State of Hawaii
2015
Ambient Air Monitoring Network 5-Year Assessment

Prepared by:
State of Hawaii
Department of Health
Environmental Management Division
Clean Air Branch

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Table of Contents

List of Tables

List of Figures

Abbreviations and Definitions

AADT	Annual Average Daily Traffic
BAM	Met-One Beta-Attenuation Monitor
CBSA	Core-based Statistical Area
CFR	Code of Federal Regulations
CIP	Campbell Industrial Park (Oahu)
CO	Carbon monoxide gas
DBEDT	State of Hawaii Department of Economic Development and Tourism
DoH	Hawaii State Department of Health
ECA	Emissions Control Area (MARPOL)
EPA (R9)	United States Environmental Protection Agency (Region 9)
FEM	Federal Equivalent Method
FRM	Federal Reference Method
H_2S	Hydrogen sulfide gas
HECO	Hawaiian Electric Company
HVNP	Hawaii Volcanoes National Park
IMPROVE	Integrated Monitoring of Protected Visual Environments
MARPOL	International Convention for the Prevention of Pollution from Ships
MSA	U. S. Census Bureau, Metropolitan Statistical Area
NAAQS	National Ambient Air Quality Standards
NCore	National Core Multi-pollutant Monitoring Stations
NEI	National Emissions Inventory (2011)
NO_2	Nitrogen dioxide gas
NPS	U. S. National Park Service
O_3	Ozone
OMB	U. S. Office of Management and Budget
Pb	Lead
$PM_{2.5}$	Particulate matter less than or equal to 2.5 microns in aerodynamic diameter
PM_{10}	Particulate matter less than or equal to 10 microns in aerodynamic diameter
PGV	Puna Geothermal Venture
PSD	Prevention of Significant Deterioration
ppb	Parts per billion, a measurement unit for gases
ppm	Parts per million; a measurement unit for gases
PWEI	Population Weighted Emissions Index, an EPA calculation that triggers SO_2 monitoring
SLAMS	State and Local Air Monitoring Stations
SO_2	Sulfur dioxide gas
SPMS	Special Purpose Monitoring Stations
TPD	Tons per day
TPY	Tons per year
vog	Haze due to volcanic emissions
WD	Wind direction
WS	Wind speed
$\mu g/m^3$	micrograms per cubic meter of air; a measurement unit for particulate matter

I. Executive Summary

A. Purpose of Assessment

40 Code of Federal Regulations (CFR) Part 58 requires that a network assessment of the air quality surveillance system be conducted once every five years to determine if the network is effective and efficient in meeting monitoring objectives, whether new sites are needed or existing sites or monitors can be terminated and whether there are new technologies that can be incorporated.

Conducted once every five years, with the first one completed in 2010, the assessment provides a more robust and comprehensive conceptualization of the current and future needs of the state's air surveillance network. The annual network plan consequently applies, resources allowing, the recommendations and decisions resulting from the assessment.

B. Ambient Air Monitoring Networks

The State of Hawaii Department of Health (DoH) currently operates 14 ambient air monitoring stations on four of the major islands. The Kahului, Maui station currently operates one $PM_{2.5}$ monitor with the gas monitors coming online by the summer of 2015 (Table 1). The NCore station became fully operational in January 2011 with lead (Pb) monitoring beginning in January 2012.

Ambient air monitoring is also being conducted by private industry and the U.S. National Park Service (NPS). Data from these networks are publically available and supplements the data being collected by the DoH.

The main air surveillance concerns in the state include:

- Sulfur dioxide (SO_2) and sulfate aerosols ($PM_{2.5}$) from the ongoing Kilauea volcano eruption;
- Hydrogen sulfide (H_2S) emissions from geothermal energy production and exploration;
- Cane-burning on the island of Maui;
- Implementing new monitoring as required by revisions or additions to the National Ambient Air Quality Standards (NAAQS) as well as revisions and additions to 40 CFR 58;
- Cruise ship emissions on the island of Kauai

C. Summary of 2015 Findings

The biggest challenge for the program is that compliance with new monitoring requirements as well as meeting the state's monitoring priorities are outpacing funding and resources. The necessity of doing more with less was one of the principal considerations when planning the future of the state's air monitoring network. Where allowed, DoH will partner with the private sector to accomplish monitoring goals.

Prioritization of Pollutants

DoH analyzed historical data from the monitoring network on a pollutant-by-pollutant basis to determine a priority ranking of each of the criteria pollutants. The ranking was based on each pollutant's average percentage of the NAAQS, whether the trend increased or decreased and its relative importance in meeting the state's monitoring objectives and goals. Based on those factors, the priority ranking was determined to be:

1. SO_2
2. $PM_{2.5}$
3. Nitrogen dioxide (NO_2)
4. Ozone (O_3)
5. Coarse particles (PM_{10})
6. Carbon Monoxide (CO)

Findings

DoH also considered the effects of climate and topography, population characteristics and location of emission sources before conceptualizing the future of the air monitoring network.

- Generally, the current network is effectively meeting the state's monitoring objectives and minimum federal requirements;
- Other than fulfilling the requirements for new U.S. Environmental Protection Agency (EPA) initiatives (e.g. near-road NO_2 and the SO_2 Data Requirements Rule), no new monitoring is needed;
- Specific recommendations:
    - To efficiently use resources, merge the Kapolei State and Local Air Monitoring Station (SLAMS) and National Core Multi-pollutant Monitoring Station (NCore). These stations are currently located side-by-side duplicating monitoring for CO and SO_2. The recommendations are to discontinue the SLAMS CO monitor and investigate the possibility of operating a dual-range SO_2 monitor at NCore to capture both the low and high range values.
    - Closely track population estimates for the Urban Honolulu Metropolitan Statistical Area (MSA). Should the population reach one million, monitoring for CO and $PM_{2.5}$ at the near-road site would need to be included.
    - Install a 10-meter meteorological tower for collection of wind speed and direction information to assist in the determination of sources contributing to the formation of O_3 at the Sand Island station.
    - The maximum sulfur content of marine fuel was reduced in August 2012 for ships operating within the Emissions Control Area (ECA) around the Hawaiian Islands. After the fuel sulfur reduction became effective, there was a correlated reduction in ambient concentrations of SO_2 at the Niumalu monitoring station. The second fuel sulfur reduction became effective January 2015 and SO_2 data at the Niumalu station will be analyzed for one-year post-reduction to determine the ambient effects, if any, of the fuel sulfur limits placed on cruise ships.

If there is a substantial decrease in ambient SO_2, the station may either be closed or moved to the population centers of Lihue or Kapaa.

- Establish two new SO_2 monitoring stations by January 1, 2017 to satisfy the Data Requirements Rule. To demonstrate compliance with the 1-hour SO_2 NAAQS, DoH is anticipating source-monitoring of three to four facilities within the Urban Honolulu MSA that exceed the minimum SO_2 emission threshold proposed by EPA.
- The cost of consumables for the 13 $PM_{2.5}$ Beta-Attenuation continuous monitors (BAM) is becoming prohibitive. Other Federal Equivalent Method (FEM) continuous $PM_{2.5}$ monitors that do not have as much consumable costs will be explored to replace the BAM units as needed. DoH will ensure that collocation requirements are met should there be a change in the sampling method.

II. Introduction

In the CFR, EPA promulgated a requirement for all states to conduct and submit a network assessment once every five years [40 CFR 58.10(e)].

"The state, or where applicable local, agency shall perform and submit to the EPA Regional Administrator an assessment of the air quality surveillance system every 5 years to determine, at a minimum, if the network meets the monitoring objectives defined in appendix D to this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation into the ambient air monitoring network. The network assessment must consider the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma), and, for any sites that are being proposed for discontinuance, the effect on data users other than the agency itself, such as nearby States and Tribes or health effects studies. For $PM_{2.5}$, the assessment also must identify needed changes to population-oriented sites. The State, or where applicable local, agency must submit a copy of this 5-year assessment, along with a revised annual network plan, to the Regional Administrator. The first assessment is due July 1, 2010."

Elements evaluated in the assessment include environmental justice concerns, location of asthma corridors, population shifts and emissions inventory. The assessment allows decision-makers to ensure that the current and future air surveillance network is established and operated efficiently and effectively to meet the state's environmental goals.

Ambient air data is used for a variety of purposes including:

- NAAQS compliance;
- Providing near real-time air quality information to the public;
- Permit modeling;
- Pollutant trend analysis;
- Health studies;

- Forecasting;
- Source monitoring; and,
- Evaluating the effects of emissions controls

Questions asked during the assessment included:

- Are the current monitoring objectives being met or should the objectives be modified?
- Based on trend evaluation, what is the priority ranking by pollutant and by station?
- Are there areas that are underserved based on population and health statistics?
- Are there monitors or stations that could/should be discontinued or moved?
- Are there new technologies that can be used to optimize, streamline, or enable the network to operate more efficiently?
- Are there hot spot areas that would benefit from the deployment of temporary or mobile monitoring?
- How can resources be used most efficiently and effectively?

III. Current Air Monitoring in the State of Hawaii

The DoH currently operates 14 monitoring stations on four islands. There are two Metropolitan Statistical Areas (MSA) in the state: Urban Honolulu (hereafter called Oahu), which encompasses the island of Oahu; and the newly designated (as of February 28, 2013) Kahului-Wailuku-Lahaina MSA (hereafter called Maui) covering the County of Maui. There are also two Micropolitan Statistical Areas: Hilo (Hawaii County) and Kapaa (Kauai County). The state's network meets or exceeds the minimum monitoring requirements in 40 CFR 58 Appendix D.

In addition to DoH ambient air monitoring stations, there are other private as well as federal air monitoring stations operating within the state. These include:

Hawaiian Electric Company (HECO) West Oahu Air Monitoring Network

In April 2009, HECO (Oahu's only electrical utility provider) began operating three ambient air monitoring stations along the Waianae coast of Oahu. This was part of a commitment to the west Oahu communities for the development and operation of a new power generation station in the nearby Campbell Industrial Park (CIP). All three stations monitor for CO, SO_2, NO_2, O_3 and $PM_{2.5}$ as well as wind speed (WS), wind direction (WD), ambient temperature and precipitation. Data from the three stations are publicly available on their website at www.westoahuair.com

Puna Geothermal Ventures (PGV)

PGV operates a geothermal energy production facility on the island of Hawaii. As a condition of their non-covered source permit, the facility is required to operate and maintain three perimeter stations for the continuous monitoring of

hydrogen sulfide gas (H_2S) as well as wind speed and direction. The most recent 5-minute H_2S data is publically available on the PGV webpage.

National Park Service (NPS)

The NPS operates and maintains the two Integrated Monitoring of Protected Visual Environments (IMPROVE) stations in the state. Hawaii has two Class I visibility areas: Haleakala National Park on Maui and Volcanoes National Park on Hawaii (HVNP). Additionally, there are two stations in HVNP that continuously monitor the SO_2 emissions from the Kilauea volcano. This data is publically available at www.hawaiiso2network.com/havoalert.php

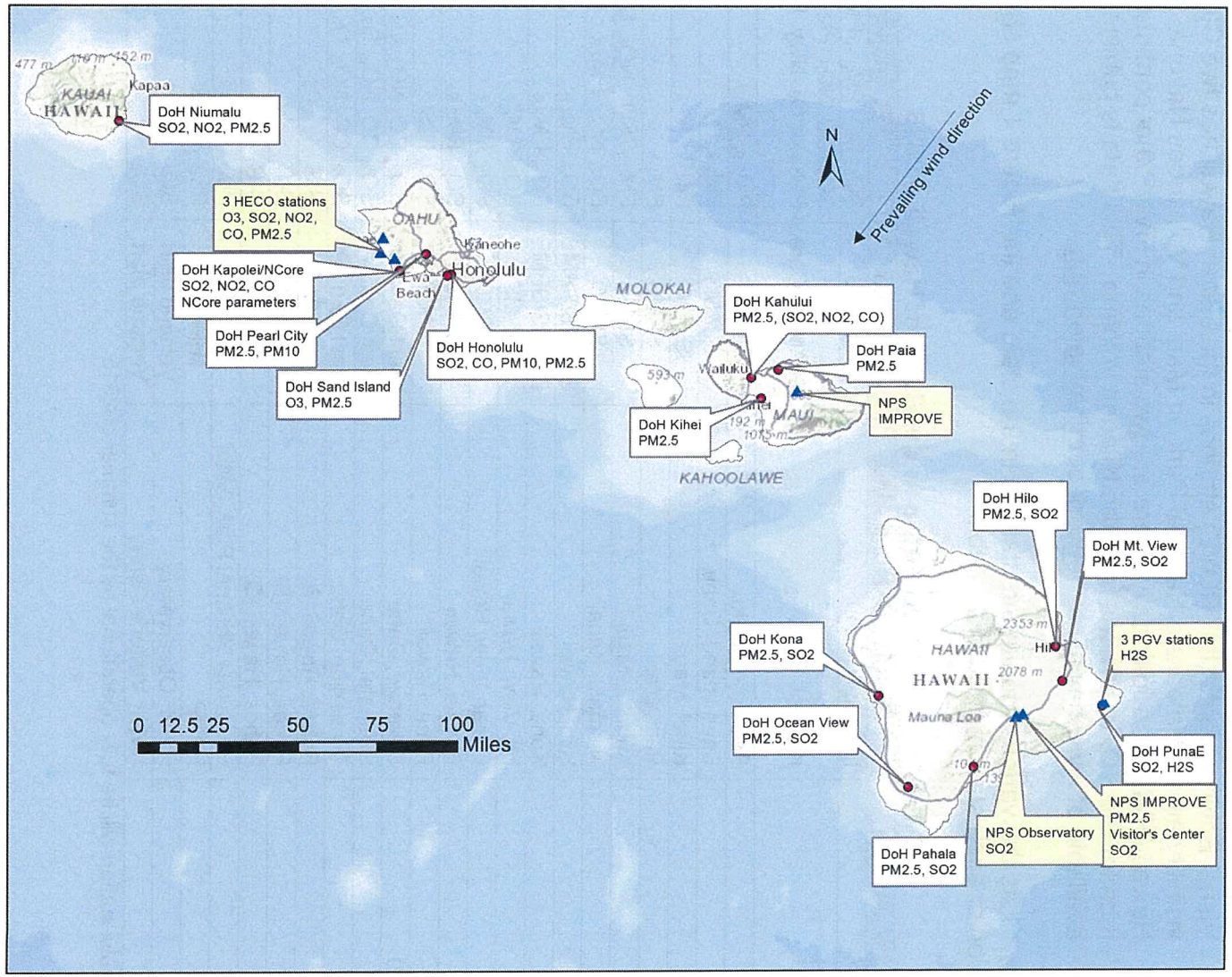
Table 1 lists the various monitoring stations in the state and the Figure 1 map shows the location of each station listed in the table.

Table 1. Air Monitoring in the State of Hawaii – 2015

Entity	Location of Monitoring	Program	Parameters
DoH	Honolulu, Oahu	SLAMS	SO_2, CO, $PM_{2.5}$, PM_{10}
	Kapolei, Oahu	SLAMS/NCore	SO_2, CO, NO_2, $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$, O_3, NOy, $PM_{2.5}$ spec., Pb
	Pearl City, Oahu	SLAMS	$PM_{2.5}$, PM_{10}
	Sand Island, Oahu	SLAMS	$PM_{2.5}$, O_3
	Kihei, Maui	SLAMS	$PM_{2.5}$
	Paia, Maui	SPMS	$PM_{2.5}$
	Kahului, Maui [1]	SPMS	$PM_{2.5}$ (SO_2, NO_2, CO)
	Niumalu, Kauai	SPMS	SO_2, NO_2, $PM_{2.5}$
	Hilo, Hawaii	SLAMS/SPMS	SO_2, $PM_{2.5}$
	Kona, Hawaii	SLAMS/SPMS	SO_2, $PM_{2.5}$
	Mt. View, Hawaii	SPMS	SO_2, $PM_{2.5}$
	Ocean View, Hawaii	SPMS	SO_2, $PM_{2.5}$
	Pahala, Hawaii	SPMS	SO_2, $PM_{2.5}$
	Puna, Hawaii	SPMS	SO_2, H_2S
HECO	Waianae, Oahu	West Oahu Air	SO_2, CO, NO_2, O_3, $PM_{2.5}$
	Lualualei, Oahu	West Oahu Air	SO_2, CO, NO_2, O_3, $PM_{2.5}$
	Timberline, Oahu	West Oahu Air	SO_2, CO, NO_2, O_3, $PM_{2.5}$
PGV	Pahoa, Hawaii (A)	PGV	H_2S
	Pahoa, Hawaii (B)	PGV	H_2S
	Pahoa, Hawaii (C)	PGV	H_2S
NPS	Haleakala National Park, Maui	IMPROVE	$PM_{2.5}$ spec.
	HVNP	IMPROVE	$PM_{2.5}$ spec.
	HVNP Observatory	Volcano alert	SO_2
	HVNP Visitor's Center	Volcano alert	SO_2

[1] Kahului station will be fully operational by the summer of 2015.

Figure 1. Air Monitoring Stations in the State of Hawaii - 2015



IV. Climate, Population and Emission Source Characteristics

A. Climate and Topography[1]

Climate

The Hawaiian archipelago is the most isolated populated area in the world. The closest landmass is California, approximately 2,400 miles to the northeast. The climate is predominantly influenced by the surrounding ocean and its tropical latitude location producing relatively mild temperatures and moderate humidity. There are basically two seasons: summer from May through October, and winter from October through April.

The islands are actually the summits of a volcanic mountain range. The mountain and valley landscapes produce a complex air flow system with wide variability in wind speeds, rainfalls and temperatures. Strong diurnal wind patterns can be found on the southern and western leeward coasts of the islands. This diurnal pattern consists of sea breezes during the afternoon and early evening hours and land breezes at night.

The most dominant climatic attribute affecting the dispersion of air pollutants and allowing for the normally clean air is the nearly persistent trade-wind or northeasterly winds. During the summer months, the trades are prevalent 80 to 95 percent of the time, decreasing in the winter months as cold fronts move through the islands bringing with them southerly winds. Emissions from the active Kilauea volcano on the island of Hawaii can travel up the island chain with these southerly or "Kona" winds. The volcanic emissions, also called "vog" create hazy conditions sometimes as far north as Kauai.

Some of the major climatic regions are:

1. Windward lowlands
   Less than 2,000 feet on the northern to northeastern sides of the islands, these lowlands lie perpendicular to the prevailing trade-winds, is often cloudy with frequent trade showers (see Figure 2) and mild temperature fluctuations.
2. Leeward lowlands:
   Dryer, warmer weather prevail in these areas often with afternoon sea breezes. The exception is the Kona coast on the island of Hawaii which has its own distinctive climate.
3. Kona coast on the island of Hawaii:
   This is the only region where the rainfall is higher in the summer than in the winter. An eddy off the coast caused by the two large mountain peaks of Mauna Kea to the north and Mauna Loa to the south results in the volcanic plume circling back onto land and allowing the vog to be nearly constant during trade-wind weather.

[1] Sources for climate information from Western Regional Climate Center (www.wrcc.dri.edu) and the National Weather Service, Honolulu (www.prh.noaa.gov/hnl)

Topography

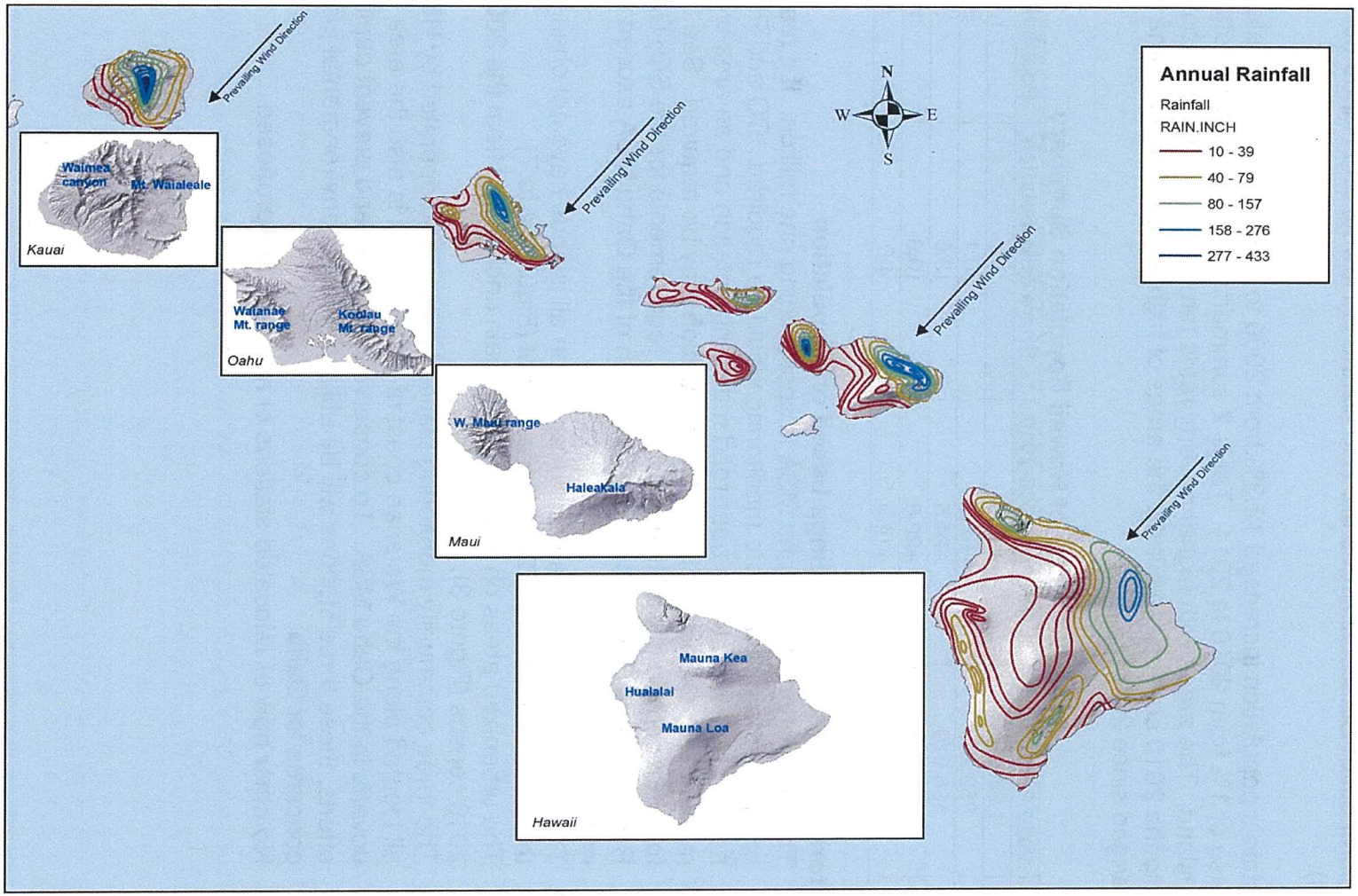
Each island has unique topographical influences:

4. Oahu
   The most significant factor influencing Oahu's environment is the urban Honolulu setting where tall, dense building structures tend to cause warmer temperatures and turbulent winds within the city center. The impact of city pollution is minimized by the trade-winds that normally blow them out to sea.
5. Kauai
   Being the northern-most major island, Kauai is largely exposed to the northwest frontal systems that bring rain during the winter months. Mt. Waialeale in the center of the island is one of the wettest spots in the world.
6. Maui
   The Maui MSA lies in the interior lowland between the two peaks of Haleakala and the West Maui mountains. The flat valley terrain can result in a night-time inversion layer that may restrict vertical transport of air pollutants.
7. Hawaii
   The largest geographical influences are the two mountain peaks of Mauna Kea (13,796 ft.) and Mauna Loa (13,678 ft.) as well as the 32-year eruption of the Kilauea volcano. The mountain peaks create an eddy effect along the Kona coast that brings the volcanic plume, which would normally be moved off shore by the trade-winds, back onto land in the form of sulfate aerosols. When the winds turn southerly, as occurs during the winter months with the more frequent cold fronts, the plume travels directly to the Hilo coast on the eastern side of the island. Because of the relatively short distance between the volcano vents and Hilo, the volcanic plume is mainly detected as SO_2.

Monitoring Assessment Findings based on Climate and Topography

1. The majority of the monitoring stations are located on the downwind side of the islands where most of the air pollution is expected.
2. The new Kahului station is located in the interior lowland of central Maui where there is a potential for restricted transport of air pollutants.
3. The Kona air monitoring station is located to detect sulfate aerosols as $PM_{2.5}$ and the Hilo and Mt. View stations are located to monitor for SO_2 from the volcano when the winds come from a non-prevalent direction.
4. No new or relocated stations or monitors are proposed.

Figure 2. Climate and Topography



B. Population

There are two MSAs in the state: Oahu, and the newly designated Maui MSA. The two Micropolitan Statistical Areas are Hilo (island of Hawaii) and Kapaa (island of Kauai).

The state's population increased 12.3% from 2000 to 2010 with an estimated increase of 1% from 2010 to 2014. Table 2 summarizes the population totals on each island. The areas with higher poverty rates remained unchanged from the 2000 to the 2010 census. Similarly, the areas of highest childhood asthma were unchanged since 2010[2].

Table 2. State of Hawaii Population Summary

	2010 Population	% Change 2000-2010	% Share of Population	Population (2013 est.)
State	1,360,301	+12.3		1,404,054
Oahu	953,207	+8.8	70.1	983,429
Hawaii	185,079	+24.5	13.6	190,821
Maui	144,444	+22.8	10.6	160,292
Kauai	66,921	+14.8	4.9	69,512

Monitoring Assessment Findings based on Population

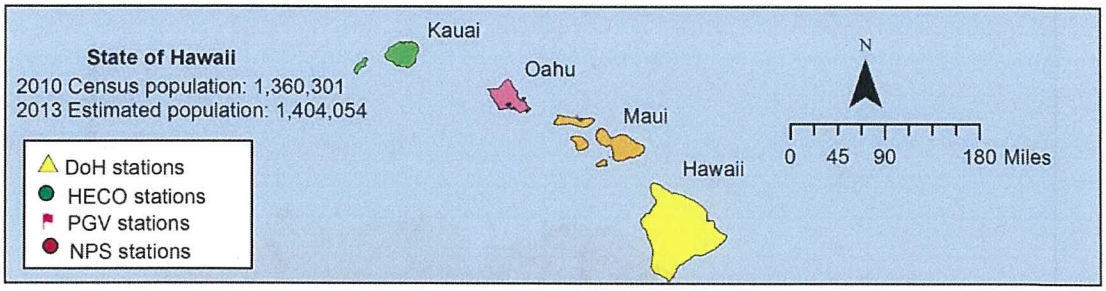
1. The population of the Oahu MSA is approaching one million. If it reaches or exceeds one million, more monitoring would be required. CO and $PM_{2.5}$ will need to be added to the near-road monitoring station and an area-wide NO_2 monitor with expected highest concentration may be required. See Section VI for a description of additional monitoring requirements for the SO_2 Data Requirements Rule should the population of the Oahu MSA exceed one million.
2. The poverty and asthma corridor areas on all islands have not changed since the 2000 census or the 2010 assessment (Figures 4 to 7).
3. The urbanized areas on each island remain unchanged from the 2000 to the 2010 census (Figure 3).
4. The three community monitoring stations owned and operated by HECO are all located along the Waianae coast of Oahu, which is also the area of highest poverty in the Oahu MSA. To conserve resources and prevent duplication of efforts, these three stations will be utilized to meet environmental justice concerns for Oahu.
5. No other new or relocated stations or monitors are proposed.

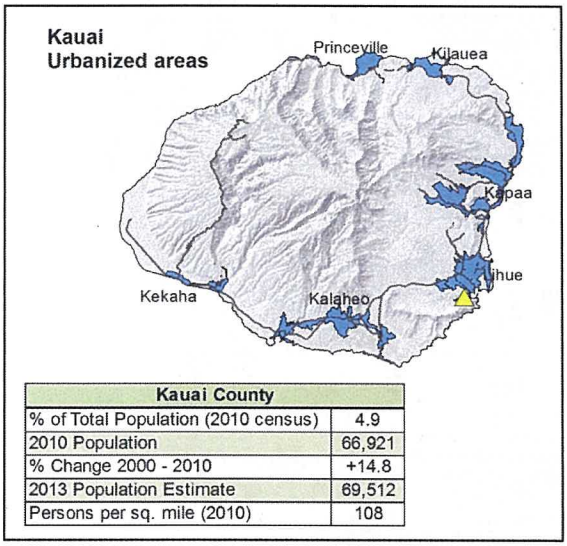
[2] Hawaii Health Data Warehouse; Hawaii State Department of Health, Behavioral Risk Factor Surveillance System, *Current Asthma Among Children and Adolescents in Hawaii, by State, County, Island, and Community, for the Years 2011-2012.* Report created 3/25/2014.

Figure 3

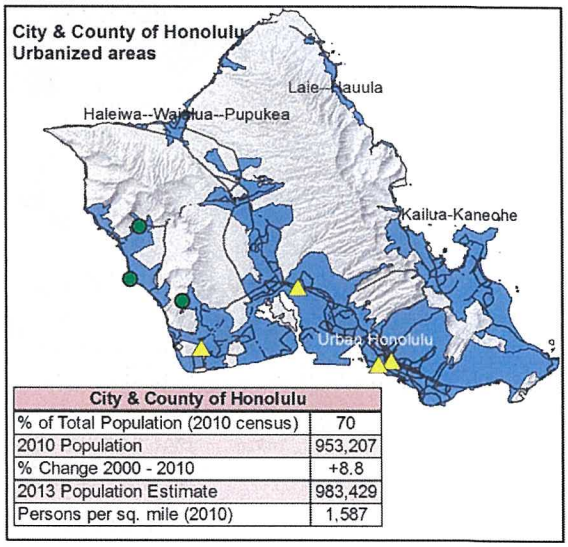
State of Hawaii Population by County: 2010 Census

Source: 2010 U. S. Census Bureau and the 2013 State of Hawaii Data Book (DBEDT)

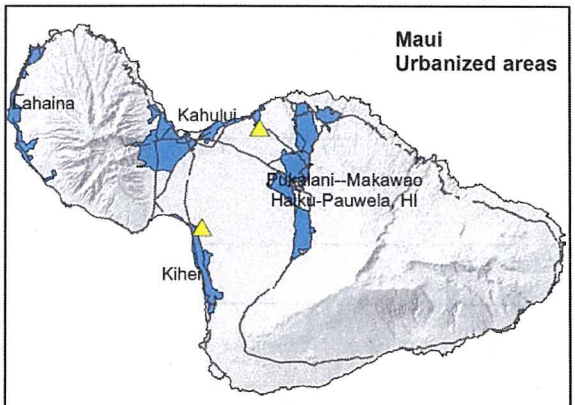




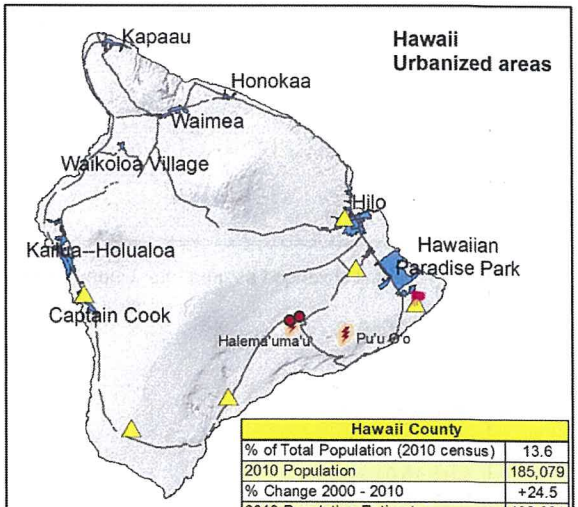
Kauai County	
% of Total Population (2010 census)	4.9
2010 Population	66,921
% Change 2000 - 2010	+14.8
2013 Population Estimate	69,512
Persons per sq. mile (2010)	108



City & County of Honolulu	
% of Total Population (2010 census)	70
2010 Population	953,207
% Change 2000 - 2010	+8.8
2013 Population Estimate	983,429
Persons per sq. mile (2010)	1,587



Maui County	
% of Total Population (2010 census)	11.3
2010 Population	144,444
% Change 2000 - 2010	+22.8
2013 Population Estimate	160,292
Persons per sq. mile (2010)	133



Hawaii County	
% of Total Population (2010 census)	13.6
2010 Population	185,079
% Change 2000 - 2010	+24.5
2013 Population Estimate	190,821
Persons per sq. mile (2010)	46

Figure 4

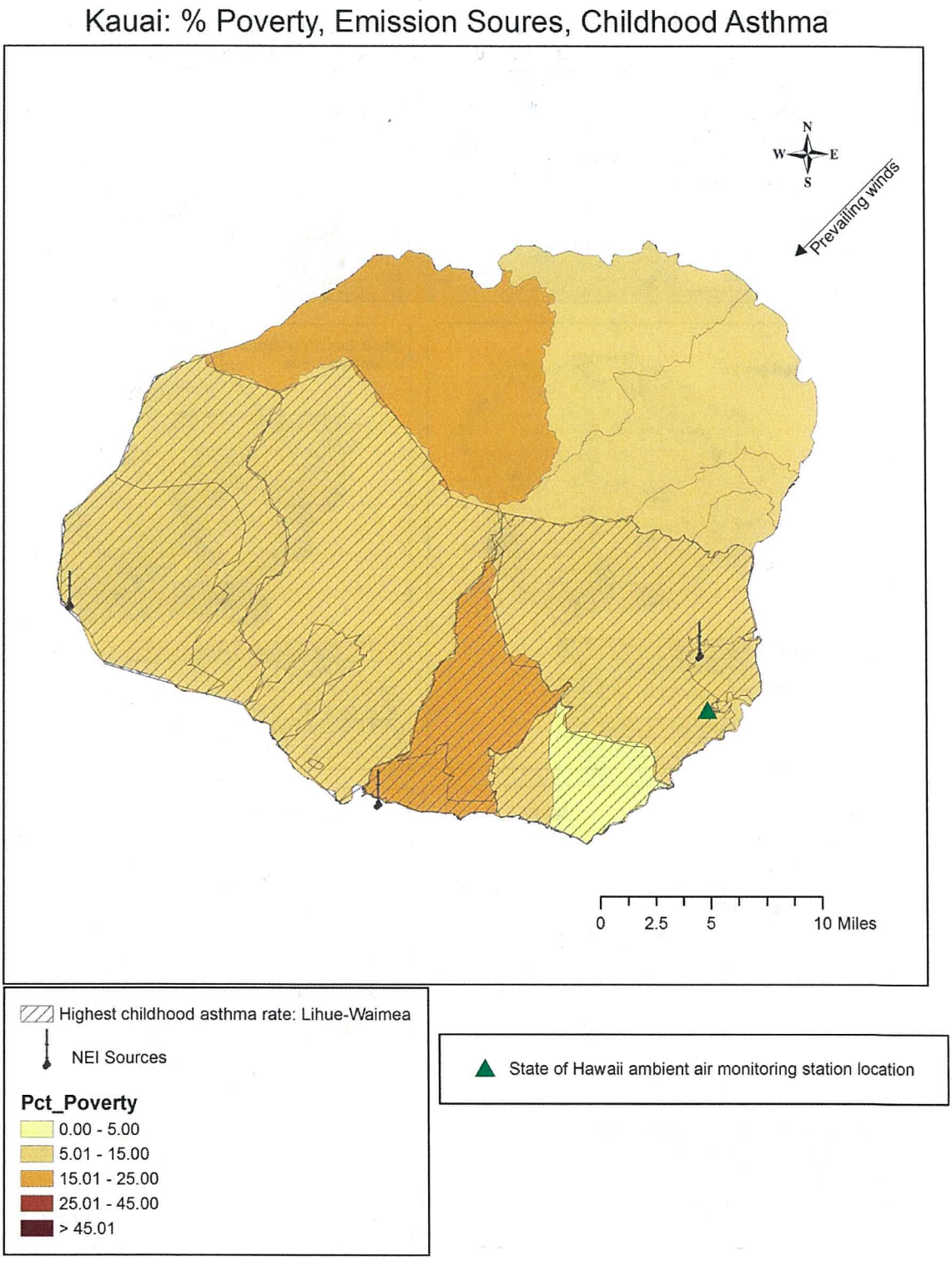

Kauai: % Poverty, Emission Soures, Childhood Asthma
N
W
E
S
Prevailing winds
0
2.5
5
10 Miles
Highest childhood asthma rate: Lihue-Waimea
NEI Sources
Pct_Poverty
0.00 - 5.00
5.01 - 15.00
15.01 - 25.00
25.01 - 45.00
> 45.01
State of Hawaii ambient air monitoring station location

Figure 5

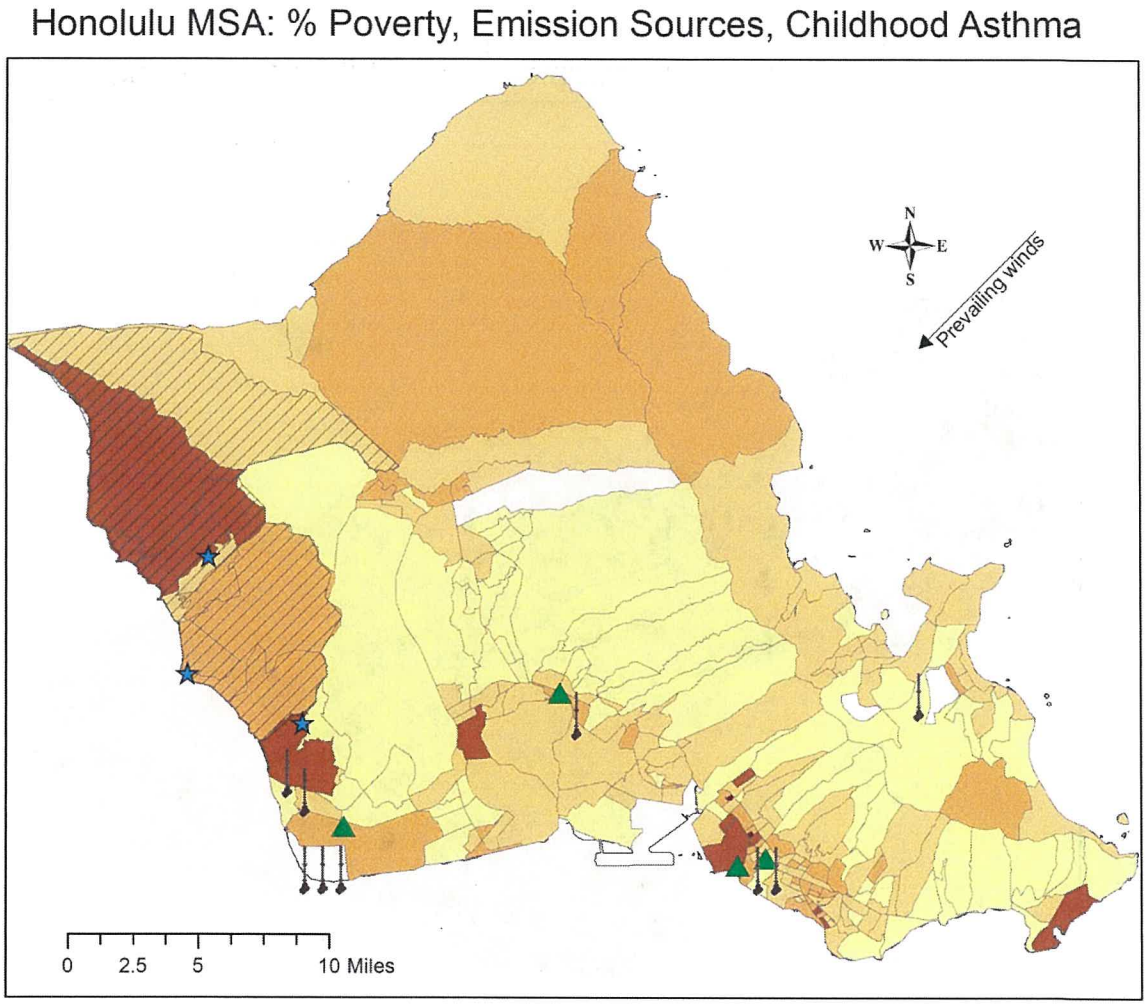

Honolulu MSA: % Poverty, Emission Sources, Childhood Asthma
N
W
E
S
Prevailing winds
0
2.5
5
10 Miles
Legend
Highest childhood asthma rate: Nanakuli/Waianae
NEI Sources
Pct_Poverty
0.00 - 5.00
5.01 - 15.00
15.01 - 25.00
25.01 - 45.00
> 45.01
State of Hawaii ambient air monitoring station location
Hawaiian Electric Co. (HECO) West Oahu Air Network

Figure 6

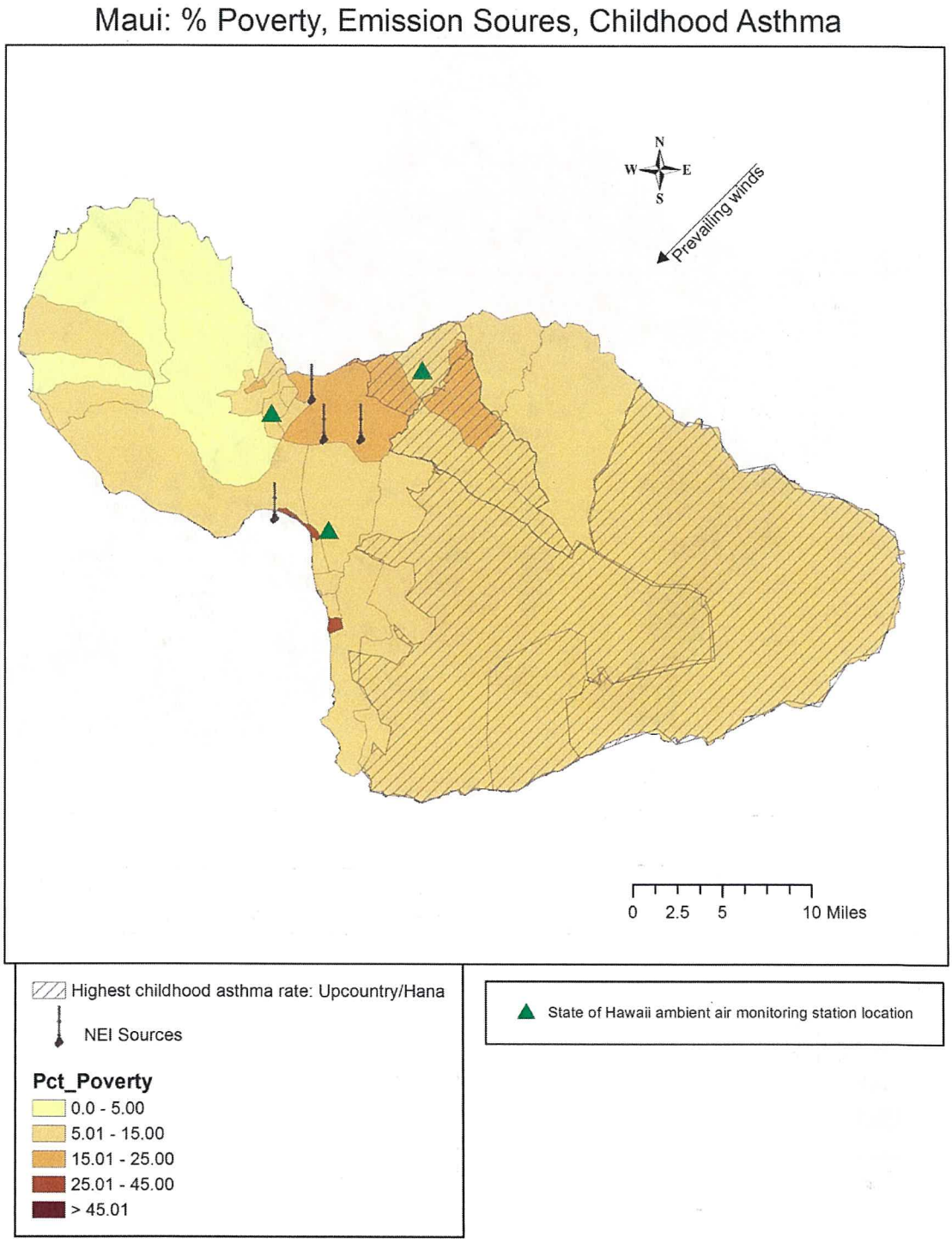
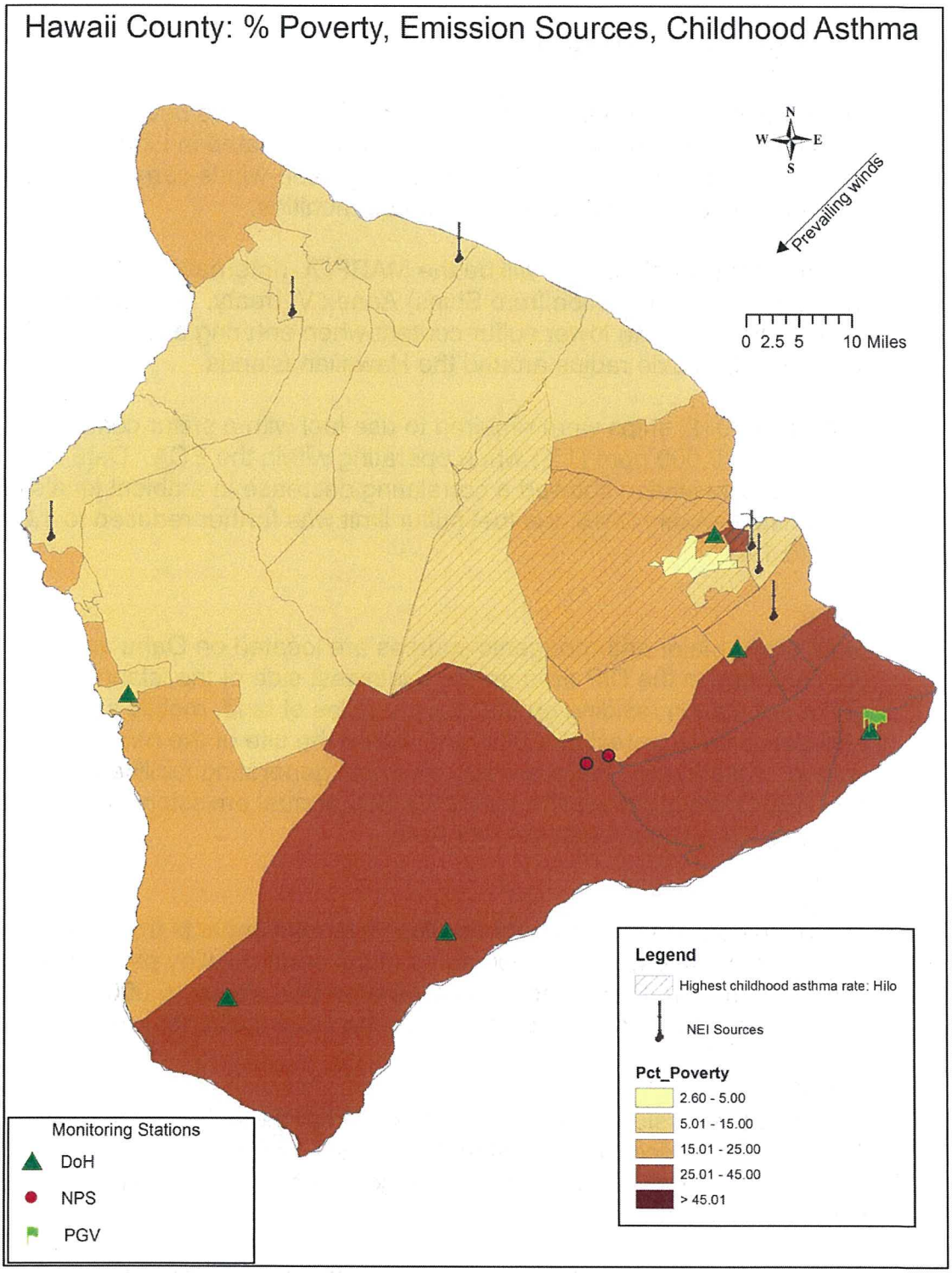

Maui: % Poverty, Emission Soures, Childhood Asthma
N
W
E
S
Prevailing winds
0 2.5 5 10 Miles
Highest childhood asthma rate: Upcountry/Hana
NEI Sources
Pct_Poverty
0.0 - 5.00
5.01 - 15.00
15.01 - 25.00
25.01 - 45.00
> 45.01
State of Hawaii ambient air monitoring station location

Figure 7


Hawaii County: % Poverty, Emission Sources, Childhood Asthma
N
W
E
S
Prevailing winds
0 2.5 5 10 Miles
Legend
Highest childhood asthma rate: Hilo
NEI Sources
Pct_Poverty
2.60 - 5.00
5.01 - 15.00
15.01 - 25.00
25.01 - 45.00
> 45.01
Monitoring Stations
DoH
NPS
PGV

C. Emission Sources

There have not been a significant number of new or relocated major emission sources in the past five years since the 2010 assessment was conducted.

Summary of Emission Sources by Island

- Kauai
  The predominant air pollution concern on this island has been cruise ship emissions from Nawiliwili harbor. The harbor is located in Lihue on the eastern side of the island and the prevailing trade-winds carry the emissions on-shore impacting nearby residential communities.

  An important consideration will be the MARPOL (International Convention for the Prevention of Pollution from Ships) Annex VI treaty. This treaty requires ships to use fuel with lower sulfur content when entering any ECA, which includes a 200 mile radius around the Hawaiian islands.

  In August 2012, ships were required to use fuel with a sulfur content of not more than 10,000 ppm (1%) when operating within the ECA. Data from the DoH Niumalu station showed a correlating decrease in ambient levels of SO_2. Beginning January 2015, the fuel sulfur limit was further reduced to 1,000 ppm (0.1%).

- Oahu
  Most of the major anthropogenic sources are located on Oahu and concentrated in the CIP area on the southwest side of the island. With 70% of the population residing on 602 square miles of land, mobile source pollution is the greatest on Oahu and will be the site of the near-road NO_2 station. Additionally, there are two electrical generating facilities (HECO Kahe and HECO Waiau) that will exceed the SO_2 annual emissions threshold in the proposed SO_2 Data Requirements Rule.

- Maui
  The main concern for residents on Maui is smoke impacts from cane-burning. There are approximately 36,000 acres in the central valley planted in sugar cane. Each year, from March to early December, about 15,000 acres of the sugar cane is burned prior to harvesting the cane stalks for processing.

- Hawaii
  The largest emission source in the state is from the active Kilauea volcano. The U.S. Geological Survey estimates the SO_2 output at between 4,000 to 6,000 tons per day. This source by far generates the greatest air pollution impact statewide.

  Additionally, there are concerns of H_2S emissions as a result of geothermal energy exploration and production, especially for residents in the Puna area.

Summary of Emissions by Pollutant

A summary of the criteria pollutant emissions from the 2011 National Emissions Inventory (NEI) is provided in Table 3. As expected, the majority of anthropogenic emissions occur on the island of Oahu where most of the industrial and mobile sources are located.

When only major source emissions are considered, the Hawaiian Commercial & Sugar facility in Maui County is the largest CO emitter. However when all sources are included, Oahu by far has the most CO, primarily from mobile sources. Increases in PM_{10} and $PM_{2.5}$ emissions on Oahu when all sources are considered are primarily due to construction dust.

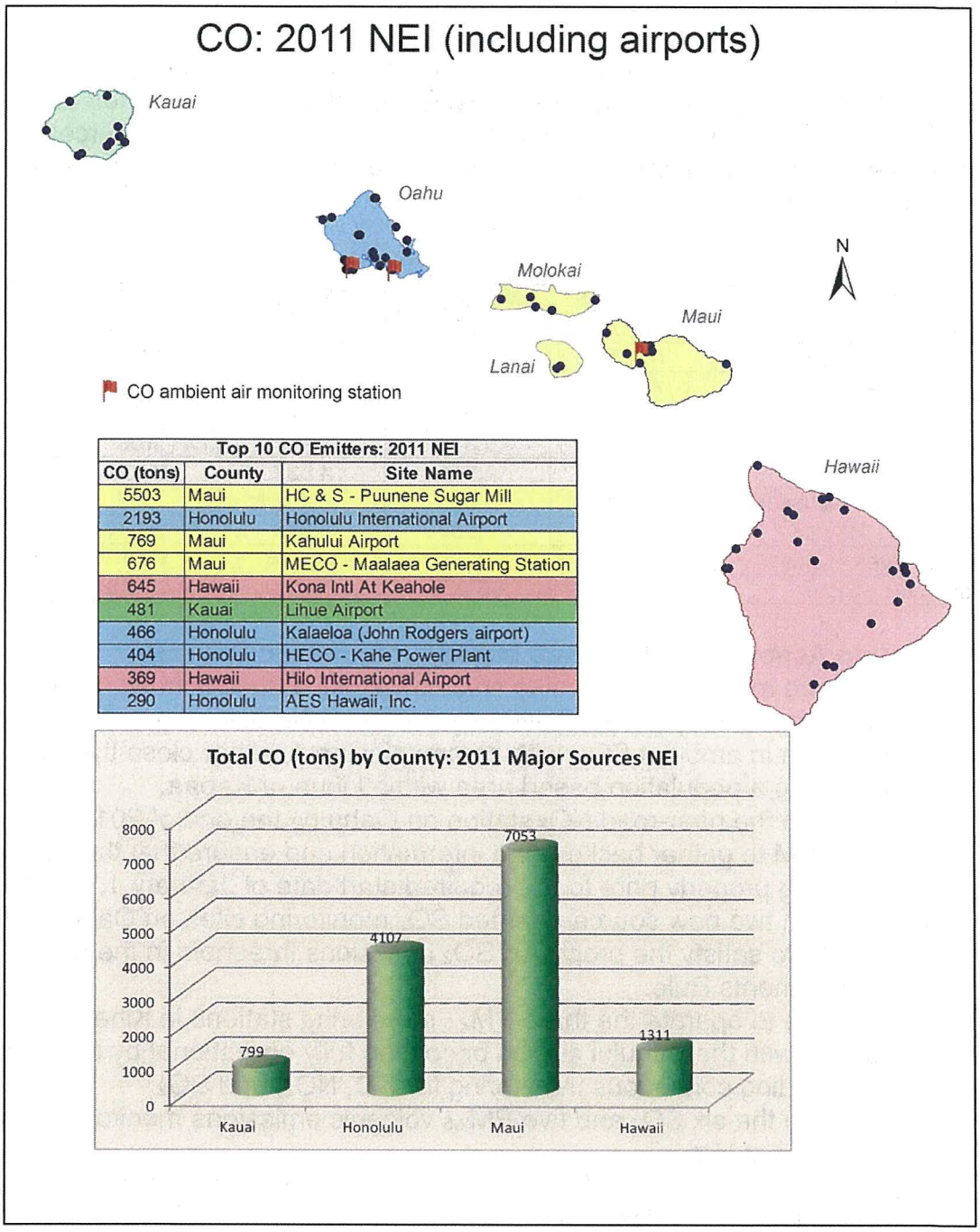
Table 3. 2011 NEI

County	CO (tpy)[1]	NOx (tpy)	SO_2 (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)
Major sources – Kauai	799	1,827	72	178	145
All sources – Kauai	14,076	3,746	336	4,547	1,039
Major sources – Oahu	4,107	20,474	15,336	1,970	1,705
All sources – Oahu	106,250	34,851	19,034	16,971	4,280
Major sources – Maui	7,053	5,346	3,291	156	152
All sources – Maui	36,374	9,941	4,537	9,948	2,771
Major sources – Hawaii	1,311	1,336	3,347	509	439
All sources - Hawaii	36,264	6,737	3,833	9,764	1,989
Major sources – State	13,270	28,983	22,046	2,813	2,441
All sources – State	192,963	55,276	27,740	41,229	10,079

Monitoring Assessment Findings based on Emission Sources

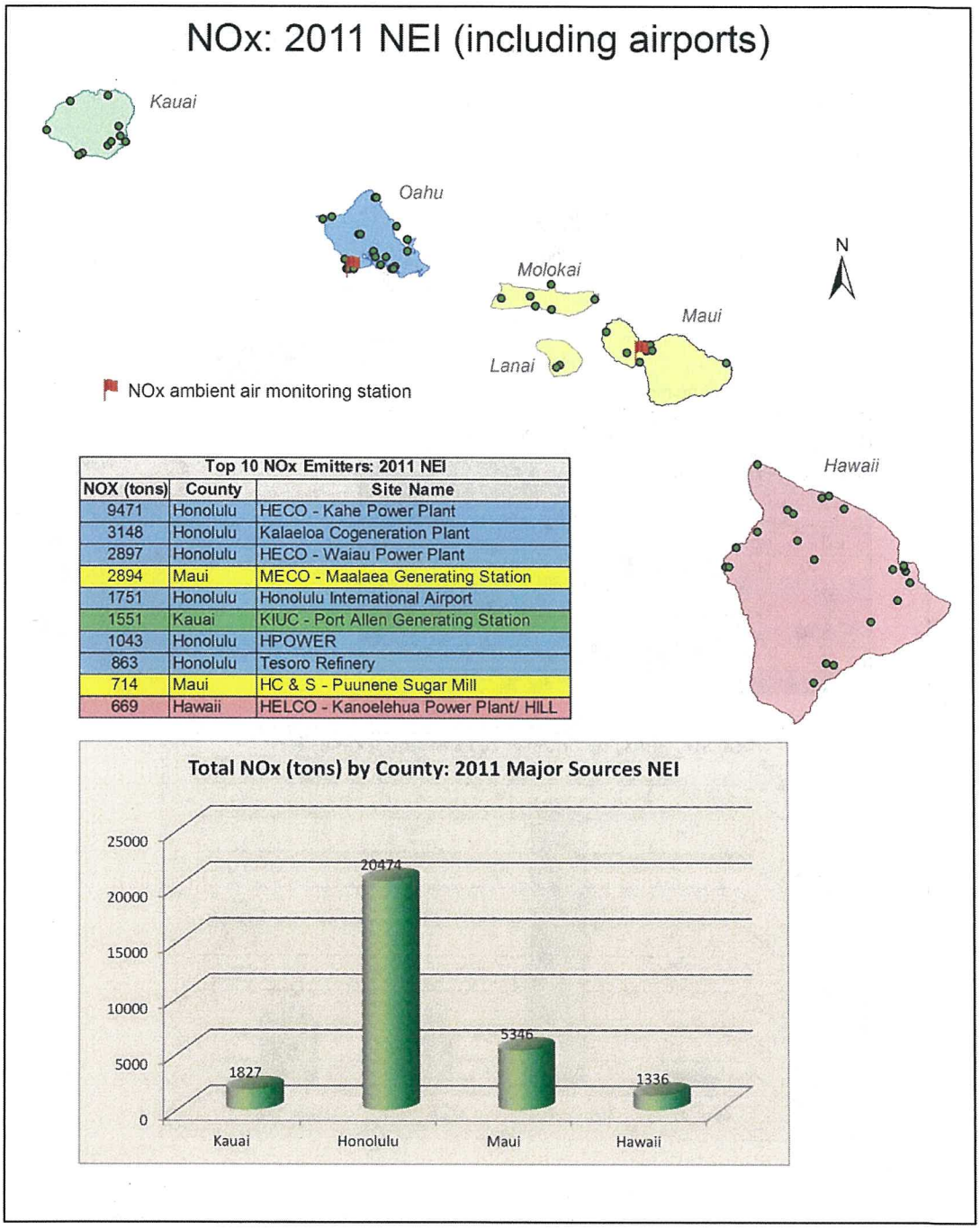
1. Continue monitoring for cruise ship emissions at the Niumalu, Kauai station a minimum of one year (until January 2016). If the data shows a significant reduction in ambient SO_2, with community input, either close the station or move it to a population based area within Lihue or Kapaa.
2. Establish the near-road NO_2 station on Oahu by the end of 2015 or early 2016 as a SPM to gather background information and ensure that the equipment is operating properly prior to the required start date of January 1, 2017.
3. Establish two new source-oriented SO_2 monitoring sites on Oahu by January 1, 2017 to satisfy the proposed SO_2 emissions threshold in the Data Requirements Rule.
4. Continue to operate the three $PM_{2.5}$ monitoring stations in Kihei, Paia and Kahului with the Kahului station becoming fully operational by the summer of 2015 adding continuous monitoring for CO, NO_2, and SO_2.
5. Continue the six SO_2 and five $PM_{2.5}$ volcanic emissions monitoring stations on the island of Hawaii.
6. Continue monitoring for H_2S in Puna for emissions from geothermal energy production and exploration.
7. No other new or relocated stations or monitors are proposed.

Figure 8.



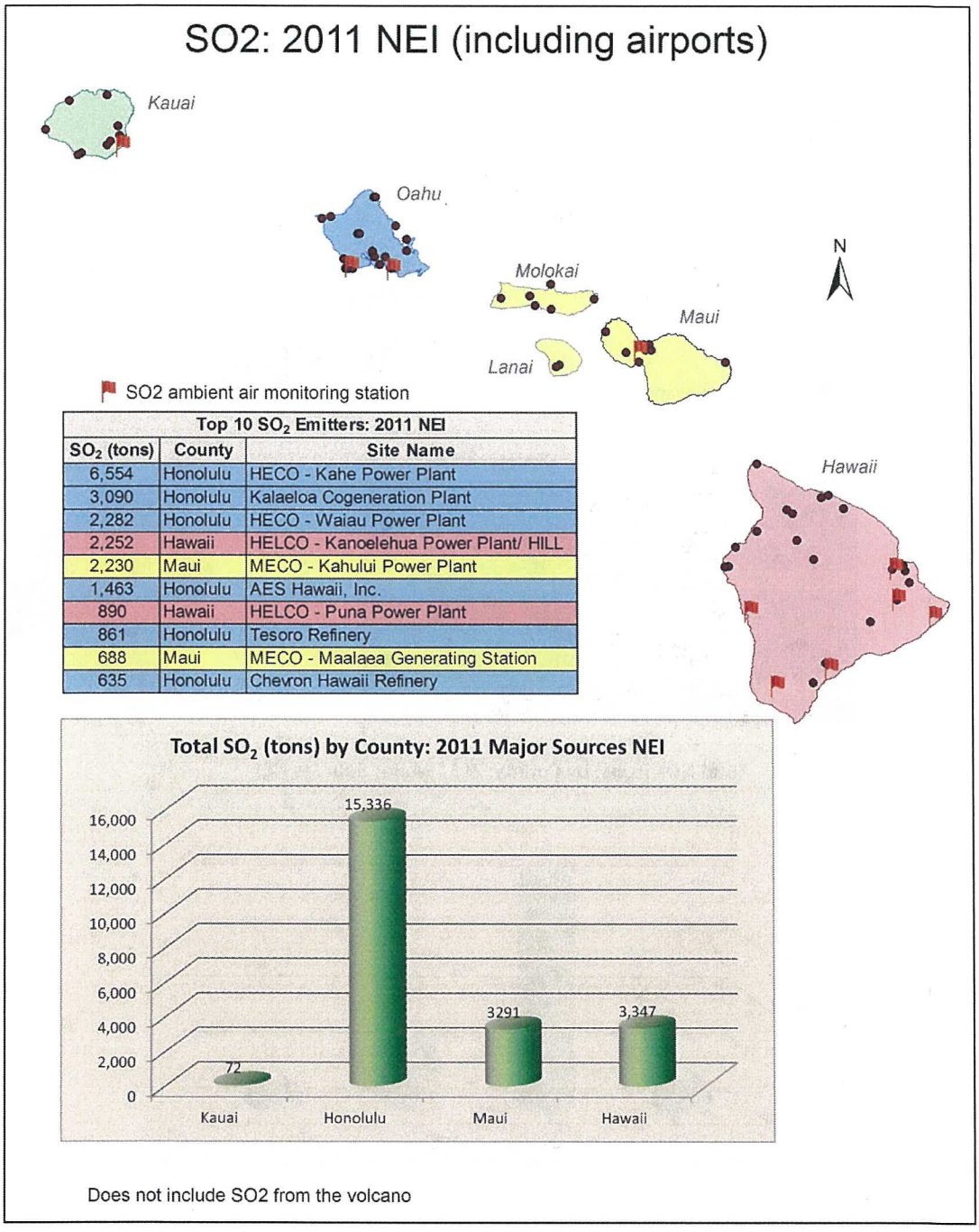
Top 10 CO Emitters: 2011 NEI		
CO (tons)	County	Site Name
5503	Maui	HC & S - Puunene Sugar Mill
2193	Honolulu	Honolulu International Airport
769	Maui	Kahului Airport
676	Maui	MECO - Maalaea Generating Station
645	Hawaii	Kona Intl At Keahole
481	Kauai	Lihue Airport
466	Honolulu	Kalaeloa (John Rodgers airport)
404	Honolulu	HECO - Kahe Power Plant
369	Hawaii	Hilo International Airport
290	Honolulu	AES Hawaii, Inc.

Figure 9.



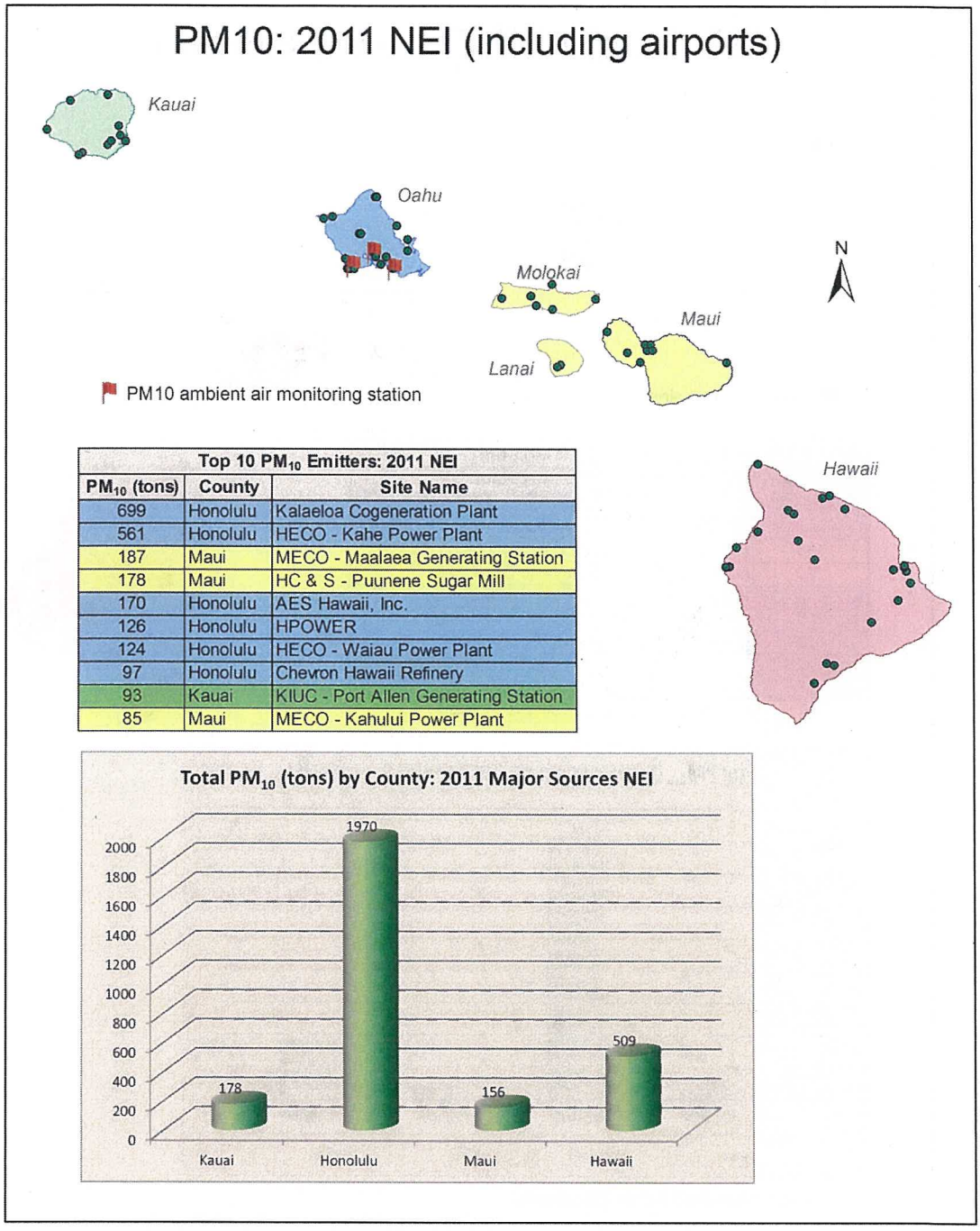
Top 10 NOx Emitters: 2011 NEI		
NOX (tons)	County	Site Name
9471	Honolulu	HECO - Kahe Power Plant
3148	Honolulu	Kalaeloa Cogeneration Plant
2897	Honolulu	HECO - Waiau Power Plant
2894	Maui	MECO - Maalaea Generating Station
1751	Honolulu	Honolulu International Airport
1551	Kauai	KIUC - Port Allen Generating Station
1043	Honolulu	HPOWER
863	Honolulu	Tesoro Refinery
714	Maui	HC & S - Puunene Sugar Mill
669	Hawaii	HELCO - Kanoelehua Power Plant/ HILL

Figure 10.



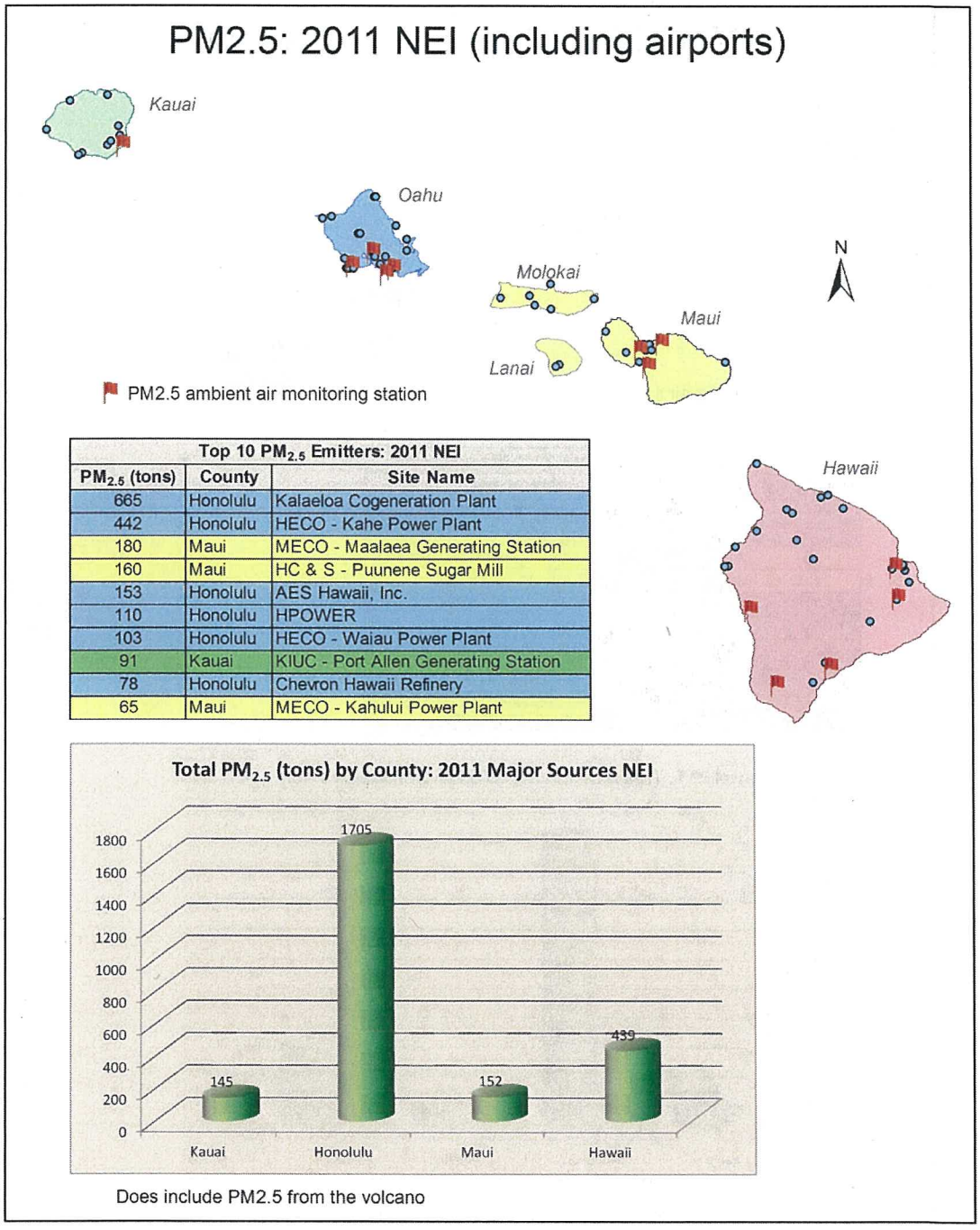
Top 10 SO_2 Emitters: 2011 NEI		
SO_2 (tons)	County	Site Name
6,554	Honolulu	HECO - Kahe Power Plant
3,090	Honolulu	Kalaeloa Cogeneration Plant
2,282	Honolulu	HECO - Waiau Power Plant
2,252	Hawaii	HELCO - Kanoelehua Power Plant/ HILL
2,230	Maui	MECO - Kahului Power Plant
1,463	Honolulu	AES Hawaii, Inc.
890	Hawaii	HELCO - Puna Power Plant
861	Honolulu	Tesoro Refinery
688	Maui	MECO - Maalaea Generating Station
635	Honolulu	Chevron Hawaii Refinery

Figure 11.



Top 10 PM_{10} Emitters: 2011 NEI		
PM_{10} (tons)	County	Site Name
699	Honolulu	Kalaeloa Cogeneration Plant
561	Honolulu	HECO - Kahe Power Plant
187	Maui	MECO - Maalaea Generating Station
178	Maui	HC & S - Puunene Sugar Mill
170	Honolulu	AES Hawaii, Inc.
126	Honolulu	HPOWER
124	Honolulu	HECO - Waiau Power Plant
97	Honolulu	Chevron Hawaii Refinery
93	Kauai	KIUC - Port Allen Generating Station
85	Maui	MECO - Kahului Power Plant

Figure 12.



Top 10 $PM_{2.5}$ Emitters: 2011 NEI		
$PM_{2.5}$ (tons)	County	Site Name
665	Honolulu	Kalaeloa Cogeneration Plant
442	Honolulu	HECO - Kahe Power Plant
180	Maui	MECO - Maalaea Generating Station
160	Maui	HC & S - Puunene Sugar Mill
153	Honolulu	AES Hawaii, Inc.
110	Honolulu	HPOWER
103	Honolulu	HECO - Waiau Power Plant
91	Kauai	KIUC - Port Allen Generating Station
78	Honolulu	Chevron Hawaii Refinery
65	Maui	MECO - Kahului Power Plant

V. Data Assessment

Trends

Data from the past 10 years (2004 through 2013) was analyzed to determine trends and pollutants of significance for the state. As expected, the upward trending for SO_2 and $PM_{2.5}$ were due to the increase in volcanic emissions after a second vent opened in March 2008. NO_2 concentrations have increased, although remaining well below the NAAQS. O_3 has increased slightly in the past 10 years, however concentrations are still about 60% of the NAAQS. On Oahu, PM_{10} was a concern due to the New Year's fireworks celebrations but concentrations have steadily decreased since the City and County began regulating its use. CO levels have remained relatively unchanged and well below any of the NAAQS.

Figure 13.

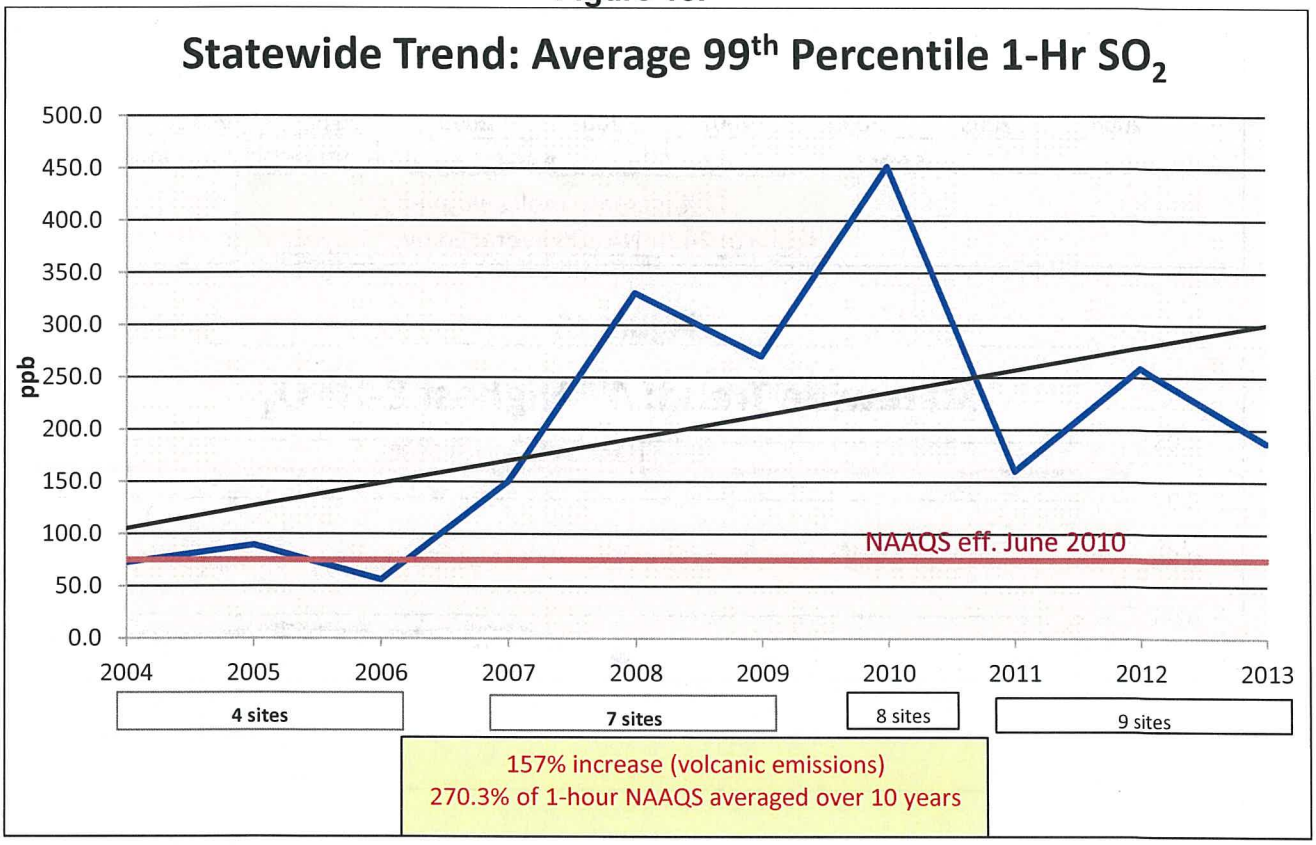


Figure 14.

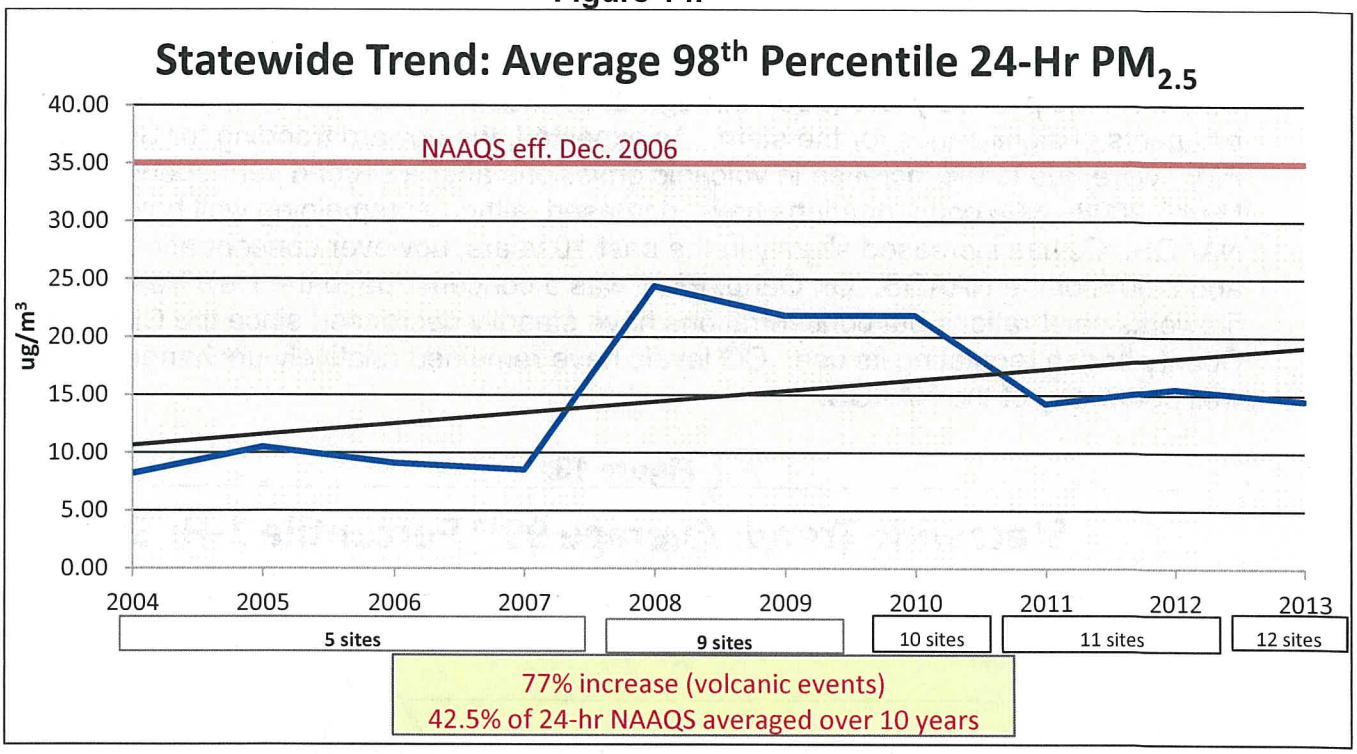


Figure 15.

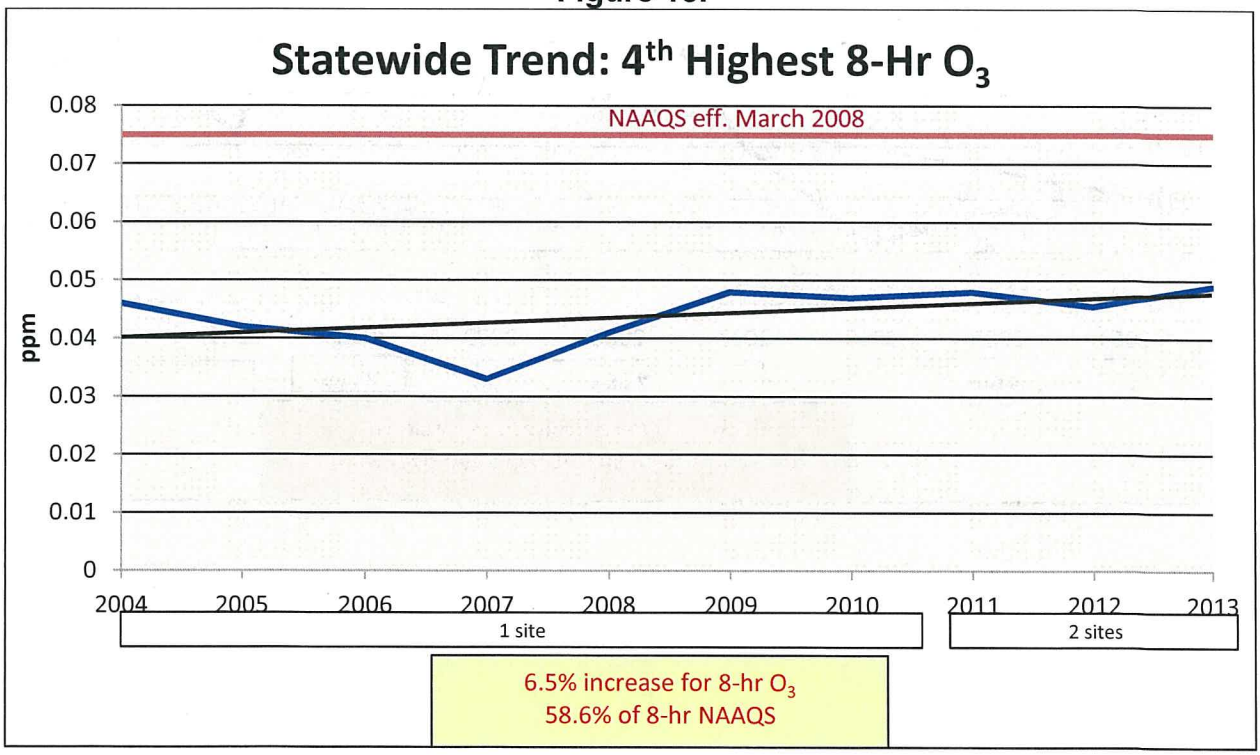


Figure 16.

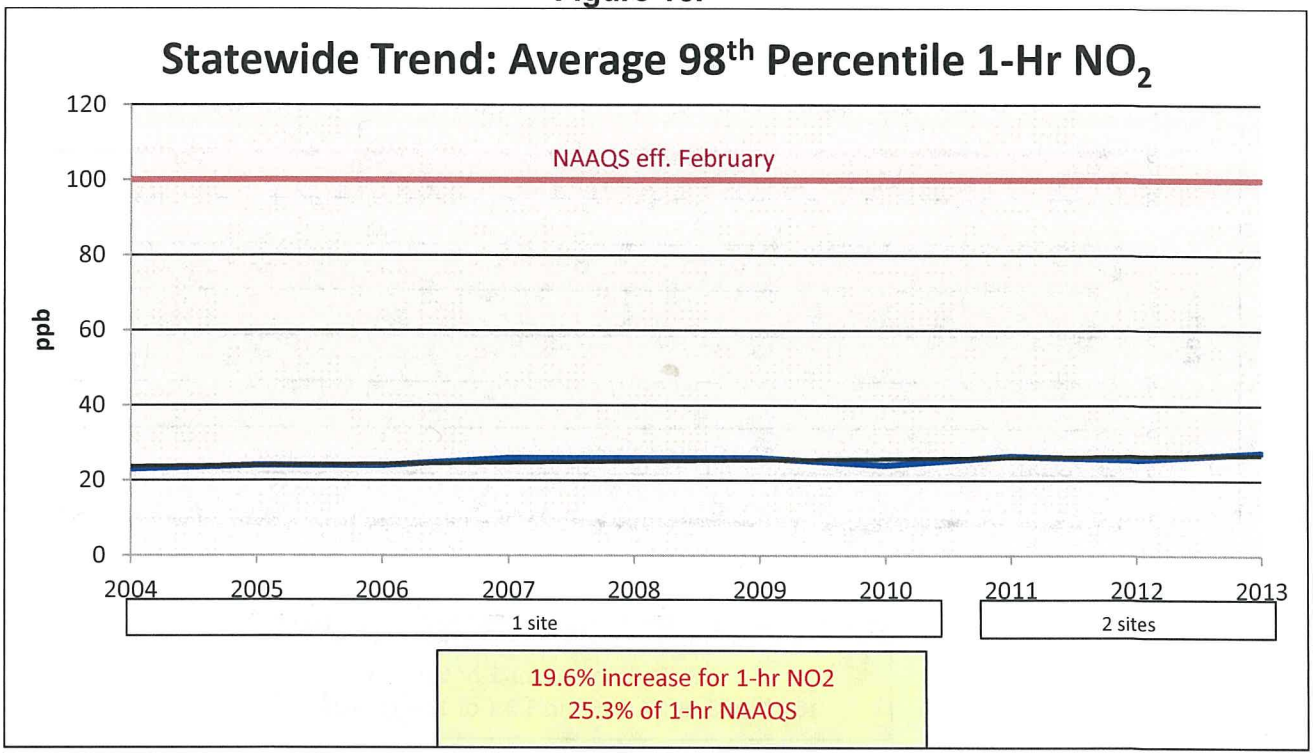


Figure 17.

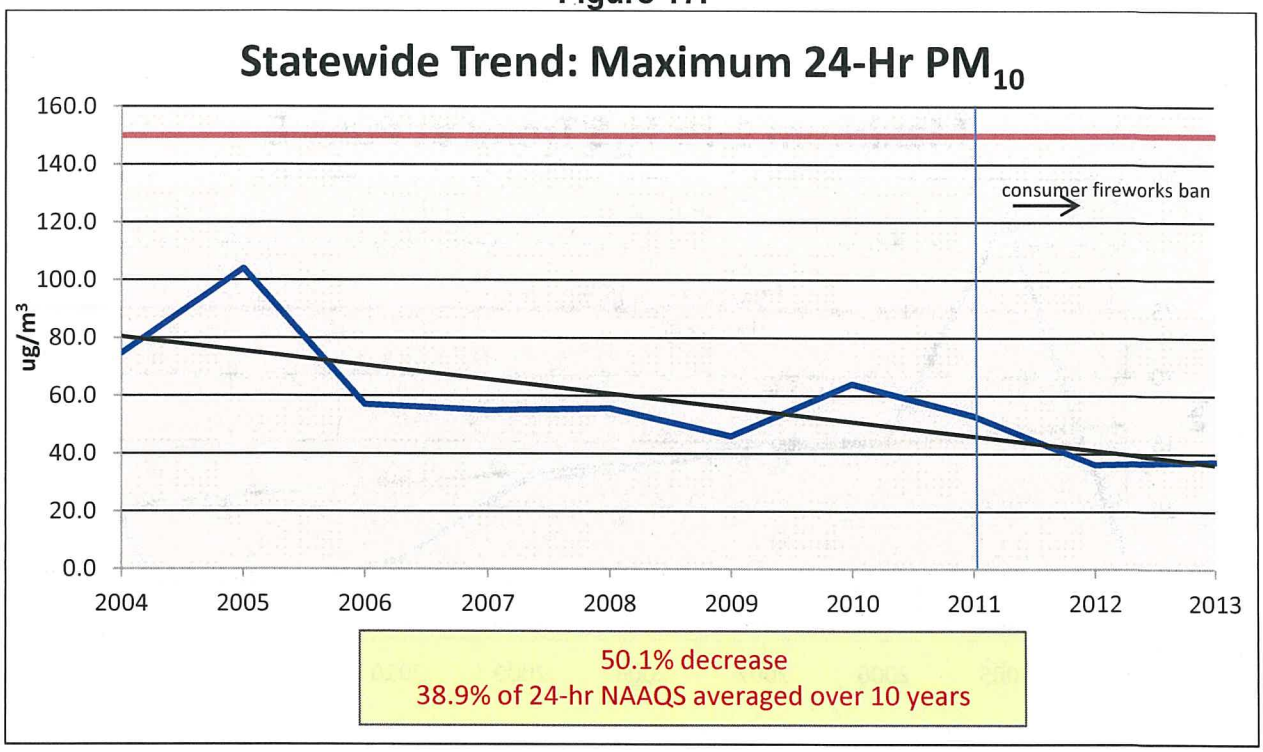


Figure 18.

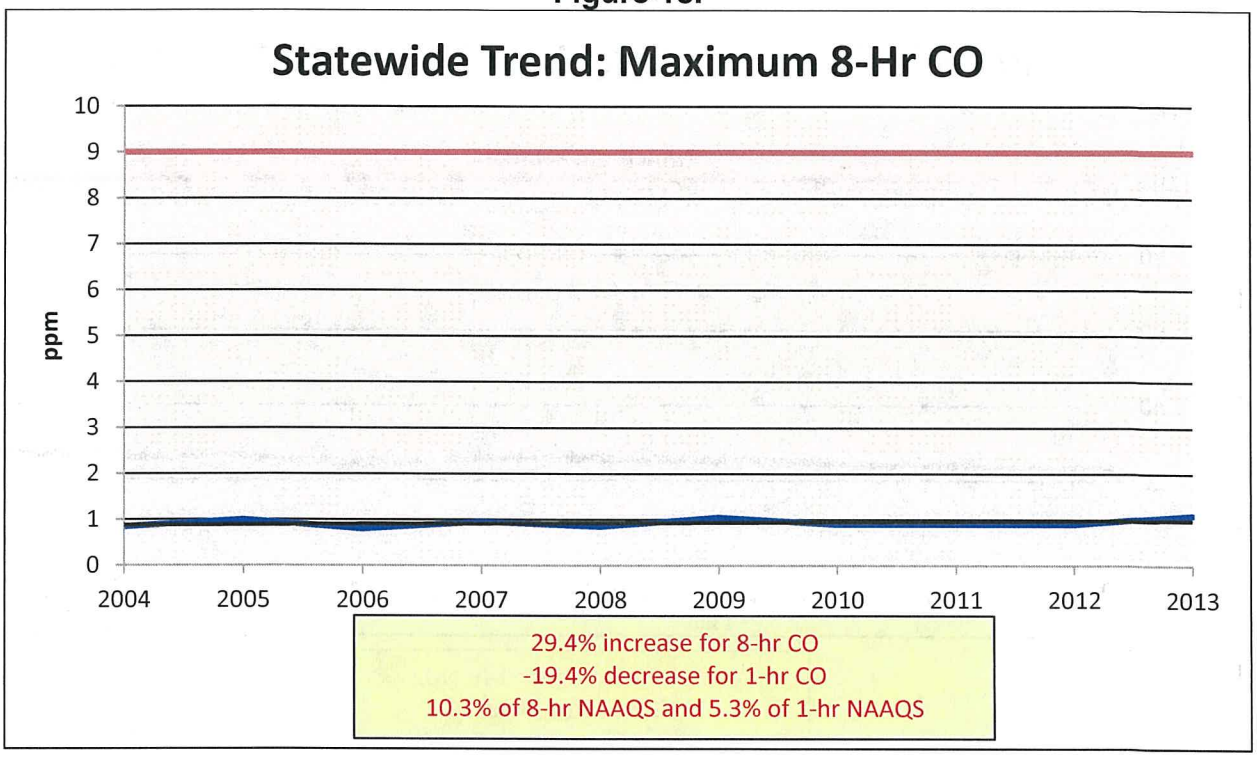
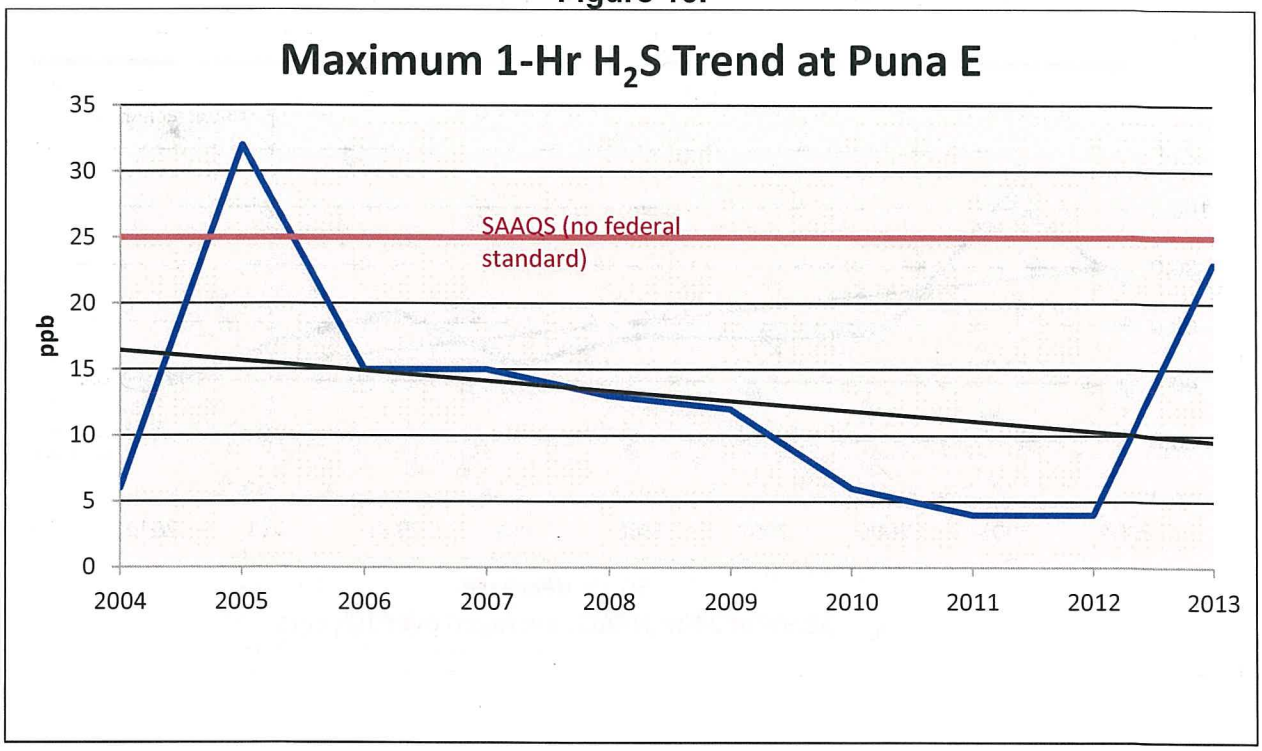


Figure 19.



Monitoring Assessment Findings Based on Data and Trends

1. Criteria pollutant prioritization: SO_2, $PM_{2.5}$, NO_2, O_3, PM_{10}, CO
    a. The primary pollutants of concern for the state are SO_2 and $PM_{2.5}$ mainly due to volcanic events.
        i. Except for the new Kahului station, no new SO_2 monitors are required, but communication with EPA is ongoing regarding the SO_2 data requirement rule and possible placement of any monitors for designation purposes.
        ii. Maintain the Kapolei NCore low-range SO_2 monitor as required but investigate the option of operating a dual-range monitor to capture possible higher values from the nearby CIP. If it is a feasible option, discontinue the Kapolei SLAMS SO_2 monitor.
        iii. Since 13 of the state's 14 stations monitor for $PM_{2.5}$, no new or relocated $PM_{2.5}$ monitors are needed.
    b. Other than the near-road NO_2 station and new NO_2 monitoring at Kahului, data trends do no indicate a need for any new monitoring.
    c. Although there is only a slight upward trend for O_3, EPA is considering lowering the current 8-hour O_3 NAAQS and the data collected at the two O_3 sites will be closely monitored. To better characterize the formation of O_3 at the Sand Island station, a 10 meter meteorological tower for WS and WD should be installed.
    d. PM_{10} values have decreased on Oahu since the City & County began regulating the use of fireworks for the New Year's celebrations. The state currently meets the minimum PM_{10} monitoring requirements in 40 CFR 58, no new or relocated monitors are needed.
    e. CO values have been consistently low at all monitors with no indication of an increase in CO emission sources. Discontinue the redundant CO monitor at the Kapolei SLAMS station since CO is being monitored at Kapolei NCore.

VI. New NAAQS

In June 2010, EPA promulgated a new 1-hour SO_2 NAAQS, replacing the 24-hour and annual standards. EPA also proposed a new approach for implementing the standard by allowing states to use either monitoring or refined dispersion modeling to demonstrate compliance with the new 1-hour NAAQS.

As part of the implementation strategy, EPA is finalizing a Data Requirements Rule that will provide the requirements and guidance for SO_2 source-oriented monitoring and modeling. The expected timeline for the state to identify their compliance method is January 2016. At that time, the state will also be required to identify sources that are at or above the SO_2 threshold levels within and outside of the Core-based Statistical Area (CBSA). EPA is proposing a threshold of 1,000 tons per year (TPY) of SO_2 for sources located inside CBSAs with populations greater than one million and 2,000 TPY of SO_2 for sources outside of CBSAs with populations greater than one million.

Although the actual Oahu MSA population is still less than one million, the total is quickly approaching that milestone with the OMB estimating the 2014 population at 991,788. Currently, EPA has not indicated the basis for the population count, therefore, in anticipation of the Oahu MSA population exceeding one million within the SO_2 NAAQS compliance timeline, DoH is beginning analysis and planning for additional SO_2 monitoring. However, even if the Oahu population remains below one million, there are facilities with SO_2 emissions above 2,000 TPY. Currently, DoH prefers monitoring to modeling.

Using the proposed threshold of 1,000 TPY SO_2 emissions inside the CBSA, Oahu has four facilities that would require monitoring based on the 2013 annual emissions. They are: HECO Kahe electrical generating facility with 6,268 TPY; HECO Waiau electrical generating facility with 2,659 TPY; Kalaeloa Partners with 2,416 TPY and AES Hawaii at 1,504 TPY. There are no anthropogenic sources of SO_2 outside the Oahu MSA with SO_2 emissions at or above the proposed 2,000 TPY threshold.

Preliminary SO_2 modeling of these facilities indicate that none of the current DoH stations would be suitable for SO_2 source monitoring. Since there are budgetary, staff and time constraints, DoH is looking to partner with HECO to establish monitoring stations before the January 1, 2017 deadline.

The majority of the time, prevailing northeasterly winds transport the emissions from all affected facilities out to sea. As discussed earlier, HECO operates three monitoring stations in west Oahu, and preliminary modeling shows that one of those stations (Timberline) is in an impact area for the Kahe facility (Figure 20) during non-prevalent wind conditions. The Timberline station was also used for pre-construction monitoring for the Prevention of Significant Deterioration (PSD) permit for the new HECO electrical generating station located near Kalaeloa and AES. Preliminary modeling for HECO Waiau shows an impact area during non-prevalent wind directions near the Waiau facility within HECO's easement property (Figure 21).

DoH will be discussing these monitoring options with both EPA and HECO.

Monitoring Assessment Findings Based on New NAAQS Requirements

1. Establish two new SO_2 monitoring stations by January 1, 2017:
    - Locate one station in or near the area of maximum SO_2 emissions impact from the HECO Kahe facility well as for Kalaeloa and AES located in Campbell Industrial Park. Explore the possibility of partnering with HECO to utilize their established Timberline air monitoring station for this purpose.
    - Locate one station in or near the area of maximum SO_2 emissions impact from the HECO Waiau facility in Central Oahu. Explore the possibility of partnering with HECO in establishing, operating and maintaining this station on HECO's easement property north of the facility.

Figure 20.


HECO Timberline station
N
Prevailing wind direction
HECO Kahe
AES
Kalaeloa

Figure 21.


N
Prevailing wind direction
Possible Monitoring Site
HECO Waiau
Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

VII. Technology

In 2009, shortly after the Met-One Beta-Attenuation continuous $PM_{2.5}$ monitor (BAM) received Federal Equivalent Method (FEM) designation, the state completed the migration of all of its manual $PM_{2.5}$ monitors to the continuous method. Most of the monitors have been operating for eight or nine years and are breaking down. Additionally, the associated cost of the consumables for this instrument is becoming prohibitive.

Operating all continuous $PM_{2.5}$ instruments continues to be the state's objective. However, to reduce the cost burden of operating and maintaining the BAM instruments, the DoH will begin investigating other FEM instruments with little or no consumables. If acceptable equipment is found, collocation with a BAM instrument will be required and data compared prior to any purchase commitment. Any conversion should occur on an as-needed basis to allow for the distribution of costs over a period of time.

VIII. 2015 Assessment Findings

Implementation of the 2010 Assessment Findings

Most of the network proposals resulting from the 2010 assessment were implemented within the past five years. One lesson learned from the first assessment was that there should be equal consideration given to monitor or station closures as well as additions and relocations to ensure effective resource management.

The major obstacles to the monitoring program as a whole have been and continue to be inadequate funding and resources. As more unfunded federally mandated programs become effective, such as NCore and NO_2 near-road monitoring, the funding and staffing resources are being persistently challenged. However, despite these issues, the DoH managed to establish four new monitoring stations as proposed in the 2010 assessment (Table 4).

Table 4. 2010 Assessment Implementation

2010 Assessment Recommendation	Implementation
Establish a new Waikoloa station on the island of Hawaii to determine what impacts there may be from volcanic emissions.	The Waikoloa station was established on July 1, 2012 monitoring for $PM_{2.5}$ and SO_2. The data showed that there were no measurable impacts from volcanic emissions and the station was closed on March 31, 2014.
Establish the NCore station.	The NCore station began operating at Kapolei on January 1, 2011 with Pb monitoring beginning January 1, 2012.
Establish a Kahului, Maui station	The Kahului station began $PM_{2.5}$ monitoring in January 2015 with SO_2, NO_2, and CO monitoring anticipated to begin by summer 2015.
Establish a Lihue, Kauai station to monitor for cruise ship emissions	The Niumalu station began operating on April 1, 2011, monitoring for $PM_{2.5}$, SO_2 and NO_2.

2010 Assessment Recommendation	Implementation
Establish a station on the Waianae coast of Oahu for environmental justice concerns	DoH decided not to establish a new station on the Waianae coast but instead rely on three existing ambient air monitoring stations operated by HECO, Oahu's utility company. These stations began operating in April 2009 and the data is publicly available on the internet. The three stations monitor for CO, SO_2, NO_2, O_3 and $PM_{2.5}$.
Establish a new Kailua, Oahu station monitoring for $PM_{2.5}$	Due to resource and budget limitations, a new $PM_{2.5}$ site will not be established. $PM_{2.5}$ is the most monitored pollutant in the state with 13 monitors statewide and it was decided that another $PM_{2.5}$ site was not currently required.
Close the West Beach, Oahu station	The station was closed on 3/31/2011.
Move the Kihei, Maui station due to potential development of the area.	Development plans have not progressed. The Kihei station will remain at its current location.
Close the Sand Island, Oahu station.	Originally, the idea to close the station was due to its close proximity to a large source of NO_2 and a large body of water, potentially providing O_3 interference. Also, since the NCore station would monitor for O_3, and the MSA only requires one O_3 monitor, Sand Island's O_3 monitor would not be needed. However, since then, several things have happened: the nearby HECO Honolulu facility has been deactivated; the O_3 monitor at the NCore station has been very unreliable; and, the O_3 NAAQS is being reviewed, so it is an inadvisable time to be closing monitors.

Summary of 2015 Assessment Findings

1. Merge the Kapolei SLAMS and Kapolei NCore stations:
   - The SLAMS station began operating at the current location in 2002 monitoring for CO, SO_2, NO_2, PM_{10} and $PM_{2.5}$;
   - In 2011, the state's required NCore station began operating at this site monitoring for the NCore parameters CO (trace), SO_2 (trace), NO/NOy, O_3, $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$, WS/WD, ambient temperature, relative humidity and Pb (beginning in 2012);
   - These stations operate side-by-side and CO monitoring at the SLAMS station can be discontinued after ensuring that all requirements in 40 CFR 58.14 are met;
   - Discussions will be initiated with EPA on merging the SLAMS with the NCore stations provided the following are incorporated:
     - SO_2 monitoring must be able to capture any potential releases from the nearby industrial park. Since the NCore station monitor is spanned for trace SO_2, either a dual-range monitor or two SO_2 monitors will be required;
     - Continue NO_2 monitoring.
2. Establish the near-road NO_2 station:
   - The site has been selected near the roadway on Oahu with the highest Annual Average Daily Traffic (AADT);
   - Establish the station by the end of 2015 or early 2016 prior to the required start date of January 1, 2017 as a SPMS to gather preliminary data and ensure that the monitor is operating properly;
   - Include details of the station in the 2015 Annual Network Plan;

- Continue to track the population of the Oahu MSA as it approaches one million residents. If the population reaches or exceeds one million, CO and $PM_{2.5}$ monitoring will need to be added.

3. Install a 10 meter meteorological tower at the Sand Island station to better characterize the formation of O_3 from sources originating in downtown Honolulu.
4. Continue cruise ship monitoring on Kauai for at least one year:
   - When monitoring began at the Niumalu station, there were exceedances of the 1-hour SO_2 NAAQS and increased concentrations when ships were in port;
   - In August 2012, the first reduction in fuel sulfur content became effective for ocean going ships operating within the ECA. This sulfur limit was established at 10,000 ppm (1%). There was a corresponding decrease in ambient SO_2 concentrations and no exceedances;
   - In January 2015, the second fuel sulfur reduction became effective. Ocean going vessels operating within the ECA are now required to use fuel with a sulfur content of no more than 1,000 ppm (0.1%);
   - Continue to collect and analyze data from the Niumalu station for a minimum of one-year. If the data shows significant reduction in SO_2, consult with the community on closing or moving the station;
   - If resources allow, consider moving the station to the population centers of Lihue or Kapaa which is listed as a micropolitan statistical area.
5. Establish two new stations to monitor for SO_2 to satisfy the requirements of the Data Requirement Rule:
   - The affected facilities are anticipated to be the HECO Kahe electrical generating facility, Kalaeloa Power Partners and AES Hawaii all located in West Oahu and HECO Waiau electrical generating facility in Central Oahu;
   - Utilize a private/public partnership with HECO in establishing, operating, and maintaining these two stations;
   - Preliminary SO_2 modeling indicate suitable monitoring sites are located in areas that already have a HECO operated monitoring station or is on their easement property;
   - Start discussions with EPA to ensure that the anticipated timeline for the Data Requirements Rule is met.
6. Research alternative continuous $PM_{2.5}$ monitors having little consumable costs and if one is found that meets monitoring needs, begin replacing the Met-One BAMS as they breakdown while ensuring that all collocation requirements are met.