollutants away from the Class I areas a majority of the time.

Table 4.2-5 Difference in Statewide Anthropogenic $PM_{2.5}$ Emissions

Source Category	Statewide $PM_{2.5}$ (TPY)						
	2005	2011	2014	2016	2017	Difference	Percent Change
Point Sources	2,900	2,458	2,259	2,006	1,857	-1,043	-36%
Area Sources	1,245	4,409	7,547	7,934	3,991	2,746	221%
Agricultural Burning	1,379	1,441	515	82	-	-1,379	-100%
Other Fire/Prescribed Burning	6	674	11,150	-	571	565	>100%
On-Road Mobile Sources	379	277	300	233	308	-71	-19%
Non-Road Mobile Sources	620	383	337	322	309	-311	-50%
Marine	262	313	35	174	96	-166	-63%
Total Anthropogenic	**6,791**	**9,955**	**22,143**	**10,750**	**7,131**	**340**	**5%**

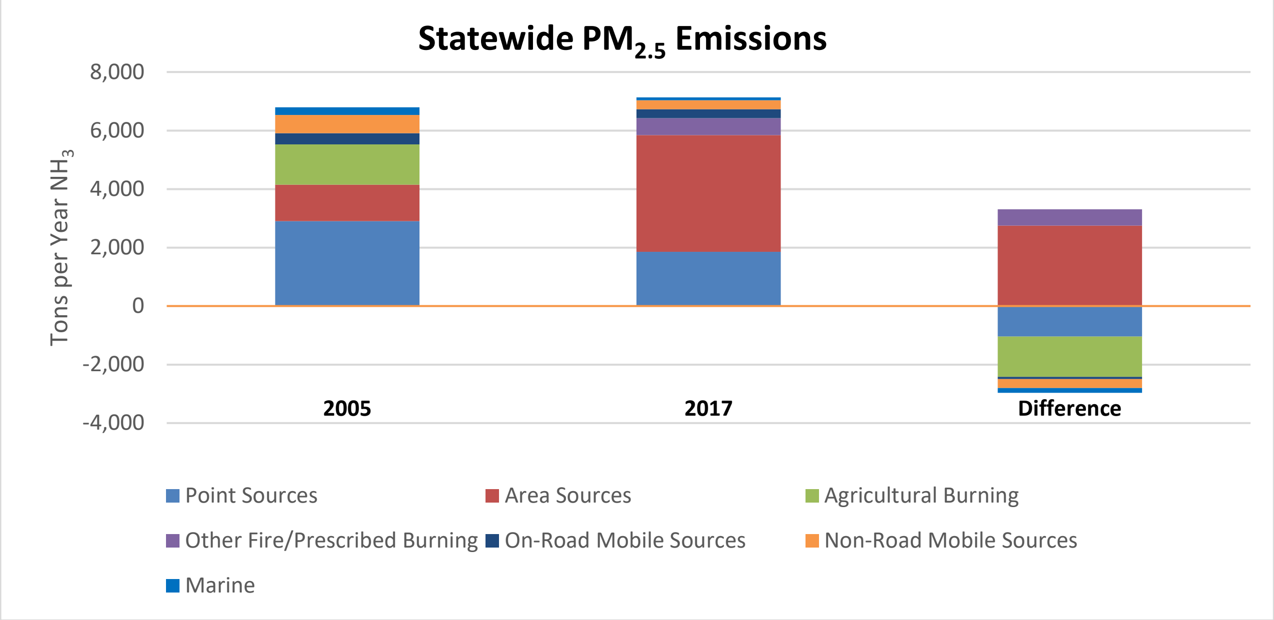


Figure 4.2-5 2005 & 2017 Statewide $PM_{2.5}$ Emissions and Difference

The difference in NH_3 emissions inventory totals from the 2005 to 2017 baselines of the first and second regional haze planning periods, respectively, in Table 4.2-5 and Figure 4.2-5 show an overall 82% decrease in statewide NH_3 emissions from 12,293 tons per year in 2005 to 2,265 tons per year in 2017. Increases in NH_3 emissions are shown for point, other fire/prescribed burning, non-road mobile, and marine source categories. For point sources, non-road mobile and marine source categories, 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 other fire/prescribed burning, non-road mobile, and marine source categories about 1% and 5% of the total NH_3 emitted by all sources statewide for the 2005 and 2017 emission years, respectively.

Table 4.2-6 Difference in Statewide Anthropogenic NH_3 Emissions

Source Category	Statewide NH_3 (TPY)						
	2005	2011	2014	2016	2017	Difference	Percent Change
Point Sources	12	1,031	247	238	232	220	>100%
Area Sources	11,136	7,547	3,884	1,579	1,583	-9,553	-86%
Agricultural Burning	60	148	2,551	391	-	-60	-100%
Other Fire/Prescribed Burning	0	59	951	-	109	109	
On-Road Mobile Sources	1,085	412	338	316	332	-753	-69%
Non-Road Mobile Sources	0	6	6	7	7	7	
Marine	0	3	0	2	2	2	
Total Anthropogenic	**12,293**	**9,206**	**7,977**	**2,533**	**2,265**	**-10,028**	**-82%**

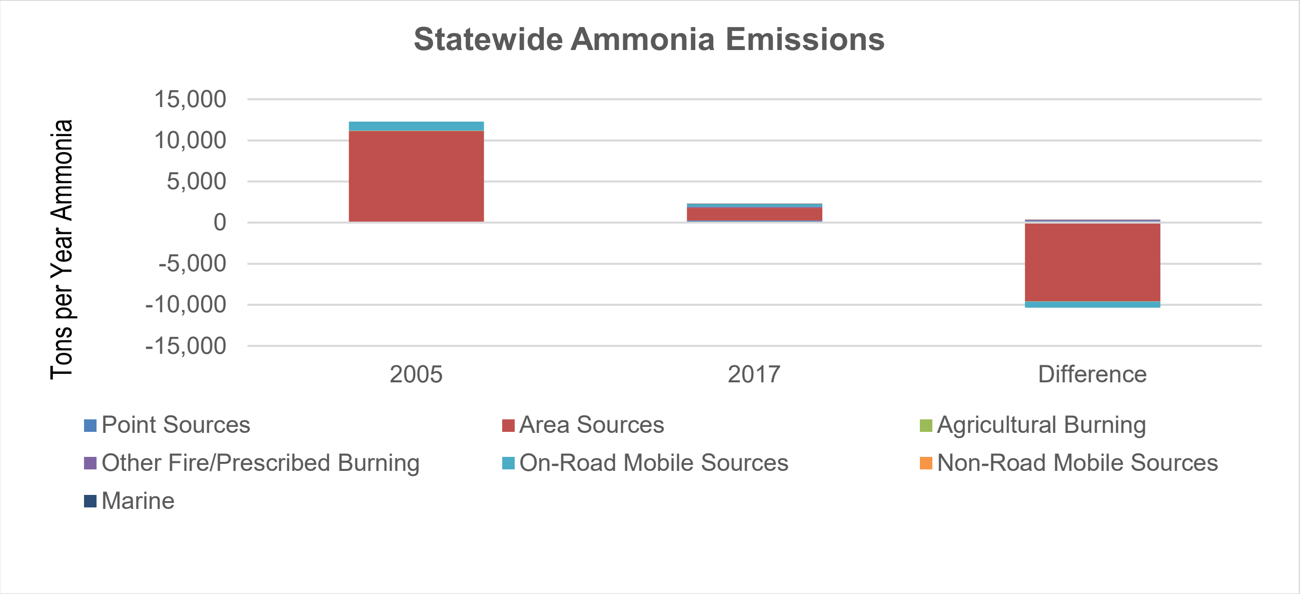


Figure 4.2-6 2005 & 2017 Statewide NH_3 Emissions and Difference

The change in Hawaii emissions from 2017 to projected 2028, based upon data from Tables 4.1-6 (2017) & 4.1-7 (projected 2028) are shown below in Tables 4.2-7 through 4.2-12.

Table 4.2-7 Change in Hawaii SO_2 Emissions 2017 to 2028 (Percent) ^{a,b}

Source Category	SO_2		
	2017	2028	% Change
Point Sources	17,265	14,619	-15%
Area Sources	1,141	99	-91%
Agricultural Burning	-	30	-
Other Fire/Prescribed Burning	50	-	-100%
On-Road Mobile Sources	52	34	-35%
Non-Road Mobile Sources	5	6	12%
Marine	110	357	224%
Anthropogenic Total	18,624	15,146	-19%
Natural Sources	1,925,657	2,089,626	9%
Total	1,944,281	2,104,772	8%

a. Percent change is the emissions percent change from 2017 to projected 2028. A negative % change indicates a projected reduction in emissions in 2028.
b. Natural sources of emissions include volcano, sea spray, windblown dust, wildfire, and biogenic plant and soil emissions.

Table 4.2-8 Change in Hawaii NO$_X$ Emissions 2017 to 2028 (Percent) [a,b]			
Source Category	NO$_X$		
	2017	2028	% Change
Point Sources	21,596	20,669	-4%
Area Sources	807	469	-42%
Agricultural Burning	-	55	
Other Fire/Prescribed Burning	90	-	-100%
On-Road Mobile Sources	9,327	3,221	-65%
Non-Road Mobile Sources	3,288	2,086	-37%
Marine	4,401	5,658	29%
Anthropogenic Total	39,509	33,793	-14%
Natural Sources	1,522	3,611	137%
Total	41,031	37,404	-9%

a. Percent change is the emissions percent change from 2017 to projected 2028. A negative % change indicates a projected reduction in emissions in 2028.

b. Natural sources of emissions include volcano, sea spray, windblown dust, wildfire, and biogenic plant and soil emissions.

Table 4.2-9 Change in Hawaii VOC Emissions 2017 to 2028 (Percent) [a,b]			
Source Category	VOC		
	2017	2028	% Change
Point Sources	3,519	3,903	11%
Area Sources	14,387	13,925	-3%
Agricultural Burning	-	77	-
Other Fire/Prescribed Burning	1,562	-	-100%
On-Road Mobile Sources	8,109	4,024	-50%
Non-Road Mobile Sources	4,454	3,016	-32%
Marine	276	561	104%
Anthropogenic Total	32,307	25,506	-21%
Natural Sources	128,977	46,279	-64%
Total	161,284	71,785	-55%

a. Percent change is the emissions percent change from 2017 to projected 2028. A negative % change indicates a projected reduction in emissions in 2028.

b. Natural sources emissions include volcano, sea spray, windblown dust, wildfire, and biogenic plant and soil emissions.

Table 4.2-10 Change in Hawaii PM_{10} Emissions 2017 to 2028 (Percent) [a,b]

Source Category	PM_{10}		
	2017	2028	% Change
Point Sources	2,108	2,136	1%
Area Sources	18,908	37,950	101%
Agricultural Burning	-	93	
Other Fire/Prescribed Burning	673	-	-100%
On-Road Mobile Sources	841	527	-37%
Non-Road Mobile Sources	327	212	-35%
Marine	102	207	103%
Anthropogenic Total	22,958	41,125	79%
Natural Sources	429,877	440,785	3%
Total	452,835	481,910	6%

a. Percent change is the emissions percent change from 2017 to projected 2028. A negative % change indicates a projected reduction in emissions in 2028.

b. Natural sources of emissions include volcano, sea spray, windblown dust, wildfire, and biogenic plant and soil emissions.

Table 4.2-11 Change in Hawaii $PM_{2.5}$ Emissions 2017 to 2028 (Percent) [a,b]

Source Category	$PM_{2.5}$		
	2017	2028	% Change
Point Sources	1,857	1,862	0%
Area Sources	3,991	7,970	100%
Agricultural Burning	-	82	-
Other Fire/Prescribed Burning	571	-	-100%
On-Road Mobile Sources	308	195	-37%
Non-Road Mobile Sources	309	201	-35%
Marine	96	195	103%
Anthropogenic Total	7,131	10,504	47%
Natural Sources	15,760	25,002	59%
Total	22,891	35,506	55%

a. Percent change is the emissions percent change from 2017 to projected 2028. A negative % change indicates a projected reduction in emissions in 2028.

b. Natural sources of emissions include volcano, sea spray, windblown dust, wildfire, and biogenic plant and soil emissions.

Table 4.2-12 Change in Hawaii NH_3 Emissions 2017 to 2028 (Percent) [a,b]			
Source Category	NH_3		
	2017	2028	% Change
Point Sources	232	225	-3%
Area Sources	1,583	1,619	2%
Agricultural Burning	-	391	
Other Fire/Prescribed Burning	109	-	-100%
On-Road Mobile Sources	332	272	-18%
Non-Road Mobile Sources	7	8	14%
Marine	2	3	41%
Anthropogenic Total	2,265	2,518	11%
Natural Sources	64	838	1209%
Total	2,328	3,356	44%

a. Percent change is the emissions percent change from 2017 to projected 2028. A negative % change indicates a projected reduction in emissions in 2028.
b. Natural sources of emissions include volcano, sea spray, windblown dust, wildfire, and biogenic plant and soil emissions.

The charts below show statewide emission trends from National Emission Inventory (NEI) years 2011, 2014, and 2017, broken down by emission source categories for each visibility impairing pollutant. The charts show a downward trend in emissions from 2011 through 2017. 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 4.2-7 through 4.2-9 show the primary contributors are point sources for SO_2 and NO_X, and area sources for VOC's, NH_3, PM_{10}, and $PM_{2.5}$.

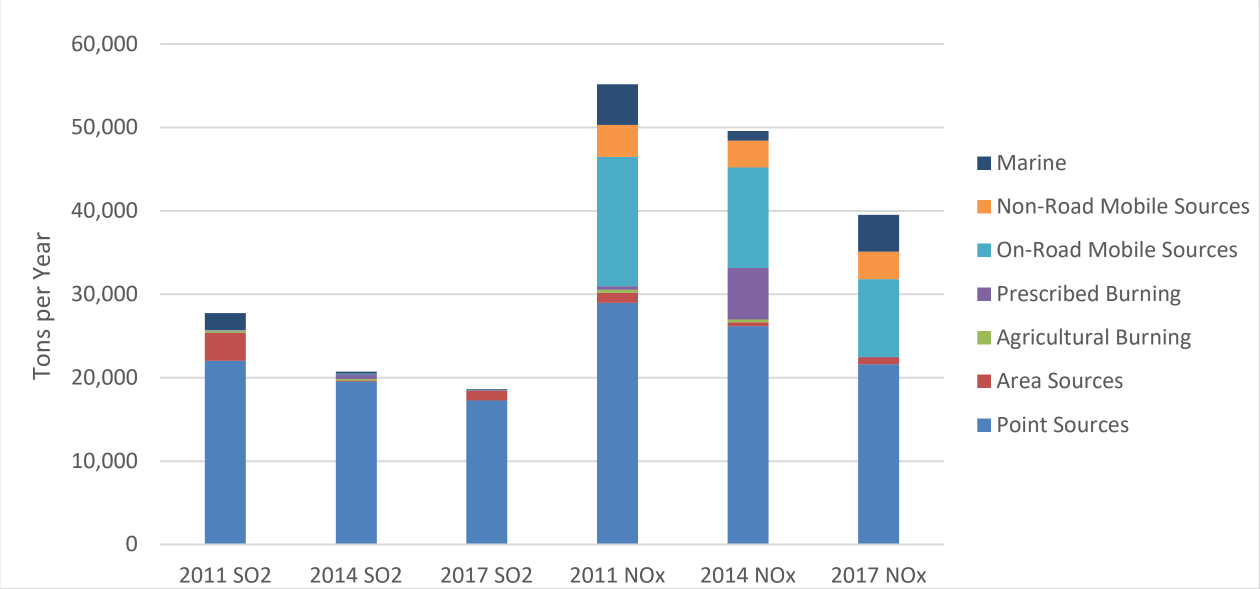


Figure 4.2-7 Hawaii's NEI SO_2 and NO_X Emission Trends

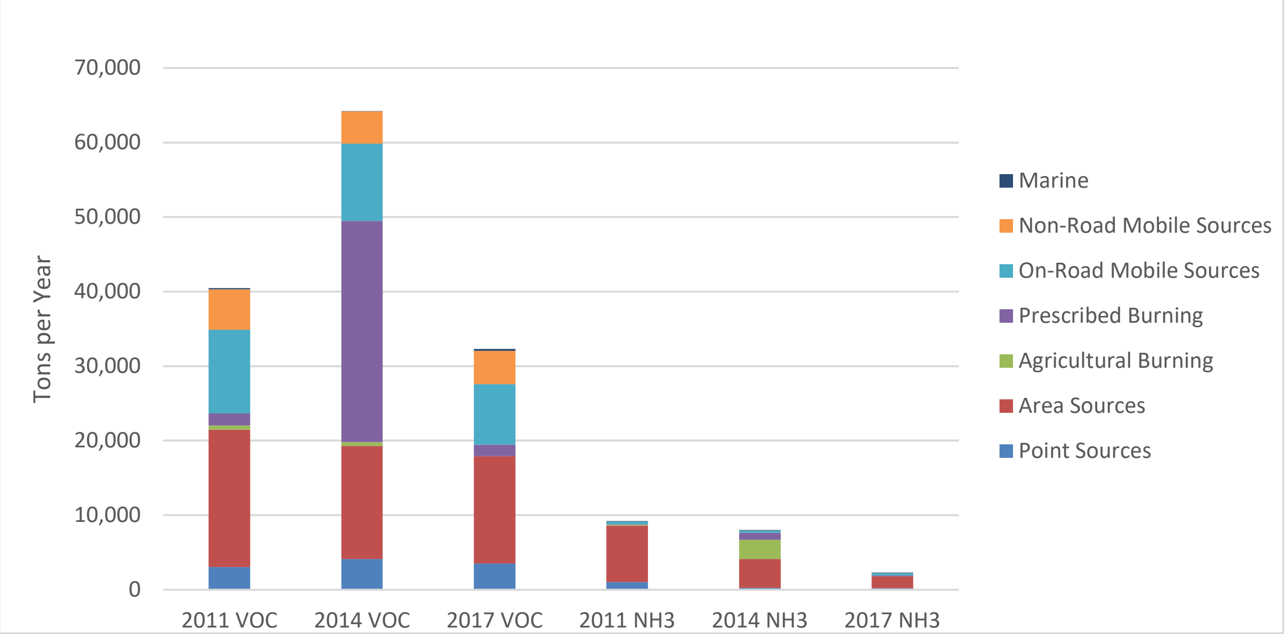


Figure 4.2-8 Hawaii's NEI VOC and NH_3 Emission Trends

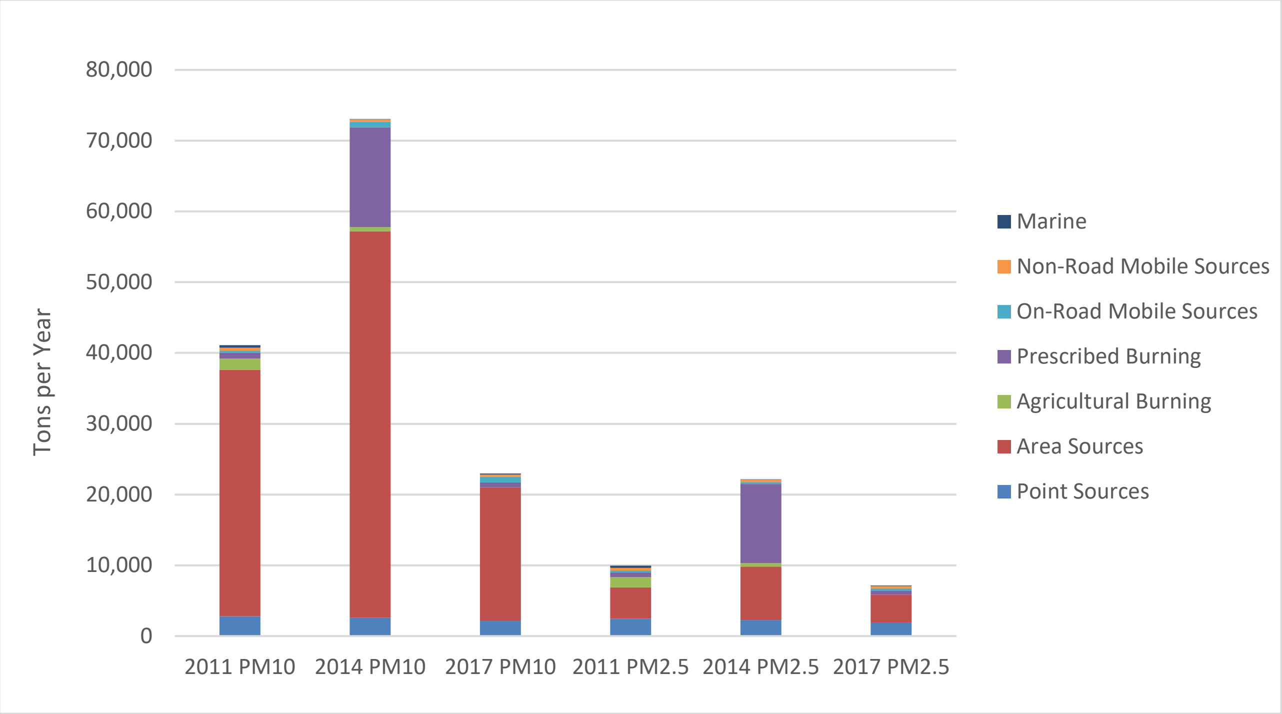


Figure 4.2-9 Hawaii's NEI PM_{10} and $PM_{2.5}$ Emission Trends

Chapter 5 Source Screening

5.0 Screening —40 CFR §51.308(f)(2)(i)

Hawaii first used a Q/d screening tool developed from work led by WRAP with Ramboll US Corporation (Ramboll) to determine which sources required a four-factor analysis. The "Q/d" surrogate for screening is the annual emissions in tons per year (tpy) divided by the distance in kilometers (km) between a source and the nearest Class I area. This surrogate is correlated to a certain degree with visibility impacts as would be estimated with modeling. [28] Electric plants on Oahu, Maui, and the Big Island, identified with Q/d to significantly affected visibility, were notified to provide a four-factor analysis. Please note that the Q/d metric is only a rough indicator of actual visibility impact because it does not consider transport, dispersion, and photochemical processes.[28]

After reviewing four-factor analyses for the seven facilities screened with Q/d, WRAP/Ramboll provided a more sophisticated weighted emissions potential/area of influence (WEP/AOI) analysis to screen facilities. There are differences between the Q/d source screening assessment and the WEP/AOI analysis completed early in February 2021. The Q/d screening provided an assessment of SO_2, NO_X, and PM_{10}, while the WEP/AOI analysis provided an individual Q/d assessment for SO_2 and NO_X. The WEP/AOI also accounted for meteorological data such as wind patterns and the specific light extinction contribution of the particle species (nitrates and sulfates). Based on WEP/AOI rankings, sources selected with Q/d on Oahu which did not rank high in their potential to affect visibility in the national parks were excluded from requiring a four-factor analysis. The WEP/AOI analysis; however, determined that electric plants on Maui and the Big Island and the Mauna Loa Macadamia Nut Corporation plant on the Big Island required a four-factor analysis for regional haze control measures.

5.1 Emissions Inventory and Sources

For the Q/d analysis, draft EPA Guidance in 2016 recommended evaluating eighty percent (80%) of the emissions impact at each Class I area from major and minor stationary sources and area sources to ensure a reasonably large fraction of emissions affecting visibility in the Class I areas on the twenty percent (20%) most impaired days are assessed.[28] As stated in the draft guidance, the eighty percent (80%) threshold, however, may not be fully applicable when Q/d is used as a surrogate for visibility impacts.[28] The 80% threshold was removed from final EPA guidance issued on August 20, 2019.[16] The draft EPA guidance recommended that major sources be compared to the threshold individually, but that minor sources of a similar type be grouped. Except when sources are clustered geographically near a Class I area, all sources including major sources should be grouped and aggregated. Mobile sources were excluded from the screening analysis because the state does not have regulatory authority to control emissions from these sources. The Hawaii Administrative Rules exempt mobile sources from air permitting requirements.

---

[28] Draft Guidance on Progress Tracking Metrics, Long-term Strategies, Reasonable Progress Goals and Other Requirements for Regional Haze State Implementation Plans for Second Implementation Period, U.S. EPA, July 2016. Available at: https://www.epa.gov/sites/production/files/2016-07/documents/draft_regional_haze_guidance_july_2016.pdf

5.2 Haleakala National Park

Haleakala National Park is shown in Figure 5.2-1 shaded in pink. Two (2) noncontiguous regions of the national park are identified in Figure 5.2-2. These regions are labeled “Haleakala NP: big island” and “Haleakala NP: small island”. For the Q/d analysis, a Q/d value is provided based on the emissions and distance between the source and the national park for each noncontiguous region.

5.3 Hawaii Volcanoes National Park

Hawaii Volcanoes National Park is shown in Figure 5.3-1 shaded in pink. Two (2) noncontiguous regions of the national park are identified. These regions are labeled “Hawaii Volcanoes National Park” and “Hawaii Volcanoes National Park: Olaa Tract”. For the Q/d analysis, a Q/d value is provided based on the emissions and distance between the source and the national park for each noncontiguous region.

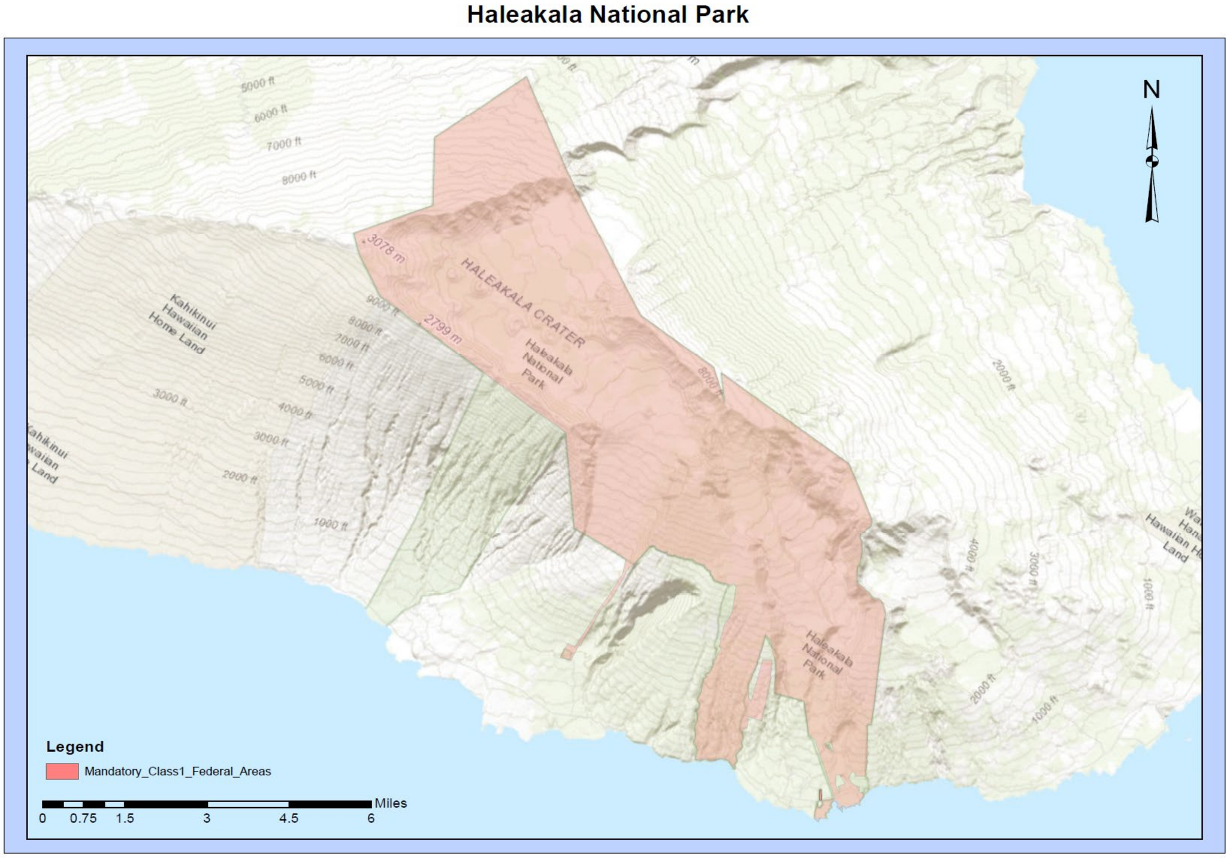


Figure 5.2-1 Map of Haleakala National Park

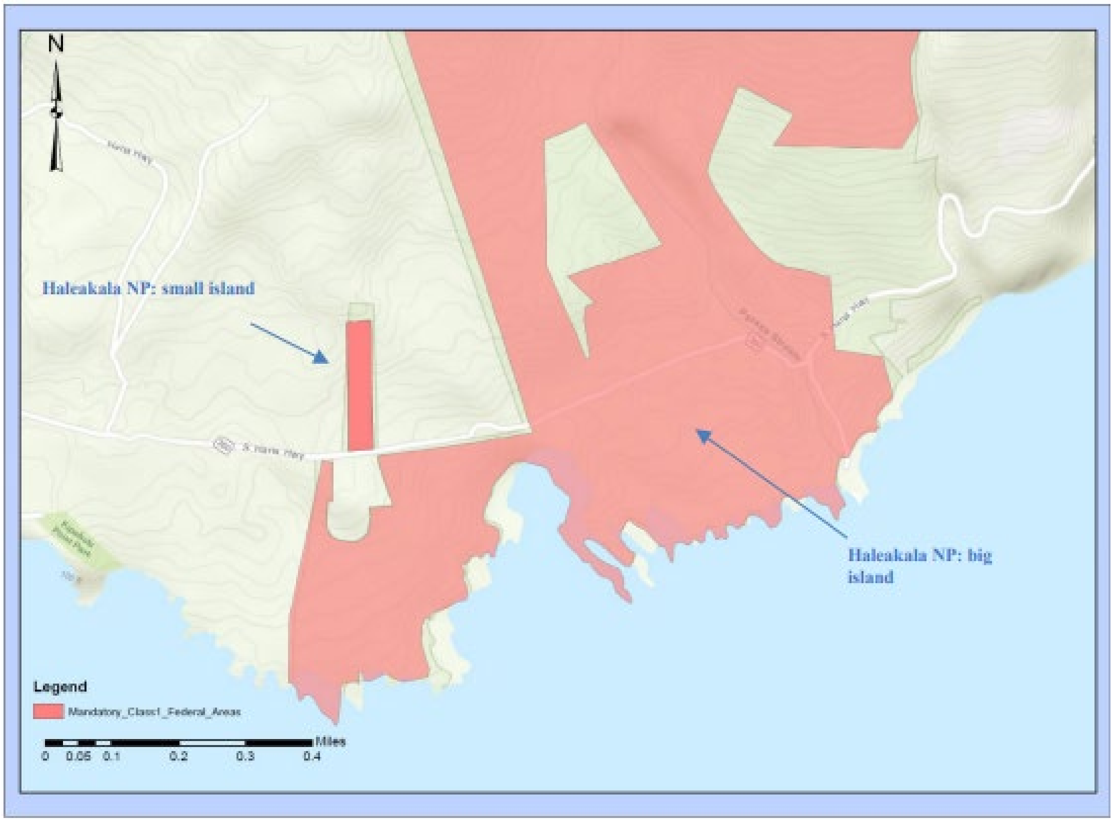


Figure 5.2-2 Map Closeup of Haleakala National Park

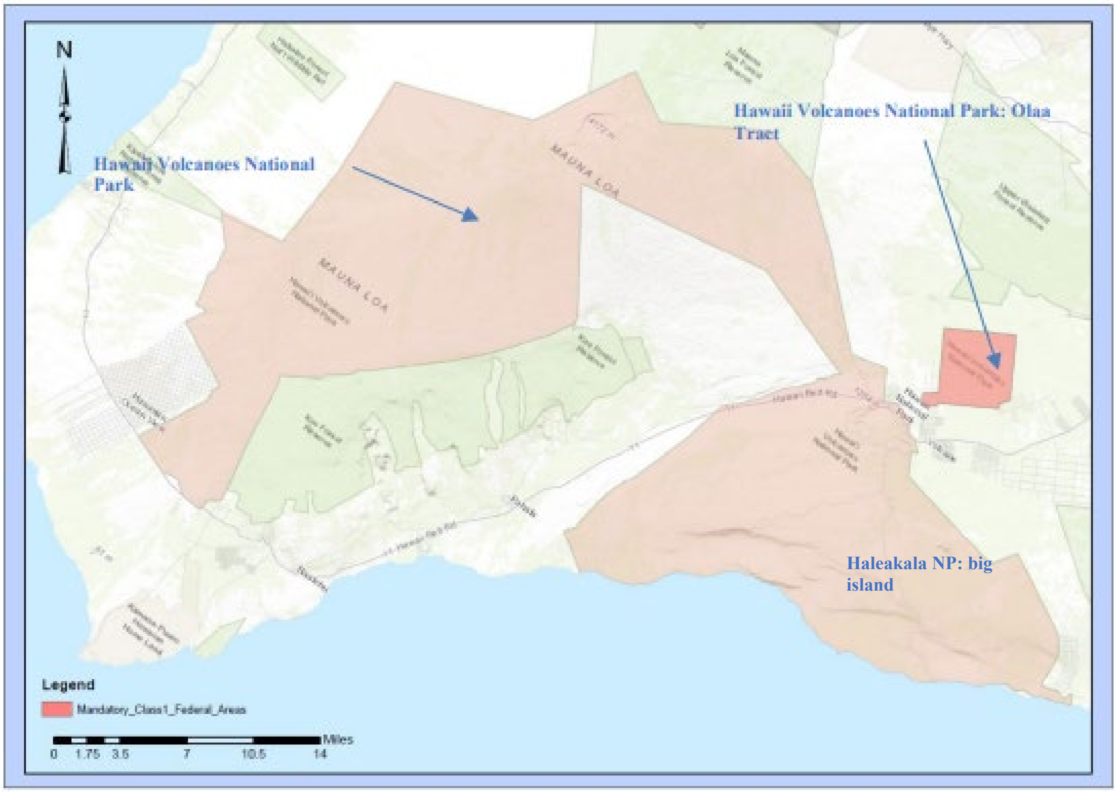


Figure 5.3-1 Map of Hawaii Volcanoes National Park

5.4 Point Source Q/d Screening Methodology

The following were assumed for the Q/d screening analysis using the screening tool developed by Ramboll to assist states with the Q/d screening process:

a. The visibility facility-level emissions are the total combined emissions of nitrogen oxide (NO_X,) sulfur dioxide (SO_2), and particulate matter less than 10 microns in diameter (PM_{10}) - facility level ton per year emission $Q = Q_{NOX} + Q_{SO2} + Q_{PM10.}$
b. Distance (d) from the Class I area in kilometers, includes only facilities within 400 km (250 miles) of a Class I area. When evaluating sources for impacts, the larger of the two (2) Q/d values were used for noncontiguous regions of each national park.
c. Emissions were from the 2014 National Emissions Inventory (NEI)v2.
d. For facilities with multiple emission units/processes, facility location was based on the emission unit/process with the highest Q.
e. Screening thresholds were set at Q = 25 tons per year and Q/d = 10 tpy/km to pre-screen sources for four-factor analysis.

5.5 Point Source Q/d Screening Results

Table 5.5-1 through 5.5-4 below provide a list of point sources identified by the screening analysis with Q greater than 25 and a Q/d greater than 10. The analysis is for each noncontiguous national park region sorted by Q/d in descending order. These sources combined account for 79% to 91% of the total point source Q (91% Haleakala National Park: big island, 88% Haleakala National Park: small island, 79% Hawaii Volcanoes National Park, and 79% Hawaii Volcanoes National Park: Olaa Track.

Table 5.5-1 Haleakala NP: big island

Source [a]	d (km)	Q/d (TPY/km) $NO_x + SO_2 + PM_{10}$	Q (TPY)		
			NO_X	SO_2	PM_{10}
ME – Maalaea Generating Station	25.52	110.18	2,114	549	148
ME – Kahului Power Plant	26.49	82.20	483	1,634	60
HE – Kahe Power Plant	206.11	67.77	7,858	5,555	556
HC & S – Puunene Sugar Mill	23.94	46.77	692	219	209
Kalaeloa Cogeneration Plant	201.09	30.91	2,628	2,917	671
HE – Waiau Power Plant	190.89	30.53	2,844	2,784	200
Kahului Airport	24.41	20.45	438	47	15
HL – Kanoelehua-Hill Power Plant	147.01	17.13	611	1,852	56
AES Hawaii, LLC Cogeneration Plant	201.95	16.01	915	2,243	75
Honolulu International Airport	186.72	11.45	1,903	182	54

a. Hawaiian Electric Company, Inc. (HE), Hawaiian Electric Light Company, Inc. (HL), Maui Electric Company, Limited (ME).

Table 5.5-2 Haleakala NP: small island					
Source	d (km)	Q/d (TPY/km) $NO_x + SO_2 + PM_{10}$	Q (TPY)		
			NO_X	SO_2	PM_{10}
HE – Kahe Power Plant	229.2	60.94	7,858	5,555	556
ME – Maalaea Generating Station	48.49	57.98	2,114	549	148
ME – Kahului Power Plant	50.16	43.41	483	1,634	60
Kalaeloa Cogeneration Plant	224.13	27.74	2,628	2,917	671
HE – Waiau Power Plant	214.19	27.21	2,844	2,784	200
HC&S – Puunene Sugar Mill	47.55	23.54	692	219	209
HL – Kanoelehua-Hill Power Plant	147.66	17.06	611	1,852	56
AES Hawaii, LLC Cogeneration Plant	224.98	14.37	915	2,243	75
Kahului Airport	48.06	10.39	438	47	15
Honolulu International Airport	209.88	10.19	1,903	182	54

Table 5.5-3 Hawaii Volcanoes National Park					
Source	d (km)	Q/d Value (TPY/km) $NO_x + SO_2 + PM_{10}$	Q (TPY)		
			NO_X	SO_2	PM_{10}
HE – Kanoelehua-Hill Power Plant	34.53	72.94	611	1,852	56
HE – Kahe Power Plant	328.98	42.46	7,858	5,555	556
HL – Puna Power Plant	27.46	22.70	70	524	29
Kalaeloa Cogeneration Plant	322.50	19.28	2,628	2,917	671
HE – Waiau Power Plant	318.39	18.31	2,844	2,784	200
ME – Maalaea Generating Station	169.61	16.57	2,114	549	148
ME – Kahului Power Plant	176.82	12.31	483	1,634	60
AES Hawaii, LLC Cogeneration Plant	323.26	10.00	915	2,243	75

Table 5.5-4 Hawaii Volcanoes National Park: Olaa Tract					
Source	d (km)	Q/d (TPY/km) $NO_x + SO_2 + PM_{10}$	Q (TPY)		
			NO_X	SO_2	PM_{10}
HL – Kanoelehua-Hill Power Plant	25.69	98.07	611	1,852	56
HE – Kahe Power Plant	361.50	38.64	7,858	5,555	556
HL – Puna Power Plant	23.01	27.09	70	524	29
Kalaeloa Cogeneration Plant	355.36	17.49	2,628	2,917	671
HE – Waiau Power Plant	349.32	16.68	2,844	2,784	200
ME – Maalaea Generating Station	191.85	14.65	2,114	549	148
ME – Kahului Power Plant	197.82	11.01	483	1,634	60

5.6 Point Sources Considered with Q/d

Table 5.6.1 describes point sources considered for four-factor analysis using the Q/d methodology. The HC&S Puunene Sugar Mill on the island of Maui permanently shut down on December 16, 2016 and was, therefore, removed from the list of sources considered for further evaluation. Listed sources include two (2) independent power producers (IPPs), six (6) plants from the three Hawaiian Electric Utility Companies, and two (2) airports.

Table 5.6-1 Point Sources Considered for Four-Factor Analysis [a]

Facility	Permit No.	Description	Island
IPP Plants			
Facility	**Permit No.**	**Description**	**Island**
AES Hawaii, LLC Cogeneration Plant	CSP No. 0087-02-C	203 MW Coal Fired Generation Plant Consisting of Two (2) CFB Boilers and Two Limestone Dryers. The Boilers are Each Equipped with Lime Injection, SNCR, and a Baghouse.	Oahu
Kalaeloa Partners, L.P. Cogeneration Plant	CSP No. 0214-01-C	Two (2) 86 MW CTs with Steam Injection, Two (2) HRSGs, and 51 MW Steam Turbine.	Oahu
Hawaiian Electric Plants			
Facility	**Permit No.**	**Description**	**Island**
Kahe Power Plant	CSP No. 0240-01-C	Six (6) Boilers (92 MW to 142 MW) and Two (2) 2.5 MW Black Start DEGs.	Oahu
Waiau Power Plant	CSP No. 0239-01-C	Six (6) Boilers (49 MW to 92 MW), 50 MW CT and 52 MW CT.	Oahu
Hawaii Electric Light Plants			
Facility	**Permit No.**	**Description**	**Island**
Kanoelehua-Hill Power Plant[b]	CSP No. 0234-01-C	14.1 MW Boiler, 23 MW Boiler, 11.6 MW CT, 2.0 MW DEG with Oxidation Catalyst, and Three (3) 2.75 MW DEGs with Oxidation Catalyst.	Hawaii
Puna Power Plant [b]	CSP No. 0235-01-C	20 MW CT with water injection, 1,250 hp Black Start DEG, and 15.5 MW Boiler with Multicyclone Dust Collector.	Hawaii
Maui Electric Company, Limited Plants			
Facility	**Permit No.**	**Description**	**Island**
Kahului Power Plant	CSP No. 0232-01-C	Two (2) 5.0 MW Boilers, One (1) 11.5 MW Boiler, and 12.5 MW Boiler.	Maui
Maalaea Generating Station	CSP No. 0067-01-C	Three (3) 2.5 MW DEGs with Oxidation Catalyst and Lube Oil Separator, Six (6) 5.6 MW DEGs with Oxidation Catalyst and Open Crankcase Filtration System, Two (2) 12.5 MW DEGs with Oxidation Catalyst and Open Crankcase Filtration System, Two (2) 12.5 MW DEGs with Oxidation Catalyst, Crankcase Filtration System, and FITR, Two (2) 20 MW CTs with Water Injection, Two (2) HRSGs,18 MW Steam Turbine, Two (2) 20 MW CTs with Water Injection, HRSG, Two (2) 2.5 MW DEGs with Oxidation Catalyst, Lube Oil Separator, and FITR, and 600 kW Black Start DEG.	Maui
Airports			
Facility	**Permit No.**	**Description**	**Island**
Kahului Airport	-------------------	Emissions include those from the landing and take-off portion of aircraft operations and from the ground support equipment at airports.	Maui
Honolulu International Airport	-------------------		Oahu

a: CFB-circulating fluidized bed, NO_x-nitrogen oxide, CT- combustion turbine, DEG-diesel engine generator, FITR-fuel injection timing retard, HRSG-heat recovery steam generator, kW-kilowatt, MW-megawatt, SCR-selective catalytic reduction, and SNCR-selective non-catalytic reduction.

b: Boilers at the Kanoelehua-Hill Power Plant and Puna Power Plant in Hilo on the Big Island are subject to a total combined 3,550 ton per year SO_2 emissions cap based on the reasonable progress goal established in the first regional haze implementation period.

5.7 Point Source Selection with Q/d

The following were determined in selecting point sources for the four-factor analysis with Q/d:

- Airports –-The airports listed in the Table 5.6-1 were excluded from the list of point sources requiring a four-factor analysis because the state does not have authority to regulate emissions from these sources. Pursuant to HAR §11-60.1-62(d)(21), internal combustion engines propelling mobile sources, such as airplanes, are exempt from permitting. In accordance with HAR §11-60.1-62(d), diesel fired portable ground support equipment used exclusively to start aircraft or provide temporary power or support service to aircraft prior to start-up are also exempt from permitting.
- AES Hawaii, LLC –-The two (2) coal fired boilers at this cogeneration plant are each equipped with state-of-the-art air pollution controls. These controls include SNCR with ammonia/urea injection, low temperature-staged combustion, limestone injection, and baghouses as part of PSD/BACT determinations. The permit application review to renew the permit for this plant indicates a 70% NO_X reduction for SNCR, a 75% to 90% SO_2 reduction for limestone injection, and 99.99% PM/PM_{10} reduction for particulate control with the baghouses.

  Based on review of the RACT/BACT/LEAR Clearinghouse[29] for coal burning plants over the past ten (10) years, emission controls for the AES Hawaii, LLC facility were consistent with those determined to be BACT for other coal fired plants. Therefore, a four-factor analysis would likely result in the conclusion that no further controls would be reasonable. In addition, the permit for this facility was amended to comply with Hawaii Act 023 (September 14, 2020) for the cessation of coal burning. There is a federally enforceable emission limit specified in the permit for this cogeneration plant to cease all coal burning or consumption of coal by December 31, 2022. Please see amended permit to incorporate a GHG emission cap for partnering facilities at: https://health.hawaii.gov/cab/files/2020/10/2020_10_28_DFileNo_20-439E_0087-02-C.pdf. However, it is important to note that the AES Hawaii, LLC facility, located on Oahu, was screened out from performing a four-factor analysis by the WEP/AOI analysis, because it does not contribute in any significance to haze in Hawaii's national parks. The WEP/AOI analysis ranks the top 10 facilities that contribute to haze in Hawaii's national parks, and point source contribution potential of nitrates and sulfates for the AES Hawaii, LLC cogeneration plant was 0.01% for Haleakala National Park and 0.10% and 0.01%, respectively, for Hawaii Volcanoes National Park. The WEP/AOI analysis considers meteorology, haze species, emissions and distance from the national parks. Therefore, the AES Hawaii, LLC facility was screened out of requiring further analysis.

  According to a December 12, 2022, letter from AES Hawaii, LLC, the Coal-Fired Cogeneration Plant and associated structures located in Kapolei, Oahu are being decommissioned in preparation for demolition in the first quarter of 2023.

---

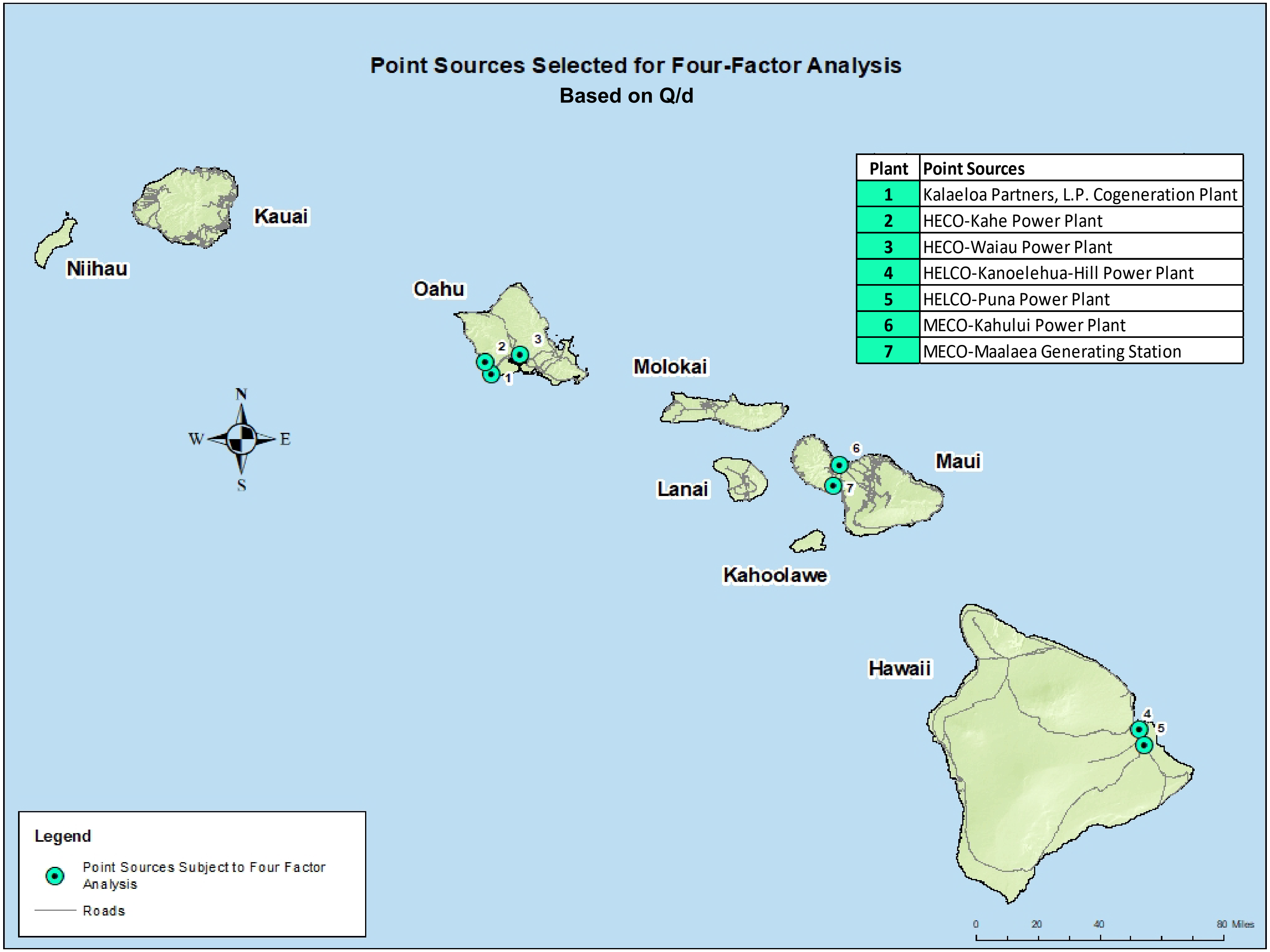
[29] USEPA. 2017. RACT/BACT/LAER Clearinghouse (RBLC). Available at: https://cfpub.epa.gov/RBLC/index.cfm?action=Home.Home&lang=en .Accessed: June 2019.

- Table 5.7-1 shows point sources selected for four-factor analysis using Q/d methodology:

Table 5.7-1 Point Sources Selected for Four-Factor Analysis

Source	Q (TPY)	d (km)	Q/d	Class I Area
Kalaeloa Partners, L.P. Plant	6,216	201.9	30.91	1) Haleakala NP
HE -–Kahe Power Plant	13,968	206.11	67.77	1) Haleakala NP
		328.98	42.46	2) Hawaii Volcanoes NP
HE -–Waiau Power Plant	5,828	190.89	30.53	1) Haleakala NP
		318.39	18.31	2) Hawaii Volcanoes NP
HL -–Kanoelehua-Hill Power Plant	2,519	147.01	17.13	1) Haleakala NP
		25.69	98.07	2)Hawaii Volcanoes NP
HL -–Puna Power Plant	623	23.01	27.09	1) Hawaii Volcanoes NP
ME -–Kahului Power Plant	2,177	26.49	82.20	1) Haleakala NP
		176.82	12.31	2) Hawaii Volcanoes NP
ME -–Maalaea Generating Station	3,508	25.52	110.18	1) Haleakala NP
		169.61	16.57	2)Hawaii Volcanoes NP

- Point sources selected for four-factor analysis based on Q/d screening are shown on map in Figure 5.7-1. Electric plant sources, including sources on Oahu, selected in the Q/d analysis were sent notifications to provide a four-factor analysis (Appendix B). Four-factor analyses for these facilities were submitted for the state to review (Appendices D-F for sources on Oahu) and (Appendices G-J for sources on the Big Island and Maui). Sources on Oahu were later excluded from the four-factor analysis based on results from the WEP/AOI analysis.



Plant	Point Sources
1	Kalaeloa Partners, L.P. Cogeneration Plant
2	HECO-Kahe Power Plant
3	HECO-Waiau Power Plant
4	HELCO-Kanoelehua-Hill Power Plant
5	HELCO-Puna Power Plant
6	MECO-Kahului Power Plant
7	MECO-Maalaea Generating Station

Figure 5.7-1 Point Sources Selected for Four-Factor Analysis Based on Q/d

5.8 2017 Point Source Emissions – 40 CFR §51.308(f)(2)(iii)

The 2014 v2 national emissions inventory (NEI) data (available September 2017) was used for baseline Q/d screening. Since 2017 NEI data was not available in a finalized form until February 2020, the DOH-CAB did not believe it practicable to revise the Q/d screening using 2017 NEI data after WRAP already used the 2014 NEI data to determine the applicable Q/d facilities subject to requirements to submit a four-factor analysis.

Nonetheless, 2017 SLEIS emissions were checked to determine if any additional point source facilities would have been pulled into the four-factor analysis. Results showed that no additional 2017 facilities would have exceeded Q/d ≥10, and further that the HL Puna facility would have been screened out (Q/d = 9.88). Since HL Puna Q/d is so close to ten (10) and no permit limitations were included to ensure that future Q/d will not exceed 10, Puna Generating Station was assumed to be screened into the four-factor analysis based upon the 2014 NEI data.

5.9 Other Considerations

The following are two key issues in screening facilities for four-factor analysis that were not covered by the Q/d screening analysis:

Trade Winds
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 5.9-1 with wind data from Honolulu International Airport, Molokai Airport, and Kahului International Airport showing predominate northeast trade winds for these islands between years 2015 and 2019. Wind roses with the wind data are shown in Appendix C.

Meteorology
A more sophisticated WEP/AOI analysis, using meteorology and grided emissions from EPA's photochemical modeling, was performed to determine the potential of sources to contribute to visibility impairment at the national parks for the most impaired days. This methodology to screen sources for four-factor analysis would be more representative than screening with Q/d; especially for sources in Hawaii with prevailing trade winds and sources on Oahu down-wind and hundreds of miles away from the national parks. The WEP/AOI analysis is detailed in Section 5.10 of this RH-SIP.

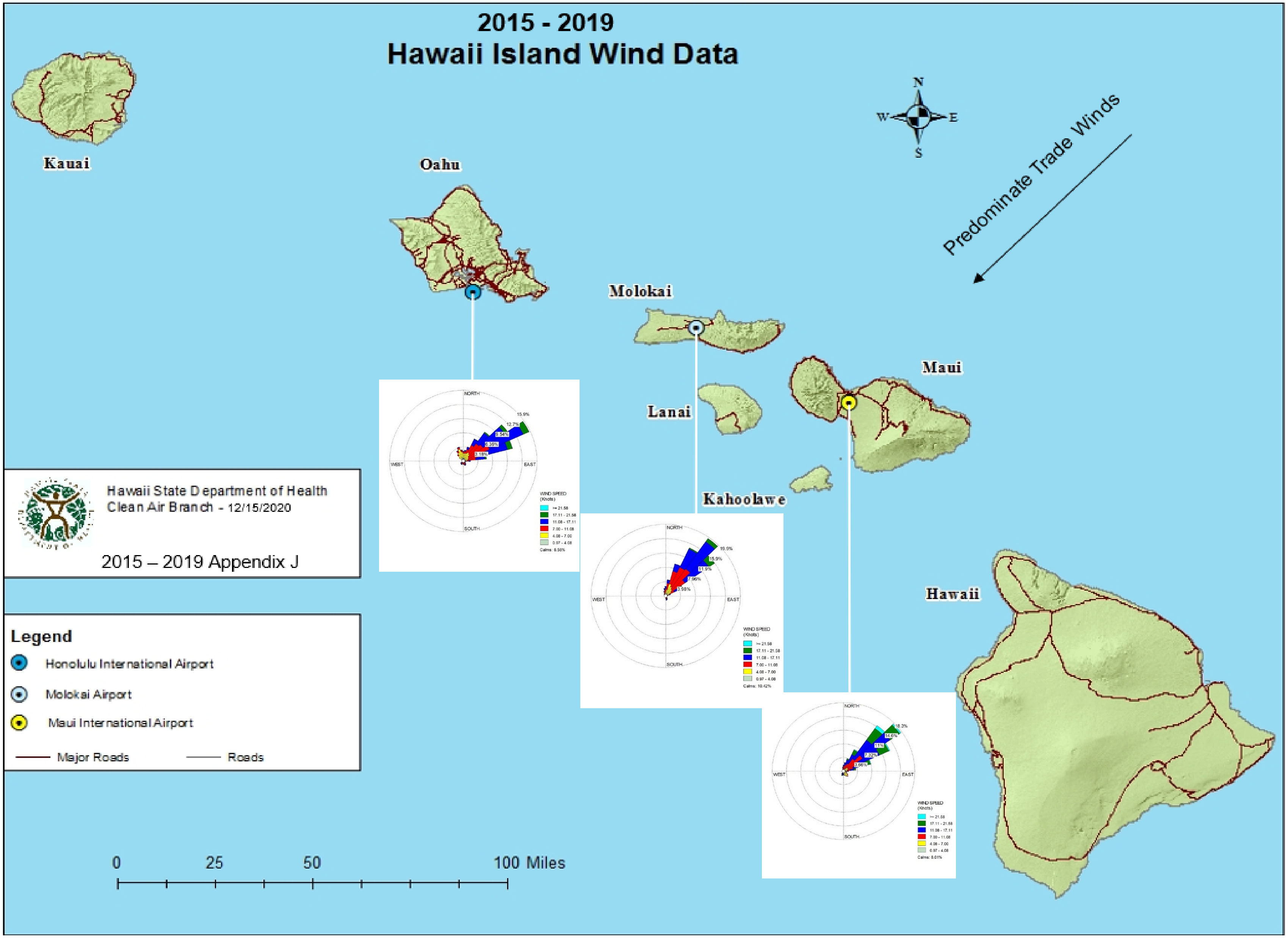


Figure 5.9-1 2015-2019 Wind Data for Oahu, Molokai, and Maui Islands

5.10 WEP/AOI Analysis

A WEP/AOI analysis was conducted by WRAP/Ramboll with hybrid single-particle lagrangian integrated trajectory (HYSPLIT) back trajectories to regional haze IMPROVE monitoring sites on the most impaired days. The WEP/AOI analysis was performed using both gridded emissions from the EPA's 2016 Hawaii modeling platform and 2017 and 2028 facility-level emissions data provided by Hawaii's Clean Air Branch. The 2028 emission reductions were used in conjunction with the 2017 NEI data to arrive at 2028 facility-level emissions based on information from Hawaiian Electric's PSIP. Plots of gridded emissions of NO_X, SO_X, PEC (primary elemental carbon), and POA (primary organic aerosols) from EPA's 2016 Hawaii modeling platform were used for the HYSPLIT model for the analysis of Ammonium Nitrate (Amm_NO_3), Ammonium Sulfate (Amm_SO_4), organic aerosol (OA), and elemental carbon (EC). The residence time (RT) of the most impaired day back trajectories was calculated for grid cells of EPA's 27-km modeling domains. The RT analysis provides an area of influence or frequency of occurrence that back trajectories passing over a grid cell arrive at the Class I area on the most impaired days. The RT analysis was expanded to an extinction weighted residence time (EWRT) analysis by weighting the HYSPLIT back trajectories by the daily light extinction on the most impaired days at the Class I areas for specific particulate species. Major point source emissions were overlaid with the EWRT to provide a ranking of the facility's visibility precursor emissions potential to contribute to visibility impairment at the national parks for the most impaired days.

HYSPLIT calculated back trajectories to arrive at the IMPROVE sites on the most impaired days from 2014 to 2018. The HYSPLIT model simulated 72-hour (3-day) back trajectories arriving at each of the sites on the most impaired days at four (4) times a day local standard time (06:00, 12:00, 18:00, and 24:00). The back trajectories were calculated to arrive at the IMPROVE sites on the most impaired days at four (4) different heights above ground level (100 m, 200 m, 500 m, and 1,000 m). The WEP/AOI plots represent the potential 2016 emissions to Haleakala NP and Hawaii Volcanoes NP.

Figures 5.10-1 and 5.10-2 provide RT plots aggregated from all four (4) trajectory heights for Haleakala National Park and Hawaii Volcanoes National Park, respectively. The RT plots of individual trajectory heights (100 m, 200 m, 500 m, and 1,000 m) can be obtained by accessing the WRAP TSS. The RT is the frequency that air masses passed over a location prior to arriving at a specific Class I area, as defined by HYSPLIT back trajectories.

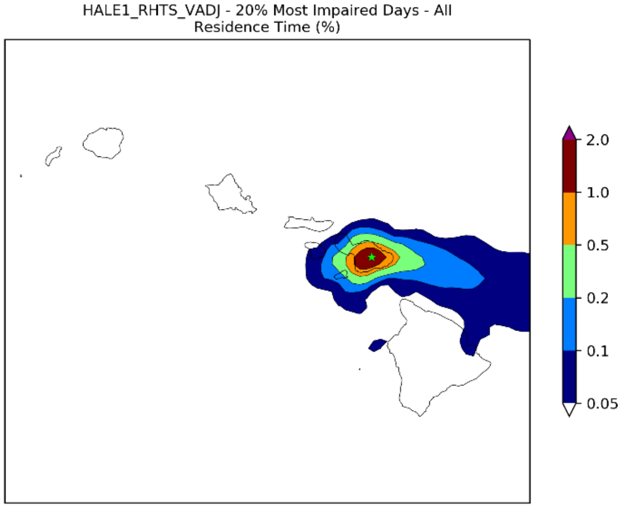


Figure 5.10-1 Haleakala NP, RT

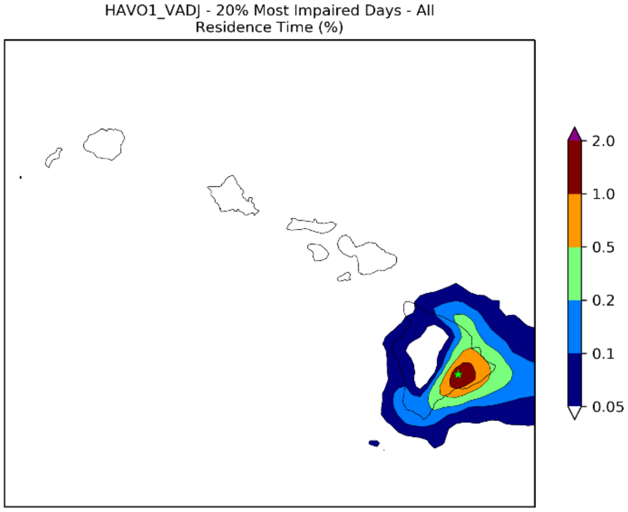


Figure 5.10-2 Hawaii Volcanoes NP, RT

Figures 5.10-3 through 5.10-6 provide EWRT plots (all heights) for Haleakala NP and Hawaii Volcanoes NP. The EWRT provides the relative probability that sources of the visibility precursor in the grid cell contributed to extinction at the national park on the MIDs.

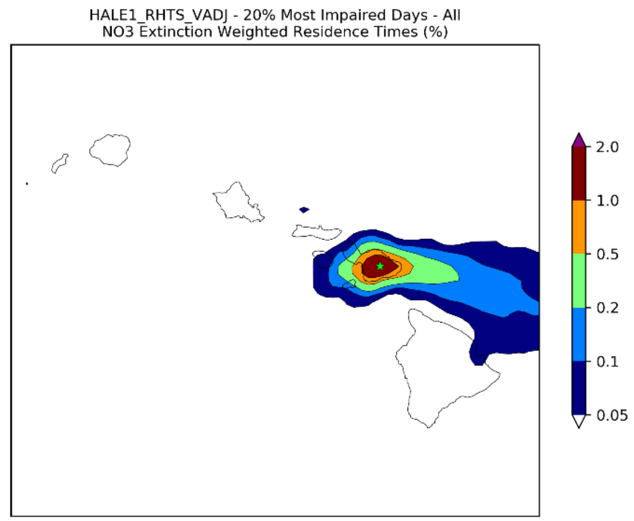

HALE1_RHTS_VADJ - 20% Most Impaired Days - All
NO3 Extinction Weighted Residence Times (%)

Figure 5.10-3 Haleakala NP, EWRT Amm_NO_3

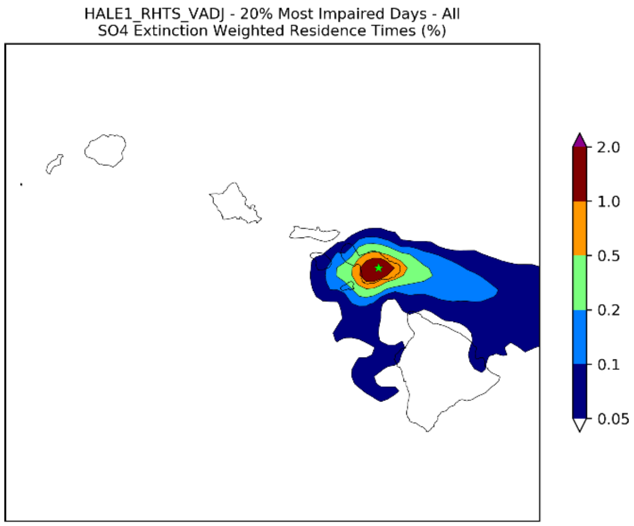

HALE1_RHTS_VADJ - 20% Most Impaired Days - All
SO4 Extinction Weighted Residence Times (%)

Figure 5.10-4 Haleakala NP, EWRT Amm_SO_4

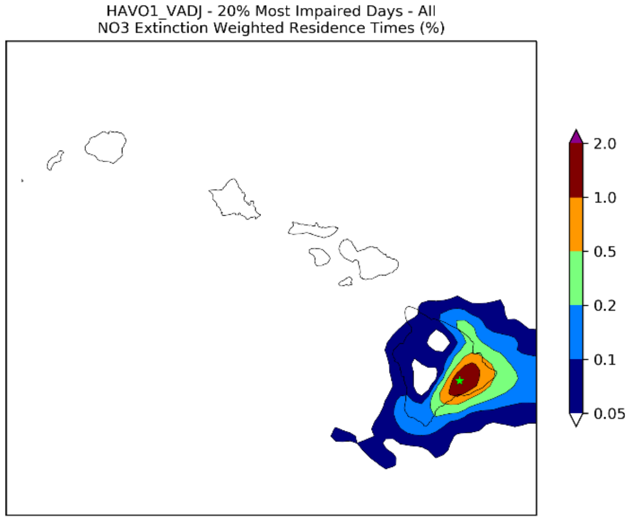

HAVO1_VADJ - 20% Most Impaired Days - All
NO3 Extinction Weighted Residence Times (%)

Figure 5.10-5 HAVO1 NP, EWRT Amm_NO_3

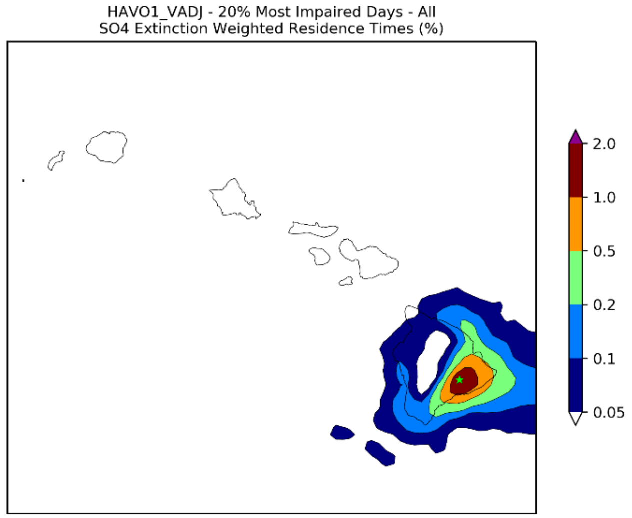
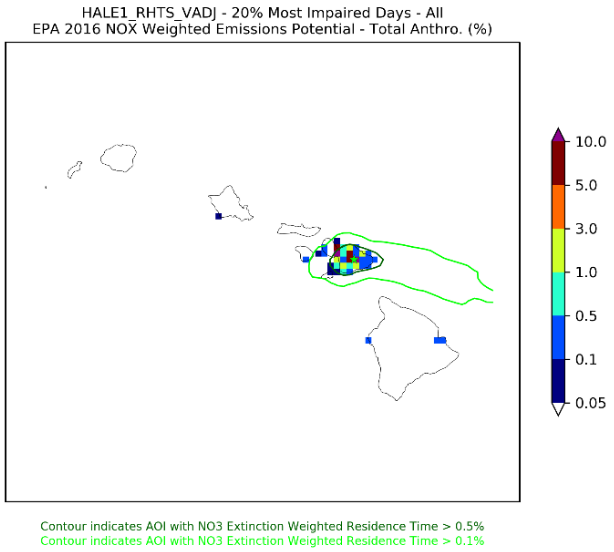

HAVO1_VADJ - 20% Most Impaired Days - All
SO4 Extinction Weighted Residence Times (%)

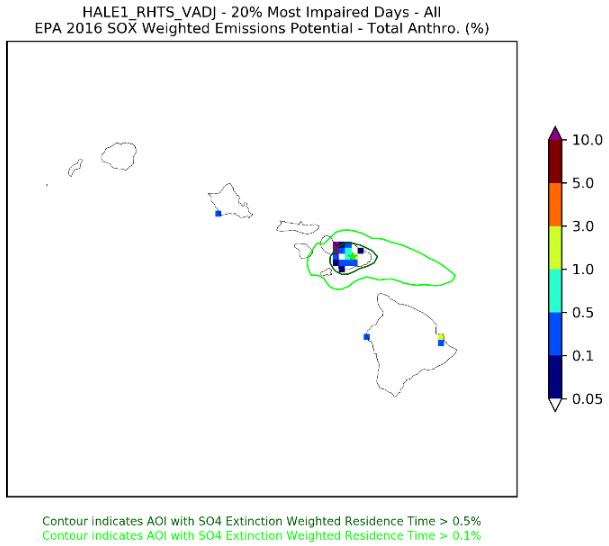
Figure 5.10-6 HAVO1 NP, EWRT Amm_SO_4

Figures 5.10-7 through 5.10-10 are WEP plots (all heights) that combine emissions and AOIs. The WEP is calculated by overlaying the EWRT results with emissions of light extinction precursors (e.g., NO_X emissions for ammonium nitrate extinction). The results are normalized by the sum of the WEP for total anthropogenic emissions. The dark and light green isopleths in the WEP plots that correspond to the 0.5 and 0.1 percent frequency from the corresponding EWRT are the AOIs. The AOIs indicate geographic areas where the haze species are coming from. Source grids within the light green, 0.5 percent frequency range are more likely to contribute to haze than those within the dark blue 0.1 percent frequency range. Each grid location contains at least one point source but may contain more than one point source. Grids that show up far away from the isopleths, such as the South-West corner of Oahu, contribute less than sources within the 0.5 and 0.1 isopleths.


HALE1_RHTS_VADJ - 20% Most Impaired Days - All
EPA 2016 NOX Weighted Emissions Potential - Total Anthro. (%)

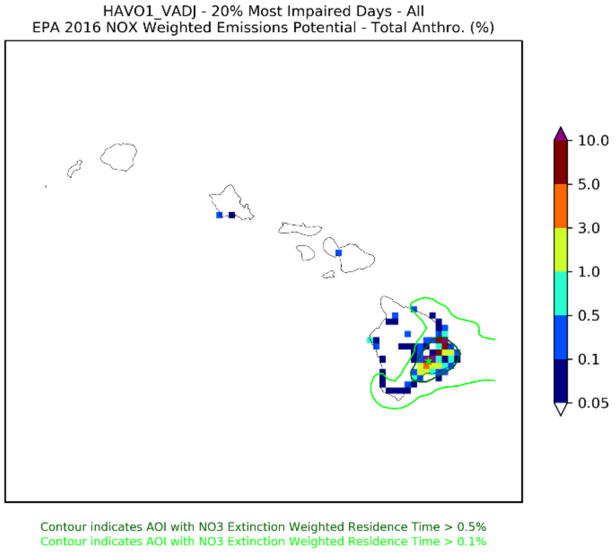
Contour indicates AOI with NO3 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with NO3 Extinction Weighted Residence Time > 0.1%

Figure 5.10-7 Haleakala NP, WEP Amm_NO_3


HALE1_RHTS_VADJ - 20% Most Impaired Days - All
EPA 2016 SOX Weighted Emissions Potential - Total Anthro. (%)

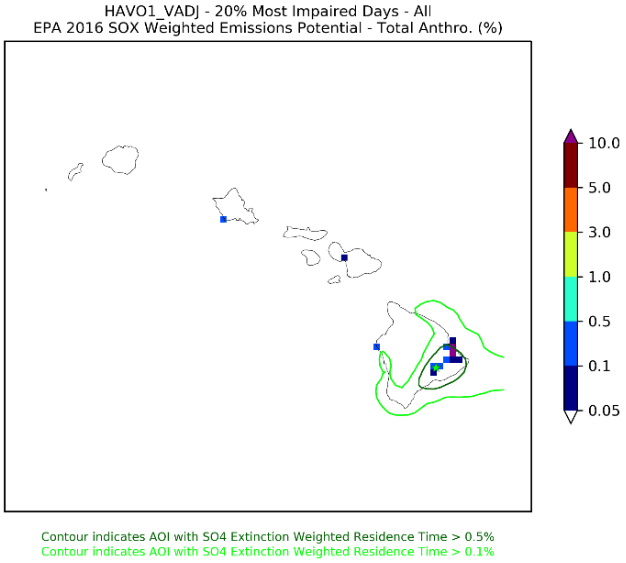
Contour indicates AOI with SO4 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with SO4 Extinction Weighted Residence Time > 0.1%

Figure 5.10-8 Haleakala NP, WEP Amm_SO_4


HAVO1_VADJ - 20% Most Impaired Days - All
EPA 2016 NOX Weighted Emissions Potential - Total Anthro. (%)

Contour indicates AOI with NO3 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with NO3 Extinction Weighted Residence Time > 0.1%

Figure 5.10-9 HAVO1 NP, WEP Amm_NO_3


HAVO1_VADJ - 20% Most Impaired Days - All
EPA 2016 SOX Weighted Emissions Potential - Total Anthro. (%)

Contour indicates AOI with SO4 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with SO4 Extinction Weighted Residence Time > 0.1%

Figure 5.10-10 HAVO1 NP, WEP Amm_SO_4

The WEP/AOI ranking provides the relative potential of a point source to contribute to visibility impairment for each national park. The ten (10) facilities that have the highest WEP/AOI values include some facilities that were not selected as part of the initial Q/d screening assessment.

Tables 5.10-1 and 5.10-2 provide the point source ranking of the WEP/AOI for ammonium nitrate at Haleakala National Park and Hawaii Volcanoes National Park, respectively. These tables are based on the RANK_POINT spreadsheets that consist of facility level emissions of NO_X overlaid with the corresponding EWRT for Amm_NO_3 for the 2017 emissions scenario. Emissions from airports were excluded for the point source ranking.

Table 5.10-1 Haleakala NP, Facility Contribution Ranking for NO_3

Facility Rank	Facility Name	WEP Amm_NO_3	Amm_NO_3% Contribution
1	ME - Maalaea Generating Station	91,737.709	86.91%
2	ME - Kahului Power Plant	11,524.123	10.92%
3	HC&D Camp 10 Quarry	1,154.769	1.09%
4	ME - Miki Basin Power Plant	416.505	0.39%
5	HL - Kanoelehua Power Plant/ HILL	268.138	0.25%
6	HE - Kahe Power Plant	105.440	0.10%
7	ME - Palaau Power Plant	85.497	0.08%
8	HL - Keahole Power Plant	70.778	0.07%
9	Kalaeloa Cogeneration Plant	45.052	0.04%
10	Mauna Loa Macadamia Nut Plant	29.166	0.03%

Table 5.10-2 Hawaii Volcanoes NP, Facility Contribution Ranking for NO_3

Facility Rank	Facility Name	WEP Amm_NO_3	NO_3% Contribution
1	HL - Kanoelehua Power Plant/ HILL	11,579.191	79.63%
2	Mauna Loa Macadamia Nut Plant	1,331.709	9.16%
3	HL - Puna Power Plant	1,047.520	7.20%
4	ME - Maalaea Generating Station	128.522	0.88%
5	HE - Kahe Power Plant	124.804	0.86%
6	HL - Keahole Power Plant	87.640	0.60%
7	Hamakua Energy, LLC - Hamakua Energy Plant	53.656	0.37%
8	Kalaeloa Cogeneration Plant	52.923	0.36%
9	HL - Waimea Power Plant	28.156	0.19%
10	HPOWER	18.282	0.13%

Tables 5.10-3 and 5.10-4 show the point source ranking of the WEP/AOI for ammonium sulfate at Haleakala National Park and Hawaii Volcanoes National Park, respectively. These tables are based on the RANK_POINT spreadsheets that consist of facility level emissions of SO_2 overlaid with the corresponding EWRT for Amm_SO for the 2017 emissions scenario. Emissions from airports were excluded for the point source ranking.

Table 5.10-3 Haleakala NP, Facility Contribution Ranking for SO_4

Facility Rank	Facility Name	WEP Amm_SO_4	SO_4% Contribution
1	ME - Kahului Power Plant	640,503.639	83.78%
2	ME - Maalaea Generating Station	102,281.522	13.38%
3	HL - Kanoelehua Power Plant/ HILL	15,591.339	2.04%
4	HL - Puna Power Plant	2,388.154	0.31%
5	HL - Keahole Power Plant	1,699.209	0.22%
6	HE - Kahe Power Plant	1,121.539	0.15%
7	Kalaeloa Cogeneration Plant	559.328	0.07%
8	Kapolei Refinery (IES Downstream, LLC)	102.500	0.01%
9	AES Hawaii, LLC	85.362	0.01%
10	HC&D Camp 10 Quarry	42.288	0.01%

Table 5.10-4 Hawaii Volcanoes NP, Facility Contribution Ranking for SO_4

Facility Rank	Facility Name	WEP Amm_SO_4	SO_4% Contribution
1	HL - Kanoelehua Power Plant/HILL	2,342,219.833	84.06%
2	HL - Puna Power Plant	425,758.317	15.28%
3	HL - Keahole Power Plant	7,303.296	0.26%
4	Mauna Loa Macadamia Nut Plant	3,211.788	0.12%
5	HE - Kahe Power Plant	2,856.909	0.10%
6	Kalaeloa Cogeneration Plant	1,414.019	0.05%
7	ME - Kahului Power Plant	1,233.516	0.04%
8	ME - Maalaea Generating Station	666.451	0.02%
9	HE - Waiau Power Plant	450.037	0.02%
10	Kapolei Refinery (IES Downstream, LLC)	260.055	0.01%

The Kahului, Maalaea, and Kanoelehua-Hill power plants along with the HC&D Camp 10 Quarry 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 1.09% to 10.92% to 86.91% for the Camp 10 Quarry, 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.

The Mauna Loa Macadamia Nut Corporation Plant and HC&D Camp 10 Quarry were among the top three (3) facilities with the highest potential to contribute to haze for ammonium nitrates in Hawaii's Class I areas based on WEP/AOI rankings but were not selected for control evaluation after initial Q/d screening. These facilities were below a Q/d threshold of ten (10).

Based on the WEP/AOI analysis, the DOH-CAB decided to require a four-factor analysis for the Mauna Loa Macadamia Nut Corporation plant since its ranking for ammonium nitrate of 9.16% as a contributor to visibility impairment at Hawaii Volcanoes National Park was relatively high. The total combined ammonium nitrate contribution for Hawaii Volcanoes National Park from the top three (3) facilities, that included the Mauna Loa Macadamia Nut Corporation plant, accounted for approximately 96% of the ranking. The Mauna Loa Macadamia Nut Corporation plant is evaluated further in Chapters 6 and 7.

For the HC&D Camp 10 Quarry, the WEP/AOI ranking of 1.09% for ammonium nitrate as a contributor to visibility impairment at Haleakala National Park was relatively low. The total combined ammonium nitrate contribution for Haleakala National Park from the top two (2) facilities, with the HC&D Camp 10 Quarry excluded, accounted for approximately 98% of the ranking. Therefore, HC&D Camp 10 Quarry was excluded from further evaluation.

5.11 Sources Selected With WEP/AOI Analysis

The 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 from 2014 to 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. The WEP point source contribution potential for these facilities ranged from 0.04% to 0.86% and 0.02% to 0.15% for nitrates and sulfates, respectively. Therefore, Kalaeloa, Kahe, and Waiau Power Plants were excluded from requiring controls in this second regional haze planning period.

The WEP/AOI analysis showed that sources on the islands of Maui and Hawaii, where the national parks are located, had the greatest potential to impair visibility. Control measures were selected for the Kanoelehua-Hill and Puna Power Plants and the Mauna Loa Macadamia Nut Corporation Plant on the island of Hawaii and the Kahului and Maalaea Power Plants on the island of Maui. Control measures selected were those below the \$5,800/ton (8-12-2022 RH-SIP submittal) and \$6,800/ton (2023 RH-SIP Submittal Update) of total combined pollutant (SO_2, NO_X, and PM_{10}) removed cost threshold. Please refer to Appendix K and Chapters 6 and 7.

Additionally, as illustrated in Figure 5.9-1, from 2015 to 2019, Oahu was influenced by winds from the northeast direction 58.7% of the time. In addition, higher wind speeds, in the range of 7.00 knots to 21.58 knots occur 77.0% from the northeast direction. These northeast trade winds blow emissions from Kalaeloa Partners L.P., Kahe and Waiau power plants away from Hawaii's Class I areas. Generally, in order for these emissions to significantly influence Hawaii's Class I areas, sustained winds from the west-northwest direction are needed. As Figure 5.9-1 shows, winds from this direction are virtually non-existent.

An analysis of the 2015 to 2019 raw wind rose data illustrated in Figure 5.9-1, for the Honolulu International Airport (now Daniel K. Inouye International Airport) was conducted to demonstrate the significantly low number of hours that winds with the appropriate direction, speed, and duration could impact Hawaii's Class I areas. The raw wind rose data consisted of 43,824 hourly wind speed and wind direction measurements. The scope of the analysis demonstrated that winds with the necessary direction, wind speed magnitude, and duration to blow emissions from the Kalaeloa Partners L.P., Kahe, and Waiau power plants toward, and reach Hawaii's Class I areas is extremely rare. Within the analysis, straight-line distances are defined as the shortest distance between the specified emission source and the Class I area. This analysis did not attempt to demonstrate the deciview impacts from the emission sources on Hawaii's Class I areas.

As stated in Section 5.10, The WEP/AOI analysis was performed using gridded emissions data and incorporating the residence time (RT) of back trajectories for the most impaired days calculated for grid cells of modeling domains. The RT analysis provides an area of influence or frequency of occurrence of back trajectories passing over a grid cell that arrive at the Class I area.

Our analysis focuses on evaluating both the frequency and duration that emissions from the Oahu facilities (i.e., Kalaeloa Partners L.P., Kahe, and Waiau power plants) could impact visibility by traveling to and passing over the Class I areas based on wind direction and speed.

A subset of the 2015 to 2019 raw wind rose data was evaluated in detail with focus on occurrences with sustained winds from the west-northwest directions or 275 to 315 degrees. These are time periods when the Oahu facilities potentially could influence visibility at Hawaii's Class I areas. The number of occurrences provides an indication of the potential weighted residence time or frequency that a back trajectory could pass over Hawaii's Class I areas once it arrives.

With time of travel being excluded, there were two days within the 2015 to 2019 data set where emissions from the Oahu facilities potentially could have arrived at the HALEOBS Class I area. On February 13, 2015, and February 10, 2019, there were one (1) and three (3) occurrences, respectively, where emissions from the Oahu facilities potentially could have impacted the HALEOBS Class I area (Haleakala NP).

Since each occurrence measures one-hour intervals, the maximum duration of each occurrence is not expected to exceed one hour for a total of four (4) hours from 2015 to 2019. The total number of measured data or occurrences is 43,824, of which four (4) were determined to have the potential to impact the HALEOBS Class I area based on of wind direction and speed. This represents less than 0.01% of the total time, which demonstrates the rarity of occurrences that potentially could have an influence on Hawaii's Class I areas.

The required wind magnitude and duration for emissions to impact HVNP Class I area (Hawaii Volcanoes NP) did not occur at any time from 2015 to 2019.

Table 5.11-1 below shows:

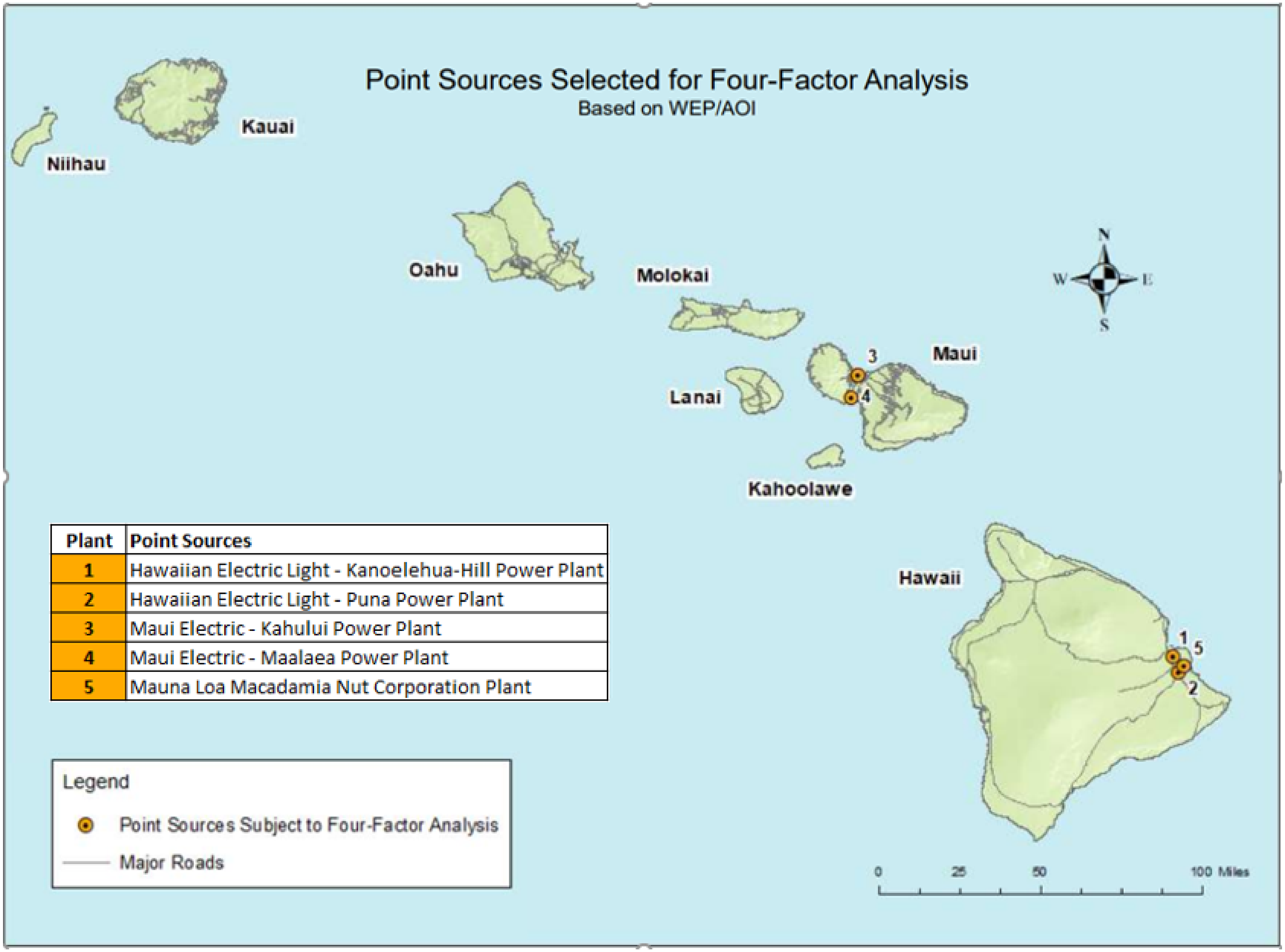
1. The locations of the Kalaeloa Partner L.P., Kahe and Waiau Power Plants and also representative locations of Haleakala NP and Hawaii Volcanoes NP;
2. The straight-line distances from each power plant to Haleakala NP and Hawaii Volcanoes NP, respectively; and
3. The straight-line wind direction from each power plant that is needed for emissions to impact Haleakala NP and Hawaii Volcanoes NP, respectively.

Table 5.11-1 Oahu Sources Impact on HALEOBS and HVNP

Location	Latitude (°)	Longitude (°)	Distance to HALEOBS (mi.)	Wind Direction to HALEOBS (°)	Distance to HVNP (mi.)	Wind Direction to HVNP (°)
Kalaeloa	21.301803	-158.096257	125	289	224	305
Kahe	21.356642	-158.128566	128	290	227	306
Waiau	21.388572	-158.960798	120	293	220	308
Haleakala Observatory (HALEOBS)	20.708102	-156.256688				
Hawaii Volcanoes NP Visitor Center (HVNP)	19.429561	-155.257165				

The straight-line wind directions needed for emissions to impact Haleakala NP and Hawaii Volcanoes NP range from 289° to 308°. A conservative range of wind directions from 275° to 315° was chosen for the purpose of this analysis. The raw wind rose data shows that winds within this range occur a total of 848 hours or 1.93% of the 43,824 hours. The data also shows that the magnitude and duration necessary for emissions to impact Haleakala NP occurs conservatively on only two (2) occasions: six (6) hours from 14:00 to 19:00 on February 13, 2015, and four (4) hours from 14:00 to 17:00 on February 10, 2019. The required wind magnitude and duration for emissions to impact Hawaii Volcanoes NP did not occur at any time from 2015 to 2019. Therefore, as the data demonstrates, winds with the necessary direction, magnitude, and duration to blow emissions from the Kalaeloa Partners, L.P., Kahe, and Waiau power plants toward, and reach Hawaii's Class I areas are extremely rare. Therefore, Kalaeloa Partners, L.P., Kahe, and Waiau power plants on Oahu were excluded from requiring controls in this second regional haze planning period. Controls were only selected for sources on Hawaii and Maui Islands that ranked high in their potential to affect visibility in the national parks based on results from the WEP/AOI analysis.

Point sources selected for four-factor analysis from WEP/AOI screening are shown on map in Figure 5.11-1. Hawaiian Electric Light and Maui Electric facilities were already notified to provide a four-factor analysis based on Q/d screening results. A letter was sent to the Mauna Loa Macadamia Nut Corporation Plant for providing a four-factor analysis based on the WEPA/AOI results. Please refer to Note a in Table 7.5-4 from Chapter 7 for additional information.



Plant	Point Sources
1	Hawaiian Electric Light - Kanoelehua-Hill Power Plant
2	Hawaiian Electric Light - Puna Power Plant
3	Maui Electric - Kahului Power Plant
4	Maui Electric - Maalaea Power Plant
5	Mauna Loa Macadamia Nut Corporation Plant

Figure 5.11-1 Point Sources Selected for Four-Factor Analysis Based on WEP/AOI

5.12 Area Source Screening Methodology

The following were assumed for the area source screening analysis:

a. Gather 2014 EPA NEIv2 emissions data across the state for Kauai, Honolulu, Maui, and Hawaii Counties.
b. Visibility emissions were total combined ton per year emissions of NO_X, SO_2, and PM_{10} (facility level emission $Q = Q_{NOX} + Q_{SO2} + Q_{PM10}$).
c. Remove, PM_{10} primary area source emissions from Honolulu and Kauai Counties since PM_{10} does not generally experience high transport distances.
d. Determine the Q threshold which achieves inclusion of SCCs with the largest Qs until at least 80% of total Q emissions across all SCCs throughout the state are accounted for (i.e., Q > 1,139 tons per year includes three (3) sectors which account for 85% of the total nonpoint Q).[30]

5.13 Area Source Screening Results

Tables 5.13-1 and 5.13-2 below show a list of the larger area sources sorted by Q in descending order for Maui and Hawaii Counties, respectively.

Table 5.13-1 Maui County Area Sources [a]

Sector	Description	Q (tpy)	Q (tpy)		
		$NO_X + SO_2 + PM_{10}$	NO_X	SO_2	PM_{10}
Dust-Unpaved Road Dust	Fugitive Dust, Unpaved Roads	8,011	-----	-----	8,011
Fires-Agricultural Field Burning	Sugarcane Burning Emissions.[b]	1,139	359	197	583
Dust-Construction Dust	Fugitive Dust: Road, Residential, and Nonresidential Construction.	786	-----	-----	786
Mobile-Commercial Marine Vessels	Port and Underway Emissions.	354	317	28	9
Agricultural-Crops & Livestock Dust	Fugitive Dust: Dust Kicked up by Hooves and Tilling.	221	-----	-----	221
Dust-Paved Road Dust	Fugitive Dust: Paved Roads	177	-----	-----	177
Waste Disposal	Open Burning: Land Clearing Debris, Yard Waste-Leaves & Brush, Household Waste,	126	25	7	94
Fuel Combustion-Residential-Wood	Wood Stove, Wood Fireplace Insert, Outdoor Wood Burning, and Fireplace.	89	9	1	79

a. Maui County includes Kahoolawe, Lanai, Maui, and Molokai Islands.
b. HC&S transitioned out of farming sugar on the island of Maui and shut down in 2016. This was the only facility in Hawaii that processed sugar. Currently, there is no sugar cane burning in Hawaii.

---

[30] EPA's SCC Site at: https://ofmpub.epa.gov/sccwebservices/sccsearch/

Table 5.13-2 Hawaii County Area Sources [a]					
Sector	Description	Q (tpy)	Q (tpy)		
		NO_X +SO_2 + PM_{10}	NO_X	SO_2	PM_{10}
Dust-Unpaved Road Dust	Fugitive Dust: Unpaved Roads.	24,856	-----	-----	24,856
Agricultural-Crops & Livestock Dust	Fugitive Dust: Dust Kicked up by Hooves and Tilling.	1,130	-----	-----	1,130
Dust-Construction Dust	Fugitive Dust: Road, Residential, and Nonresidential Construction.	563	-----	-----	563
Dust-Paved Road Dust	Fugitive Dust: Paved Roads.	354	-----	-----	354
Waste Disposal	Open Burning: Land Clearing Debris, Yard Waste-Leaves & Brush, Household Waste.	244	46	11	187
Fuel Combustion-Residential-Wood	Wood Stove, Wood Fireplace Inserts, Outdoor Wood Burning, and Fireplaces.	237	25	4	208
Mobile-Commercial Marine Vessels	Port Emissions.[b]	191	143	43	5

a. Hawaii County includes Hawaii Island only.

b. No underway emissions were provided for Mobile-Commercial Marine Vessels for Hawaii County.

Table 5.13-3 on the next page shows the results of the screening analysis for area sources with a Q value of greater than 1,139 tons per year for the largest SCCs which are at least 80% of the total statewide area source emissions. The total Q for all of Hawaii's area sources is 39,967 tons per year. For the screening analysis, area sources are ranked from highest to lowest Q statewide. In Table 5.13-3, the top three (3) area source emitters among those evaluated statewide account for 85% of the statewide area source emissions.

Table 5.13-3 Top Three (3) Area Source Emitters [a]

Sector	Description	County [a,b]	% Statewide Q (39,967 tpy) [c]	Q (tpy)	Q (tpy)		
				$NO_X + SO_2 + PM_{10}$	NO_X	SO_2	PM_{10}
Dust-Unpaved Road Dust	Fugitive Dust, Unpaved Roads	Hawaii	62% See Note c	24,886	-----	-----	24,886
Dust-Unpaved Road Dust	Fugitive Dust, Unpaved Roads	Maui	20% See Note d	8,011	-----	-----	8,011
Fires-Agricultural Field Burning	Sugarcane Burning Emissions [f]	Maui	3% See Note e	1,139	-----	-----	1,139
Total-→			85% See Note e	34,036	-----	-----	34,036

a. Hawaii County includes Hawaii Island only.
b. Maui County includes Kahoolawe, Lanai, Maui, and Molokai Islands.
c. (24,886 tpy/39,967 tpy) x 100% = 62%
d. [(8,011 tpy)/39,967 tpy] x 100% = 20%
e. [(1,139 tpy)/39,967 tpy] x 100% = 20%
f. [(24,886 tpy + 8,011 tpy + 1,139 tpy] x 100% = 85%
f. HC&S transitioned out of farming sugar and the plant on the island of Maui shut down in 2016. This was the only facility in Hawaii that processed sugar. Currently, there is no sugar cane burning in Hawaii.

5.14 Area Source Selection

In selecting area sources for further evaluation:

- Since the HC&S plant permanently shut down on the island of Maui in 2016, there is no more sugar cane burning in the state of Hawaii. Therefore, this area source was screened out from requiring further analysis.
- Fugitive dust from unpaved roads on Hawaii Island was selected for its potential to affect visibility in Hawaii Volcanoes National Park.
- Fugitive dust from unpaved roads on Maui Island was selected for its potential to affect visibility in Haleakala National Park.

Further evaluation of area sources for potential controls was not performed in this second regional haze planning period. Emissions of SO_2 and NO_X are the greatest contributors to haze in Hawaii's national parks, so DOH -CAB chose to focus on these pollutants in this second planning period, for which the largest contributors are point and mobile sources. DOH-CAB does not have the authority to regulate mobile sources, and therefore the focus fell on point sources. As such, area source screening is for information only. Please refer to Section 6.7 in Chapter 6 for additional information regarding the evaluation of area sources.

Chapter 6 Emission Control Measures

6.0 Introduction

Hawaii is required to identify potential controls for sources screened in Chapter 5 to determine what measures are necessary to make reasonable progress towards natural visibility by 2064. Most units at point sources screened for further evaluation operate with minimal or no emission controls. Examples of control measures to consider for regional haze include control device retrofits; fuel switches/mixing with inherently lower SO_2, NO_X, and PM_{10} emissions; operating restrictions on hours and fuel input; emission limits; and plant shut downs.

Chapter 6 includes four-factor analyses for two RH-SIP submittals. Sections 6.1 through 6.3 provide details for point sources evaluated in the initial RH-SIP submittal to EPA on August 12, 2022. Sections 6.4 through 6.6 are updates to the four-factor analyses for a second 2023 RH-SIP submittal to EPA that completely replaces the plan and appendices submitted on August 12, 2022. Area sources are addressed in Section 6.7.

In the first regional haze planning period (2001-2018), the emphasis was on Best Available Retrofit Technology (BART) to address reasonable progress that included a 0.5 deciview threshold. In this second planning period (2018-2028), there is no BART or deciview threshold. The focus in the second planning period is on determining reasonable progress through analysis of the four factors identified in §169A(g)(1) of the Clean Air Act.

EPA guidance notes that because regional haze results from a multitude of sources over a broad geographic area, progress may require addressing many relatively small contributions to impairment. Thus, a measure may be necessary for reasonable progress even if that measure in isolation does not result in perceptible visibility impairment.

Initial Q/d screening identified seven (7) power plants that required a four-factor analysis. The four-factor analyses, comments on the analyses, report revisions, and changes to worksheets are shown in Appendices D through I for all facilities screened with the Q/d methodology.

Following initial Q/d screening, the WEP/AOI analysis conducted by WRAP/Ramboll identified three Oahu power plants with low relative potential for contributing to visibility impairment at the Class I areas. Therefore, control measures identified in the four-factor analyses of Appendices D through F in the 8-12-2022 submittal were excluded from consideration for additional controls in this planning period for the Kalaeloa Partners, L.P. and Hawaiian Electric Kahe and Waiau power plants, respectively, that are located on Oahu. The WEP/AOI ranked remaining plants selected with Q/d high in their potential to affect visibility in the national parks. Therefore, controls evaluated in the four-factor analyses of Appendices G through J were considered for the Hawaii Electric Light Kanoelehua-Hill and Puna power plants and Maui Electric Kahului and Maalaea power plants, respectively in the 8-12-22 RH-SIP submittal. Updates to the control measure analyses for these sources is provided in Sections 6.4 through 6.6 and Chapter 7 for the 2023 RH-SIP submittal.

The WEP/AOI also ranked the Mauna Loa Macadamia Nut Corporation plant on the Big Island high in its potential to affect visibility at Hawaii Volcanoes National Park. The four-factor analysis for the Mauna Loa Macadamia Nut Corporation plant is evaluated in Sections 6.4 through 6.6 of Chapter 6, and Chapter 7 for the 2023 RH-SIP submittal.

6.1 Four-Factor Analysis, 8-12-2022 RH-SIP Submittal (Point Sources)

Potential control measures that could be implemented were determined based on four-factor analyses from facilities identified in the screening process. The four-factor analysis considers cost of compliance, the time necessary for compliance, the energy and non-air quality environmental impacts of compliance, and the remaining useful life of the affected anthropogenic source of visibility impairment. Control costs were compared against a $5,800/ton cost threshold determined in Section 6.2 of the RH-SIP.

Cost of Compliance

A driving factor in selecting controls is the cost based on assumptions used in calculations to determine the cost per tons of pollutant removed by the control measure. Calculation methodologies to determine the control measure cost are provided in EPA's Air Pollution Control Cost Manual. Since facilities did not incorporate relevant changes requested in comments on the analyses (e.g., those pertaining to current prime interest rate of 3.25% versus 7% interest rate, cost/total combined tons of pollutant removed, estimated equipment life, retrofit factor, Hawaii Island construction cost multiplier, Maui Island construction cost multiplier, etc.), the DOH-CAB requested the original control cost worksheets and made the appropriate changes as part of its review.

Control costs are summarized in Tables 6.1-1 through 6.1-4 for the Hawaii Electric Light Kanoelehua-Hill, Hawaii Electric Light Puna, Maui Electric Kahului, and Maui Electric Maalaea power plants based on the factor analyses provided for these facilities. The cost per ton of pollutant removed, highlighted in green, are costs after changes were made to worksheets by DOH-CAB to align with EPA guidance and the comments provided by EPA and the National Park Service (NPS). For costs highlighted in green, the DOH-CAB assumed a remaining useful life thirty (30) years for SCR and wet scrubber and twenty (20) years for all other controls.

Four-Factor Analysis for Kanoelehua-Hill Power Plant (8-12-2022 Submittal)
For Boilers Hill 5 and Hill 6, a fuel switch to ULSD with 0.0015% sulfur content was determined to be cost effective at $4,319/ton and $4,684/ton respectively for SO_2, NO_X, and PM_{10} combined. The costs per ton of pollutant removed, highlighted in green, are costs after changes were made to worksheets by DOH-CAB to align with EPA guidance and comments provided by EPA and the FLMs. For costs highlighted in green, the DOH-CAB assumed a remaining useful life of thirty (30) years for SCR and wet scrubbers and twenty (20) years for all other controls. An SCR construction cost multiplier of 1.0 was used instead of 1.840. A 3.25% prime interest rate was used versus a 7% interest rate. A retrofit factor of 1.0 was used for SNCR. Please refer to Appendix G.

Combustion Turbine CT-1 and Diesel Engine Generators D-11, D-15, D-16, and D-17 operated on a limited basis in 2017. Therefore, a four-factor analysis was not conducted for these units.

Table 6.1-1 Four-Factor Analysis for Kanoelehua-Hill Power Plant (8-12-2022 Submittal) Hawaii

Unit	Description	Primary Fuel	Control Measure & Cost per Ton [a,b,c,d,e]
Hill 5	14 MW Boiler	Fuel Oil No. 6 with 2.0% maximum sulfur content	• Fuel switch to residual/distillate fuel blend with 1.0% maximum sulfur content - $6,559/ton SO_2 for Hill 5 and 6 • Fuel switch to distillate fuel with 0.4% maximum sulfur content - $6,119/ton SO_2 for Hill 5 and 6 • Fuel switch to residual/ULSD fuel blend with 1.0% maximum sulfur content - $5,682/ton SO_2 for Hill 5 and 6 • Fuel switch to ULSD with 0.0015% maximum sulfur content - $5,026/ton SO_2 for Hill 5 and 6 • Fuel switch to ULSD with 0.0015% sulfur content - $4,319/ton SO_2, NO_X, and PM_{10} combined for Hill 5 • Fuel switch to ULSD with 0.0015% sulfur content - $4,684/ton SO_2, NO_X, and PM_{10} combined for Hill 6 • LNB w/OFA/FGR for Hill 5 - $1,188 ($1,051)/ton NO_X • LNB w/OFA/FGR for Hill 6 - $678 ($598)/ton NO_X • SCR for Hill 5 - $3,873 ($1,733)/ton NO_X • SCR for Hill 6 - $4,021 ($1,858)/ton NO_X • SCR + Combustion Controls for Hill 5 - $4,122 ($2,116)/ton NO_X • SCR + Combustion Controls for Hill 6 - $4,011 ($2,041)/ton NO_X
Hill 6	23 MW Boiler	Fuel Oil No. 6 with 2.0% maximum sulfur content	
CT-1	11.6 MW Combustion Turbine	Fuel Oil No. 2 with 0.4% maximum sulfur content	
D-11	2.75 MW DEG	ULSD	

Table 6.1-1 Four-Factor Analysis for Kanoelehua-Hill Power Plant (8-12-2022 Submittal) Hawaii

Unit	**Description**	**Primary Fuel**	**Control Measure & Cost per Ton** [a,b,c,d,e]
D-15	2.75 MW DEG	ULSD	• SNCR for Hill 5 - \$2,322 (\$1,884)/ton NO_X • SNCR for Hill 6 - \$1,552 (\$1,274)/ton NO_X • SNCR + Combustion Controls for Hill 5 - \$2,568 (\$2,147)/ton NO_X • SNCR + Combustion Controls for Hill 6 - \$1,903 (\$1,597)/ton NO_X • Wet Scrubber for Hill 5 – \$11,128 (\$10,438)/ton PM_{10} • Wet Scrubber for Hill 6 – \$9,728 (\$8,914)/ton PM_{10} • Wet ESP for Hill 5 - \$67,514 (\$61,169)/ton PM_{10} • Wet ESP for Hill 6 – \$91,694 (\$82,918)/ton PM_{10}
D-16	2.75 MW DEG	ULSD	
D-17	2.75 MW DEG	ULSD	

a. CDS-circulating dry scrubber, DEG-diesel engine generator, ESP-electrostatic precipitator, FGR-flue gas recirculation, LNB-low NO_X burner, MW-megawatt, OFA-overfire air, SCR-selective catalytic reduction, ULSD-ultra-low sulfur diesel, and combustion controls are LNB with OFA and/or FGR.

b. Combustion Turbine CT-1 is considered a limited use unit.

c. As per EPA guidance, fuel combustion units that are restricted to using only ULSD or distillate fuel with a sulfur content of no more than 0.0015 percent, per enforceable requirements, do not need further evaluation of SO_2 and particulate matter (PM) control measures.

d. CT-1, D-11, D-15, D-16, and D-17 operate on a limited basis. Therefore, a four-factor analysis was not conducted for these units for NO_X.

e. According to the four-factor analysis, it is unknown if LNB alone can achieve a controlled NO_X emission level of 0.30 lb/MMBtu and 0.20 lb/MMBtu for Hill 5 and Hill 6, respectively. Therefore, costing is based on a range of costs cost for LNB with OFA. The cost of FGR and LNB with FGR are expected to be covered by this range and have similar NO_X control.

Four-Factor Analysis for Puna Power Plant (8-12-2022 Submittal)

For the boiler, a fuel switch to ULSD with 0.0015% sulfur content was determined to be cost effective at \$4,690/ton SO_2, NO_X, and PM_{10} combined. The costs per ton of pollutant removed, highlighted in green, are costs after changes were made to worksheets by DOH-CAB to align with EPA guidance and comments provided by EPA and the FLMs. For costs highlighted in green, the DOH-CAB assumed a remaining useful life thirty (30) years for SCR and scrubbers, and twenty (20) years for all other controls. A construction cost multiplier of 1.0 was used instead of 1.840 for SCR. A 3.25% prime interest rate was used versus a 7% interest rate. A retrofit factor of 1.0 was used for SNCR. Please refer to Appendix H.

Combustion Turbine CT-3 operated on a limited basis in 2017. Therefore, a four-factor analysis was not conducted for this unit.

Table 6.1-2 Four-Factor Analysis for Puna Power Plant (8-12-2022 Submittal) Hawaii

Unit	Description	Primary Fuel	Control Measure & Cost per Ton [a, b, c]
Boiler	15.5 MW Boiler	Fuel Oil No. 6 with 2.0% maximum sulfur content	• Fuel switch to residual/distillate fuel blend with 1.0% maximum sulfur content - \$7,422/ton SO$_2$ for Boiler • Fuel switch to residual/distillate fuel blend with 0.4% maximum sulfur content - \$6,921/ton SO$_2$ for Boiler • Fuel switch to ULSD with 0.0015% sulfur content - \$4,690/ton SO$_2$, NO$_X$, and PM$_{10}$ for Boiler • SCR for Boiler - \$59,655 (\$23,478)/ton NO$_X$ • SCR + Combustion Control for Boiler - \$49,119 (\$22,229)/ton NO$_X$ • SNCR for Boiler - \$29,311 (\$22,621)/ton NO$_X$ • SNCR + Combustion Controls -Boiler - \$34,235 (\$27,558)/ton NO$_X$ • LNB w/OFA/FGR for Boiler - \$13,431 (\$11,785)/ton NO$_X$ • Wet Scrubber for Boiler - \$35,648 (\$32,150)/ton PM$_{10}$ • Wet ESP for Boiler - \$496,875 (\$448,892)/ton PM$_{10}$
CT-3	20 MW Combustion Turbine	Fuel Oil No. 2 with 0.4% maximum sulfur content	

a. CDS-circulating dry scrubber, ESP-electrostatic precipitator, FGR-flue gas recirculation, LNB-low NO$_X$ burner, MW-megawatt, OFA-overfire air, SCR-selective catalytic reduction, ULSD-ultra-low sulfur diesel, and combustion controls are LNB with OFA and/or FGR.

b. Combustion Turbine CT-3 is considered a limited use unit.

c. Wet ESP was assumed to be 90% efficient at removing particulate. A wet scrubber was assumed to be 50% efficient at removing particulate.

Four-Factor Analysis for Kahului Power Plant (8-12-2022 Submittal)

For all boilers, a fuel switch to ULSD with 0.0015% sulfur content was determined to be cost effective since the cost of this control measure for each boiler was less than at \$5,800/ton SO$_2$, NO$_X$, and PM$_{10}$ combined. The costs per ton of pollutant removed, highlighted in green, are costs after changes were made to worksheets by DOH-CAB to align with EPA guidance and comments provided by EPA and the FLMs. For costs highlighted in green, the DOH-CAB assumed a remaining useful life thirty (30) years for SCR and wet scrubbers, and twenty (20) years for all other controls. A construction cost multiplier of 1.0 was used instead of 1.938 for SCR. A 3.25% prime interest rate was used versus a 7% interest rate. Please see Appendix I.

Table 6.1-3 Four-Factor Analysis for Kahului Power Plant (8-12-2022 Submittal) Maui

Unit	Description	Primary Fuel	Control Measure & Cost per Ton [a,b,c,d]
K-1	5.0 MW Boiler	Fuel Oil No. 6 with 2.0% maximum sulfur content	• Fuel switch to residual/distillate fuel blend with 1.0% maximum sulfur content - \$7,548/ton SO_2 for K1 through K-4 • Fuel switch to residual/ULSD fuel blend with 1.0% maximum sulfur content - \$6,535/ton SO_2 for K1 through K-4 • Fuel switch to ULSD with 0.0015% maximum sulfur content - \$5,820/ton SO_2 for K1 through K-4 • Fuel switch to ULSD with 0.0015% sulfur content - \$4,935/ton SO_2, NO_X, and PM_{10} combined for K1 • Fuel switch to ULSD with 0.0015% sulfur content - \$4,910/ton SO_2, NO_X, and PM_{10} combined for K2 • Fuel switch to ULSD with 0.0015% sulfur content - \$4,920/ton SO_2, NO_X, and PM_{10} combined for K3 • Fuel switch to ULSD with 0.0015% sulfur content - \$5,156/ton SO_2, NO_X, and PM_{10} combined for K4 • LNB w/OFA/FGR for K-1 - \$4,222 (\$3,723)/ton NO_X • LNB w/OFA/FGR for K-2 - \$3,676 (\$3,239)/ton NO_X • LNB w/OFA/FGR for K-3 - \$906 (\$803)/ton NO_X • LNB w/OFA/FGR for K-4 - \$2,317 (\$2,050)/ton NO_X • SCR for K-1 - \$9,135 (\$3,719)/ton NO_X • SCR for K-2 - \$9,433 (\$3,795)/ton NO_X • SCR for K-3 - \$3,295 (\$1,456)/ton NO_X • SCR for K-4 - \$5,596 (\$2,381)/ton NO_X • SCR + Combustion Controls for K-1 - \$9,268 (\$4,422)/ton NO_X • SCR + Combustion Controls for K-2 - \$9,717 (\$4,595)/ton NO_X • SCR + Combustion Controls for K-3 - \$3,501 (\$1,769)/ton NO_X • SCR + Combustion Controls for K-4 - \$5,713 (\$2,813)/ton NO_X • SNCR for K-1 - \$8,934 (\$6,359)/ton NO_X • SNCR for K-2 - \$7,858 (\$6,178)/ton NO_X • SNCR for K-3 - \$1,885 (\$1,549)/ton NO_X • SNCR for K-4 - \$4,245 (\$3,420)/ton NO_X • SNCR + Combustion Controls for K-1 - \$7,171 (\$5,495)/ton NO_X • SNCR + Combustion Controls for K-2 - \$7,097 (\$5,794)/ton NO_X
K-2	5.0 MW Boiler	Fuel Oil No. 6 with 2.0% maximum sulfur content	
K-3	11.5 MW Boiler	Fuel Oil No. 6 with 2.0% maximum sulfur content	

Table 6.1-3 Four-Factor Analysis for Kahului Power Plant (8-12-2022 Submittal)
Maui

Unit	Description	Primary Fuel	Control Measure & Cost per Ton [a,b,c,d]
K-4	11.5 MW Boiler	Fuel Oil No. 6 with 2.0% maximum sulfur content	• SNCR + Combustion Controls for K-3 - \$2,109 (\$1,777)/ton NO$_X$ • SNCR + Combustion Controls for K-4 - \$3,832 (\$3,195)/ton NO$_X$ • Wet Scrubber for K-1 - \$17,310 (\$16,494)/ton PM$_{10}$ • Wet Scrubber for K-2 - \$24,223 (\$23,052)/ton PM$_{10}$ • Wet Scrubber for K-3 - \$7,091 (\$6,663)/ton PM$_{10}$ • Wet Scrubber for K-4 - \$13,647 (\$12,738)/ton PM$_{10}$ • Wet ESP for K-1 - \$56,071 (\$51,030)/ton PM$_{10}$ • Wet ESP for K-2 - \$77,314 (\$70,369)/ton PM$_{10}$ • Wet ESP for K-3 - \$35,665 (\$32,343)/ton PM$_{10}$ • Wet ESP for K-4 - \$86,708 (\$78,535)/ton PM$_{10}$

a. CDS-circulating dry scrubber, ESP-electrostatic precipitator, FGR-flue gas recirculation, LNB-low NO$_X$ burner, MW-megawatt, OFA-overfire air, SCR-selective catalytic reduction, ULSD-ultra-low sulfur diesel, and combustion controls are LNB with OFA and/or FGR.
b. For particulate control the Kahe boilers are subject to a filterable PM standard of 0.030 lb/MMBtu on a thirty-boiler operating day rolling average for non-continental liquid oil-fired units in accordance with EGU MACT.
c. Dry ESPs, cyclones, and fabric filters are not good technical matches since particulate emissions from residual oil-fired boilers tend to be sticky and small.
d. According to the four-factor analysis, LNB and possibly LNB in combination with OFA and FGR can achieve a NO$_X$ emission level of 0.15 lb/MMBtu.

Four-Factor Analysis for Maalaea Power Plant (8-12-2022 Submittal)

For DEG units M1, M2, and M3, fuel ignition timing retard (FITR) was determined to be cost effective, as the cost of this control, ranging from \$3,030/ton NO$_X$ to \$5,225/NO$_X$, is less than the \$5,800/ton threshold.

For DEG unit M7, SCR was determined to be cost effective, as the cost of this control of \$5,530/ton NO$_X$ is less than the \$5,800/ton threshold.

The costs per ton of pollutant removed, highlighted in green, are costs after changes were made to worksheets by DOH-CAB to align with EPA guidance and comments provided by EPA and the FLMs. For costs highlighted in green, the DOH-CAB assumed a remaining useful life thirty (30) years for SCR (later changed to 20 years for the DEGs in Section 6.4 of the RH-SIP) and twenty (20) years for all other controls. An SCR construction cost multiplier of 1.0 was used instead of 1.938. A 3.25% prime interest rate was used versus a 7% interest rate. Please see Appendix J.

Table 6.1-4 Four-Factor Analysis for Maalaea Power Plant (8-12-2022 Submittal)
Maui

Unit	Description	Primary Fuel	Control Measure & Cost per Ton [a]
M1	2.5 MW DEG	ULSD	• Fuel switch to ULSD with 0.0015% maximum sulfur content - \$10,347/ton SO$_2$ (PM$_{10}$ and NO$_X$
M2	2.5 MW DEG	ULSD	
M3	2.5 MW DEG	ULSD	

Table 6.1-4 Four-Factor Analysis for Maalaea Power Plant (8-12-2022 Submittal)
Maui

Unit	Description	Primary Fuel	Control Measure & Cost per Ton [a]
M4	5.6 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	emissions for ULSD and F.O. #2 are considered to be similar) • FITR for M1 - \$4,159 (\$3,030)/ton NO_x • FITR for M2 - \$7,173 (\$5,225)/ton NO_x • FITR for M3 - \$4,159 (\$3,030)/ton NO_x • SCR for M1 - \$19,383 (\$13,996)/ton NO_x • SCR for M2 - \$29,578 (\$19,778)/ton NO_x • SCR for M3 - \$19,295 (\$13,896)/ton NO_x • SCR for M4 - \$11,072 (\$10,336)/ton NO_x • SCR for M5 - \$8,371 (\$7,327)/ton NO_x • SCR for M6 - \$12,130 (\$10,823)/ton NO_x • SCR for M7 - \$6,162 (\$5,530)/ton NO_x • SCR for M8 - \$12,151 (\$10,857)/ton NO_x • SCR for M9 - \$9,562 (\$9,087)/ton NO_x • SCR for M10 - \$8,335 (\$8,757)/ton NO_x • SCR for M11 - \$8,546 (\$8,859)/ton NO_x • SCR for M12 - \$11,832 (\$12,423)/ton NO_x • SCR for M13 - \$10,805 (\$11,292)/ton NO_x • SCR for X1 - \$33,856 (\$23,041)/ton NO_x • SCR for X2 - \$33,024 (\$22,388)/ton NO_x • SCR for M14 - \$60,413 (\$23,854)/ton NO_x • SCR for M16 - \$52,326 (\$20,660)/ton NO_x • SCR for M17 - \$67,266 (\$26,559)/ton NO_x • SCR for M19 - \$77,700 (\$30,679)/ton NO_x • DPF for M4 - \$41,214 (\$30,031)/ton PM_{10} • DPF for M5 - \$52,455 (\$38,221)/ton PM_{10} • DPF for M6 - \$52,455 (\$38,221)/ton PM_{10} • DPF for M7 - \$48,084 (\$35,036)/ton PM_{10}
M5	5.6 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M6	5.6 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M7	5.6 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M8	5.6 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M9	5.6 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M10	12.5 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M11	12.5 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M12	12.5 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M13	12.5 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
X1	2.5 MW DEG	ULSD	
X2	2.5 MW DEG	ULSD	
M14	20 MW Combustion Turbine	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content and 0.015% average nitrogen content	
M16	20 MW Combustion Turbine	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content and 0.015% average nitrogen content	
M17	20 MW Combustion Turbine	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content and 0.015% average Ce nitrogen content	

Table 6.1-4 Four-Factor Analysis for Maalaea Power Plant (8-12-2022 Submittal) Maui			
Unit	**Description**	**Primary Fuel**	**Control Measure & Cost per Ton** [a]
M19	20 MW Combustion Turbine	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content and 0.015% average nitrogen content	

a. DPF-diesel particulate filters, FITR-fuel ignition timing retard, MW-megawatt, SCR-selective catalytic reduction, ULSD-ultra-low sulfur diesel.

Remaining Useful Life (8-12-2022 Submittal)

In accordance with EPA's control cost manual and comments provided, the DOH-CAB used thirty (30) years for the remaining useful life of SCR at power plants. The DOH-CAB used twenty (20) years for the remaining useful life for all other control equipment. Trinity Consultants used a remaining useful life of thirty (30) years for SCR, combustion controls, and post combustion controls. Trinity Consultants used a twenty (20) year remaining useful life for SNCR. The DOH-CAB also determined costs for scrubber systems assuming a remaining useful life of thirty (30) years after additional feedback from the EPA and the FLMs. For fuel switching, the remaining useful life does not impact the annualized costs since fuel switching will not require capital investments in new equipment. It was indicated that fuel switching would require changes to the injectors and fuel system; however, these expenses were not included in the analysis. Although some Hawaiian Electric units are planned to be retired, since there are no commitments to retire plant equipment through federally enforceable emission limits, the remaining useful life is the useful life of the controls rather than the source.

Time Necessary for Compliance (8-12-2022 Submittal)

According to information from the four-factor analyses, the time necessary to implement control measures is as follows:

- Fuel switching – Two to three years for Hawaiian Electric units and one year for units at the Kalaeloa Partners, L.P. power plant.
- CDS – Two to three years.
- FITR – Three to five years.
- SCR, SNCR, and combustion controls (LNB, OFA, and FGR) – Three to five years.
- Water injection – Three to five years.
- Wet ESPs and wet scrubbers – Three to five years.

Energy and Non-air Environmental Impacts (8-12-2022 Submittal)

The following information for the energy and non-air environmental impact factor was provided in the four factor analyses:

- Fuel Switching – There are no energy and non-air quality environmental impacts of compliance for fuel switching.
- CDS – CDS systems require electricity to operate the ancillary equipment. In addition, solid waste streams are generated that require disposal.
- DPF – There are no energy and non-air quality environmental impacts of compliance for adding diesel particulate filters.

- SCR and SNCR – These control systems require electricity to operate the ancillary equipment. SCR and SNCR can potentially cause environmental impacts related to storage of ammonia. These control systems can also release unreacted ammonia referred to as ammonia slip.
- Wet ESPs – ESPs apply energy for removing particulate form the exhaust stream of the emissions source. Wet ESPs generate wastewater streams that must be treated onsite or sent to a wastewater treatment plant. The wastewater treatment process will generate filter cake that would likely require landfilling.
- Wet Scrubbers – Wet scrubbers require energy to force exhaust gases through the scrubber and generate wastewater streams that would need to be treated.

6.2 Control Cost Threshold, 8-12-2022 RH-SIP Submittal

To remain consistent to the current value of the dollar, the control cost threshold of $5,000/ton of pollutant removed in 2009 dollars (one year into the first regional haze planning period) should be subject to escalation to 2019 dollars (one year into the second regional haze planning period). One cost index that has been used extensively by EPA for escalation purposes is the Chemical Engineering Plant Cost Index (CEPCI).

The CEPCI tracks costs of equipment, construction labor, buildings, and supervision in chemical process industries. A chart showing the history of the CEPCI is provided below as Figure 6.2-1.

Since the first planning period, when less than $5,000/ton of pollutant removed was generally considered reasonable in accepting a control measure as economically feasible, there has been a 16% increase in the CEPCI. Therefore, since there was a 16% increase to the CEPCI between 2009 and 2019, there should also be a 16% increase to the control cost threshold. Proceeding with this methodology would result in an updated control cost threshold of $5,800/ton of pollutant removed, 16% higher than the $5,000/ton of pollutant removed threshold. It is important to note that the control cost threshold is a guideline for evaluating cost effective controls and is not considered a definitive line. Control measures that are above the control cost threshold may still be considered reasonable.

Chemical Engineering Plant Cost Index (CEPCI)

Year	Index	CEPCI % growth from 1999	CEPCI % growth from 2000	CEPCI % growth from 2001	CEPCI % growth from 2002	CEPCI % growth from 2003	CEPCI % growth from 2004	CEPCI % growth from 2005	CEPCI % growth from 2006	CEPCI % growth from 2007	CEPCI % growth from 2008	CEPCI % growth from 2009	CEPCI % growth from 2010	CEPCI % growth from 2011	CEPCI % growth from 2012	CEPCI % growth from 2013	CEPCI % growth from 2014	CEPCI % growth from 2015	CEPCI % growth from 2016	CEPCI % growth from 2017	CEPCI % growth from 2018
1999	390.6																				
2000	394.1	101%																			
2001	394.3	101%	100%																		
2002	395.6	101%	100%	100%																	
2003	402.0	103%	102%	102%	102%																
2004	444.2	114%	113%	113%	112%	110%															
2005	468.2	120%	119%	119%	118%	116%	105%														
2006	499.6	128%	127%	127%	126%	124%	112%	107%													
2007	525.4	135%	133%	133%	133%	131%	118%	112%	105%												
2008	575.4	147%	146%	146%	145%	143%	130%	123%	115%	110%											
2009	521.9	134%	132%	132%	132%	130%	117%	111%	104%	99%	91%										
2010	550.8	141%	140%	140%	139%	137%	124%	118%	110%	105%	96%	106%									
2011	593.2	152%	151%	150%	150%	148%	134%	127%	119%	113%	103%	114%	108%								
2012	582.2	149%	148%	148%	147%	145%	131%	124%	117%	111%	101%	112%	106%	98%							
2013	567.3	145%	144%	144%	143%	141%	128%	121%	114%	108%	99%	109%	103%	96%	97%						
2014	576.1	147%	146%	146%	146%	143%	130%	123%	115%	110%	100%	110%	105%	97%	99%	102%					
2015	556.8	143%	141%	141%	141%	139%	125%	119%	111%	106%	97%	107%	101%	94%	96%	98%	97%				
2016	541.7	139%	137%	137%	137%	135%	122%	116%	108%	103%	94%	104%	98%	91%	93%	95%	94%	97%			
2017	574.0	147%	146%	146%	145%	143%	129%	123%	115%	109%	100%	110%	104%	97%	99%	101%	100%	103%	106%		
2018	603.1	154%	153%	153%	152%	150%	136%	129%	121%	115%	105%	116%	109%	102%	104%	106%	105%	108%	111%	105%	
2019	607.5	156%	154%	154%	154%	151%	137%	130%	122%	116%	106%	116%	110%	102%	104%	107%	105%	109%	112%	106%	101%

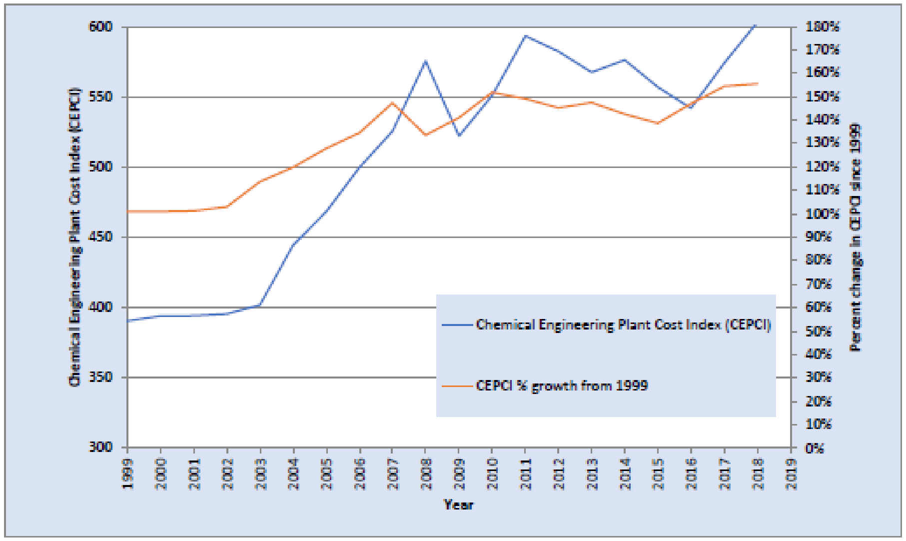


Figure 6.2-1 1999-2019 Chemical Engineering Plant Cost Index (CEPCI), 8-12-2022 RH-SIP Submittal

6.3 Controls Selected, 8-12-2022 RH-SIP Submittal

The 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 selected were those below the $5,800/ton of pollutant removed cost threshold with the greatest reductions in visibility impairing pollutants (SO_2, NO_X, and PM_{10}). Please refer to Appendix K.

Tables 6.3-1 and 6.3-2 provide a summary of the control measures selected, emission reductions, and compliance times based on a four-factor analyses for Hawaii and Maui Island sources, respectively, in the August 12, 2022, RH-SIP submittal. These sources ranked high in the WEP/AOI analysis in their potential to affect visibility in the national parks. After further consultation with Hawaiian Electric on the controls selected from a four-factor analysis, various alternative control measure alternatives were proposed for making reasonable progress during this second planning period. The final control measures selected for facilities are provided in Tables 6.6-1 and 6.6-2 for the Hawaii and Maui Island sources, respectively.

Table 6.3-1 Controls Selected for Hawaii Island Sources (8-12-2022 Submittal)

Power Plant	Controls Selected	Emission Reductions (Tons)				Compliance Time after Permit Issuance [a]
		NO_X	SO_2	PM_{10}	Total	
Kanoelehua-Hill	SCR + Combustion Controls + ULSD for Boilers Hill 5 and Hill 6	585	2,165	49	2,799	2 years – ULSD 3 years – SCR and combustion controls
Puna	ULSD for Boiler	4.5	184	8	197	2 years – ULSD
	Total→	590	2,349	56	2,995	See note a

a: Pursuant to 2016 Updates to the Assessment of Reasonable Progress for Regional Haze in Mane-VU Class I areas, two (2) year period after SIP approval is adequate for pre-combustion controls and three (3) year period for installation of post combustion controls.

Table 6.3-2 Controls Initially Selected for Maui Island Sources (8-12-2022 Submittal)

Power Plant	Controls Selected	Emission Reductions (Tons)				Compliance Time after Permit Issuance [a]
		NO_X	SO_2	PM_{10}	Total	
Kahului	SCR + Combustion Controls + ULSD for Boilers K-1, K-2, K-3, and K-4	588	2,219	72	2,879	2 years – ULSD 3 years – SCR and combustion controls
Maalaea	FITR for Diesel Engine Generators M1, M2, and M3 SCR for Diesel Engine Generator M7	124	-----	-----	124	2 years for FITR 3 years – SCR
	Total→	712	2,219	72	3,003	See note a

a: Pursuant to 2016 Updates to the Assessment of Reasonable Progress for Regional Haze in Mane-VU Class I areas, two (2) year period after SIP approval is adequate for pre-combustion controls and three (3) year period for installation of post combustion controls.

Table 6.3-3 below shows Q/d values based on actual emissions from facilities for years 2014 and 2017 and reductions from actual 2017 baseline emissions after control measures from Tables 6.3-1 and 6.3-2 are accounted for in the emission estimates. Where Q is the total combined emissions of NO_X, SO_2, and PM_{10} in tons and d is the distance of the source from the Class I area in kilometers. Please refer to Appendix K for Q/d values.

Table 6.3-3 Q/d Values Before and After Controls (8-12-2022 Submittal)

Source	Q/d			Class I Area
	2014	2017	2017	
	Before Controls[a]	Before Controls[b]	After Controls[c]	
HELCO – Kanoelehua-Hill Power Plant	17	19	0.2	1) Haleakala NP
	98	110	1.0	2) Hawaii Volcanoes NP
HELCO – Puna Power Plant	27	10	0.3	1) Hawaii Volcanoes NP
MECO – Kahului Power Plant	82	110	1.1	1) Haleakala NP
	12	16	0.2	2) Hawaii Volcanoes NP
MECO – Maalaea Generating Station	110	124	104	1) Haleakala NP
	17	19	15.7	2) Hawaii Volcanoes NP

a. Worst case Q/d values based on 2014 actual emissions before controls selected in Tables 6.3-1 and 6.3-2.
b. Worst case Q/d values based on 2017 actual emissions before controls selected in Tables 6.3-1 and 6.3-2.
c. Worst case Q/d values based on 2017 baseline emissions after controls selected in Tables 6.3-1 and 6.3-2.

The DOH-CAB sent letters to Hawaiian Electric requesting permit applications to incorporate the regional haze control measures selected for the Kahului, Kanoelehua-Hill, Maalaea, and Puna power plants. Hawaiian Electric responded with new information that was not provided in Hawaiian Electric's four-factor analyses for these facilities. This included the need to install secondary tank containment liners and fuel atomization systems for the fuel switches, a claim that 7% is the nominal interest rate, revised construction cost multiplier for SCR of 1.2, a commitment to enforceable shut downs of boilers at the Kahului and Kanoelehua-Hill Generating Stations to exclude these units from the four-factor analysis, and new remaining useful life assumptions for diesel engine generators at the Maalaea Generating Station. Please see Chapter 7 and Sections 6.4 through 6.6 of the RH-SIP for additional evaluation.

6.4 Four-Factor Analysis, 2023 RH-SIP Submittal Update (Point Sources)

Potential control measures that could be implemented were determined based on updated information for the four-factor analyses from facilities identified in the screening process. Updates included changes in compliance dates for shutting down boilers at the Kahului and Kanoelehua-Hill Generating Stations, proposals from Hawaiian Electric to shut down units at the Maalaea generating station, and updated information for the Mauna Loa Macadamia Nut Corporation plant. The four-factor analyses for the RH-SIP revision was also based on a higher prime interest rate and control cost threshold of $6,800/ton, since the CEPCI and current prime interest rate have changed significantly since the time the initial RH-SIP was submitted to EPA. The initial RH-SIP for this second planning period was submitted to EPA on August 12, 2022, to avoid a “Failure to Submit” finding. Please see Appendix P, Industry Consultation – Hawaiian Electric Draft Permit Amendments, Draft Permit Application Reviews, and Draft Technical Support Document for 2023 RH-SIP Submittal and Industry Consultation – Mauna Loa Macadamia Nut Corporation Plant Draft Permit Amendment and Draft Technical Support Document, 2023 RH-SIP Submittal.

Cost of Compliance (2023 Submittal Update)

A driving factor in selecting controls is the cost based on assumptions used in calculations to determine the cost per tons of pollutant removed by the control measure. Calculation methodologies to determine the control measure cost are provided in EPA's Air Pollution Control Cost Manual. In this RH-SIP revision, the EPA directed DOH-CAB to use the current prime interest rate, currently at 8.25%, in its revised cost calculations that would increase costs from those previously determined using a 3.25% prime interest rate.

Control costs and notes are summarized in Tables 6.4-1 through 6.4-5 for the Hawaii Electric Light Kanoelehua-Hill and Puna power plants, Maui Electric Kahului and Maalaea power plants, and the Mauna Loa Macadamia Nut Corporation plant. Costs are based on the four-factor analyses provided for these facilities, and also incorporating the new prime interest rate. Units at the Kanoelehua-Hill and Kahului facilities were committed to permanent and enforceable shut down dates in the August 12, 2022, RH-SIP submittal, and therefore are not subject to a four-factor analysis using the new prime interest rate of 8.25%.

Four-Factor Analysis for Kanoelehua-Hill Power Plant (2023 Submittal Update)

Table 6.4-1 Four-Factor Analysis for Kanoelehua-Hill Power Plant (2023 Submittal) Hawaii

Unit	**Description**	**Primary Fuel**	**Control Measure & Cost per Ton**
Hill 5	14 MW Boiler	Fuel Oil No. 6 with 2.0% maximum sulfur content	• For the August 12, 2022, RH-SIP submittal, Boilers Hill 5 and Hill 6 were committed to an enforceable shut down by the beginning of 2028. Therefore, they are no longer subject to a four-factor analysis using the current prime interest rate and higher control cost threshold. The compliance date for the shut down of Boilers Hill 5 and Hill 6 was changed to the end of 2028 for the 2023 RH-SIP submittal pursuant to Hawaiian Electric's request. • Combustion Turbine Generator 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 increase in NO_X emissions reported for this unit through SLEIS; however, shows a steady increase in use of the combustion turbine generator from 2017 to 2022. The NO_X emissions for CT-1 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 20.66 tons per year in 2021 to 27.56 tons per year in 2022. Another round of screening sources for four-factor analysis will be performed in the third regional haze planning period. • 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 remain 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 D-15, D-16, and D-17. A
Hill 6	23 MW Boiler	Fuel Oil No. 6 with 2.0% maximum sulfur content	
CT-1	11.6 MW Combustion Turbine	Fuel Oil No. 2 with 0.4% maximum sulfur content	
D-11	2.75 MW DEG	ULSD	
D-15	2.75 MW DEG	ULSD	

Table 6.4-1 Four-Factor Analysis for Kanoelehua-Hill Power Plant (2023 Submittal)
Hawaii

Unit	Description	Primary Fuel	Control Measure & Cost per Ton
D-16	2.75 MW DEG	ULSD	four-factor analysis may be appropriate for these units during the third regional haze planning period if future emissions increase.
D-17	2.75 MW DEG	ULSD	

<u>Four-Factor Analysis for Puna Power Plant (2023 Submittal Update)</u>
For the boiler, a fuel switch to ULSD with 0.0015% sulfur content was determined to be cost effective at $6,014/ton SO_2, NO_X, and PM_{10} combined since the cost was below the $6,800/ton threshold. Combustion turbine generator CT-3 operates on a limited basis. Therefore, a four-factor analysis was not conducted for this unit. The costs per ton of pollutant removed, highlighted in green and blue, are costs after changes were made by DOH-CAB to align with EPA guidance and comments provided by EPA and the FLMs, including the new prime interest rate of 8.25%. For costs highlighted in green and blue, the DOH-CAB assumed a remaining useful life thirty (30) years for SCR and wet scrubbers, and twenty (20) years for all other controls. Costs, highlighted in green, are DOH-CAB's costs from the previous RH-SIP submittal using a 3.25% interest rate. Cost highlighted in orange is the cost of the fuel switch after additional information was submitted concerning secondary containment liners and fuel atomization using a 6.56% nominal interest rate. Costs highlighted in blue are DOH-CAB's costs determined in the RH-SIP revision using the higher interest rate of 8.25%. A construction cost multiplier of 1.0 was used instead of 1.840 for SCR. A retrofit factor of 1.0 was used for SNCR. Please refer to page 524 of Appendix P (Draft TSD for CSP No. 0235-01-C, 2023 RH-SIP Submittal) for further details on the cost analysis.

Table 6.4-2 Four-Factor Analysis for Puna Power Plant (2023 Submittal)
Hawaii

Unit	Description	Primary Fuel	Control Measure & Cost per Ton [a, b, c]
Boiler	15.5 MW Boiler	Fuel Oil No. 6 with 2.0% maximum sulfur content	• Fuel switch to ULSD with 0.0015% sulfur content - $4,690/ton ($5,794) ($6,014) SO_2, NO_X, and PM_{10} for Boiler • Boiler Combustion Controls (LNB w/OFA/FGR) - $13,431 ($19,109) /ton NO_X • SCR for Boiler - $59,655 ($23,478) ($43,254)/ton NO_X. • SCR + Combustion Control for Boiler - $49,119 ($39,793)/ton NO_X • SNCR for Boiler - $29,311 ($22,621) ($36,345)/ton NO_X.

Table 6.4-2 Four-Factor Analysis for Puna Power Plant (2023 Submittal)
Hawaii

Unit	Description	Primary Fuel	Control Measure & Cost per Ton [a, b, c]
CT-3	20 MW Combustion Turbine	Fuel Oil No. 2 with 0.4% maximum sulfur content	• SNCR + Combustion Controls – Boiler - $34,235 ($27,558) ($44,417)/ton NO$_X$ • Wet Scrubber for Boiler - $35,648 ($32,150) ($39,352)/ton PM$_{10}$ • Wet ESP for Boiler - $496,875 ($575,625) ($583,295)/ton PM$_{10}$. • CT-3 was considered a limited use unit based on its operation in 2017, and therefore a four-factor analysis was not conducted for this unit.

a. ESP-electrostatic precipitator, FGR-flue gas recirculation, LNB-low NO$_X$ burner, MW-megawatt, OFA-overfire air, SCR-selective catalytic reduction, ULSD-ultra-low sulfur diesel, and combustion controls are LNB with OFA and/or FGR.
b. Combustion turbine CT-3 is considered a limited use unit.
c. Wet ESP was assumed to be 90% efficient at removing particulate. A wet scrubber was assumed to be 50% efficient at removing particulate.

Four-Factor Analysis for Kahului Power Plant (2023 Submittal Update)

Table 6.4-3 Four-Factor Analysis for Kahului Power Plant (2023 Submittal)
Maui

Unit	Description	Primary Fuel	Control Measure & Cost per Ton
K-1	5.0 MW Boiler	Fuel Oil No. 6 with 2.0% maximum sulfur content	• During the initial RH-SIP Submittal, Boilers K-1, K-2, K-3, and K-4 were committed to an enforceable shut down by the beginning of December 31, 2028. Therefore, they are no longer subject to a four-factor analysis. The compliance date for the shut down of Boilers K-1 through K-4 was changed to the end of 2028 in Revision 1 of the RH-SIP pursuant to Hawaiian Electric's request. The permit amendment to incorporate this change is included with the RH-SIP, Revision 1 submittal. Please see Chapter 7 for further details.
K-2	5.0 MW Boiler	Fuel Oil No. 6 with 2.0% maximum sulfur content	
K-3	11.5 MW Boiler	Fuel Oil No. 6 with 2.0% maximum sulfur content	
K-4	11.5 MW Boiler	Fuel Oil No. 6 with 2.0% maximum sulfur content	

Four-Factor Analysis for Maalaea Power Plant (2023 Submittal Update)

Fuel ignition timing retard (FITR) was determined to be cost effective for diesel engine generators M1 and M3 as the cost of controls for each unit is less than $6,800/ton NO$_X$.

Hawaiian Electric agreed to staggered shut down dates for diesel engine generators M7 and M10 through M13 to reduce the remaining useful life of equipment to render the control costs economically infeasible. The remaining useful life is the time between December 31, 2027 (agreed compliance date for installing SCR) and the shut down date. Even with the shut down date of December 31, 2032, the SCR control cost of $6,258/ton of NO$_X$ removed using a 5-year remaining useful life was still cost effective for M10. With a remaining useful life of 4 years for M10, the control cost was found to be $6,859/ton of NO_X removed, which is very close to the $6,800 threshold. Since the threshold is not a hard and fast cutoff limit, SCR was considered cost effective for a 4-year remaining useful life of the unit. Another option to SCR for M10 would be an enforceable condition to shut down the unit by December 30, 2030. This results in a 3-year remaining useful life and a control cost to install SCR of $7,864/ton of NO_X removed.

The costs per ton of pollutant removed (highlighted in green, blue, orange, and purple) are costs after changes were made to worksheets by DOH-CAB to align with guidance and correct errors in previous cost estimate submittals. The DOH-CAB assumed a remaining useful life of twenty (20) years for all controls except for M7 and M10-M13 that were proposed to be shut down according to a staggered shut down schedule. A construction cost multiplier of 1.0 was used instead of 1.938 for retrofitting the combustion turbines with SCR. Costs highlighted in green are costs determine in the August 12, 2022, RH-SIP submittal using a 3.25% prime interest rate. Costs highlighted in purple and blue are DOH-CAB's costs determined in Revision 1 of the RH-SIP (2023 submittal) using the current prime interest rate of 8.0% and 8.25%, respectively. Cost highlighted in orange for combustion turbine generators M14, M16, M17, and M19 are revised calculations from the initial RH-SIP submittal, which used a 3.25% interest rate but also included a calculation error which is now corrected. Please see Appendix P (Draft Permit Amendment for CSP No. 0067-01-C, 2023 RH-SIP Submittal). Also see Appendix P (Draft TSD for CSP No. 0235-01-C, 2023 RH-SIP Submittal) for further details.

Table 6.4-4 Four-Factor Analysis for Maalaea Power Plant (2023 Submittal)
Maui

Unit	Description	Primary Fuel	Control Measure & Cost per Ton [a]
M1	2.5 MW DEG	ULSD	• Fuel switch to ULSD with 0.0015% maximum sulfur content $10,347/ton SO_2 (No PM_{10} and NO_X emissions are included since ULSD and F.O. #2 are considered to be similar). • FITR for M1 - $4,159 ($3,030) ($5,328)/ton NO_X • FITR for M2 - $7,173 ($5,225) ($9,186)/ton NO_X • FITR for M3 - $4,159 ($3,030) ($5,328)/ton NO_X • FITR + CEMS for M1 – $18,804 ($12,430)/ton NO_X • FITR + CEMS for M3 - $18,617 ($12,430)/ton NO_X • Tier 4 Replacement for M1 ($37,758)/ton NO_X. • Tier 4 Replacement for M2 ($62,314)/ton NO_X. • Tier 4 Replacement for M3 ($37,689)/ton NO_X. • SCR for M1 - $19,383 ($13,996) ($40,396)/ton NO_X. • SCR for M2 - $29,578 ($19,778) ($69,251)/ton NO_X. • SCR for M3 - $19,295 ($13,896) ($40,395)/ton NO_X. • SCR for M4 - $11,072 ($10,336) ($9,267)/ton NO_X. • SCR for M5 - $8,371 ($7,327) ($9,056)/ton NO_X. • SCR for M6 - $12,130 ($10,823) ($12,250)/ton NO_X. • SCR for M7 - $6,162 ($5,530) ($7,753)/ton NO_X. • SCR for M8 - $12,151 ($10,857) ($14,373)/ton NO_X. • SCR for M9 - $9,562 ($9,087) ($8,624)/ton NO_X. • SCR for M10 - $8,335 ($8,757) ($6,258)/ton NO_X
M2	2.5 MW DEG	ULSD	
M3	2.5 MW DEG	ULSD	
M4	5.6 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M5	5.6 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M6	5.6 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M7	5.6 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M8	5.6 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M9	5.6 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M10	12.5 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	

Table 6.4-4 Four-Factor Analysis for Maalaea Power Plant (2023 Submittal)
Maui

Unit	Description	Primary Fuel	Control Measure & Cost per Ton [a]
M11	12.5 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	• SCR for M11 - $8,546 ($8,859) ($7,174)/ton NO_x. • SCR for M12 - $11,832 ($12,423) ($7,256)/ton NO_x . • SCR for M13 - $10,805 ($11,292) ($7,020)/ton NO_x. • SCR for X1 - $33,856 ($23,041) ($106,612)/ton NO_x. • SCR for X2 - $33,024 ($22,388) ($105,025)/ton NO_x • SCR for M14 - $60,413 ($23,854) ($6,389) ($11,060)/ton NO_x. • SCR for M16 - $52,326 ($20,660) ($5,534) ($9,579)/ton NO_x. • SCR for M17 - $67,266 ($26,559) ($7,114) ($12,314)/ton NO_x. • SCR for M19 - $77,700 ($30,679) ($8,217) ($14,224)/ton NO_x. • DPF for M4 - $41,214 ($30,031) ($51,828)/ton PM_{10}. • DPF for M5 - $52,455 ($38,221) ($65,963)/ton PM_{10} • DPF for M6 - $52,455 ($38,221) ($65,963)/ton PM_{10} • DPF for M7 - $48,084 ($35,036) ($60,466)/ton PM_{10}
M12	12.5 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M13	12.5 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
X1	2.5 MW DEG	ULSD	
X2	2.5 MW DEG	ULSD	
M14	20 MW Combustion Turbine	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content and 0.015% average nitrogen content	
M16	20 MW Combustion Turbine	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content and 0.015% average nitrogen content	
M17	20 MW Combustion Turbine	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content and 0.015% average Ce nitrogen content	
M19	20 MW Combustion Turbine	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content and 0.015% average nitrogen content	

a. DPF-diesel particulate filters, FITR-fuel ignition timing retard, MW-megawatt, SCR-selective catalytic reduction, ULSD-ultra-low sulfur diesel.

For costs in blue from Table 6.4-4, Hawaiian Electric proposed the following shut down dates for M7 and M10 - M13 to reduce the remaining useful life:

a. **December 31, 2037**, for M7 (remaining useful life of 10 years);
b. **December 31, 2032,** for M10 and M11 (remaining useful life of 5 years); and
c. **December 31, 2037,** for M12 and M13 (remaining useful life of 10 years).

Four-Factor Analysis for Mauna Loa Macadamia Nut Corporation (2023 Submittal Update)

The main boiler was committed to a federally enforceable shut down by December 31, 2026, and is thereby exempt from a four-factor analysis in this planning period. After boiler shut down, the main boiler will be replaced with a new unit.

Additional pollution controls were not found to be cost-effective for the backup boiler or the diesel engine generators (DEG1 and DEG2). Installation of an economizer, low NOx burner, and SCR were evaluated for the backup boiler. The cost of installing SCR was also evaluated for DEG1 and DEG2. In addition, a Detroit diesel engine distributor was contacted for replacing the diesel engine generators with a new Tier 4 unit. The distributor said that the cost of a new Tier 4 unit would be more than the cost to retrofit the diesel engine generators with SCR. A 7.75% interest rate was assumed for the cost analysis.

Table 6.4-5 Four-Factor Analysis for Mauna Loa Macadamia Nut Corporation Plant
(2023 Submittal)
Hawaii

Unit	Description	Primary Fuel	Control Measure & Cost per Ton
Main Boiler	35.7 MMBtu/hr	Biomass/Used Oil	• The Main Boiler was committed to a federally enforceable shut down by December 31, 2026, and therefore is not subject to a four-factor analysis. • Economizer for Backup Boiler - (\$61,615)/ton NO$_X$. • Low NO$_X$ Burner for Backup Boiler - (\$8,208)/ton NO$_X$. • SCR for Backup Boiler - (\$22,652)/ton NO$_X$. • SCR for DEG1 - (\$11,167)/ton NO$_X$. • SCR for DEG2 - (\$7,525)/ton NO$_X$. • Tier 4 Replacement for DEG 1 & DEG2 – (> \$11,167)/ton NO$_X$.
Backup Boiler	14.7 MMBtu/hr	ULSD	
DEG1	460 kW	ULSD	
DEG2	460 kW	ULSD	

Remaining Useful Life (2023 Submittal Update)

In accordance with EPA's control cost manual and comments provided, the DOH-CAB used thirty (30) years for the remaining useful life for retrofitting boilers with SCR and wet scrubbers at the power plants. The DOH-CAB used twenty (20) years for the remaining useful life for all other control equipment, except for units at the Maalaea Generating Station that were proposed to be shut down for purposes of reducing the remaining useful life.

Trinity Consultants, evaluating control costs for the power plants, used a remaining useful life of thirty (30) years for SCR, combustion controls, and post combustion controls. Trinity Consultants used a twenty (20) year remaining useful life for SNCR.

For the Puna Generating Station, in the situation of an enforceable requirement for the source to cease operation before the end of the useful life of the controls under consideration, EPA guidance allows the use of the enforceable shut down date as the end of the remaining useful life. If no enforceable shut down date exists for units requiring controls, the remaining useful life is the full useful life of the control under consideration. Twenty-five (25) years is assumed for atomization equipment and berm liners based on the referenced PUC filing in Hawaiian Electric's letter dated June 16, 2021, since there is no documented useful life for installation of fuel atomization systems and tank containment liners in the CCM. As indicated in the PUC filing (Docket Number 2020-0187) filed on November 10, 2020, for the Waiau Fuel Tank Containment Project Berm Lining, the life expectancy of the liner, accounting for a majority of the capital costs, is upwards of twenty-five (25) years.

For the Maalaea Generating Station, Hawaiian Electric provided revised SCR cost tables with a proposal to shut down DEGs M7 and M10-M13 to lower the remaining useful life to between 5 and 10 years and render SCR control costs ineffective. Note that according to 40 CFR Part 51, Appendix Y BART guidelines, the remaining useful life is the difference between the date the controls are put in place and the date the facility permanently stops operations. Although the BART guidelines are not directly relevant to reasonable progress determinations, this is the best guidance available when controls have not been installed and there is an enforceable shut down requirement after the end of the 2018-2028 regional haze planning period. Also, as indicated in EPA's 2019 regional haze guidance[16] the year 2028 (the end of the second regional haze planning period) is not a bright line for not selecting a source for four-factor analysis. According to the guidance, a state may be able to justify not selecting a source for four-factor analysis of control measures if there is an enforceable requirement for the source to cease operation by a date after 2028. For Hawaiian Electric's cost evaluation, the remaining useful life would start at 2027 since it was agreed that SCR could be installed for equipment by December 31, 2027.

Hawaiian Electric ultimately agreed to the following enforceable shut down dates for M7 and M10-M13 based on revised numbers in a March 6, 2023, letter (the default remaining useful life of 20 years was assumed for all other units):

- M7: December 31, 2037, with remaining useful life of 10 years;
- M10 and M11: December 31, 2032, with remaining useful life of 5 years; and
- M12 and M13: December 31, 2037, with remaining useful life of 10 years.

For the Mauna Loa Macadamia Nut Corporation Plant, they chose to use 21 years in their four-factor analysis for installing SCR on the backup boiler. Although twenty (20) years would have been acceptable, this is a more conservative approach and was deemed acceptable.

Time Necessary for Compliance (2023 Submittal Update)

Based on evaluation by DOH-CAB, the following amounts of time are necessary to implement regional haze control measures:

- Four (4) years from permit issuance for switching fuel for the Puna Generating Station Boiler to ULSD. The permit was amended to switch boiler fuel to ULSD on August 10, 2022. Therefore, the fuel switch is required by August 10, 2026.
- December 31, 2027, for installing FITR on M1 and M3 at Maalaea Generating Station.
- December 31, 2027, for installing SCR for M7 and M10 through M13 at Maalaea Generating Station. These units may also be shut down by the following dates as an option to installing SCR:
  - December 31, 2037, for M7,
  - December 31, 2030, for M10 and/or M11;
  - December 31, 2032, for M10 or M11 if one of these units is shut down by 2030 or installs SCR; and
  - December 31, 2037, for M12 and M13.
- December 31, 2026 for the main boiler at the Mauna Loa Macadamia Nut Corporation Plant. The main boiler will be replaced with another unit after the existing unit is shut down.

Energy and Non-air Environmental Impacts (2023 Submittal Update)
The following information for the energy and non-air environmental impact factor was provided in Hawaiian Electric's four-factor analyses:

- Fuel Switching - There are no energy and non-air quality environmental impacts of compliance for fuel switching.
- CDS - CDS systems require electricity to operate the ancillary equipment. In addition, solid waste streams are generated that require disposal.
- DPF – There are no energy and non-air quality environmental impacts of compliance for adding diesel particulate filters.
- SCR and SNCR - These control systems require electricity to operate the ancillary equipment. SCR and SNCR can potentially cause environmental impacts related to storage of ammonia. These control systems can also release unreacted ammonia referred to as ammonia slip.
- Wet ESPs - ESPs apply energy for removing particulate form the exhaust stream of the emissions source. Wet ESPs generate wastewater streams that must be treated onsite or sent to a wastewater treatment plant. The wastewater treatment process will generate filter cake that would likely require landfilling.
- Wet Scrubbers - Wet scrubbers require energy to force exhaust gases through the scrubber and generate wastewater streams that would need to be treated.

The following information for the energy and non-air environmental impact factor was provided in Mauna Loa Macadamia Nut Corporation's four-factor analysis:

- LNB – Electrical usage is increased by installing three horsepower combustion air fan to accommodate LNB.
- SCR – Electrical usage increases due to an increase in combustion air motor horsepower to accommodate pressure drop from installing SCR.

6.5 Control Cost Threshold, 2023 RH-SIP Submittal Update

The CEPCI for determining the control cost threshold and interest rates have changed significantly since the time the initial RH-SIP was submitted to EPA. For revision 1 of the RH-SIP (2023 RH-SIP submittal), DOH-CAB evaluated the feasibility of regional haze control measures based on EPA's recommendation to escalate the cost threshold to 2021 dollars and use the current prime interest rate for the four-factor analysis. The 2021 CEPCI has a value of 708 which is a 136% increase from the 2009 CEPCI of 521.9. This results in a revised threshold of $6,800 per ton of pollutant removed. Note that the 2022 CEPCI is not available at the time DOH-CAB started its cost evaluation for the RH-SIP revision. Please refer to Figure 6.5-1 for the updated CEPCI data.

Chemical Engineering Plant Cost Index (CEPCI)

Year	Index	CEPCI % growth from 2000	CEPCI % growth from 2001	CEPCI % growth from 2002	CEPCI % growth from 2003	CEPCI % growth from 2004	CEPCI % growth from 2005	CEPCI % growth from 2006	CEPCI % growth from 2007	CEPCI % growth from 2008	CEPCI % growth from 2009	CEPCI % growth from 2010	CEPCI % growth from 2011	CEPCI % growth from 2012	CEPCI % growth from 2013	CEPCI % growth from 2014	CEPCI % growth from 2015	CEPCI % growth from 2016	CEPCI % growth from 2017
2000	394.1																		
2001	394.3	100%																	
2002	395.6	100%	100%																
2003	402.0	102%	102%	102%															
2004	444.2	113%	113%	112%	110%														
2005	468.2	119%	119%	118%	116%	105%													
2006	499.6	127%	127%	126%	124%	112%	107%												
2007	525.4	133%	133%	133%	131%	118%	112%	105%											
2008	575.4	146%	146%	145%	143%	130%	123%	115%	110%										
2009	521.9	132%	132%	132%	130%	117%	111%	104%	99%	91%									
2010	550.8	140%	140%	139%	137%	124%	118%	110%	105%	96%	106%								
2011	593.2	151%	150%	150%	148%	134%	127%	119%	113%	103%	114%	108%							
2012	582.2	148%	148%	147%	145%	131%	124%	117%	111%	101%	112%	106%	98%						
2013	567.3	144%	144%	143%	141%	128%	121%	114%	108%	99%	109%	103%	96%	97%					
2014	576.1	146%	146%	146%	143%	130%	123%	115%	110%	100%	110%	105%	97%	99%	102%				
2015	556.8	141%	141%	141%	139%	125%	119%	111%	106%	97%	107%	101%	94%	96%	98%	97%			
2016	541.7	137%	137%	137%	135%	122%	116%	108%	103%	94%	104%	98%	91%	93%	95%	94%	97%		
2017	574.0	146%	146%	145%	143%	129%	123%	115%	109%	100%	110%	104%	97%	99%	101%	100%	103%	106%	
2018	603.1	153%	153%	152%	150%	136%	129%	121%	115%	105%	116%	109%	102%	104%	106%	105%	108%	111%	105%
2019	607.5	154%	154%	154%	151%	137%	130%	122%	116%	106%	116%	110%	102%	104%	107%	105%	109%	112%	106%
2020	596.2	151%	151%	151%	148%	134%	127%	119%	113%	104%	114%	108%	101%	102%	105%	103%	107%	110%	104%
2021	708.0	180%	180%	179%	176%	159%	151%	142%	135%	123%	136%	129%	119%	122%	125%	123%	127%	131%	123%

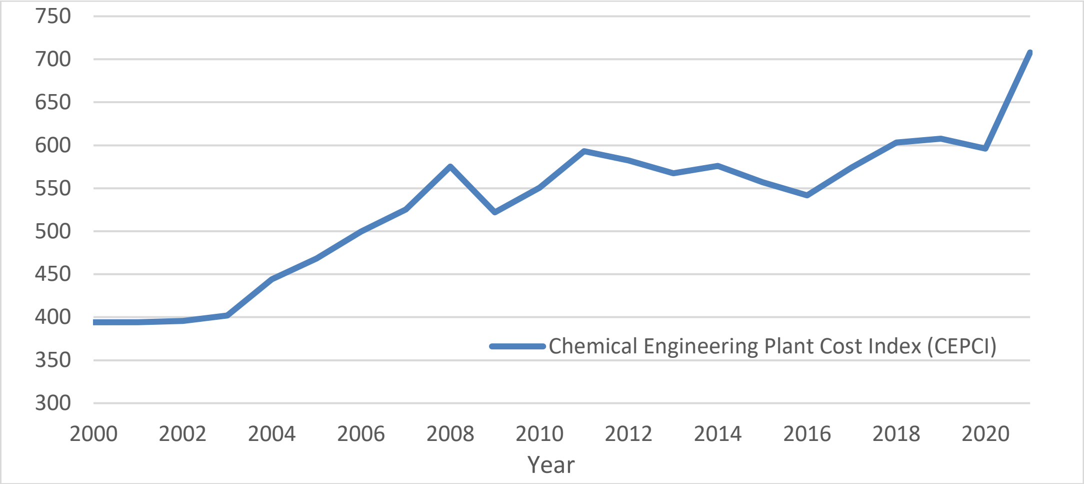


Figure 6.5-1 1999-2021 Chemical Engineering Plant Cost Index (CEPCI) for 2023 RH-SIP Submittal Update

6.6 Controls Selected, 2023 RH-SIP Submittal Update

Tables 6.6-1 and 6.6-2 provide a summary of the control measures selected, emission reductions, and compliance times based on four-factor analyses (using 2017 baseline) and proposed shut downs for Hawaii and Maui Island sources. These sources ranked high in the WEP/AOI analysis in their potential to affect visibility in the national parks. Please refer to Appendix K for Q/d values from sources selected with the WEP/AOI analysis.

Mauna Loa Macadamia Nut Corporation must provide an effective control demonstration or conduct a four-factor analysis for replacing the main boiler at its plant with another unit. This can be accomplished during the permitting process to replace the main boiler with a new unit.

Table 6.6-1 Controls Selected for Hawaii Island Sources (2023 Submittal)

Plant	Controls Selected	Emission Reductions (Tons)				Compliance Time
		NO_X	SO_2	PM_{10}	Total	
Kanoelehua-Hill Power Plant	Shut down of Boilers Hill 5 and Hill 6.	605	2,167	57	2,829	December 31, 2028
Mauna Loa Macadamia Nut Corporation Plant	Shut down of Main Boiler.	----	------	-----	----	December 31, 2026
Puna Power Plant	Fuel Switch to ULSD for Boiler.	4.5	184	8	197	August 10, 2026
	Total→	610	2,351	65	3,026	See notes a, b & c

a: Kanoelehua-Hill permit was amended in the RH-SIP revision to change the compliance date for the boiler shutdown from December 31, 2027, to December 31, 2028.

b: Emission reductions for Mauna Loa Macadamia Nut Corporation Plant will be determined when permit is revised to install main boiler replacement.

c: The permit for the Puna Generating Station was amended to incorporate the fuel switch to ULSD on August 10, 2022. The compliance date for the fuel switch is four years from permit issuance.

Table 6.6-2 Controls Selected for Maui Island Sources (2023 Submittal)

Power Plant	Controls Selected	Emission Reductions (Tons)				Compliance Time
		NO_X	SO_2	PM_{10}	Total	
Kahului	Shut down of Boilers K-1, K-2, K-3, and K-4.	603	2,221	84	2,908	December 31, 2028
Maalaea	FITR to Control NO_X for Diesel Engine Generators M1 and M3. SCR to Control NO_X for Diesel Engine Generators M7 and M10-M13 as an alternative to shut down.	1,841	-----	-----	1,841	December 31, 2027, for FITR. Cannot operate M7 and M10-M13 on and after December 31, 2027 without SCR installed
	Total→	2,444	2,221	84	4,749	See notes a and b

a: Kahului permit was amended in the RH-SIP revision to change compliance date for boiler shut down from December 31, 2027, to December 31, 2028.

b: An alternative to SCR for diesel engine generators M7 and M10- M13 is to shorten the useful life of the units with commitment to shut down as proposed in Hawaii Electric's March 6, 2023, letter. Unit M10 would need to be shut down earlier than what was proposed in the letter. Please see four-factor analysis for the Maui Electric Maalaea Generating Plant in Section 6.4 of Chapter 6.

Table 6.6-3 below shows Q/d values based on actual emissions from facilities for years 2014 and 2017 and reductions from actual 2017 baseline emissions after control measures from Tables 6.6-1 and 6.6-2 are accounted for in the emission estimates. Where Q is the total combined emissions of NO_X, SO_2, and PM_{10} and d is the distance of the source from the Class I area. Please refer to Appendix K for Q/d values from sources selected with the WEP/AOI analysis.

Table 6.6-3 Q/d Values Before and After Controls (2023 Submittal)

Source	Q/d			Class I Area
	2014	2017	2017	
	Before Controls[a]	Before Controls[b]	After Controls[c]	
Kanoelehua-Hill Power Plant	17	19	17	1) Haleakala NP
	98	110	100	2) Hawaii Volcanoes NP
Puna Power Plant	27	10	9	1) Hawaii Volcanoes NP
Kahului Power Plant	82	110	100	1) Haleakala NP
	12	16	15	2) Hawaii Volcanoes NP
Maalaea Generating Station	110	124	124	1) Haleakala NP
	17	19	16	2) Hawaii Volcanoes NP

a. Worst case Q/d values based on 2014 actual emissions before controls selected in Tables 6.6-1 and 6.6-2.
b. Worst case Q/d values based on 2017 actual emissions before controls selected in Tables 6.6-1 and 6.6-2.
c. Worst case Q/d values based on 2017 baseline emissions after controls selected in Tables 6.6-1 and 6.6-2.

6.7 Four-Factor Analysis (Area Sources)

A four-factor analysis was not performed for fugitive dust from unpaved roads identified as a potential source for controls in Chapter 5. In accordance with EPA guidance, a state is not required to evaluate all sources of emissions in each implementation period.

The DOH-CAB is issuing rules with provisions for regulating fugitive dust emissions. Please refer to Sections 7.3 and 7.5.b in Chapter 7 for Hawaii's fugitive dust requirements.

Chapter 7 Long Term Strategy

7.0 Description – 40 CFR §51.308(f)(2)

a. 40 CFR §51.308(f)(2): 40 CFR §51.308(f)(2)[7] states that the long-term strategy must include the enforceable emissions limitations, compliance schedules, and other measures that are necessary to make reasonable progress. This includes actions to:

i. Evaluate and determine the emission reduction measures that are necessary to make reasonable progress by considering the costs of compliance, the time necessary for compliance, the energy and non-air quality environmental impacts of compliance, and the remaining useful life of any potentially affected anthropogenic source of visibility impairment, which are discussed in Chapters 6 and 8;
ii. Consult with those States that have emissions that are reasonably anticipated to contribute to visibility impairment in the mandatory Class I Federal area to develop coordinated emission management strategies, which does not apply to Hawaii; and

iii. Document the technical basis, including modeling, monitoring, cost, engineering, and emissions information, to determine the emission reduction measures that are necessary to make reasonable progress as discussed in Chapter 6.

b. 40 CFR §51.308(f)(2)(iv): 40 CFR §51.308(f)(2)(iv) further requires States to consider the following factors when determining their long-term strategy:

i. Emissions reductions due to ongoing air pollution control programs including measures to address reasonably attributable visibility impairment;
ii. Measures to mitigate construction activities;
iii. Source retirement and replacement schedules;
iv. Basic smoke management practices for prescribed fire used for agricultural and wildland vegetation management purposes and smoke management programs; and
v. The anticipated net effect on visibility due to projected changes in point, area, and mobile source emissions over the planning period.

7.1 Ongoing Air Pollution Control Programs Under State Regulations – 40 CFR §51.308(f)(2)(iv)(A)

a. Renewable Portfolio Standards (RPSs): 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 L) which establishes a percentage of net electricity each company sells for consumption that must be generated from renewable energy by the end of years shown in Table 7.1-1.

Table 7.1-1 HRS §269-92 Renewable Portfolio Standards

Dates	Net Electricity Sold Using Renewable Energy
December 31, 2010	10%
December 31, 2015	15%
December 31, 2020	30%
December 31, 2030	40%
December 31, 2040	70%
December 31, 2045	100%

The State of Hawaii Public Utilities Commission (PUC) is required by HRS §269-95 to evaluate the RPS every five (5) years, beginning in 2013 and may 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; and 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 2019 Hawaii State's Legislature on RPS (refer to Appendix M) indicates that while there is some uncertainty regarding the more distant future RPS benchmarks, the existing RPS benchmarks remain appropriate and effective and are sufficiently achievable based on best currently available information. Findings include:

i. The RPS remains effective in helping the State of Hawaii achieve its policies and objectives with respect to developing renewable energy resources.

ii. Achievement of the 2020 RPS requirement of 30% is highly likely for both Hawaiian Electric (including its subsidiaries Maui Electric Company and Hawai'i Electric Light Company) and Kaua'i Island Utility Cooperative (KIUC). KIUC has already achieved the 2020 requirement.

iii. It appears likely that the 2030 RPS requirement of 40% is achievable for both Hawaiian Electric and KIUC, provided that reasonably expected amounts of utility-scale renewable energy projects and distributed renewable generation are successfully developed and integrated on the utility systems. KIUC has already achieved the 2030 requirement.

iv. The cost of renewable projects under development and recently proposed are below recent costs of most fossil fuel generation, making renewable projects cost competitive alternatives to continuing to utilize fossil fuel generation resources.

v. Reliability events that occurred on Kauai and Maui in 2017 and 2018, both islands with high levels of inverter-based renewable generation, suggest that continued research and development of grid integration technologies and grid management solutions will be necessary for reliable operation of the grid as the State progresses towards the longer term RPS goals.

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, sale of electricity data from Section 5 of the PUC RPS Report to the 2019 Legislature (refer to Appendix M) was compiled to provide an estimate of the statewide impact of the RPS on visibility. The report presented sales of electricity data for 2017 and projected data for 2020 and 2030 in units of gigawatt-hours (GWh). A breakdown of the sales data was made between sales from all fuel sources and renewable sources. The renewable sales data were further broken down to establish a sub-group consisting of sales from biomass and biofuel sources, which were excluded from the estimates. The percentage of renewables less biofuels and biomass relative to the statewide total sales from all fuel sources were calculated and subtracted from 100% to provide a reasonable measure of the impact the RPS will have on visibility. As shown in the following tables, the percentage of electricity sales from renewables, less biofuels and biomass sources, are projected to increase from 2017 to 2030. Therefore, as the RPS progresses, the impact of fuel-fired electric plants on visibility is expected to decline.

Table 7.1-1a Sales of Electricity (GWh)	
Annual Sales by Hawaiian Electric[a]	8,690
Annual Sales by KIUC[a]	445
Statewide Total Sales from all Fuel Sources[a]	9,135

Table 7.1-1b Statewide[b] Sales from Renewables Less Sales from Biofuel & Biomass

Calendar Year (P=Projected)	2017	2020P	2030P
Sales of Renewables (GWh)	1,465.7	1,926.7	3,333.5
Sales from Biofuels & Biomass (GWh)	483.3	704.3	773.3
Renewables less Biofuels & Biomass (GWh)	982.4	1222.4	2560.2
Statewide Total Sales from all Fuel Sources[a] (GWh)	9,135	9,135	9,135
Renewables less Biofuels & Biomass (%)	11%	13%	28%
Estimated Impact to Visibility Impairment (%) – Fuel Sources	89%	87%	72%

a. Data Source: Footnote 10 in the PUC RPS Report to the 2019 Legislature.
b. Data Source: Tables 3 & 4 in the PUC RPS Report to the 2019 Legislature.

b. Energy Efficiency Portfolio Standard (EEPS): The main focus of the State of Hawaii's EEPS is on reducing consumption (or demand) of electricity by improving efficiency. These standards are codified in HRS §269-96 (see Appendix L), which is designed to achieve a reduction in the consumption of 4,300 gigawatt hours (GWh) of electricity statewide by 2030. The HRS tasks PUC with establishing interim goals for 2015, 2020, and 2025; and authorizes the PUC to adjust the 2030 standard and to establish incentives and penalties based on performance in achieving the 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 the Hawaii State's Legislature every five (5) years.

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 latest PUC Report to the 2019 Hawaii State's Legislature on EEPS (refer to Appendix N) identified a savings of 2,030 GWh for the first interim period ending in 2015, which exceeded its goal of 1,375 GWh of energy savings by nearly 50%. Saving for the second interim period is 530 GWh as of the end of 2017, which exceeds half the interim goal of 980 GWh. An annual target of approximately 196 GWh is used to established interim goals as shown below in Table 7.1-2.

Table 7.1-2 Hawaii's Interim Goals for the Energy Efficiency Portfolio Standard

Calendar Year	Interim Savings Goal (GWh)	Actual Savings Achieved (GWh)	Notes
2015	1,375	2,030	See note [a]
2020	980	530	Data for 2016 and 2017
2025	980		
2030	980		
Total	4,315	2,560	

a. Customer solar panel photovoltaic installations after 2014 no longer count towards the EEPS goal.

However, the PUC's report also stated that maintaining the past level of savings is becoming more difficult. Preliminary findings suggest that the EEPS goal is achievable, but requires strategic adaptation, possible increases in energy efficiency program budgets, continued innovation in program design, and a more aggressive approach by Hawaii Energy to maintain future saving levels. In addition, savings from customer solar photovoltaic (PV) installations accrued prior to 2015 counted towards the EEPS goal; however, these installations are now counted to the RPS.

c. Greenhouse Gas (GHG) Rules: The GHG rules were enacted to further implement the goals of Act 234, 2007 Hawaii Session Laws to effect policies on climate change. The rules specify a carbon dioxide equivalent (CO_2e) emissions cap to reduce GHGs in the State of Hawaii from large stationary sources. By January 1, 2020, the State of Hawaii's goal was a reduction in statewide GHG emissions to levels at or below the best estimates of statewide GHG emissions for 1990. The GHG cap, as a measure for meeting the statewide GHG emission reduction goals, applies to facilities, except for municipal waste combustion operations, with the potential to emit GHG emissions (biogenic plus nonbiogenic) equal to or above 100,000 short tons of CO_2e per year.

Actions to reduce GHGs will also reduce emissions of other air pollutants as a co-benefit of implementing the Hawaii Administrative Rules (HAR) §11.60-1, Subchapter 11 (GHG Rules). As an example, thirteen (13) electric plants shown on the map in Figure 7.1-1 and listed in Table 7.1-3 by facility name and number, are partnering to meet the emission cap specified in the GHG Rules. As illustrated in Table 7.1-4, by implementing the GHG Rules, statewide estimated reductions in maximum potential NO_x, SO_2, and PM_{10} are 23,058 TPY, 26,456 TPY, and 4,865 TPY, respectively.

The facilities in Table 7.1-3 that chose partnering to meet the GHG emission cap requirement are allowed to exceed their individual emission cap of at least 16% below a facility's established GHG baseline level as long as the total combined cap for all facilities is at least 16% below the total combined baseline emissions level. The baseline is set at the 2010 GHG emission level for each facility unless another year or an average of other years between 2006 and 2010 is more representative of normal operations. Permits for these partnering facilities are available on the Clean Air Branch GHG Program website.[31] All point sources screened in Chapter 5 for requiring a four-factor analysis are among those facilities listed in Table 7.1-3 that are subject to GHG emission caps.

Annual GHG emissions and projections for facilities subject to the CO_2e emission caps are provided in the Hawaii greenhouse gas inventory reports posted on the Clean Air Branch GHG Program website.[32] These include stationary combustion emissions from electric plants and petroleum refineries, as well as fugitive emissions from the petroleum refineries. Biogenic carbon dioxide (CO_2) emissions are excluded from the annual facility-wide GHG emission cap totals which promotes the use of biofuels to meet the GHG reduction requirements.

Table 7.1-3 Point Sources from Figure 7.1-1

Plant	Partnering Facilities [a]	CO_2e Baseline Emissions (TPY)	CO_2e Cap (TPY)	CO_2e Reduction (TPY)[b,c]
1	AES Hawaii, LLC Cogeneration Plant	1,681,605	1,412,548	269,057
2	Hamakua Energy, LLC Cogeneration Plant	182,975	153,699	29,276
3	Kalaeloa Partners, L.P. Cogeneration Plant	1,094,813	1,164,577	-69,764

---

[31] DOH-CAB Greenhouse Gas Permits at: https://health.hawaii.gov/cab/ghg-permits/

[32] DOH-CAB Hawaii Greenhouse Gas Program at: https://health.hawaii.gov/cab/hawaii-greenhouse-gas-program/

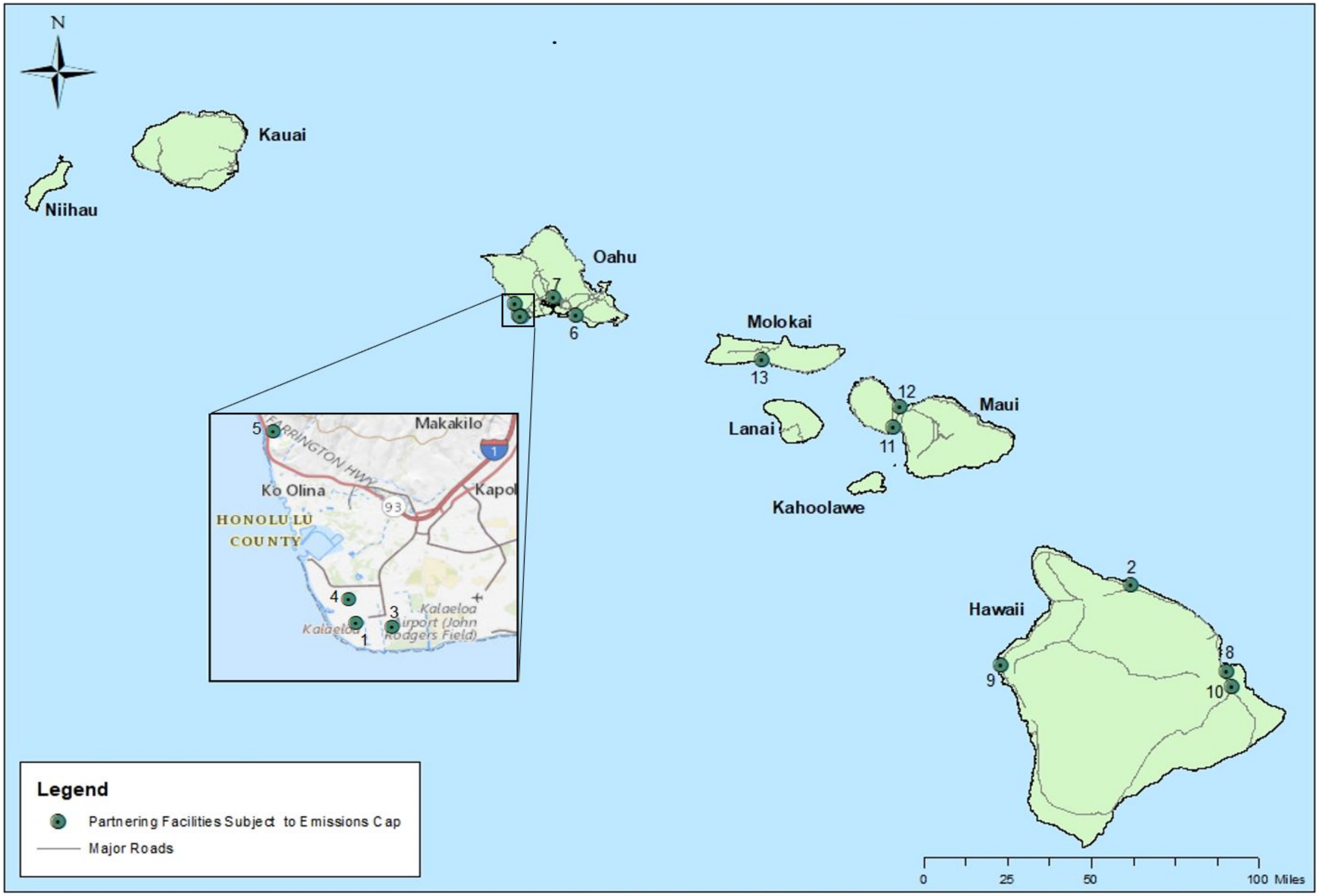
Table 7.1-3 Point Sources from Figure 7.1-1				
Plant	Partnering Facilities [a]	CO_2e Baseline Emissions (TPY)	CO_2e Cap (TPY)	CO_2e Reduction (TPY)[b,c]
	Hawaiian Electric Company, Inc.:			
4	Campbell Industrial Park Power Plant	14,946	123,504	-108,558
5	Kahe Power Plant	2,776,073	2,203,516	572,556
6	Honolulu Power Plant	133,609	0	133,609
7	Waiau Power Plant	1,074,359	878,050	196,309
	Hawaii Electric Light Company, Inc.:			
8	Kanoelehua-Hill Power Plant	222,784	172,456	50,328
9	Keahole Power Plant	191,387	242,208	-50,821
10	Puna Power Plant	99,691	31,747	67,944
	Maui Electric Company, Ltd.:			
11	Kahului Power Plant	230,839	154,633	76,206
12	Maalaea Generating Station	619,512	459,864	159,448
13	Palaau Power Plant	28,236	26,454	1,783

a. Based on Hawaiian Electric's proposed plan, revision date May 19, 2020.

b. A negative number for the reduction is an increase in emissions from the baseline level.

c. Total combined reduction for the facilities is a 16% reduction from the total combined baseline emissions.

Table 7.1-4 Reductions in Visibility Impairing Pollutants after Capping GHGs from Thirteen (13) Partnering Facilities as a Co-benefit				
Pollutant	Maximum Potential Emissions			
	Uncapped	Capped	Reduction	Reduction
	(TPY)	(TPY)	(TPY)	(%)
NO_X	83,239	60,181	23,058	28%
SO_2	58,029	31,573	26,456	46%
PM_{10}	13,066	8,381	4,685	36%
Combined	154,334	100,135	54,199	35%



Service Layer Credits: USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census

Figure 7.1-1 Thirteen (13) Partnering Facilities Subject to GHG Emission Reductions

d. Open Burning – 40 CFR §51.308(f)(2)(iv)(D): The State of Hawaii does not have a smoke management plan. Instead, planned open burning is regulated as codified in Hawaii Administrative Rules (HAR) §11-60.1 Subchapter 3 (please refer to Appendix O). 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 O). 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 as deemed prudent in times of drought, or where other concerns may be prevalent.

Tables 7.1-5a and 7.1-5b summarize emissions from open burning and wildfires for the major islands in the state. Emissions were based on the National Emissions Inventory (NEI) for years 2014 and 2017 and emissions inventory data from the Hawaii State Department of Health Regional Haze Progress Report dated October 2017.[33] An NEI report is prepared and posted on EPA's Air Emissions Inventories website on a three-year basis.

On Maui, Hawaiian Commercial and Sugar Company (HC&S) was the last sugar cane plantation in the state where AGPs were issued to burn cane. With the shut down of HC&S in 2016, no agricultural burning emissions have been reported in the 2017 NEI. However, an increase in wildfire events in 2019 and 2020, attributable primarily to dryer weather conditions, are a growing concern for all islands.

Table 7.1-5a Emissions (TPY) from Open Burning and Wildfires

Year	County→	Maui Island			Hawaii Island		
	Source↓ Pollutant→	SO_2	NO_X	PM_{10}	SO_2	NO_X	PM_{10}
2005	Agricultural Burning	132	298	---	0	2	---
	Prescribed Burning	---	---	---	---	---	---
	Wildfires	14	52	---	469	1,712	---
	Sub – Total	146	350		469	1,714	
2008	Agricultural Burning	132	298	1,154	---	2	3
	Prescribed Burning	---	---	---	---	---	---
	Wildfires	---	---	---	---	---	---
	Sub – Total	132	298	1,154		2	3
2011	Agricultural Burning	132	298	1,154	---	2	3
	Prescribed Burning	10	88	219	26	297	630
	Wildfires	---	---	---	9	99	162
	Sub – Total	132	386	1,373	35	398	795

---

[33] Hawaii's 5-Year RH Progress Report (2017) at: https://health.hawaii.gov/cab/files/2020/04/2017-Progress-Report.pdf

Table 7.1-5a Emissions (TPY) from Open Burning and Wildfires (Continued)							
Year	CountyŸ	Maui Island			Hawaii Island		
	SourceŹ PollutantŸ	SO_2	NO_X	PM_{10}	SO_2	NO_X	PM_{10}
2014	Agricultural Burning	197	359	583	---	---	---
	Prescribed Burning	42	560	872	487	5,529	13,096
	Wildfires	---	---	---	---	---	---
	Sub ï Total	239	919	1,455	487	5,529	13,096
2017	Agricultural Burning	---	---	---	---	---	---
	Prescribed Burning	31	51	462	4	10	42
	Wildfires	---	---	---	35	79	350
	Sub ï Total	31	51	462	39	89	392

Table 7.1-5b Emissions (TPY) from Open Burning and Wildfires							
	CountyŸ	Honolulu			Kauai		
	SourceŹ PollutantŸ	SO_2	NO_X	PM_{10}	SO_2	NO_X	PM_{10}
2005 NEI Report	Agricultural Burning	---	---	---	---	---	---
	Prescribed Burning	---	---	---	---	---	---
	Wildfires	---	---	---	---	---	---
	Sub ï Total	---	---	---	---	---	---
2008 NEI Report	Agricultural Burning	---	---	---	---	---	---
	Prescribed Burning	---	---	---	---	---	---
	Wildfires	---	---	---	---	---	---
	Sub ï Total	---	---	---	---	---	---
2011 NEI Report	Agricultural Burning	---	---	---	---	---	---
	Prescribed Burning	---	---	---	---	---	---
	Wildfires	---	---	---	---	---	---
	Sub ï Total	---	---	---	---	---	---
2014 NEI Report	Agricultural Burning	---	---	---	---	---	---
	Prescribed Burning	5	65	119	---	---	---
	Wildfires	---	---	---	---	---	---
	Sub ï Total	5	65	119			
2017 NEI Report	Agricultural Burning	---	---	---	---	---	---
	Prescribed Burning	12	23	147	2	6	22
	Wildfires	4	9	37	5	11	46
	Sub ï Total	16	32	184	7	17	68

e. Sulfur Dioxide (SO_2) Emission Caps: The Hawaiiôs Regional Haze Federal Implementation Plan (RH-FIP) imposed a 3,550 TPY SO_2 combined emissions cap on five (5) boilers at three (3) of the Hawaii Electric Light Company, Inc.ôs power plants on the island of Hawaii. This combined emissions cap was incorporated into the air permits for two of the three power plants and two boilers located at the third power plant were retired prior to implementation of the combined emissions cap. The impact of implementing the combined SO_2 emissions cap on the five (5) boilers is illustrated in Table 7.1-6 that shows maximum potential SO_2 emissions in comparison to the cap.

Table 7.1-6 Boilers Subject to the SO_2 Total Emissions Cap

Plant	CSP No.	Emission Unit	SO_2 Emissions (TPY)
Kanoelehua-Hill	0234-01-C	14.1 MW Boiler Hill 5	1,899
		23 MW Boiler Hill 6	2,400
Puna	0235-01-C	15.5 MW Boiler	2,399
Shipman [a]	0236-01-C	7.5 MW Boiler	1,118
		7.7 MW Boiler	1,134
Total Potential SO_2 Emissions from five (5) Boilers Without Cap			8,950
Total SO_2 Emissions with Cap			3,550
Total Reduction in Potential SO_2 Emissions			5,400

a. Boilers are now retired.

f. Motor Vehicle Regulations: HAR Ä11-60.1-34 prohibits motor vehicles from discharging visible smoke while in operation (operating while the vehicle is stationary or moving) and removing or failing to maintain air pollution devices of a motor vehicle, subject to certain exceptions and conditions.

g. North American Emissions Control Area (NA ECA): The NA ECA, which became enforceable in August 2012, regulates NO_X, SO_2, and $PM_{2.5}$ emissions from ships. The NA ECA includes waters adjacent to the Pacific coast, the Atlantic/Gulf coast, and the eight main Hawaiian Islands.[34] Emissions control area standards involve reductions in fuel sulfur content from 15,000 ppm (1.5%) to 10,000 ppm (1.0%) in 2010 to 1,000 ppm (0.1%) in 2015 and a Tier III NO_X standards in 2016.[34] The Tier I NO_X standards range from 9.8 to 17 g/kW-hr, depending on engine size.[34] The Tier III standards will be an 80 percent NO_X reduction below the Tier I standard.[34] Ship operators may also use air pollution control devices for the exhaust gas as an option to the lower sulfur fuel standards for complying with the NA ECA.

---

[34] United States Environmental Protection Agency, Regulatory Announcement, Designation of North American Emission Control Area to Reduce Emissions from Ships, Office of Transportation and Air Quality, EPA-420-F-10-015, March 2010.

7.2 Ongoing Air Pollution Control Programs under Federal Regulations – 40 CFR §51.308(f)(2)(iv)(A)

a. Volkswagen (VW) Settlement: VW was charged with selling approximately 590,000 model year 2009 to 2016 diesel motor vehicles equipped with computer "defeat devices". 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 the following[35]:

   i. A statewide Vehicle Assistance Program (VAP) for the purpose of offering financial assistance to private and/or public vehicle owners looking to medium/heavy duty vehicle or engine with clean alternative. HSEO plans to initially focus the VAP on rebates for medium and heavy-duty buses and trucks, while recognizing that the program may need to evolve in response to market demand and economic conditions including disruptions such as COVID-19.
   ii. 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 reduce 0.997 tons of NO_X emissions annually.
   ii. 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, which could possibly include Hawaii. 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. [36]

b. Federal Regulations: The following existing federal regulations were previously implemented to control emissions of air pollutants that adversely impacts visibility and were determined to be applicable to one (1) or more of the seven (7) point sources initially selected for conducting a four-factor analysis:

   i. 40 CFR Part 50: Establishes the National Primary Ambient Air Quality Standards for NO_x, SO_2, PM_{10}, $PM_{2.5}$, and lead (Pb). An 8,610 gallon per hour consumption limit for Boiler K-6 was imposed onto the Kahe Generating Station to comply with the ambient air quality standards for SO_2.

---

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

[36] Volkswagen Settlement State Scorecard dated May 2019 at: https://publicinterestnetwork.org/wp-content/uploads/2019/05/USP-VW-Scorecard-May19-1.pdf

ii. 40 CFR Part 52.21(b): Establishes provisions for the Prevention of Significant Deterioration (PSD) of Air Quality. The requirements apply to the construction of any new major stationary source or any major modification at an existing major stationary source in an area designated as attainment or unclassifiable. The following control measures at the respective facilities were imposed by PSD permits:

- Boiler K-6 at the Kahe Generating Station is subject a limit on its heat input rate of 433.5 MMBtu/hr, together with a 600 hr/yr operating limit, to keep NO_X below the 40 ton per year PSD emissions threshold for BACT review. Also, PSD conditions in the permit imposes a 0.30 lb/MMBtu limit for controlling NOx during startup and 0.23, 0.53, and 0.10 lb/MMBtu limits during normal operations to control NO_x (for other than startup), SO_2, and PM, respectively.
- Combustion turbines CT1 and CT2 at Kalaeloa Cogeneration Plant are subject to this same regulation, which imposes a NOx emissions limit of 130 ppmvd (483 lbs/hr), a fuel sulfur content limit of 0.5 percent maximum by weight, and a sulfur dioxide emission limit of 98 ppmvd.

iii. 40 CFR Part 60, Subpart D Standards of Performance for New Stationary Sources (NSPS) for Fossil-Fuel-Fired Steam Generators with capacity greater than 73 MW (250 MMBtu/hr) and the unit commenced construction after August 17, 1971: Boiler K-6 at the Kahe Generating Station is subject to this federal regulation, however, the PSD emission limits are either equivalent or more stringent and therefore no added benefit to visible impairment is expected.

iv. 40 CFR Part 60, Subpart GG NSPS for Stationary Gas Turbines is applicable to stationary gas turbines with a heat input at peak load equal to or greater than 10.7 gigajoules/hr (10 MMBtu/hr), but less than or equal to 107.2 gigajoules/hr (100 MMBtu/hr), based on the lower heating value of the fuel fired and any facility which commences construction, modification, or reconstruction after October 3, 1977. The combustion turbines, CT1 and CT2 at Kalaeloa Cogeneration Plant, are subject to this this federal regulation, however, since the PSD NO_X emissions limit of 130 ppmvd (483 lbs/hr) is more stringent, no added benefit to visible impairment is expected.

v. 40 CFR Part 63, Subpart ZZZZ ï National Emission Standards for Hazardous Air Pollutants (NESHAP) is applicable to stationary reciprocating internal combustion engines (RICE) at a major or area source of hazardous air pollutant (HAP) emissions. 40 CFR Ä63.6604(a) requires all existing non-emergency, non-black start stationary RICE at Kanoelehua-Hill and Maalaea Generating Stations, with a site rating of more than 300 brake hp and a displacement of less than 30 liters per cylinder, to operate on ULSD in accordance with 40 CFR Ä80.510(c). Emergency stationary RICE at area sources of HAP are not subject to this federal regulation if equipment meets 40 CFR Ä63.6585(f). However, 40 CFR Ä63.6603(a) requires that the air cleaner for the black start stationary compression ignited RICE at the Puna Generating Station, be inspected every 1,000 hours of operation or annually, whichever comes first, and replaced as necessary to comply with the requirements in Table 2d to Subpart ZZZZ.

vi. 40 CFR Part 63, Subpart JJJJJJ, NESHAP applies to Industrial, Commercial, and Institutional Boilers at Area Sources of HAP. The following control measures at the respective facilities are required by Subpart JJJJJJ:

- At the Kahului Generating Station, the 11.5 MW, 12.5 MW boilers, and the two (2) 5.0 MW boilers are subject to ongoing tune-ups every 5 years as specified in 40 CFR §63.11223;
- At the Kanoelehua-Hill Generating Station, the 14.1 MW & 23 MW boilers are equipped with oxygen trim systems and are subject to ongoing tune-ups every five (5) years as specified in 40 CFR §63.11223.
- At the Puna Generating Station, the 15.5 MW boiler is equipped with an oxygen trim system and is subject to ongoing tune-ups every five (5) years as specified in 40 CFR §63.11223.

vii. 40 CFR Part 63, Subpart UUUUU, NESHAPs: Coal- and Oil-Fired Electric Utility Steam Generating Units is applicable to boiler units that meet the definition of an electric utility steam generating unit (EGU). An EGU means any fossil fuel-fired combustion unit of more than 25 megawatts electric (MWe) that serves a generator that produces electricity for sale. Pursuant to 40 CFR §63.999, the following boilers were required to meet the emission limits for filterable PM or HAP metals (total combined or individual limits) and the work practice standards by April 16, 2015:

- Kahe Generating Station – Boilers K-1 through K-6; and
- Waiau Generating Station – Boilers 3 through 8.
-

7.3 Construction Activity Impact Mitigation – 40 CFR 51.308(f)(2)(iv)(B)

a. 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.

b. 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.

7.4 Source Retirements – 40 CFR 51.308(f)(2)(iv)(C)

a. Hawaiian Electric: Hawaiian Electric's Integrated Grid Planning (IGP) Report of 2023 was developed to meet the 100% renewable portfolio standard (RPS) goal by 2045.[37] This report supersedes Hawaiian Electric's Power Supply Improvement Plan (PSIP) of 2016.

As the State of Hawaii moves toward meeting the 100% RPS goal, conventional generating units are being replaced with sources of renewable energy. Historically, steam units provided the bulk of the energy needs. Gas turbines and combined cycle resources were incorporated into the system, which are more flexible and efficient than steam units. The operational flexibility of gas turbines makes it better suited for supporting renewable sources with high variable energy production rates, such as solar photovoltaic (PV) systems and wind. As opposed to steam units, gas turbines are able to start quickly, ramp up and down at high rates, and start and stop multiple times a day. Due to its higher efficiency, gas turbines potentially can offset higher fuel cost and reduce overall production cost and emissions of air pollutants. However, gas turbines can also increase production cost depending on the difference in fuel and maintenance cost between steam units and gas turbines.

The scheduled removal dates of fossil fuel units may be adjusted based on further optimization taking into account actual fuel costs and resource availability at the time of the decision, and on the timing of proposed renewable energy and firm dispatchable additions. A case-by-case evaluation will determine whether an existing unit will be immediately retired, deactivated, used for seasonal cycling, or kept operational. The goal is to manage assets in a manner that provides maximum value for customers.

Planned removal from service schedules are shown in Table 7.4-1 for the islands of Oahu, Hawaii, and Maui according to Hawaiian Electric's Integrated Grid Planning Report.

---

[37] Hawaiian Electric's Integrated Grid Planning Report: https://hawaiipowered.com/igpreport/.

Table 7.4-1 Hawaiian Electric Emission Reductions from Unit Shut Downs

Year	Facility	Description of Unit(s) Planned to be Removed from Service	Total Combined Emissions Reduced 2017 Inventory (TPY) [a]	
			NO_x	SO_2
2022	AES Hawaii, LLC Cogeneration Plant [b]	Boiler A	331.22	199.72
		Boiler B	363.36	230.52
		Limestone Dryer A	<0.001	<0.001
		Limestone Dryer B	<0.11	<0.001
		Total→	**694.69**	**430.24**
2024	HECO Waiau Generating Station	49 MW Boiler Unit 3	64.85	89.92
		49 MW Boiler Unit 4	95.51	92.84
		Total→	**160.36**	**182.76**
2025	HELCO Puna Generating Station (Standby Only)	15.5 MW Boiler Unit Boiler	---------	---------
2027	HECO Waiau Generating Station	57 MW Boiler Unit 5	366.70	280.51
		58 MW Boiler Unit 6	340.49	344.14
		Total→	**707.19**	**624.65**
2027	HELCO Kanoelehua - Hill Generating Station	14 MW Boiler Unit 5	251.54	820.55
		23 MW Boiler Unit 6	353.62	1,346.62
		Total→	**605.16**	**2,167.17**
2027	MECO Kahului Generating Station	5.0 MW Boiler Unit 1	65.83	293.14
		5.0 MW Boiler Unit 2	62.30	253.29
		11.5 MW Boiler Unit 3	292.63	898.54
		12.5 MW Boiler Unit 4	182.68	775.81
		Total→	**603.44**	**2,220.78**
2027	Maalaea	1.25 MW Boiler Unit 10	580.27	11.59
		1.25 MW Boiler Unit 11	506.23	10.14
		1.25 MW Boiler Unit 12	405.84	11.38
		1.25 MW Boiler Unit 13	419.54	11.00
		Total→	**1,911.88**	**44.11**
2029	HECO Waiau Generating Station	92 MW Boiler Unit 7	839.47	814.35
		92 MW Baiter Unit 8	491.02	672.45
		Total→	**1,330.49**	**1486.80**
2030	Maalaea	2.5 MW Boiler Unit 1	9.97	0.00147
		2.5 MW Boiler Unit 2	5.81	0.00854
		2.5 MW Boiler Unit 3	9.96	0.00146
		5.9 MW Boiler Unit 4	80.82	1.45
		5.9 MW Boiler Unit 5	82.70	1.97
		5.9 MW Boiler Unit 6	61.13	1.10
		5.9 MW Boiler Unit 7	122.90	2.07
		5.9 MW Boiler Unit 8	61.26	1.10
		5.9 MW Boiler Unit 9	2.61	1.83
		Total→	**437.16**	**9.53**
2033	HECO Kahe Generating Station	92 MW Boiler Unit 1	932.72	841.79
		90 MW Boiler Unit 2	962.95	659.50
		Total→	**1895.67**	**1501.29**

Table 7.4-1 Hawaiian Electric Emission Reductions from Unit Shut Downs

Year	Facility	Description of Unit(s) Planned to be Removed from Service	Total Combined Emissions Reduced 2017 Inventory (TPY) [a]	
			NO_x	SO_2
2037	HECO Kahe Generating Station	92 MW Boiler Unit 3	661.7	836.26
		93 MW Boiler Unit 4	732.18	859.83
		Total→	**1,3993.88**	**1,696.09**
2046	HECO Kahe Generating Station	142 MW Boiler Unit 5	2044.16	1,136.17
		142 MW Boiler Unit 6	630.11	1,431.46
		Total→	**2,674.27**	**2,567.63**

a. Emissions reported for units in the State and Local Emissions Inventory System (SLEIS) for operating year 2017.

b. AES Hawaii LLC permit was amended on October 27, 2020, to incorporate GHG emission cap and provision to cease the burning of coal by December 31, 2022, in accordance with Hawaii Act 023 (September 15, 2020). On December 12, 2022, AES Hawaii LLC sent a letter to DOH-CAB indicating actions of decommissioning the Coal-Fired Cogeneration Plant and associated structures located in Kapolei Oahu, in preparation for demolition in the first quarter of 2023.

b. Kaua'i Island Utility Cooperative (KIUC): KICU did not include any plans for retiring fossil fuel units in their 2018 annual RPS Status Report to the PUC. However, KIUC's 2019 Annual Report[38] stated that a diesel generator, located at the Kapaia Power Station, was upgraded to run as a synchronous condenser. That means the engine can run with little or no fuel to provide inertia, fault current, voltage support, and frequency stabilization to the grid. This is especially important given the intermittent nature of solar PV systems and hydropower sources.

In addition, more than 56% of the electricity generated in 2019 on Kauai came from a mix of renewable resources, such as solar, hydropower and biomass, which exceeds the State's RPS 2020 target of thirty percent (30%). KIUC's progress towards 100% renewable energy, as evidenced from its initial unveiling of the world's first utility-scale solar plus battery storage generation facility in March 2017 to other renewable projects, is illustrated in Figure 7.4-1 taken from KIUC's 2019 Annual Report. Based on KIUC's current rate of progress and potential renewal energy projects planned towards meeting the State's energy goal, it is anticipated that existing fossil fueled units will inevitably be retired and/or upgraded.

---

[38] KIUC 2019 Annual Report at: https://kiuc.coop/sites/default/files/documents/annual_reports/AnnualReport19.pdf

	Type	MW	% of Sales
Active In Use			
KIUC, Kōloa	Solar	12.0	3.7
KIUC, Anahola	Solar	12.0	3.8
Green Energy Team	Biomass	6.7	10.6
McBryde, Port Allen	Solar	6.0	2.3
McBryde, Wainiha/Kalaheo	Hydro	6.0	3.9
KIUC, Waiahi	Hydro	1.5	0.8
Gay & Robinson, Olokele	Hydro	7.3	6.2
KAA, Waimea/Kekaha	Hydro	1.5	0.3
Pioneer, Waimea	Solar	0.3	0.1
Kapa'a Solar	Solar	1.0	0.4
Tesla Solar+Storage	Solar	13.0	4.6
AES Lāwa'i Solar+Storage	Solar	20.0	7.7
MP2, 'Ōma'o	Solar	0.3	0.1
Customer Solar	Solar	32.2	12.0
Under Construction			
AES PMRF Solar+Storage	Solar	14.0	7.8
Under Development			
West Kaua'i Energy Project	Hydro	24.0	23.2

Total Renewable Energy in Service 2020

119.8 MW/56.5%

Potential Renewable Energy in Service 2025

157.8 MW/87.5%

Figure 7.4-1 KIUC Total Renewable Energy in Service in 2019 and Potential Renewable Energy in Service in 2025

7.5 Further Controls on Sources (Permitting for 2018 - 2028 Planning Period)

a. Projected Changes in Point Source Emissions – 40 CFR 51.308(f)(2)(iv)(E): Section II.B.3 of EPA's Guidance on Regional Haze State Implementation Plans states, "A key flexibility of the regional haze program is that a state is not required to evaluate all sources of emissions in each implementation period."[16] This section describes the process and criteria used to select point sources of anthropogenic emissions of NO_X, SO_2, and PM_{10} with the greatest potential impact on visibility impairment on Class I areas in the State of Hawaii for analysis of additional emission control measures. This section further describes how point sources are evaluated using statutory factors to characterize and determine what control measures are necessary to make reasonable progress over the 2018 - 2028 planning period.

1. Initial Source Screening: The initial screening method used to identify point sources with reasonably large potential for contributing to visibility impairment at each Class I area was based on the total combined ton per year emissions (Q) of nitrogen oxide (NO_X), sulfur dioxide (SO_2), and particulate matter less than ten (10) microns (PM_{10}) divided by the distance (d) from the Class I area in kilometers or Q/d. Point sources with Q/d exceeding 10 tpy/km were requested to perform a four-factor analysis. The following facilities were identified to have exceeded this threshold:

    - Kalaeloa Partners, L.P. Power Plant (Island of Oahu)
    - Kahe Power Plant (Island of Oahu)
    - Waiau Power Plant (Island of Oahu)
    - Kanoelehua-Hill Power Plant (Island of Hawaii)
    - Puna Power Plant (Island of Hawaii)
    - Kahului Power Plant (Island of Maui)
    - Maalaea Power Plant (Island of Maui)

    A full description of the method used, and the sources selected during the initial screening process is covered in Chapter 5.
2. Four-Factor Analysis: The first step in the control measure selection process was to identify technically feasible control measures for pollutants that contribute to visibility impairment, i.e., NO_X, SO_2, and PM_{10}. Technically feasible control measures were further characterized and evaluated using the following four regulatory factors pursuant to 40 CFR §51.308(f)(2)(i):

    - The cost of compliance;
    - The time necessary to achieve compliance;
    - The energy and non-air quality environmental impacts of compliance; and
    - The remaining useful life of any existing source subject to such requirements.

    Cost of Compliance: A driving factor in selecting reasonable control measures is the facility's cost of compliance, which is the "cost effectiveness" or the dollar cost per tons of pollutant removed. When a control measure, such as a fuel switch, impacted multiple pollutants, emissions were combined in performing these calculations.

Capital cost or capital investment associated with a technically feasible control measure is annualized by amortization or is converted to an equivalent uniform annual cost (EUAC) using the nominal interest rate and the useful life of the equipment as described in EPA's Air Pollution Control Cost Manual and in Chapter 6. The facility's annualized capital cost is then combined with the increase in the facility's annual operating and maintenance cost associated with the control measure under evaluation. This includes differences in fuel cost, and additional cost to inspect, test, and repair equipment needed for implementing the control measure. The combined annual cost is then divided by the estimated tons of pollutants removed per year.

Time necessary to achieve compliance: Compliance schedules may be used as a measure for making reasonable progress pursuant to Section II.B.5.e) of EPA's Guidance on Regional Haze State Implementation Plans.[16] Characterizing the time necessary for compliance involves estimating the time needed for a source to comply with a potential control measure, which may be based on prior experiences with planning and installation of new emission controls. However, Section II.B.4. d) of EPA's Guidance also recommends that states consider source specific factors where appropriate and states, "there is no requirement in the Regional Haze Rule that emission control measures that have been determined to be necessary to make reasonable progress must be installed as expeditiously as practicable or within 5 years of EPA's approval of the SIP revision." Section II.B.5. e) of the EPA's Guidance further states, "The state may establish a compliance deadline that provides reasonable time for an affected source to come into compliance in an efficient manner, without unusual amounts of overtime, above-market wages and prices, or premium charges for expedited delivery of control equipment".[16] An appropriate source specific factor to consider is the State of Hawaii's RPS which mandates the transitioning of companies that generate and sell electricity for consumption from using fossil fuels to renewable sources. Hawaiian Electric's Integrated Grid Planning Report provides a tentative schedule to retire specific point sources. However, past experience has demonstrated unexpected delays for some of the past renewable projects, which are attributable to factors that are not completely within Hawaiian Electric's control, including PUC approvals. Therefore, extending the time of compliance provides a more flexible schedule to proceed in an efficient manner by aligning Hawaiian Electric's current efforts with realizing the RPS goal, including the retirement and lower utilization of some of these facilities' commitment without incurring unreasonable additional cost.

Energy and Non-Air Quality Environmental Impacts of Compliance: In Section II.B.5. c) of the EPA's Guidance, EPA recommends that states consider energy impacts by accounting for any increase or decrease in energy use at the source as part of the costs of compliance.[16] EPA also recommends that states consider relevant non-air quality environmental impacts, such as water usage or waste disposal of spent catalyst or reagent, by accounting for them as part of the costs of compliance. Fuel switching from residual oil to ULSD may have an energy impact in both the fuel refining and fuel combustion processes. However, Section II.B.4. e) of EPA's Guidance recommends that states focus their analysis on direct energy consumption at the source rather than indirect energy inputs needed to produce raw materials.[16]

Therefore, energy impacts are accounted for by including the annual fuel cost difference and the annualized capital cost of atomization to improve fuel combustion efficiency within the cost of compliance. The lower viscosity of ULSD can have non-air quality environmental impacts in the event of inadvertent or accidental spills and therefore, the capital cost of installing secondary containments to comply with EPA's Spill Prevention, Controls, and Countermeasures (SPCC) requirements is also included as an annualized cost of compliance.

Combustion controls do not have non-air quality environment impacts. However, improper feed rate of OFA can result in heat loss and decreased boiler efficiency.

Remaining useful life of equipment: In the situation of an enforceable requirement for the source to cease operation before the end of the useful life of the controls under consideration, EPA guidance allows the use of an enforceable shut down date as the end of the remaining useful life. If no enforceable shut down date exists for units requiring controls, the remaining useful life is the full useful life of the control under consideration. Useful life of the equipment with the nominal interest rate are used to convert capital cost or capital investment associated with a technically feasible control measure as an annualized cost used in determining the cost of compliance and is described further in Chapter 6 of this RH-SIP

3. <u>Photochemical Modeling:</u> EPA's photochemical modeling platform incorporates meteorology, emissions, and air quality modeling, and is used to further develop the photochemical grid modeling or the Comprehensive Air quality Model with Extensions (CAMx). The CAMx provides the 2016 baseline and 2028 emission projections which enables users to evaluate reasonable progress goals at IMPROVE sites representing individual Class I areas for regional haze. These modeling programs are also capable of estimating contributions of anthropogenic emissions from international sources thus providing a means for comparing projections to both the unadjusted and adjusted reasonable progress goals. A description of this is covered in Chapter 8.
4. <u>Weighted emissions potential (WEP)/Area of Influence (AOI):</u> Western Regional Air Partnership (WRAP) with RAMBOLL developed this modeling platform by incorporating residence time (RT), area of influence (AOI), and extinction weighted residence time (EWRT) analysis, with back trajectories generated from the HYSPLIT modeling program. The HYSPLIT simulates 72-hour (3-day) back trajectories, which are the wind travel paths arriving at the IMPROVE monitoring sites on the most impaired days (MIDs) at four different times a day and at four (4) different elevations. IMPROVE observations that represent Class I areas in Hawaii for the 5-year period of 2014 to 2018 were used for this analysis. The RT analysis provides an AOI or amount of time a back trajectory to a Class I area on the MIDs passes over a grid cell. The EWRT is developed from the RT weighted by the measured extinction by species (i.e., pollutant). For each point source, the rank point files are developed to show the WEP of each facility using facility-specific emissions (Q) with the EWRT for each species divided by the distance (d) between the point source and the IMPROVE monitoring site. The WEP data is used to determine the potential contributions of each point source to visibility impairment at each Class I area based on the MIDs. The WEP ranking, which is based on a more sophisticated and refined analysis for selecting facilities, shows

a combined contribution of less than 1.5% of the total contributions of all Oahu facilities excluding airports. Therefore, the Oahu facilities identified on the initial screening were removed, however, Mauna Loa Macadamia Nut Corporation Plant on the Big Island with contribution as high as 9.16% was added to the list. Since the focus of the WEP/AOI analysis is on the MIDs, a supplemental analysis was conducted to examine all potential back trajectories from the 2015 to 2019 using raw wind rose data from the Daniel K. Inouye International Airport (aka., Honolulu International Airport). Due to the predominant trade wind patterns that exist in the State of Hawaii and the location of the Oahu facilities relative to the Class I areas, contributions from these facilities were estimated to be 0.06% of the total occurrences to the daily light extinction. A full description of the WEP analysis and refinements made from the initial screening and source selection are covered in Chapter 5 of this RH-SIP.

5. Establish Reasonable Control Cost Threshold and Control Costs: A control cost threshold of $5,800/ton of pollutant removed was established in the 8-12-2022 RH-SIP submittal that was later increased to $6,800/ton of pollutant removed for the 2023 RH-SIP submittal to account for an increase in the CEPCI. A full description of relevant factors used to develop these cost thresholds is covered in Sections 6.2 and 6.5 of Chapter 6.

In letters dated March 30, 2021, and June 16, 2021, new information was provided by Hawaiian Electric that was not included in the initial four-factor analyses from Chapter 6. This included the need to install secondary containment liners and fuel atomization systems to accomplish boiler fuel switches to ULSD, documentation to support Hawaiian Electric's claim that 7% is the nominal interest rate, new remaining useful life assumptions, and revised construction cost multiplier of 1.2. Please refer to Appendix P for additional details. DOH-CAB reviewed the information and revised assumptions, as applicable, to align with EPA and NPS guidance for performing the cost analysis. Changes included an interest rate of 6.56% for Hawaii Island sources, interest rate of 5.31% for Maui Island sources, a 25-year life for fuel atomization systems and tank containment liners instead of a 20-year life, and a construction cost multiplier of 1 instead of 1.2. Please see Appendix P for Regulated Industry Correspondence with Hawaiian Electric.

In letters dated January 20, 2023, and March 6, 2023, Hawaiian Electric provided revised cost tables for installing SCR on diesel engine generators M1-M13, X1 and X2 at the Maalaea Generating Station. The letters included staggered shut down dates for M10-M13 to increase control costs above the control cost threshold to make SCR economically infeasible to install. Hawaiian Electric assumed interest rates of 7% to 7.75% for the cost analyses. They also used a starting point for remaining useful life of December 31, 2027, and increased the cost of materials 50% for anticipated cost from inflation for construction that would occur in 2025. DOH-CAB reviewed the information and revised the assumptions as applicable, to align with EPA and NPS guidance. Changes included an 8.0% - 8.25% prime interest rate and the de-escalation of the material costs by 50%.

The NPS agrees that inflating the cost into the future by estimating future inflation is not appropriate for estimating the control cost. Also, Chapter 2 of the CCM, Cost Estimation: Concepts and Methodology, Section 2.5.3, page 18 provides the following statement:

"This Manual uses real prices for estimation of capital costs (in this case, an older capital cost to a more recent year), and other costs for any given cost analysis, not nominal prices. Using a price of reagent, catalyst, or other cost input to reflect possible price changes over the equipment lifetime is not correct in adjusting for inflation. Hence, the inclusion of price inflation via escalation estimates or having input prices reflect price changes over time as part of capital cost estimation is not allowed under the Control Cost Manual Methodology. The capital cost should be estimated for the time that the cost estimate is prepared, and should not be escalated to some future year, such as an anticipated date that construction will be completed or some other future year unless the analyst has a robust method to forecast future inflation. A linear extrapolation of past inflation is not a robust method of forecasting future inflation."

Regional haze control measures necessary to make reasonable progress, as well as the associated monitoring, recordkeeping and reporting requirements, are made practically and federally enforceable by incorporating the measures into air permits as a significant modification.

Hawaiian Electric committed to an enforceable shut down of boilers at the Kahului and Kanoelehua-Hill Generating Stations by the beginning of 2028. Covered Source Permit (CSP) 0232-01-C, provided in Appendix P, was amended to change the compliance date for boiler shut down from December 31, 2027, to December 31, 2028 for the Kahului Generating Station. CSP No. 0234-01-C, provided in Appendix P, was amended to change the compliance date for boiler shut down from December 31, 2027, to December 31, 2028, for the Kanoelehua-Hill Generating Station.

The Puna Generating Station was re-evaluated to verify reasonable controls using an 8.25% interest rate and $6,800/ton cost threshold. CSP No. 0235-01-C, provided in Appendix P, was amended during the initial RH-SIP submittal to incorporate regional haze controls for Puna Generating Station. Further evaluation found that the regional haze controls (boiler fuel switch from fuel oil No. 6 to ULSD, installation fuel atomization system, and fuel tank liner construction) for the Puna Generating Station was economically feasible. Please see Appendix P that provides the technical support document for amending the Puna Generating Station permit.

Due to the greater complexity of determining reasonable controls for Maalaea Generating Station, federally enforceable limits for this facility are included in this RH-SIP revision. Please refer to Appendix P for regional haze controls that included the installation of FITR for two diesel engine generators and the option for unit shut down or installation of SCR for five other larger diesel engine generators. The cost of SCR for DEGs at the Maalaea Generating Station was ultimately based on cost estimates provided by Hawaiian Electric on May 5, 2023.

Emission control measures were found to be infeasible for some units at facilities subject to a four-factor analysis. For these units, EPA's August 2019 Regional Haze Guidance requires emission limits to be included for sources for which added emission controls are not feasible due to a four-factor analysis. However, the guidance further states that if a source that has been selected for analysis of emission control measures has recent actual emissions below its permitted levels, for example due to voluntary operation restrictions, and the state reasonably projects that this situation will continue through 2028 based on the best available information, a state can reasonably conclude based on appropriate considerations that requiring the source to abide by an emission limit is not a measure that is necessary to make reasonable progress.

Historical data on units for Kahului and Maalaea Generating Stations on Maui, and for Kanoelehua-Hill and Puna Generating Stations on Hawaii Island, from 2011 to 2020, show that they have consistently operated below their potential to emit (PTE) emissions listed in their air permits and will emit even less in future years to comply with Hawaii's RPS requirements. Hawaiian Electric's RPS commitment is to reach 70 percent electricity generation from renewable sources by 2030. In 2020, Hawaiian Electric produced 36 percent of their electricity from renewable sources, providing the reasonable assumption that they will need to restrict unit operating hours even more to attain their 2030 commitment. Historical emissions for the selected Hawaiian Electric facilities are provided in Appendix Q.

Similarly, historical data for Mauna Loa Macadamia Nut Corporation Plant on Hawaii Island from 2011 to 2020 shows that this facility has also consistently operated below its PTE, and is projected to emit less in the future. Historical emissions for this facility are provided in Appendix Q.

Appendix P also provides details of the revised cost analyses for the facilities screened in Chapter 5. Tables 7.5-1 and 7.5-2 provide revised costs for the control measures ultimately selected in Chapter 6 that are shown in Table 6.4-2 for the Puna Generating Station and Table 6.4-4 for the Maalaea Generating Station for the 2023 RH-SIP submittal.

Table 7.5-1 Four-Factor Analysis for Hawaii Electric Light Puna Power Plant Hawaii

Unit	Description	Primary Fuel	Control Measure & Cost per Ton [a]
Boiler	15.5 MW Boiler	Fuel Oil No. 6 with 2.0% maximum sulfur content	• Fuel switch to ULSD with 0.0015% sulfur content + ULSD atomization + secondary tank containment liners - \$4,690, \$5,983, (\$5,804/\$5,794), (\$6,014)/ton SO_2, NO_X, and PM_{10} for Boiler.

a. For the fuel switch - first cost in black (Hawaiian Electric estimate without atomization and tank containment liners), second cost in black (Hawaiian Electric's estimate with atomization and tank containment liners using 7% interest rate), cost in green (DOH-CAB estimate with atomization and tank containment liners for initial RH-SIP submittal using a 6.56 % nominal interest rate), cost in blue (DOH-CAB estimate with atomization and tank containment liners for RH-SIP revision using an 8.25% prime interest rate).

Table 7.5-2 Four-Factor Analysis for Maui Electric Maalaea Power Plant
Maui

Unit	Description	Primary Fuel	Control Measure & Cost per Ton [a, b]
M1	2.5 MW DEG	ULSD	• FITR for M1 - $4,159, ($3,030), ($3,629), ($5,328)/ton NO_X. • FITR for M3 - $4,159, ($,3030), ($3,629), ($5,328)/ton NO_X. • SCR for M-7 - $6,162, ($5,530), ($5,977), ($8,539), ($7,521), ($7,753)/ton NO_X. • SCR for M10 - $8,335, ($8,757), ($8,452), ($8,539), ($5,979), ($6,258)/ton NO_X. • SCR for M11 - $8,546, ($8, 859), ($8,641), ($7,027), ($6,854) ($7,174)/ton NO_X. • SCR for M12 - $11,832, ($12,423), ($11,995), ($7,470), ($7,008), ($7,256)/ton NO_X. • SCR for M13 - $10,805, ($11,292), ($10,939), ($7,228), ($6,779), ($7,020)/ton NO_X.
M3			
M7	5.6 MW DEG	Diesel Fuel Oil No. 2 with 0.4% maximum sulfur content	
M10	12.5 MW DEG		
M11			
M12			
M13			

a. For FITR - cost in black (Hawaiian Electric's original estimate using 7% interest rate), cost in green (DOH-CAB estimate using 3.25% prime interest rate), cost in maroon (DOH-CAB estimate using 5.31% nominal interest rate), cost in blue (DOH-CAB cost estimate using an 8.25% prime interest rate).

b. For SCR, selected as an option to unit shut down – cost in black (Hawaiian Electric's original estimate using 7% interest rate, and 20 year remaining useful life), cost in green (DOH-CAB estimate using 3.25% prime interest rate and 30 year remaining useful life – found later that a 20 year remaining useful life is more appropriate for diesel engine generators at electric plants), costs in maroon (DOH-CAB estimate using 5.31% nominal interest rate and 20 year remaining useful life), cost in orange (Hawaiian Electric's updated estimates using 7.5% interest rate and material cost escalated 50% for anticipated construction starting in 2025, remaining useful life for M10 and M11 of five (5) years, and remaining useful life for M7, M12, and M13 of ten (10) years), costs in blue (DOH-CAB estimate using 8.0% prime interest rate and de-escalating Hawaiian Electric's escalated SCR cost by 50%, cost in purple (DOH-CAB estimate using 8.25% prime interest rate, Hawaiian Electric's revised cost numbers received on May 5, 2023, remaining useful life for M10, and M11 of five (5) years, and a remaining useful life for M7, M12, and M13 of ten (10) years).

The cost of installing FITR at the Maalaea Generating station is $5,230/ton for M1 and M3. The cost of FITR for M1 and M3 is below the $6,800/ton threshold and is a cost-effective control measure.

The cost to install SCR on diesel engine generator M10 was found to be cost effective even with the shorter assumed remaining useful life for the unit based on the proposed shut down date of **December 31, 2032**. Another option to SCR for M10 would be an enforceable shut down date of **December 31, 2030,** which correlates to a remaining useful life of 3 years at a control cost of $7,864 per ton of NO_X removed. The remaining use life of 4 years, if M10 was shut down by **December 31, 2031,** results in a control cost of $6,859 per ton of NO_X removed, which is very close to the $6,800 per ton threshold. At a control cost of $6,859 per ton of NO_X removed, SCR would be selected as a feasible control measure.

On January 14, 2022, Hawaiian Electric provided information that the proposed monitoring of NO_X with a continuous emissions monitoring system (CEMS) for Maalaea Generating Station M1 through M3 (it was found that FITR for M2 is not cost effective for the 2023 RH-SIP submittal) will result in a high cost for these units that run very little. It was indicated that the units are used as quick response during wind variability and are therefore kept offline as much as possible. Total hours of operation between January 2020 and December 2020 ranged from 177 hours for M3 to 194 hours for M1.

On January 25, 2022, Hawaiian Electric provided information that the estimated capital expense of a CEMS for M1 and M3 is $235,000 for each unit and the estimated annual operation and maintenance expense is $43,000 per unit.

The DOH-CAB randomly contacted CEMS manufactures to determine the typical price for installing and operating a CEMS (e.g., $5,000 for sample probe + $5,000 for sample line (100 ft at $50/ft) + $10,000 for sample conditioning system + $13,000 for NO_X analyzer + $7,000 for O_2 analyzer + $10,000 for rack + $50,000 for shelter + $20,000 for programable logic controller in rack + ($15,000 + $5,000 + $5,000)/3 for initial RATA testing + ($15,000 +$5,000 +$5,000)/3 for technician to start up = $136,667). Operation and maintenance expenses were also checked (e.g., ($15,000 + $5,000 + $5,000)/3 for RATA testing + ($15,000 + $5,000 + $5,000)/3 for startup + (20% x $70,000/3) for technician to calibrate = $21,334).

Control costs were updated to account for the additional costs to install and operate a CEMS for M1 and M3 at Maalaea Generating Station. A capital cost of $235,000 for installing a CEMS was added to the existing capital cost of FITR for each unit based on Hawaiian Electric's numbers. An additional $43,000 was added to the annualized capital cost for yearly operation and maintenance of each CEMS based on numbers from Hawaiian Electric. DOH-CAB's costs were based on a $136,667 capital cost of installing a CEMS and $21,334 cost for operation and maintenance. Costs estimated by DOH-CAB are highlighted in blue in Table 7.5-3 for installing and operating a CEMS for M1 and M3.

Table 7.5-3 Four-Factor Analysis for Maui Electric Maalaea Power Plant Maui

Unit	**Description**	**Primary Fuel**	**Control Measure & Cost per Ton** [a, b, c]
M1	2.5 MW DEG	ULSD	• FITR + CEMS for M1 - $16,100, ($10,147), ($18,617) ($12,430)/ton NO_X. • FITR + CEMS for M3 - $16,100 ($10,147), ($18,617) ($12,430)/ton NO_X.
M3			

a. Costs in black (DHO-CAB's estimates based on Hawaiian Electric's costs assumed for CEMS and use of a 5.31% interest rate) costs in green (DOH-CAB's estimates based on DOH-CAB's costs assumed for CEMS and use of a 5.31% interest rate), costs in maroon (DOH-CAB's estimates based on Hawaiian Electric's costs assumed for CEMS and an 8.25% interest rate), cost in blue (DOH-CAB's estimate based on DOH-CAB's costs assumed for CEMS and an 8.25% interest rate).

b. Hawaiian Electric assumed a capital cost of $235,000 and an operation and maintenance cost of $43,000.

c. DOH-CAB assumed a capital cost of $136,667 and an operation and maintenance cost of $21,334.

The cost of installing FITR plus CEMS for M1, and M3 at the Maalaea Generating Station is $12,430/ton for M1 and M3. The cost of FITR plus CEMS is considered to be too far above the $6,800/ton threshold. Therefore, installing a CEMS is not cost-effective. As such, DOH-CAB will specify annual source testing to determine compliance with the NO_X emissions limit for FITR servicing M1 and M3.

As part of the long-term strategy, 40 CFR §51.308(f)(2) requires enforceable emission limitations, compliance schedules, work practice standards, monitoring and recordkeeping/reporting requirements, and other measures necessary to make reasonable progress be clearly stated. Point sources re-evaluated based on the new information are identified with cost effective control measures (based on the four-factor analyses) and compliance schedule dates are stated in Table 7.5-4. DOH-CAB will incorporate the regional haze provisions into permits for these sources as follows (please refer to Appendix P and X for details of both the draft and final permit amendments):

Table 7.5-4 Control Measures and Compliance Schedules

Facility [a]	Unit	Unit Nos.	Shut Down	Fuel Switch	SCR	LNB w/ OFA/FGR	FITR
Kanoelehua-Hill	Boilers	Hill 5&6	12/31/28	--	--	--	--
Mauna Loa	Boiler	Main Boiler	12/31/26				
Puna	Boiler	--	--	See note [b]	--	--	--
Kahului	Boilers	K-1, K-2, K-3, & K-4	12/31/28	--	--	--	--
Maalaea	DEGs	M1 & M3	--	--	--	--	12/31/27 See note [c]
		M7 and M10-M13	--	--	12/31/27 See note [d] See note [e]	--	--

a. Mauna Loa Macadamia Nut Corporation Plant will replace main boiler by the end of 2026.

b. Fuel switch to ULSD by four (4) years from permit issuance. Permit for the fuel switch was issued on August 10, 2022.

c. Compliance with the NO_X emissions limit for FITR will be verified with annual source testing.

d. Compliance with the NO_X emissions limit for SCR will be verified with a CEMS. Cannot operate M7 and M10-M13 without an SCR system fully installed, operational, and maintained.

e. Enforceable shut downs listed in Section 6.4 for evaluating control costs at the Maalaea Generating Station are another option to the requirement to install SCR for M7 and M10-M13.

6. <u>WRAP Technical Support System (TSS):</u> Pursuant to 40 CFR §51.308(d)(1), States are required to include as reasonable progress goals, metrics to ensure there is no degradation in visibility for the least impaired days (now referred to as clearest days) over the same period of the implementation plan.
7. <u>Hawaii Administrative Rules (HAR):</u> The anticipated net effect on visibility impairment due to projected changes in point source emissions of anthropogenic particulate matter and SO_2 for this planning period is addressed by the following proposed revisions to HAR Chapter 11-60.1, upon being enacted:

- Proposed revision to §11-60.1-35(b), §11-60.1-36(b), and §11-60.1-37(b) for incinerations, biomass fuel burning boilers, and process industries, respectively to add enforceable compliance standards to emissions of particulate matter pursuant to 40 CFR Part 60, Appendix A-3, Method 5 or other EPA approved methods.
- Proposed revision to §11-60.1-38(c) will add enforceable compliance standards to the sulfur content by weight in liquid and gaseous fuel used for combustion using the American Society for Testing and Materials (ASTM) Methods.

b. <u>Projected Changes in Area Sources (40 CFR §51.308(f)(2)(iv)(E)):</u> The anticipated net effect on visibility impairment due to area source emissions of anthropogenic fugitive particles for this planning period is addressed by the following proposed revisions to HAR Title 11, Chapter 60.1, upon being enacted:

1. Proposed revision to §11-60.1-33 adds enforceable standards that prohibits emissions of visible fugitive dust that exceeds 20% opacity, as determined by using EPA 40 CFR Part 51, Appendix M, Method 203C (Refer to Appendix O).
2. Proposed revision to §11-60.1-55 for agricultural burning expands and refines the criteria for declaring “no burn” periods (Refer to Appendix O).

c. <u>Projected Changes in Mobile Sources (40 CFR §51.308(f)(2)(iv)(E))</u>:
In October 2017, by way of Act 32, Session Laws of Hawaii 2017, the Hawaii Climate Change Mitigation and Adaptation Commission (Commission) was formally established. As highlighted in its 2018 annual report, the Commission established two main focuses; one of which is the reduction of emissions from ground transportation. The second main focus is on emissions from the power sector. However, since goals have already been established by the Hawaii Clean Energy Initiative through the RPS and EEPS, the Commission decided to mainstream its attention to reducing emissions from ground transportation: The Commission recognizes that ground transportation contributes significantly to Hawaii’s share of greenhouse gas emissions. It supports a price on carbon, and mechanisms to reduce overall vehicle miles traveled, as well as converting all remaining vehicle-based ground transportation to renewable, zero-emission fuels, and technologies. Under the Climate Ready Hawaii framework, the Commission is formulating policy tools for use by all departments, such as strategies for reducing GHG emissions from mobile sources that would also reduce visibility impairing pollutants as a co-benefit.[39]

1. <u>Social Cost of Carbon:</u> In an attempt to assist the State of Hawai’i to move its economy to a low/zero-carbon growth path, the Commission, with the leadership of the Hawaii Department of Transportation, has initiated research on how to assess, incorporate, and measure the carbon footprint of projects and programs in all state departments. By properly accounting for the full cost of carbon emissions, a more accurate benefit-cost assessment will allow agencies to properly evaluate projects and associated policies. While it is a positive step for departments to consider how to reduce emissions from fuel use through fuel switching and efficiency measures, these efforts are not enough to bring about

---

[39] HI Climate Change Annual Report (2020) at: https://climate.hawaii.gov/wp-content/uploads/2020/11/HI-Climate-Annual-Report-V8.pdf

the reduction needed. *On November 28, 2018, the Commission issued a release stating that putting a price on carbon is the most effective single action that will achieve Hawaii's ambitious and necessary emissions reduction goals* (refer to Appendix R). Since releasing this statement, the Hawaii Senate had passed a carbon emission pricing bill in two consecutive years, but in both instances, the Senate has not yet managed to enact this bill. Currently, multiple carbon tax and pricing bills, such as HB134, HB460, & SB311, were again under review by the State Legislature.

2. Multi-Modal Mobility Hub: A Climate Ready Hawaii also supports mitigation efforts to reduce Hawaii's dependence on imported fossil fuels. To this end, the Commission's work is focused on active transportation and multi-modal mobility, which includes the full gamut of strategies from telework, transit, bicycling, pedestrian, and other modes to reduce vehicle miles traveled, thereby averting emissions. Specifically, this entails initiating collaborative work with the Hawaii Energy Policy Forum, counties, metropolitan planning organizations, and federal and private partners to develop plans for innovative concepts of multi-modal mobility hubs statewide.

   - Renewable Bus: Refer to Sections 7.2.a and 7.5.c.
   - Bicycling and Walking: Senate bill (refer to Appendix S) S.B. NO. 574 was again under review by the Hawaii State Legislature to develop a plan to widen shoulders on state highways with designated bike lanes to at least three feet in width, with exceptions. Senate Bill No.1402 was passed by the 2021 Hawaii State Legislature as Act 131, 06/30/2021 (Gov. Msg. No. 1233), which requires the DOT to create motor vehicle, bicycle, and pedestrian highway and pathway networks. These initiatives will encourage use of alternate means to reduce vehicle miles traveled.
   - Income Taxation of Nonresidents Working Remotely: Hawaii joined more than a dozen states in filing a brief petition with the U.S. Supreme Court to take up an October 2020 lawsuit filed by the state of New Hampshire (refer to Appendix T) that seeks to block Massachusetts from taxing its residents who no longer commute across state lines for work. The lawsuit claims that it is unconstitutional for Massachusetts to tax income "earned entirely outside its borders." A ruling by the U.S. Supreme Court that favors the petitioners will encourage working remotely out of state to reduce vehicle miles traveled.
   - Telework: Teleworking lessens traffic congestion and reduces emissions of pollutants, provides job flexibility to improve the quality of work-life of employees, and enables employers to expand their ability to recruit and retain a skilled work force. Current technology in broadband telecommunication provides the infrastructure necessary to make this a viable option. To promote teleworking, a State of Hawaii's "*Remote Work Pilot Project*"[40] was initiated by the Department of Business, Economic Development and Tourism (DBEDT) and Department of Labor and Industrial Relations (DLIR). This program focuses on enabling Hawaii's unemployed workforce, especially those affected by the pandemic, to work remotely and encourages work flexibility as a means to retain and attract local residents currently working out of state to return home. The success of this pilot project will reduce the need

---

[40] Hawaii Remote Work Pilot Project at: https://invest.hawaii.gov/hawaii-remote-work-pilot-project/

for commuting to and from work thus reducing the overall vehicle miles traveled. In addition, a number of bills are again under review by the Hawaii State Legislature that if enacted, will encourage teleworking. HB567 and SB1252 requires each department to conduct a study on best practices for teleworking and establish a telework and alternative work schedule policy for state employees as an integral part of the employer's normal business operations. It also establishes a minimum percentage of eligible employees who are required to telework or use an alternative work schedule policy. HB836 (refer to Appendix U) establishes a telework tax credit to encourage employers to allow their employees to telework.

3. Fleet Tools: One of the critical components of reducing ground transportation emissions is the conversion of public fleets to clean, renewable fuels, and more efficient vehicles. A key is assessing lifecycle costs, benefits, and emissions. Such tools will assist in making the best low/zero carbon decisions. The Commission is working with the University of Hawaii and the U.S. DOE's Clean Cities Coalition to develop cost and emission tools.

Chapter 8 Reasonable Progress Goals for Regional Haze

8.0 Reasonable Progress - 40 CFR §51.308(f)(2) and (f)(3)

Hawaii is required to set reasonable progress goals (RPGs) for the long-term strategy to achieve natural visibility conditions for Haleakala National Park and Hawaii Volcanoes National Park by 2064. The RPGs are required to provide improvement in visibility on the most impaired days and no degradation in visibility on the clearest days. The reasonable progress goals required by 40 CFR §51.308(f)(3) must be expressed in deciviews that reflect the visibility conditions that are projected to be achieved by the end of the second implementation period (2028) as a result of the enforceable emission limitations, compliance schedules, and other measures required by 40 CFR §51.308(f)(2). State-to-state consultation pursuant to 40 CFR §51.308(f)(ii) and (iii) is not applicable since emissions from anthropogenic sources in another state are not reasonably anticipated to contribute to visibility impairment in Hawaii's Class I areas. The closest states to Hawaii are Alaska and California that are about 2,500 miles away.

For establishing reasonable progress goals, potential control measures that could be implemented by the end of 2028 were determined in Chapter 6 of the RH-SIP based on a four-factor analysis and shut down schedules proposed for sources screened for further evaluation. Chapter 7 of this RH-SIP provides the final control measures selected for sources and permit amendments to incorporate the federally enforceable regional haze rule limits. Please refer to Appendix P for draft permit amendments to incorporate regional haze control measures. Final issued permits to implement regional haze control measures are provided in Appendix X.

8.1 Photochemical Modeling

To determine visibility conditions in deciviews for 2028 reasonable progress goals, EPA performed photochemical modeling to assess visibility impacts using the Community Multiscale Air Quality (CMAQ) model.[41] Input files for the CMAQ model included hourly emission estimates, meteorological data, and boundary concentrations. Emissions, meteorology, and other inputs were from a 2016 base year. For the modeling assessment, 2016 emissions were projected to future 2028 emissions. Emission plots of gridded emissions of NO_X, SO_X, PEC (elemental carbon), and POA (organic aerosol) from EPA's 2016 HI modeling platform were used.

40 CFR §51.308(f)(3)(i) requires that states establish reasonable progress goals (expressed in deciviews) that reflect visibility conditions that are projected to be achieved by the end of the implementation period as a result of the enforceable emission limitations. Hawaii therefore adjusted the RPG for Haleakala NP and Hawaii Volcanoes NP based on the proportion of emissions from all source categories with point source emission reductions divided by emissions from all source categories without enforceable point source emission reductions to determine scaling factors. Emissions were based on those from EPA's 2016 modeling platform. Scaling factors were then used to scale down average light extinction for sulfate, nitrates, and elemental carbon based on point source reductions in SO_2, NO_X, and PM_{10}, respectively. Emissions reductions were from the shut down of boilers Hill 5 and Hill 6 at the Kanoelehua - Hill Generating Station, shut down of Boilers K-1 through K-4 at the Kahului Generating Station, a fuel switch to USLD for the Puna Generating Station boiler, installation of FITR for two diesel engine generators (M1 and M3) at the Maalaea Generating Station, and installation of SCR for diesel engine generators M7 and M10-M13 for the Maalaea Generating Station.

Three (3) modeling domains were used in the model consisting of 27 km, 9 km, and 3 km cell sizes over the Hawaii Island chain from the Big Island (Hawaii) to Kauai. The modeling domain contained 35 vertical layers with the top layer at 17,550 meters. The model provided hourly concentrations for each cell across the modeling domain.

Table 8.1-1 below shows each of the CMAQ model runs performed for the analysis.

Table 8.1-1 CMAQ Model Runs

Scenario Name	Description
2016fh_16j	Historical 2016 base case
2028fh_16j	Future year 2028 "on the books" scenario
2028fh_16j_zeroanth	Future year 2028 "on the books scenario, with U.S. anthropogenic emissions zeroed out.

Meteorological inputs for the model were generated with a Weather Research and Forecasting (WRF) model for year 2016. The WRF model was applied with the settings in Table 8.1-1 above.

---

[41] TSD for EPA's Updated 2028 RH Modeling for Hawaii, Virgin Islands, and Alaska at: https://www.epa.gov/system/files/documents/2021-08/epa-454-r-21-007.pdf

Regional hemispheric inventories over North America from the Inventory Collaborative 2016 modeling platform were used in the assessment. There were thirty (30) anthropogenic emission sectors including nine (9) sectors based on the Hemispheric Transport of Air Pollution inventory and fifteen (15) sectors representing emissions in China for anthropogenic emissions outside of North America. The inventories included biogenic VOCs and NO_X emissions. Wildland fire emissions were based on SmartFire2/BlueSky. Emissions from agricultural burning were based on the Hazardous Mapping System (HMS). Sea-salt and halogen emissions from the ocean were also included. Lightning, wind-blown dust, and volcanic emissions were excluded from the modeling assessment. Anthropogenic emissions were used in the CMAQ modeling. Emission sources and key assumptions from EPA's regional haze modeling TSD are summarized as follows:

(1) Electric generating unit (EGU) emissions were based on 2016 state submitted data and held constant at the 2016 level for the 2028 projections.
(2) Non-EGU point source emissions were from the 2014 NEI. Industrial emissions were grown to 2028 based on information from the 2019 Annual Energy Outlook (AEO). Controls were incorporated to reflect relevant NSPS (e.g., reciprocating internal combustion engines (RICE), process heaters, etc.).
(3) Airport point source emissions were from the 2017 NEI that were back projected to 2016 using FAA data. Airport emissions were projected to 2028 using FAA's Terminal Area Forecast (TAF) data.
(4) On-road mobile source emissions were generated with MOVES.
(5) On-road and non-road emissions were created for 2028 with activity data projected from 2016 to 2028 based on the 2018 AEO and state provided data where available.
(6) Commercial marine vessel (CMV) emissions, modeled as point sources, were based on AIS hourly ship data for 2017 that were adjusted to 2016 based on national adjustment factors. CMV emissions were projected to 2028 using region-specific emission factors for NO_X, SO_2, and other pollutants.
(7) Nonpoint emissions were held constant from 2014 NEI for the 2016 inventory. Portions of nonpoint emissions were grown to 2028 based on expected growth in human population. Nonpoint agricultural emissions, including NH_3 and VOC from livestock and fertilizer sources, were not included due to lack of data.
(8) Nonpoint fugitive dust consisted of emissions from the 2014 NEI. Emissions from paved roads were projected from 2014 to 2016 based on county total vehicle miles traveled (VMT), but emissions from all other sources, including unpaved roads, were held constant. Paved road dust was grown to 2028 based on the growth in VMT from 2016 to 2028. The remainder of the fugitive dust sector including building construction, road construction, agricultural dust, and road dust was held constant.
(9) Residential wood combustion (RWC) emissions were projected from the 2014 NEI to represent 2016 and 2028 inventories using EPA's 2011v6.3 emissions modeling platform. Projected emissions account for growth, retirements, and NSPS.
(10) Point oil and gas emissions were based on the 2016 point source modeling platform. Oil and gas emissions were not projected to year 2028.

EPA used the 2016 and 2028 CMAQ model predictions for the components of particulate matter to project 2014-2017 IMPROVE visibility data from the national parks to 2028. The EPA Software for the Model Attainment Test – Community Edition (SMAT-CE) tool was applied to determine 2028 deciview values on the most impaired and clearest days at each Class I area using the 2028 emissions with "on the books" controls. IMPROVE data was used between 2014-2017, which included adjustments for wild-fire (organic and elemental carbon), dust storm impacts (fine crustal and coarse mass), and adjustments for volcanic emissions (sulfates).

For visibility projections, the observed baseline visibility data from 2014 to 2017 was linked to the 2016 modeling year. The baseline ambient IMPROVE monitoring should be for five (5) years from 2014 to 2018. However, since 2018 IMPROVE data was not available, the average 2014-2017 base period was used. Future year 2028 visibility on the most impaired and clearest days in each Class I area was estimated using the 2014-2017 IMPROVE data and relative percent modeled change in particulate matter species between 2016 and 2028. Table 8.1-2 provides EPA's modeling results.

Table 8.1-2 Base and Future Year Class I Area Deciview Values

Class I Area	IMPROVE Monitor	Base Year (2014-2017) Clearest Days (dv)	Future Year (2028) Clearest Days (dv)	Base Year (2014-2017) Most Impaired Days (dv)	Future Year (2028) Most Impaired Days (dv)
Haleakala NP [a,b]	HACR1	0.51	0.50	7.70	7.55
Hawaii Volcanoes NP [a]	HAVO1	3.50	3.49	16.31	16.03

a. 2014-2017 in SMAT.

b. 2001-2007 HALE1, 2008-2018 HACRA with volcano adjustment per EPA white paper.

8.2 Haleakala National Park Visibility Goals

Visibility conditions and visibility goals for Haleakala National Park are provided in the Figure 8.2-1 glidepath graph from the WRAP TSS. The Figure includes EPA's photochemical modeling results and adjustments to the IMROVE monitoring data for volcanic activity and the change in location of the monitor for Haleakala National Park. Table 8.2-1 summarizes visibility conditions shown in Figure 8.2-1 as described in Chapter 3 (see Section 3.2). EPA's photochemical modeling results that exclude SO_2 emissions from the Kilauea Volcano are provided in Table 8.1-2 and updated in Table 8.2-1 based on numbers from the WRAP TSS in the modeling Express tools under Hawaii Volcanic – Adjusted EPA Modeling Results, Hawaii – URP Glidepath with Visibility Projections.

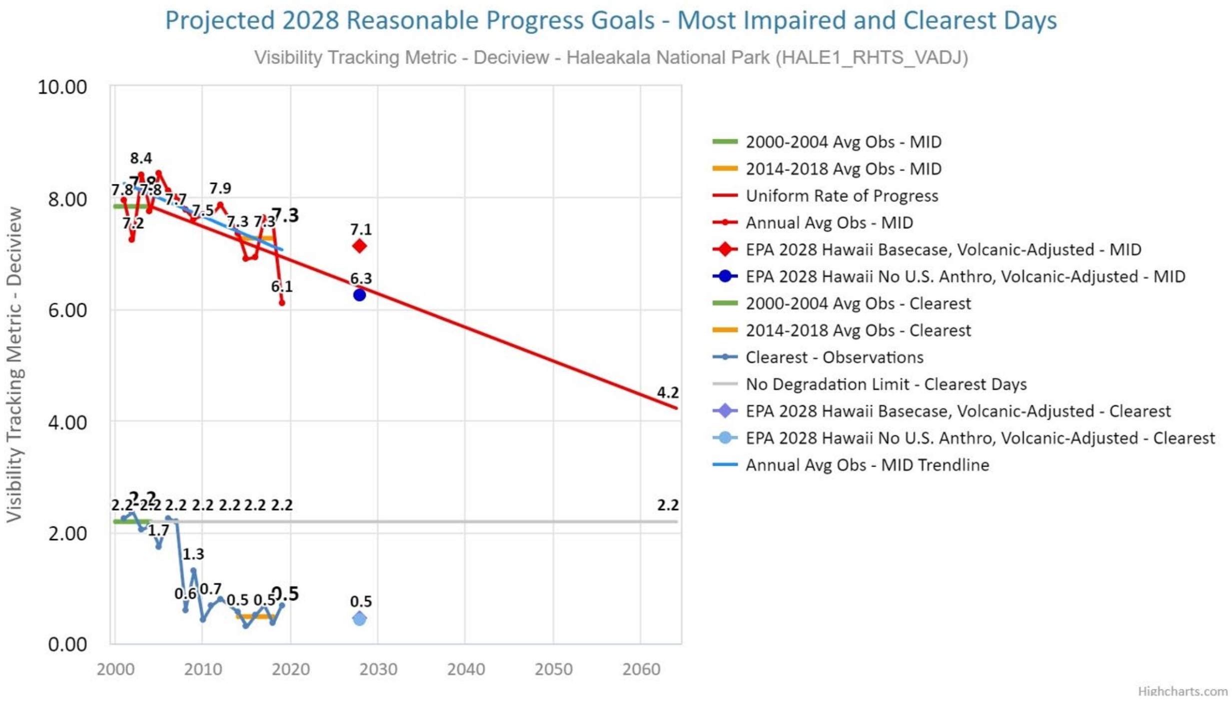


Figure 8.2-1 Modeling Results for Haleakala National Park

Table 8.2-1 Modeling Results for Haleakala National Park	
Conditions [a,b]	Deciview
Natural Visibility on 20% Most Impaired Days (Goal in 2064)	4.2
Average Baseline Visibility on 20% Clearest Days (2000-2004)	2.2
Average Baseline Visibility on 20% Most Impaired Days (2000-2004)	7.8
Uniform Rate of Progress in 2028 on the 20% Most Impaired Days	6.4
Modeled 2028 Visibility Projection for Most Impaired Days [c]	7.1
Modeled 2028 Visibility Projection for Most Impaired Days – Zero-Out [d]	6.3
Modeled 2028 Visibility Projection for Clearest Days	0.5
Modeled 2028 Visibility Projection for Clearest Days – Zero-Out	0.4

a. 2014-2018 in SMAT.

b. 2001-2018 HALE-RHTS combined and volcano adjustment per EPA white paper.

c: Model results in WRAP TSS account for updated IMPROVE data adjustments by EPA for combining visibility monitoring data for IMPROVE sites representing Haleakala National Park and volcanic activity.

d: Zero-Out – All U.S. anthropogenic emissions set to zero in the photochemical modeling assessment.

The uniform rate of improvement needed to achieve the 2028 reasonable progress goal is 1.4 dv (0.06 dv x 24 yrs between 2004 and 2028 or 7.8 dv – 6.4) on the most impaired days for Haleakala National Park, or an average of 0.06 deciviews per year on the most impaired days based on the glidepath (7.8 dv - 4.2 dv = 3.6 dv; 3.6 dv/60 yrs = 0.060 dv/yr).

The URP for 2028 at Haleakala National Park of 6.4 dv (7.8 dv - 1.4 dv), no degradation limit, and visibility conditions for the most impaired and clearest days were evaluated with the photochemical modeling results. The 2028 modeled deciview projections for both the most impaired and clearest days assumes 2016 EGU emissions are constant from 2016 to 2028 and excludes volcanic SO_2 emissions. The glidepath was not adjusted to account for international anthropogenic emissions and wildland prescribed fires. The 2028 modeled deciview projection – zero out sets all U.S. anthropogenic emissions to zero and excludes volcanic SO_2 emissions. Therefore, regional haze control measures would provide a deciview level somewhere between the 2028 base case and no U.S. anthropogenic modeling scenarios. A modeled result above 6.4 would indicate a rate of progress that is slower than the URP on the most impaired days. If the modeled result is below 6.4, it would indicate a rate of progress that is greater than the URP.

Based on the scaling factors for point source emission reductions in Appendix V, the RPGs for 2028 are 6.5099 dv and 0.3962 dv for the most impaired and clearest days, respectively. For the most impaired days, this would be a 0.054 dv/yr reduction (7.8 dv – 6.5099 dv)/24 yrs = 0.053 dv/yr) that is slower than the URP. At this rate it would take about 67 years (2028-2004 + (6.50994dv - 4.2dv)/0.054) to reach the 4.2 dv natural visibility level from year 2004. For the clearest days, the RPG of 0.3962 dv is below the no degradation level of 2.2 dv.

Figure 8.2-1 shows that the modeled projections for the most impaired days (expressed in deciviews) are as high as levels at the IMPROVE monitor for Haleakala National Park measuring actual visibility impacts from both the volcano and anthropogenic sources. This is evident even for the most impaired day projection assuming all U.S. anthropogenic and volcanic emissions are set to zero. Note that the volcano was erupting continuously from 2014 to most of 2018 emitting extremely high amounts of SO_2. For example, in 2016 SO_2 emissions from the Kilauea summit, based on USGS information, ranged from approximately 1,000 tons per day to about 9,000 tons per day. It would be expected that the model, assuming no volcanic or U.S. anthropogenic emissions, would project a visibility level that is much lower than the observed level.

Note that volcanic impacts would not be completely screened out after adjusting the IMPROVE data for episodic events due to the continuous nature of the Kilauea eruption. Therefore, projections from scaling 2028 modeling results with the observed 2014 to 2017 or 2014 to 2018 IMPROVE data on the most impaired days would still be influenced by sulfates from volcanic activity.

Although the anticipated rate of progress for the most impaired days, based on modeling results in deciviews, may be slower than the URP for Haleakala National Park, Hawaii has already conducted the source selection and control measures analyses in such a manner that addresses the requirements of 40 CFR §51.308(f)(3)(ii). The four-factor analyses in Chapter 6 and Appendix P constitute the required robust demonstration for selecting regional haze control measures based on screening results in Chapter 5. The state has also demonstrated that control measures ultimately selected in Chapters 6 and 7 are reasonable in accordance with the applicable provisions of 40 CFR §51.308(d)(1) and §51.308(f)(2)(iv)(C).

Figure 8.2-1 shows the following visibility conditions in units of deciview that were measured by the HACR1 monitor at Haleakala National Park in 2019 during a period with significant decrease in SO_2 venting after the Kilauea eruption had ceased:

a. 6.1 dv for the most impaired days which is below the URP (glidepath); and
b. 0.7 dv for the clearest days which is below the no degradation level of 2.2 dv.

8.3 Hawaii Volcanoes National Park Visibility Goals

Visibility conditions and visibility goals for Hawaii Volcanoes National Park are shown in the Figure 8.3-1 glidepath graph from the WRAP TSS. Figure 8.3-1 includes EPA's photochemical modeling results and adjustments to the IMPROVE data for volcanic activity. Table 8.3-1 summarizes visibility conditions in Figure 8.3-1 and described in Chapter 3 (see Section 3.2). Photochemical modeling results are provided in Table 8.1-2 and updated in Table 8.3-1 based on numbers from WRAP TSS in the modeling express tools under Hawaii Volcanic – Adjusted EPA Modeling Results, Hawaii – URP Glidepath with Visibility Projections.

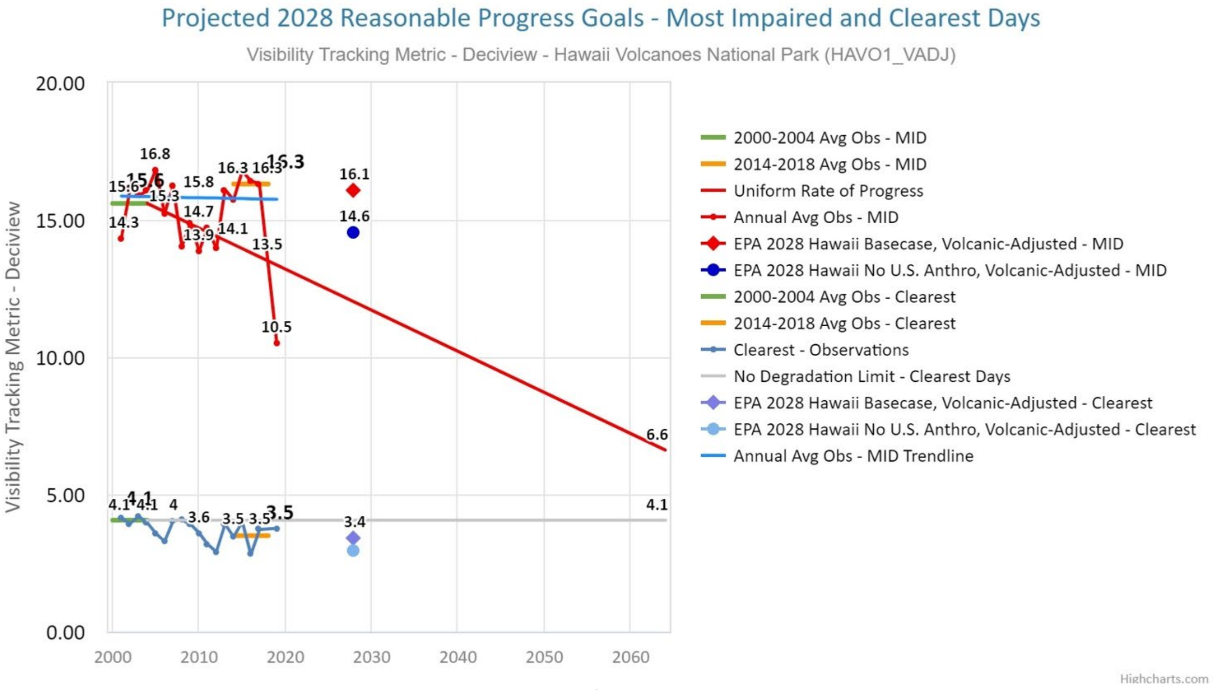


Figure 8.3-1 Modeling Results for Hawaii Volcanoes National Park

Table 8.3-1 Modeling Results for Hawaii Volcanoes National Park

Conditions [a]	Deciview
Natural Visibility on 20% Most Impaired Days (Goal in 2064)	6.6
Average Baseline Visibility on 20% Clearest Days (2000-2004)	4.1
Average Baseline Visibility on 20% Most Impaired Days (2000-2004)	15.6
Uniform Rate of Progress in 2028 on the 20% Most Impaired Days	12.0
Modeled 2028 Visibility Projections for Most Impaired Days [b]	16.1
Modeled 2028 Visibility Projection for Most Impaired Days – Zero-Out [c]	14.6
Modeled 2028 Visibility Projection for Clearest Days	3.4
Modeled 2028 Visibility Projection for Clearest Days – Zero-Out	3.0

a. 2014-2018 in SMAT.

b. Model results in WRAP TSS account for updated IMPROVE data adjustments by EPA at the IMPROVE site representing Hawaii Volcanoes National Park for volcanic activity.

c: Zero-Out – All U.S. anthropogenic emissions set to zero in the photochemical modeling assessment.

The uniform rate of improvement needed to achieve the 2028 reasonable progress goal is 3.60 dv (0.150 dv x 24 yrs or 15.6 dv – 12.0 dv) on the most impaired days for Hawaii Volcanoes National Park, or an average of 0.150 dv/yr on the most impaired days (15.6 dv -6.6 dv =9 dv; 9.0 dv/60 yrs = 0.150 dv/yr).

The URP for 2028 at Hawaii Volcanoes National Park of 12.0 dv (15.6 dv – 3.6 dv), no degradation limit, and visibility conditions for the most impaired and clearest days were evaluated with photochemical modeling results. The 2028 modeled deciview projections for both the most impaired and clearest days assumes 2016 EGU emissions are constant from 2016 to 2028 and excludes volcanic SO_2 emissions. The glidepath was not adjusted to account for international emissions and wildland prescribed fires. The 2028 modeled deciview projection – zero sets all U.S. anthropogenic emissions to zero and excludes volcanic SO_2 emissions. Therefore, regional haze control measures would provide a deciview level somewhere between the 2028 base case and no U.S. anthropogenic modeling scenarios. A modeled result above 12.0 would indicate a rate of progress that is slower than the URP.

Based on scaling factors established for point source emission reductions in Appendix V, the RPGs for 2028 are 15.0682 dv and 3.1712 dv for the most impaired and clearest days, respectively. For the most impaired days, this would be a decrease in visibility impairment of 0.022 dv/yr (15.6 dv – 15.0682 dv)/24 yrs = 0.022 dv/yr). At this rate it would take about 409 years (2028-2004 + (15.0682dv - 6.6dv)/0.022) to reach the 6.6 dv natural visibility level from year 2004. For the clearest days, the RPG of 3.1712 dv is below the no degradation level of 4.1 dv.

The modeled projections are as high as levels at the IMPROVE monitor for Hawaii Volcanoes National Park measuring visibility impacts from both the volcano and anthropogenic sources. Even if all U.S. anthropogenic sources are zeroed out, modeling projections show a level of visibility that is above the glidepath. Note that the volcano was erupting continuously from 2014 to most of 2018 emitting extremely high SO_2 emissions. For example, in 2016 SO_2 emissions from the Kilauea summit vent, based on USGS information, ranged from approximately 1,000 tons per day to about 9,000 tons per day. It would be expected that the model, assuming no volcanic emissions, would project a visibility level that is much lower than the observed level.

As stated above for Haleakala National Park, volcanic impacts would not be completely screened out after adjusting the IMPROVE data for episodic events due to the continuous nature of the Kilauea eruption. Therefore, projections from scaling 2028 modeling results with the observed 2014 to 2017 or 2014 to 2018 IMPROVE data on the most impaired days would still be influenced by volcanic activity.

Although the anticipated rate of progress for the most impaired days, based on modeling results in deciviews, may be slower than the URP for Hawaii Volcanoes National Park, Hawaii has already conducted the source selection and control measures analyses in such a manner that addresses the requirements of 40 CFR §51.308(f)(3)(ii). The four-factor analyses in Chapter 6 and Appendix P constitute the required robust demonstration for selecting regional haze control measures based on screening results in Chapter 5. The state has also demonstrated that control measures ultimately selected in Chapters 6 and 7 are reasonable in accordance with the applicable provisions of 40 CFR §51.308(d)(1) and §51.308(f)(2)(iv)(C).

The observed visibility conditions measured by the HAVO1 monitor at Hawaii Volcanoes National Park in 2019 (See Figure 8.3-1), during a period with significant decrease in SO_2 venting after the Kilauea eruption ceased, shows deciview values of:

a. 10.5 dv for the most impaired days which is below the URP (glidepath); and
b. 3.8 dv for the clearest days which is below the no degradation level of 4.1 dv.

Chapter 9 Consultation and Future Planning Commitments

9.0 Consultation and Future Planning Commitments – 40 CFR §51.102, §51.103, §51.308(d), §51.308(f), §51.308(g), §51.308(h)

The RHR requires states to commit to future planning that includes a visibility data monitoring strategy, updates to statewide emission inventories of pollutants that impair visibility, periodic RH-SIP revisions and progress reports, and continued consultation with the Federal Land Managers. Each comprehensive RH-SIP submittal must provide a determination of the adequacy of the existing plan. Procedural requirements are followed for RH-SIP revisions in accordance with RHR for the public participation process.

9.1 Monitoring Strategy – 40 CFR §51.308(f)(6)

40 CFR §51.308(f)(6) requires states to develop a monitoring strategy for measuring, characterizing, and reporting regional haze visibility impairment that is representative of all Class I areas within the state. Hawaii is relying on the continued availability of the IMPROVE program in meeting the monitoring operation, collection, and reporting requirements for measuring visibility impairment in its mandatory Class I areas. Other associated monitoring strategy requirements include:

1. 40 CFR §51.308 (f)(6)(i) - Establishment of any additional monitoring sites or equipment needed to assess whether reasonable progress goals are being achieved as follows:

    a. Hawaii will work with IMPROVE, EPA, and the FLMs to ensure that representative monitoring continues for its Class I areas.
    b. Visibility data for Haleakala National Park collected by the IMPROVE monitor (HACR1) operated and maintained by the National Park Service is considered adequate. The HACR1 site is considered adequate for assessing the reasonable progress goals for Haleakala National Park and no additional monitoring sites are necessary at this time. Hawaii worked with WRAP, TSS, and EPA representatives during this planning period to adjust IMPROVE data for the monitor relocation and to screen out episodic events related to volcanic activity (sulfates).
    c. Visibility data for Hawaii Volcanoes National Park collected by the IMPROVE monitor (HAVO1), operated and maintained by the National Park Service, is considered adequate. The HAVO1 site is considered adequate for assessing the reasonable progress goals for Hawaii Volcanoes National Park and no additional monitoring sites are necessary at this time. Hawaii worked with WRAP, TSS, and EPA

representatives during this planning period to adjust IMPROVE data to screen out episodic events related to volcanic activity (sulfates).

2. 40 CFR §51.308 (f)(6)(ii) – Procedures by which monitoring data and other information are used in determining the contribution of emissions from within the state to regional haze visibility impairment within the Class I areas are as follows:

   a. Chapter 3 - *Visibility Conditions*, Chapter 5 - *Source Screening*, Chapter 6 - *Emission Control Measures*, Chapter 7: - *Long Term Strategy*, and Chapter 8: - *Reasonable Progress Goals for Regional Haze*, describe the procedures used in developing this SIP revision. These chapters assess the relative impact of emissions on Hawaii's Class I areas.
   b. Chapter 4 - *Emissions Inventory* describes the procedures used for this RH-SIP revision to produce the statewide emissions inventory of pollutants reasonably anticipated to cause or contribute to visibility impairment in Hawaii's Class I areas.

3. 40 CFR §51.308(f)(6)(iii) – This provision is for states with no mandatory Class I area and does not apply to Hawaii.

4. 40 CFR §51.308(f)(6)(iv) – Reporting of all visibility monitoring data to EPA at least annually for each Class I area. The DOH-CAB does not directly collect, or handle IMPROVE data. The DOH-CAB will continue to participate in the exchange of IMPROVE information for developing and updating the WRAP TSS. The DOH-CAB considers the WRAP TSS to be a core part of the IMPROVE program. The DOH-CAB will report data from its two (2) Class I areas at least annually to EPA using the WRAP TSS and recommends that EPA continue to adjust future visibility data collected at Hawaii's IMPROVE monitors.

5. 40 CFR §51.308(f)(6)(v) – Hawaii with support from WRAP shows a statewide inventory of emissions that can be reasonably expected to cause or contribute to visibility impairment in Class I areas. Chapter 4 of this RH-SIP summarizes the emissions by pollutant and source category.

   Hawaii commits to updating statewide emissions periodically. The updates will be used for Hawaii's tracking of emission changes, trends, and evaluation of whether reasonable progress goals are being achieved along with other regional analyses. The inventories will be updated every three years on the same schedule as the triennial reporting required by EPA's Air Emissions Reporting Requirements.

   As a member of the WRAP, the state will utilize WRAP sponsored Emissions Data Management System and Fire Emissions Tracking System to store and access emission inventory data for the region. Hawaii will also depend upon and participate in additional periodic collective emissions inventory efforts by the WRAP. Further, Hawaii will continue to depend on and use the capabilities of the WRAP's regional modeling to simulate the visibility impacts of emissions for haze and other related air quality planning purposes. Hawaii will collaborate with WRAP members, EPA, states, and FLMs to ensure the continued operation of these technical support analysis tools and systems.

6. 40 CFR §51.308(f)(6)(vi) – Other elements, including reporting, recordkeeping, and other measures, necessary to assess and report visibility are as follows:

    a. EPA provides guidance for states to follow to establish baseline visibility and track visibility from the established baseline. The EPA guidance also outlines an adjustment process to distinguish the relative contributions from U.S. anthropogenic and natural sources.
    b. There are no other elements, including reporting, recordkeeping, or other measures necessary to address and report visibility in Hawaii's Class I areas.

9.2 Periodic Regional Haze Progress Reports

In accordance with 40 CFR §51.308(g), states are required to submit periodic regional haze progress reports. The first progress report is due five (5) years from submittal of the initial implementation plan. Subsequent progress reports are due by January 31, 2025, July 31, 2033, and every ten (10) years thereafter. Subsequent progress reports must be made available for public inspection and comment for at least thirty (30) days prior to submitting to EPA and all comments must be submitted to EPA, along with an explanation of any changes to the progress report made in response to comments. The progress reports must include the following:

1. Description of the implementation status of current SIP measures;
2. Summary of the emission reductions achieved;
3. Assessments of changes in visibility conditions for most impaired and clearest days;
4. Analysis of emission changes over the applicable five (5) year period; and
5. Assessment of any significant changes in anthropogenic emissions that have occurred since the most recent RH-SIP submittal including whether the changes were anticipated and whether the changes limited progress in improving visibility.

40 CFR §51.308(g)(1) – A description is required of the status of implementation of all measures included in the implementation plan for achieving reasonable progress goals for Class I areas within and outside the state. Below are several existing air pollution efforts that contribute to visibility improvements in the state's Class I areas; some are state programs and others are federal requirements. Hawaii's long-term strategy for regional haze provides a description of air pollution control measures to reduce emissions within the state. Some of these measures are as follows:

- Boilers at Kanoelehua-Hill and Puna power plants will continue to be subject to a 3,550 ton per year total combined SO_2 emissions cap established in the first implementation period until these units are shut down;

- Hawaii continues to implement its renewable energy and energy efficiency programs (See Section 7.1.a and 7.1.b of the RH-SIP);

- DOH-CAB has capped GHG emissions from nineteen (19) of twenty (20) facilities subject to GHG emission reductions (See Section 7.1.c of the RH-SIP and DOH-CAB website, Hawaii Greenhouse Gas Program, Greenhouse Gas (GHG) Permits https://health.hawaii.gov/cab/greenhouse-gas-ghg-permits/);

- The PSD permitting requirements protect visibility in Class I areas from new industrial sources and major changes to existing PSD sources (See Section 7.2.b.ii of the RH-SIP);

- DOH-CAB continues to regulate open burning on all islands (See Section 7.1.d of the RH-SIP); and

- International Marine Organization low-sulfur marine diesel regulation and the North America Emissions Control Area reduce CMV emissions.

40 CFR §51.308(g)(2) – A summary of the emissions reductions achieved throughout the state through implementation of the measures described in (g)(1) are provided below in Table 9.2-1. Anthropogenic emissions in Hawaii have decreased since 2011 due primarily to RPS progress goals. Electricity from renewables is projected to increase from 2017 to 2030, and therefore as the RPS progresses, the impact of fuel-fired electric plants on visibility impairment is expected to decline.

Table 9.2-1 Hawaii's NEI Emissions (2011 to 2017)

Year	SO_2	NO_X	VOC	NH_3	PM_{10}	$PM_{2.5}$
2011	27,738	55,192	40,453	9,206	41,082	9,955
2014	20,714	49,574	64,209	7,977	73,041	22,143
2017	18,623	39,509	32,307	2,265	22,958	7,131

40 CFR §51.308(g)(3) – Utilizing a summary of emissions for each Class I area within the state, the state must assess the following visibility conditions and changes, with values for most impaired, least impaired and/or clearest days as applicable expressed in terms of five-year averages of these annual values. Tables 9.2-2 and 9.2-3 below provide summaries of deciview data for most impaired and clearest days, respectively, for baseline visibility conditions (2000 - 2004), past five-year visibility conditions (2009 – 2013), and current visibility conditions (2014 - 2018).

Table 9.2-2 Most Impaired Days in Hawaii's Class I Areas

Class I Area	IMPROVE ID	Baseline (2000-2004)	Past 5 years (2009 - 2013)	Current (2014 - 2018)	Deciview change between current and past 5 years	Improvement: YES/NO
Haleakala NP [a]	HALE1_RHTS_VADJ	7.84	7.72	7.27	-0.45	YES
Hawaii Volcanoes NP	HAVO1_VADJ	15.60	14.70	16.31 [b]	1.61	NO

a. For the 2000-2004 baseline period, 2000 data at the HALE1 monitor was not available. Therefore, averages for the 2000-2004 baseline were determined from visibility data between 2001 and 2004 for the HALE1 monitor.

b. Based on data for 2014 to 2017, since no IMPROVE data for 2018 for the HAVO1 monitor.

Table 9.2-3 Clearest Days in Hawaii's Class I Areas						
Class I Area	IMPROVE ID	Baseline (2000-2004)	Past 5 years (2009 - 2013)	Current (2014 - 2018)	Deciview change between current and past 5 years	Improvement: YES/NO
Haleakala NP [a]	HALE1_RHTS_VADJ	2.18	0.80	0.48	-0.32	YES
Hawaii Volcanoes NP [b]	HAVO1_VADJ	4.06	3.5	3.5 [b]	0	NO

a. For the 2000-2004 baseline period, 2000 data at the HALE1 monitor was not available. Therefore, averages for the 2000-2004 baseline were determined from visibility data between 2001 and 2004 for the HALE1 monitor.
b. Based on data for 2014 to 2017, since no IMPROVE data for 2018 for the HAVO1 monitor.

40 CFR §51.308(g)(4) – The state is required to analyze the tracking of the change over the period since Hawaii's 2017 Progress Report approved as an RH-SIP revision, emissions of pollutants contributing to visibility impairment from all sources and activities within the state, and emissions changes identified by type of source or activity. This requirement is addressed in Section 4.1 of the RH-SIP.

40 CFR §51.308(g)(5) – An assessment of any significant changes in anthropogenic emissions from within or outside the state that have occurred since the period addressed in the most recent plan, including whether or not these changes in anthropogenic emissions were anticipated in that most recent plan and whether they have limited or impeded progress in reducing pollutant emissions and improving visibility. This requirement is addressed in Section 4.2 of the RH-SIP.

9.3 Determination of Adequacy – 40 CFR §51.308(h)

In accordance with 40 CFR §51.308(h), states are required to determine the adequacy of the existing RH-SIP based on the findings of the periodic progress reports that will be based on consultation with the FLMs and EPA.

Hawaii commits to make adequacy determinations of the existing RH-SIP at the time regional haze progress reports are due in accordance with 40 CFR §51.308(h). Hawaii, in consultation with the FLMs and EPA, will determine what actions are necessary for the adequacy determination.

9.4 Comprehensive RH-SIP Revisions

Pursuant to 40 CFR §51.308(f), states must revise and submit the RH-SIP by July 31, 2021, July 31, 2028, and every ten (10) years thereafter. In accordance with 40 CFR §51.308(f), the State of Hawaii commits to revising and submitting its RH-SIP by July 31, 2028, and every ten (10) years thereafter. The plan will contain elements and supporting documentations required by 40 CFR §51.308(f) to meet the core requirements specified in 40 CFR §51.308(d).

9.5 Federal Land Manager Consultation – 40 CFR §51.308(i)(2)

Hawaii provided the Federal Land Managers (FLMs) opportunities for consultation at least 120 days prior to holding a public hearing or any other public comment opportunity for the RH-SIP submittals in accordance with 40 CFR §51.308(i)(2). Discussions from conference calls are provided in Appendix P.

Hawaii provided an opportunity for consultation with the 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 draft RH-SIP documents. The RH-SIP was submitted to the NPS, U.S. Fish and Wildlife Service, and the U.S. Forest Service on March 24, 2022, for the August 12, 2022, RH-SIP submittal and June 7, 2023, for 2023 RH-SIP submittal, in order to receive feedback on the documents. The EPA was also notified on March 24, 2022, for the August 12, 2022, RH-SIP submittal and June 7, 2023, for the 2023 RH-SIP submittal, and provided a copy of the draft RH-SIP during the FLM review and comment periods. A regional haze consultation meeting was held on May 19, 2022, for the August 12, 2022, submittal, to discuss comments from the FLMs on Hawaii's draft RH-SIP. The NPS Air Resources Division, NPS Interior Regions 8, 9, 10, and 12; and several national park units in Hawaii hosted the RH-SIP consultation meeting with DOH-CAB. Members from the U.S. Fish and Wildlife Service and EPA (Region 9) also attended the meeting. The FLMs provided written comments on the draft RH-SIP with associated permit amendments on May 26, 2022, for the August 12, 2022, submittal. A regional haze check-in meeting was held with NPS and EPA (Region 9) on July 13, 2023, for the 2023 RH-SIP submittal. The FLMs provided written comments on the draft RH-SIP with associated permit amendments on July 28, 2023. In accordance with 40 CFR §51.308(i)(3), comments from the FLMs are provided in Appendix P.

From their review for the August 12, 2022, RH-SIP submittal, the FLMs concluded that there may be additional cost-effective opportunities to control NO_X emissions from four (4) larger diesel engines (M10–M13) at the Maalaea Generating Station on Maui. As indicated at the consultation meeting, these engines are responsible for 69% of the facility's total NO_x emissions. The FLMs stated that the draft RH-SIP could be improved by more robust justification for the cost of emission controls for these engines. The NPS analysis of SCR control costs for these engines, found that they may be below the cost-effectiveness threshold established by the state. The FLMs requested that DOH-CAB staff consider their cost estimates for Maalaea engines M10–M13 and update cost estimates for the facility if appropriate. The FLMs further recommend that Hawaii DOH-CAB staff require SCR for these engines as a technically feasible cost-effective control to reduce NO_x emissions if revised cost-effectiveness estimates are below the established threshold. The NPS supports Hawaii DOH-CAB's request for a vendor quote as this would provide the highest level of certainty for evaluating the cost-effectiveness of SCR for these engines.

After further review of the four-factor analysis for the Maalaea Generating Station to address comments from the FLMs, the DOH-CAB determined that the four-factor analysis for Maalaea Generating Station was incomplete. Therefore, additional review to determine potential control measures for the Maalaea Generating Station was addressed in Revision 1 of the RH-SIP for the 2023 RH-SIP submittal. Please see Chapters 6 and 7.

The four-factor analyses for the Mauna Loa Macadamia Nut Corporation Plant on Hawaii Island was also determined to be incomplete. Potential control measures for the Mauna Loa Macadamia Nut Corporation Plant were addressed in Revision 1 of the RH-SIP for the 2023 RH-SIP submittal. Please refer to Chapters 6 and 7.

From review of the RH-SIP for the 2023 submittal the FLMs requested that DOH-CAB specify additional requirements for the Maalaea Generating Station and Mauna Loa Macadamia Nut Corporation Plant. They requested a permit condition to notifying DOH-CAB and EPA (Region 9) on the control measure selected for M7 and M10-M13 at the Maalaea Generating Station. These units had the option of installing SCR or shutting down according to a staggered shut down schedule. The FLMs also requested that Mauna Loa Macadamia Nut Corporation provide an effective controls demonstration or conduct a four-factor analysis for the main boiler prior to installation. Changes were made to permit amendments and the RH-SIP for these facilities to address comments from the FLMs. Please see Appendix P.

9.6 Procedural Requirements – 40 CFR §51.102

Pursuant to 40 CFR §51.102, HRS Section 342B-13, and HAR §11-60.1, thirty (30) day public comment periods were afforded to consider Hawaii's initial draft RH-SIPs and the associate permit amendments to incorporate regional control measures. The public comment period was from June 24, 2022, to July 24, 2022, for the draft August 12, 2022, RH-SIP submittal and from July 1, 2022, to July 30, 2022, for the associated draft permit amendments. The public notices provided the opportunity for the public to request a public hearing. The hearing was scheduled to be held on August 2, 2022, at 9:00 a.m. Hawaii Standard Time if requested for the August 12, 2022, submittal. The FLMs and EPA were notified on June 24, 2022, and July 1, 2022, that the DOH-CAB was accepting comments on the draft RH-SIP and associated permit amendments, respectively, for the August 12, 2022, submittal. A hard-copy of the draft RH-SIP and permit amendments were provided on all the main islands for personnel viewing. The DOH-CAB also posted the draft RH-SIP submittal and associated permit amendments on its website at: https://health.hawaii.gov/cab/public-notices/. Copies of the notices sent to the Star Advertiser, Hawaii Tribune-Herald, West Hawaii Today, The Garden Island, and Maui News are provided in Appendix W.

Prior to the close of the public comment periods, comments were received on Hawaii's draft RH-SIP for the August 12, 2022, RH-SIP submittal. A summary of the comments received, the DOH-CAB's responses to the comments, and final permit amendments are provided in Appendix X.

No requests for a hearing were received by the closing date of the comment period for the August 12, 2022, RH-SIP submittal and associated permit amendments to incorporate regional haze control measures and no hearing was held.

The DOH-CAB has the legal authority to adopt Hawaii's RH-SIP and plans to adopt Revision 1 to the RH-SIP for this second planning period in accordance with Hawaii's statutory and regulatory rules. Please see Appendix Y.