Appendix V: Regional Haze Adjusted Reasonable Progress Goals

Background

40 CFR 51.308(f)(3)(i) requires that states establish reasonable progress goals (RPGs), expressed in units of deciview (dv), that reflect the visibility conditions that are projected to be achieved by the end of the applicable implementation period (2028) as a result of those enforceable emission limits. Natural (i.e., biogenic, wildland fire), agricultural burning, and EGU point source emissions from Hawaii were held constant at 2016 levels in the EPA platform, and thus the same emissions are reported for 2016 and 2028 for these categories.

Purpose

The purpose of this appendix is to determine the visibility conditions in 2028 that will result from implementation of the long-term strategy (LTS) with enforceable limits (regional haze control measures) set for 2028 and describe DOH-CAB's post-modeling approach to estimate this change in reasonable progress goals (dv) that reflects the reduction in emissions (tons per year) through these enforceable emission limits.

Narrative of Methodology Used

The DOH-CAB adjusted the 2028 projections (in deciviews), to reflect the impact of enforceable regional haze control measures required for point sources in this second regional haze planning period. Known visibility conditions projected for 2028 [1] are provided in Tables V-1 & V-2 from WRAP's technical support system (TSS) website. These visibility conditions were projected based on visibility modeling with point source emissions held constant from 2016 to 2028.

For the adjusted 2028 projections, light extinction values of certain haze species or extinction components (i.e. sulfates, nitrates, and elemental carbon) were factored down based on the emissions reductions from enforceable regional haze control measures (i.e. Kahului Generating Station – boiler shut downs, Kanoelehua-Hill Generating Station – boiler shut downs, Maalaea Generating Station – DEG retrofits with FITR and SCR, and Puna Generating Station – boiler fuel switch to ultralow sulfur diesel). Compliance times for all measures are within the 2018 – 2028 second regional haze planning period. The option to shut down diesel engine generators at the Maalaea Generating Station that are outside 2018 -2028 planning period were not evaluated.

Normalization factors were developed to calibrate DOH-CAB 2028 projections (in units of dv) to the 2028 projections on WRAP's TSS website to account for differences encountered when determining the projection using light extinction values from the modeling results. The deciview projection calculated from modeled light extinction results did not match dv projections shown in graphs on the WRAP TSS because dv projections on the WRPAP TSS were based on the average deciview among all most impaired days.

Volcano emissions were included for determining the RPG adjustment. However, impacts from the volcano were not completely screened out after adjusting IMPROVE data for episodic events due to the continuous nature of the Kilauea eruption. For the projection, DOH-CAB factored SO_2 emissions down by a factor of the monthly average emissions divided by the five month high average emissions to represent SO_2 from volcanic activity after screening the IMPROVE data for volcanic impacts. Volcanic emissions were factored down as follows for the projections:

Volcanic SO_2 emissions after screening = 2,089,626 TPY SO_2 x (4,967/5,726) = 1,812,639 TPY SO_2

DOH-CAB's normalization factors were developed by calculating the ratio of WRAP TSS dv to DOH-CAB's calculated dv using the unadjusted 2028 light extinction projections. A ratio (or normalization factor) is then applied to adjusted 2028 projections. DOH-CAB's 2028 projections were estimated [2] using extinction values from the photochemical modeling results which held electric generating unit (EGU) emissions constant at the 2016 level for the projections. Each light extinction component from the 2028 modeling projection was obtained from WRAP's TSS website.

Light extinction values were adjusted using post-modeling RPG scaling factors for light extinction components of nitrates ($AmmNO_3$), Sulfates ($AmmSO_4$), and elemental carbon (EC) based on the relative effect of enforceable control measures for reducing emissions. Table V-3 starts with 2028 emission projections based on emissions from the 2016 modeling platform. The 2016 point source emission were held constant for the 2028 projections. The reduction in emissions is subtracted from the 2016 point source emissions to determine the 2028 adjusted projected emissions. Scaling factors for NOx, SO_2, and PM_{10} were developed by dividing the 2028 adjusted projected emission by the unadjusted 2028 projected emissions and used for adjusting light extinction components of $AmmNO_3$, $AmmSO_4$, and EC, respectively in Tables V-1 and V-2. The emission reductions were calculated by taking the difference between 2016 actual emissions reported in the State & Local Emissions Inventory System (SLEIS) electronic reporting application as the emissions before enforceable control measures and the emissions after controls are implemented as shown in Table V-4.

Emissions after boilers are permanently retired at the Kahului and Kanoelehua-Hill Generating Stations were assumed to be zero for each unit. A fuel switch from fuel oil No. 6 to ultra-low sulfur diesel (ULSD) is required for the Puna Generating Station boiler as a federally enforceable limit established during August 12, 2022, RH-SIP submittal. Emissions after switching fuels were determined by multiplying the emissions before fuel switching by the ratio of emission rates after and before fuel switching for the respective pollutants. These emission rates are available in the Project Emissions section of the permit amendment's technical support document provided in Appendix P.

For Maalaea Generating Station, installation of selective catalytic reduction was specified as a control option to unit shut down for some of the larger diesel engine generators. FITR was also proposed for other units. Since it is uncertain which option will be implemented for the larger diesel engine generators, and shut downs will occur beyond the 2028 end date of the second planning period, only control measures for installing FITR and SCR were evaluated.

For the Mauna Loa Macadamia Nut Corporation Plant, a shut down date of December 31, 2026, is specified for the main boiler as a reasonable control measure. Since the main boiler will be replaced, and emissions from the boiler replacement are unknown at this time, no emission reductions were assumed for the enforceable control measure to shut down the main boiler at this plant.

Table V-1
Projected 2028 Reasonable Progress Goals (RPG)
For Haleakala NP

LTS RPG Scale Adjusted for Control Measures			No	Yes	No	Yes
MID/Clearest Days			MID	MID	Clearest Days	Clearest Days
RPG Projection in 2028 (dv)[a]			**7.1000**	**6.5099**	**0.5000**	**0.3962**
Normalization Factor[b]			0.9600	0.9600	1.0248	1.0248
WRAP TSS 2028 Projection (dv)[1]			7.1000		0.5000	
DOH-CAB 2028 Projection (dv)[c]			7.3955	6.7812	0.4879	0.3866
Light Extinction Components[d]	(a)	AmmNO3 Scale[e]	1.0000	0.9246	1.0000	0.9246
	(b)	Adj AmmNO3 (Mm^{-1}) [(b)=(a)x(c)]	0.6500	0.6010	0.1300	0.1202
	(c)	AmmNO3 (Mm^{-1})	0.6500	0.6500	0.1300	0.1300
	(a)	AmmSO4 Scale[e]	1.0000	0.8666	1.0000	0.8666
	(b)	Adj AmmSO4 (Mm^{-1}) [(b)=(a)x(c)]	8.9900	7.7907	0.7200	0.6252
	(c)	AmmSO4 (Mm^{-1})	8.9900	8.9900	0.7200	0.7200
	(a)	CM Scale	1.0000	1.0000	1.0000	1.0000
	(b)	Adj CM (Mm^{-1}) [(b)=(a)x(c)]	0.7000	0.7000	0.2100	0.2100
	(c)	CM (Mm^{-1})	0.7000	0.7000	0.2100	0.2100
	(a)	EC Scale[e]	1.0000	0.9997	1.0000	0.9997
	(b)	Adj EC (Mm^{-1}) [(b)=(a)x(c)]	0.2100	0.2100	0.0400	0.0400
	(c)	EC (Mm-1)	0.2100	0.2100	0.0400	0.0400
	(a)	OMC Scale	1.0000	1.0000	1.0000	1.0000
	(b)	Adj OMC (Mm^{-1}) [(b)=(a)x(c)]	0.6000	0.6000	0.1700	0.1700
	(c)	OMC (Mm^{-1})	0.6000	0.6000	0.1700	0.1700
	(a)	SeaSalt Scale	1.0000	1.0000	1.0000	1.0000
	(b)	Adj SeaSalt (Mm^{-1}) [(b)=(a)x(c)]	0.6400	0.6400	0.1900	0.1900
	(c)	SeaSalt (Mm^{-1})	0.6400	0.6400	0.1900	0.1900
	(a)	Soil Scale	1.0000	1.0000	1.0000	1.0000
	(b)	Adj Soil (Mm^{-1}) [(b)=(a)x(c)]	0.1600	0.1600	0.0400	0.0400
	(c)	Soil (Mm^{-1})	0.1600	0.1600	0.0400	0.0400
	(b)	Rayleigh Scattering	9.0000	9.0000	9.0000	9.0000

[1] WRAP TSS, Hawaii - URP Glidepath with Visibility Projections, Product #21. Refer to Tables 8.2-1 and 8.3-1, Chapter 8 of Hawaii's RH SIP.

Table V-2
Projected 2028 Reasonable Progress Goals (RPG)
For Hawaii Volcanoes NP

LTS RPG Scale Adjusted for Control Measures			No	Yes	No	Yes
MID/Clearest Days			MID	MID	Clearest Days	Clearest Days
RPG Projection in 2028 (dv)[a]			**16.1000**	**15.0682**	**3.4000**	**3.1712**
Normalization Factor[b]			0.9901	0.9901	1.2416	1.2416
WRAP TSS 2028 Projection (dv)[1]			16.1000		3.4000	
DOH-CAB 2028 Projection (dv)[c]			16.2610	15.2189	2.7384	2.5541
Light Extinction Components[d]	(a)	AmmNO3 Scale[e]	1.0000	0.9246	1.0000	0.9246
	(b)	Adj AmmNO3 (Mm^{-1}) [(b)=(a)x(c)]	0.4500	0.4161	0.3000	0.2774
	(c)	AmmNO3 (Mm^{-1})	0.4500	0.4500	0.3000	0.3000
	(a)	AmmSO4 Scale[e]	1.0000	0.8666	1.0000	0.8666
	(b)	Adj AmmSO4 (Mm^{-1}) [(b)=(a)x(c)]	37.4600	32.5265	1.6300	1.6264
	(c)	AmmSO4 (Mm^{-1})	37.4600	37.4600	1.6300	1.6300
	(a)	CM Scale	1.0000	1.0000	1.0000	1.0000
	(b)	Adj CM (Mm^{-1}) [(b)=(a)x(c)]	0.6700	0.6700	0.6000	0.6000
	(c)	CM (Mm^{-1})	0.6700	0.6700	0.6000	0.6000
	(a)	EC Scale[e]	1.0000	0.9997	1.0000	0.9997
	(b)	Adj EC (Mm^{-1}) [(b)=(a)x(c)]	0.5200	0.5198	0.0700	0.0700
	(c)	EC (Mm-1)	0.5200	0.5200	0.0700	0.0700
	(a)	OMC Scale	1.0000	1.0000	1.0000	1.0000
	(b)	Adj OMC (Mm^{-1}) [(b)=(a)x(c)]	1.2100	1.2100	0.3000	0.3000
	(c)	OMC (Mm^{-1})	1.2100	1.2100	0.3000	0.3000
	(a)	SeaSalt Scale	1.0000	1.0000	1.0000	1.0000
	(b)	Adj SeaSalt (Mm^{-1}) [(b)=(a)x(c)]	1.4400	1.4400	1.2200	1.2200
	(c)	SeaSalt (Mm^{-1})	1.4400	1.4400	1.2200	1.2200
	(a)	Soil Scale	1.0000	1.0000	1.0000	1.0000
	(b)	Adj Soil (Mm^{-1}) [(b)=(a)x(c)]	1.0000	1.0000	1.0000	1.0000
	(c)	Soil (Mm^{-1})	0.0900	0.0900	0.0300	0.0300
	(b)	Rayleigh Scattering	9	9	9	9

Notes to Tables V-1 & V-2:

[a] **2028 RPG projections are shown both as unadjusted (i.e., no scaling) and adjusted (with scaling).**

[b] **Normalization factors to account for differences in the dv value when calculating the projection from modeled light extinction results. The dv value determined from the model results did not match the dv projection reported on the WRAP TSS which was based on an average dv among all most impaired days. The normalization factor is as follows using the unadjusted projections:**

Normalization Factor = [WRAP TSS 2028 Projection (dv)] / [DOH-CAB 2028 Projection (dv)]

[c] **DOH-CAB 2028 Projection[2] (dv) = [10 x ln(∑each Modeled Light Extinction Component/10)]**

= [10 x ln(∑(b)/10)]

[d] **Extinction values from the 2028 photochemical modeling projections for each light extinction component were downloaded from Western Regional Air Partnership (WRAP) technical support system (TSS) website.[3]**

[e] **Light extinction values are adjusted using post-modeling RPG scaling factors developed in Table V-3 proportioned to reflect changes in emissions where enforceable control measures are planned for the regional haze second planning period.**

Acronyms used are listed below:

dv	**Deciviews**
AmmNO3	**Nitrates**
AmmSO4	**Sulfates**
EC	**Elemental Carbon**
CM	**Coarse mass**
LTS	**Long term strategy**
MID	**Most impaired days**
Mm^{-1}	**Inverse mega meters**
NP	**National Park**
OMC	**Organic Mass Carbon**

[2] Refer to Sections 1.4 and 1.5, Chapter 1, of Hawaii's RH SIP.

[3] WRAP TSS, Hawaii – 2028 Visibility Projections, Total Extinction, Product #20.

Table V-3
Relative Effect of Controls on Total Projected Emissions

Source Category	2028 Projected Emissions[a] (tpy)			2018 to 2028 Planning Period Emission Reductions [b] (tpy)			2028 Adjusted Projected Emissions (tpy)		
	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}
	Anthropogenic Sources			Anthropogenic Sources			Anthropogenic Sources		
Point Sources[b]	23,585	19,248	2,280	2,916	4,629	144	20,669	14,619	2,136
Area Sources[c]	469	99	37,950	0	0	0	469	99	37,950
Agricultural Burning[d]	55	30	93	0	0	0	55	30	93
Prescribed Burning[d]	-	-	-	0	0	0	-	-	-
On-Road Mobile Sources	3,221	34	527	0	0	0	3,221	34	527
Non-Road Mobile Sources	2,086	6	212	0	0	0	2,086	6	212
Marine[e]	5,658	357	207	0	0	0	5,658	357	207
Total Anthropogenic	**35,074**	**19,775**	**41,269**	**2,916**	**4,629**	**144**	**32,158**	**15,145**	**41,125**
	Natural Sources			Natural Sources			Natural Sources		
Volcano[f]	-	2,089,368	-	-	-	-	-	1,812,639	-
Sea Spray[g]	-	-	382,637	-	-	-	-	-	382,637
Windblown Dust[g]	-	-	46,808	-	-	-	-	-	46,808
Wildfire[d]	3,374	258	11,340	-	-	-	3,374	258	11,340
Biogenic	237	-	-	-	-	-	237	-	-
Total Natural	**3,611**	**2,089,626**	**440,785**	**-**	**-**	**-**	**3,611**	**1,812,897**	**440,785**
Total Projected Emissions	**38,685**	**2,109,401**	**482,054**	**Reduced Emissions→**			**35,769**	**1,828,042**	**481,910**
				Scaling Factors→			**0.9246**	**0.8666**	**0.9997**

Notes to Table V-3:

[a] **Emissions provided by Ramboll's email dated June 14, 2022, are from the 2016 NEI data for Hawaii from the EPA's 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 (2016th) 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] **Refer to Table V-4 for the estimated reductions in emissions from point sources that are expected to implement regional haze control measures for the second planning period.**

[c] **Area sources include nonpoint sources, fugitive dust, agricultural ammonia sources, and residential wood combustion.**

[d] **The agricultural burning emissions reported here are the point source agricultural fires in the modeling platform. Wildland fire and prescribed burning emissions are provided in a single model emissions file and thus could not be disaggregated. The total wild and prescribed fire emissions are reported as wildfire emissions here.**

[e] **Marine emissions reported here are the domain-wide total from C1 and C2 and 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.**

[f] **Based on SO2 emission rates reported by USGS for Kilauea volcano in 2016, however, emissions can change drastically as exhibited in Figures 4.1-1 and 4.1-2 of Hawaii's RH SIP. Volcano emissions were included for determining the reasonable progress goal adjustment because the impact could 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 IMPROVE data on the most impaired days would still be influenced by volcanic activity.**

[g] **Sea spray and windblown dust emissions were estimated for Hawaii as part of emission inventory work by ENVIRON International Corporation for the years 2005 and 2008 (ENVIRON, 2010). These emissions are reported here and are assumed to be representative of all years.**

Table V-4
Apply Relative Control Effect to 2016 Actuals to Obtain 2016-2028 Emissions

Point Sources	Emission Units	2016 Actual[a] Emissions (TPY)			2028 Emissions After Control Measures (TPY)			2016-2028 Reductions in Emissions (TPY)		
		(a)			(b)			(c) = (a) - (b)		
		NO_x	SO_2	PM_{10}[b]	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}
Kahului Generating Station	Boilers K-1 to K-4 Shut down by end of 2028.	473	1,701	61	0	0	0	473	1,701	61
Kanoelehua-Hill Generating Station	Boiler Hill 5 Shut down by end of 2028.	325	1,036	32	0	0	0	325	1,036	32
Kanoelehua-Hill Generating Station	Boiler Hill 6 Shut down by end of 2028.	467	1,734	43	0	0	0	467	1,734	43
Kanoelehua-Hill Generating Station	Combustion Turbine CT-1 No control measure, limited use unit.	6	0	0	6	0	0	0	0	0
Kanoelehua-Hill Generating Station	DEG D-11 No control measure, limited use unit.	1	0	0	1	0	0	0	0	0
Kanoelehua-Hill Generating Station	DEG D-15 No control measure, limited use unit.	4	0	0	4	0	0	0	0	0
Kanoelehua-Hill Generating Station	DEG D-16 No control measure, limited use unit.	1	0	0	1	0	0	0	0	0
Kanoelehua-Hill Generating Station	DEG D-17 No control measure, limited use unit.	3	0	0	3	0	0	0	0	0
Maalaea Generating Station	DEG M1 Install FITR by the end of 2027.	13	0	0	7	0	0	6	0	0
Maalaea Generating Station	DEG M2 No control measure, not cost-effective.	7	0	0	7	0	0	0	0	0
Maalaea Generating Station	DEG M3 Install FITR by the end of 2028	12	0	0	6	0	0	6	0	0
Maalaea Generating Station	DEG M4 No control measure, not cost-effective.	6	0	0	6	0	0	0	0	0

Point Sources	Emission Units	2016 Actual[a] Emissions (TPY)			2028 Emissions After Control Measures (TPY)			2016-2028 Reductions in Emissions (TPY)		
		(a)			(b)			(c) = (a) - (b)		
		NO_x	SO_2	PM_{10}[b]	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}
Maalaea Generating Station	DEG M5 No control measure, not cost-effective.	96	3	1	96	3	1	0	0	0
Maalaea Generating Station	DEG M6 No control measure, not cost-effective	35	2	1	35	2	1	0	0	0
Maalaea Generating Station	DEG M7 Install SCR by the end of 2027 or shut down by 2037 [c]	99	3	1	9.9	3	1	89	0	0
Maalaea Generating Station	DEG M8 No control measure, not cost-effective.	113	7	2	113	7	2	0	0	0
Maalaea Generating Station	DEG M9 No control measure, not cost-effective.	87	5	2	87	5	2	0	0	0
Maalaea Generating Station	DEG M10 Install SCR by the end of 2027 or shut down by 2030 [c]	418	29	8	41.8	29	8	376	0	0
Maalaea Generating Station	DEG M11 Install SCR by the end of 2027 or shut down by 2032 [c]	522	37	10	52.2	37	10	470	0	0
Maalaea Generating Station	DEG M12 Install SCR by the end of 2027 or shut down by 2037 [c]	362	31	16	36.2	31	16	326	0	0
Maalaea Generating Station	DEG M13 Install SCR by the end of 2028 or shut down by 2037 [c]	415	36	19	41.5	36	19	374	0	0
Maalaea Generating Station	Combustion Turbine M14 No control measure, not cost-effective.	94	124	35	94	124	35	0	0	0
Maalaea Generating Station	Combustion Turbine M16 No control measure, not cost-effective.	101	124	30	101	124	30	0	0	0
Maalaea Generating Station	Combustion Turbine M17 No control measure, not cost-effective.	60	63	22	60	63	22	0	0	0

Point Sources	Emission Units	2016 Actual[a] Emissions (TPY)			2028 Emissions After Control Measures (TPY)			2016-2028 Reductions in Emissions (TPY)		
		(a)			(b)			(c) = (a) - (b)		
		NO_x	SO_2	PM_{10}[b]	NO_x	SO_2	PM_{10}	NO_x	SO_2	PM_{10}
Maalaea Generating Station	Combustion Turbine M19 No control measure, not cost-effective.	87	93	26	87	93	26	0	0	0
Maalaea Generating Station	DEG X1 No control measure, not cost-effective.	4	0	0	4	0	0	0	0	0
Maalaea Generating Station	DEG X2 No control measure, not cost-effective.	4	0	0	4	0	0	0	0	0
Mauna Loa Macadamia Nut Corporation Plant [d]	Main Boiler Shut down by end of 2026.	43	2	28	[d]	[d]	[d]	[d]	[d]	[d]
Mauna Loa Macadamia Nut Corporation Plant	Backup Boiler No control measure, not cost-effective.	4	0	3	4	0	3	0	0	0
Mauna Loa Macadamia Nut Corporation Plant	DEG 1 No control measure, not cost-effective.	8	1	1	8	1	1	0	0	0
Mauna Loa Macadamia Nut Corporation Plant	DEG 2 Not control measure, not cost-effective.	8	1	1	8	1	1	0	0	0
Puna Generating Station [e]	Puna Boiler Fuel switch to ULSD by four years from permit issuance.	20	158	9	4	0	0	16	158	8
Puna Generating Station	Combustion Turbine CT-3 No control measure, limited use unit.	5	2	1	5	2	1	0	0	0
Puna Generating Station	Black Start DEG PBSG1 No control measure, limited use unit.	0	0	0	0	0	0	0	0	0
					Total Reductions			2,916	4,629	144

Notes to Table V-4

[a] **Actual emissions data from the State & Local Emissions Inventory System (SLEIS).**

[b] **PM_{10} are based on filterable + condensable.**

[c] **It is uncertain if the NOx reduction from SCR will occur in this planning period.**

[d] **It is uncertain what NO_X reduction will occur after replacing the main boiler with another unit. Emissions from the boiler replacement are unknow at this time. Emissions from the main boiler replacement will be addressed during the permitting process. An update to the status of replacing the main boiler will be provided in the regional haze progress report.**

[e] **Relative Effect of Control Measure for fuel switch for boiler at the Puna Generating Station is estimated by taking the ratio of emission rates from the Project Emissions section of the Permit Amendment's Technical Support Document (TSD). The ratio of emissions rates is the emission rates after fuel switching divided the emission rates before fuel switching for the respective pollutants as shown in the table below. The estimated 2028 emissions after control measure are determined by multiplying 2016 Actual Emissions by the ratio in column (c) in the table below.**

Pollutants	Emission Rates (lbs/hr)		Ratio of Emission Rates
	F.O. No. 6	ULSD	
	(a)	(b)	(c)=(b)/(a)
NO_x	190.98	42.580	0.223
PM_{10}[b]	71.46	3.490	0.049
SO_2	547.80	0.374	0.001