Appendix B: Air Quality Calculations

Environmental Assessment
Pacific Missile Range Facility
Land-Based Training and Testing
TABLE OF CONTENTS

List of Tables

List of Figures

APPENDIX B Air Quality Calculations

B.1 Emission Estimates

B.1.1 Emissions from Vehicle Activities

Vehicle activities associated with the Proposed Action include those related to personnel commuting to the site as well as vehicle operations during the training and testing exercises. The emission estimates assumed there would be no additional fuel deliveries to Pacific Missile Range Facility (PMRF) to support activity increases associated with the Proposed Action. Emission factors, in grams per mile(g/m) from the Air Emissions Guide for Air Force Mobile Sources, Air Force Civil Engineer Center, June 2023, were used to estimate the combustion emissions from vehicles activities. Particulate matter (PM) less than or equal to 10 microns in diameter (PM_{10}) and PM less than or equal to 2.5 microns in diameter ($PM_{2.5}$) are also generated from vehicles activities on paved and unpaved roads. U.S. Environmental Protection Agency AP-42 methodologies were used to estimate the particulate matter emissions from vehicle travel on paved and unpaved roads. It was assumed that water spraying, or other dust suppressants would not be utilized.

Tables B-1 through B-7 present the emission factors and the estimated emissions from vehicle activities.

Table B-1: Assumptions used for Estimating Combustion Emissions from Military Vehicle Operations

Activity			Transport							
Site	Activity	Frequency	Vehicle	Category	Fuel	Number of Vehicles	Number of Miles/Day per activity/per vehicle	Number of Days per Activity	Number of activities per year	Total Miles
North Launch Area 1	Missile, Rocket, and Aerial Drone Target Set-up (No Launch)	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	15	12	3	5	2700
North Launch Area 1	C5ISRT Exercise	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	5	10	60	1	3000
North Launch Area 1	C5ISRT Exercise	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	5	10	10	28	14000
North Launch Area 2	Missile, Rocket, and Aerial Target Drone Launch	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	15	10	3	10	4500
North Launch Area 2	Missile, Rocket, and Aerial Target Drone Launch	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	15	10	40	1	6000
North Launch Area 2	Missile, Rocket, and Aerial Drone Target Set-up (No Launch)	Annual	Light-Duty Diesel Vehicles (LDDV) – All diesel-powered passenger cars	On-Road Truck	Diesel	15	10	3	5	2250
North Launch Area 2	Artillery	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	6	10	4	2	480
North Launch Area 2	C5ISRT Exercise	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	5	10	60	1	3000
North Launch Area 2	C5ISRT Exercise	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	5	10	10	6	3000
South Launch Area	Missile, Rocket, and Aerial Drone Target Set-up (No Launch)	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	15	12	3	5	2700
South Launch Area	C5ISRT Exercise	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	5	10	60	1	3000
South Launch Area	C5ISRT Exercise	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	5	10	10	16	8000
MDA Hardstand	C5ISRT Exercise	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	5	10	60	1	3000
MDA Hardstand	C5ISRT Exercise	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	5	10	10	7	3500
Waiapuaa Bay	Amphibious Operations - Raid	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	4	20	3	1	240
Forward Arming and Refueling Point (FARP)	FARP Operations	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	1	10	10	19	1900
Unmanned Aircraft System Launch Area	sUAS and UAS Operations	Annual	Heavy-Duty Diesel Vehicles (HDDV) – Diesel-powered vehicles (10,001 lbs. to > 60,000 lbs. GVWR)	On-Road Truck	Diesel	1	20	1	43	860

Reference for emission factors: Air Emissions Guide for Air Force Mobile Sources, Air Force Civil Engineer Center, June 2023; Tables 5-20 and 5-25

The Joint Light Tactical Vehicle (JLTV) weighs between 14,000 and 15,639 pounds, depending on the variant and equipment.
The factory curb weight is 16,000 pounds, but when fully equipped, it can weigh up to 21,000 pounds.
The Amphibious Combat Vehicle (ACV) has a gross vehicle weight of 35 tons (77,000 lbs) and a payload of 7,300 lbs.
Used the HDDV category for estimating JLTV and ACV Emissions.
Number of miles per day are per vehicle and per activity.

Table B-2: Emission Factors and Increase in Combustion Emissions from Military Vehicle Operations

Activity		Emissions Factors, grams per mile (g/mile)							Emissions, ton/year						Emissions, MT/year
Site	Activity	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$	CO_2
North Launch Area 1	Missile, Rocket, and Aerial Drone Target Set-up (No Launch)	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0048	0.0069	0.0003	0.00001	0.0001	0.0001	3.288
North Launch Area 1	C5ISRT Exercise	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0053	0.0076	0.0003	0.00001	0.0001	0.0001	3.653
North Launch Area 1	C5ISRT Exercise	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0248	0.0356	0.0015	0.00006	0.0007	0.0006	17.047
North Launch Area 2	Missile, Rocket, and Aerial Target Drone Launch	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0080	0.0114	0.0005	0.00002	0.0002	0.0002	5.479
North Launch Area 2	Missile, Rocket, and Aerial Target Drone Launch	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0106	0.0152	0.0007	0.00003	0.0003	0.0003	7.306
North Launch Area 2	Missile, Rocket, and Aerial Drone Target Set-up (No Launch)	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0040	0.0057	0.0002	0.00001	0.0001	0.0001	2.740
North Launch Area 2	Artillery	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0009	0.0012	0.0001	0.00000	0.0000	0.0000	0.584
North Launch Area 2	C5ISRT Exercise	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0053	0.0076	0.0003	0.00001	0.0001	0.0001	3.653
North Launch Area 2	C5ISRT Exercise	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0053	0.0076	0.0003	0.00001	0.0001	0.0001	3.653
South Launch Area	Missile, Rocket, and Aerial Drone Target Set-up (No Launch)	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0048	0.0069	0.0003	0.00001	0.0001	0.0001	3.288
South Launch Area	C5ISRT Exercise	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0053	0.0076	0.0003	0.00001	0.0001	0.0001	3.653
South Launch Area	C5ISRT Exercise	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0142	0.0203	0.0009	0.00004	0.0004	0.0004	9.741
MDA Hardstand	C5ISRT Exercise	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0053	0.0076	0.0003	0.00001	0.0001	0.0001	3.653
MDA Hardstand	C5ISRT Exercise	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0062	0.0089	0.0004	0.00002	0.0002	0.0002	4.262
Waiapuaa Bay	Amphibious Operations - Raid	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0004	0.0006	0.0000	0.00000	0.0000	0.0000	0.292
Forward Arming and Refueling Point (FARP)	FARP Operations	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0034	0.0048	0.0002	0.00001	0.0001	0.0001	2.313
Unmanned Aircraft System Launch Area	sUAS and UAS Operations	1.61	2.30	0.10	0.00	0.04	0.04	1217.63	0.0015	0.0022	0.0001	0.00000	0.0000	0.0000	1.047

Table B-3: Methodology for Calculating PM Emissions from Military Vehicle Operations on Unpaved Roads

For vehicles traveling on unpaved surfaces at industrial sites, emissions are estimated from the following equation:

$$E = k\,(s/12)^a (W/3)^b \qquad (1a)$$

where k, a, b, c and d are empirical constants (Reference 6) given below and

E = size-specific emission factor (lb/VMT)
s = surface material silt content (%)
W = mean vehicle weight (tons)

Reference: AP-42 (13.2.2), November 2006, https://www.epa.gov/sites/production/files/2020-10/documents/13.2.2_unpaved_roads.pdf

Pollutant	PM_{10}	$PM_{2.5}$	
k	1.5	0.15	AP-42, Table 13.2.2-2
s	25.2	25.2	AP-42, Table 13.2.2-3
a	0.9	0.9	AP-42, Table 13.2.2-2
b	0.45	0.45	AP-42, Table 13.2.2-2
S	25	25	
W-empty, tons	8	8	The JLTV weighs between 14,000 and 15,639 pounds, depending on the variant and equipment. The factory curb weight is 16,000 pounds, but when fully equipped, it can weigh up to 21,000 pounds.
W-full, tons	11	11	
e	0	0	

Assumed no control efficiency (water spray or other controls).

Table B-4: Increase in PM Emissions from Military Vehicle Operations on Unpaved Roads

Site	VMT, total	PM_{10}, ton/year	$PM_{2.5}$, ton/year
North Launch Area 1	19700	48.4	4.8
North Launch Area 2	19230	47.2	4.7
South Launch Area	13700	33.7	3.4
MDA Hardstand	6500	16.0	1.6
Waiapuaa (Major's) Bay	240	0.6	0.1
Forward Arming and Refueling Point (FARP)	1900	4.7	0.5
Unmanned Aircraft System Launch Area	860	2.1	0.2

Table B-5: Assumptions and Increase in Combustion Emissions from Personnel Travel to the Sites

Site	Transport				Emissions Factors, grams per mile (g/mile)							Emissions, ton/year						Emissions, MT/year
	Vehicle	Category	Fuel	Total Miles	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$	CO_2	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$	CO_2
North Launch Area 1	All POV	On-Road Passenger Car	Composite	710000	4.37	0.23	0.32	0.003	0.01	0.01	401.00	3.420	0.180	0.250	0.002	0.005	0.005	285
North Launch Area 2	All POV	On-Road Passenger Car	Composite	896400	4.37	0.23	0.32	0.003	0.01	0.01	401.00	4.318	0.227	0.316	0.003	0.007	0.006	359
South Launch Area	All POV	On-Road Passenger Car	Composite	470000	4.37	0.23	0.32	0.003	0.01	0.01	401.00	2.264	0.119	0.166	0.002	0.004	0.003	188
Palai Olani	All POV	On-Road Passenger Car	Composite	313200	4.37	0.23	0.32	0.003	0.01	0.01	401.00	1.509	0.079	0.110	0.001	0.002	0.002	126
Waiapuaa Bay	All POV	On-Road Passenger Car	Composite	7800	4.37	0.23	0.32	0.003	0.01	0.01	401.00	0.038	0.002	0.003	0.000	0.000	0.000	3
Missile Defense Agency Hard Stand	All POV	On-Road Passenger Car	Composite	440000	4.37	0.23	0.32	0.003	0.01	0.01	401.00	2.119	0.112	0.155	0.001	0.003	0.003	176
Airfield Bivouac Area	All POV	On-Road Passenger Car	Composite	1260000	4.37	0.23	0.32	0.003	0.01	0.01	401.00	6.069	0.319	0.444	0.004	0.010	0.008	505
Alternate Bivouac Area	All POV	On-Road Passenger Car	Composite	60000	4.37	0.23	0.32	0.003	0.01	0.01	401.00	0.289	0.015	0.021	0.000	0.000	0.000	24
Forward Arming and Refueling Point Areas	All POV	On-Road Passenger Car	Composite	57000	4.37	0.23	0.32	0.003	0.01	0.01	401.00	0.275	0.014	0.020	0.000	0.000	0.000	23
Unmanned Aircraft System Launch Area	All POV	On-Road Passenger Car	Composite	12900	4.37	0.23	0.32	0.003	0.01	0.01	401.00	0.062	0.003	0.005	0.000	0.000	0.000	5
Ground Maneuver Area	All POV	On-Road Passenger Car	Composite	16800	4.37	0.23	0.32	0.003	0.01	0.01	401.00	0.081	0.004	0.006	0.000	0.000	0.000	7
Reference for emission factors: Air Emissions Guide for Air Force Mobile Sources, Air Force Civil Engineer Center, June 2023; Table 5-11														1.50				**1,702**

Table B-6: Methodology for Calculating PM Emissions from Personnel Vehicle Operations on Paved Roads

$Ea = (VMT)[(k)(sL)^{0.91}(W)^{1.02}](Ci)(1 - e)$			
	PM_{10}	$PM_{2.5}$	
k	0.0022	0.00054	Default value, AP-42 Table 13.2.1-1
sL	0.6	0.6	AP-42 Table 13.2.1-2 - default for Average Daily Traffic (ADT) <500
W-full, tons	2	2	Average weight of passenger cars
W-empty, tons	2	2	Average weight of passenger cars
e			Assumed no control efficiency (water spray or other controls).

13.2.1.3 Predictive Emission Factor Equations[10,29]

The quantity of particulate emissions from resuspension of loose material on the road surface due to vehicle travel on a dry paved road may be estimated using the following empirical expression:

$$E = k\,(sL)^{0.91} \times (W)^{1.02} \qquad (1)$$

where: E = particulate emission factor (having units matching the units of k),
k = particle size multiplier for particle size range and units of interest (see below),
sL = road surface silt loading (grams per square meter) (g/m^2), and
W = average weight (tons) of the vehicles traveling the road.

Table 13.2.1-1. PARTICLE SIZE MULTIPLIERS FOR PAVED ROAD EQUATION

Size range[a]	Particle Size Multiplier k[b]		
	g/VKT	g/VMT	lb/VMT
PM-2.5[c]	0.15	0.25	0.00054
PM-10	0.62	1.00	0.0022
PM-15	0.77	1.23	0.0027
PM-30[d]	3.23	5.24	0.011

[a] Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.

[b] Units shown are grams per vehicle kilometer traveled (g/VKT), grams per vehicle mile traveled (g/VMT), and pounds per vehicle mile traveled (lb/VMT). The multiplier k includes unit conversions to produce emission factors in the units shown for the indicated size range from the mixed units required in Equation 1.

[c] The k-factors for $PM_{2.5}$ were based on the average $PM_{2.5}$:PM_{10} ratio of test runs in Reference 30.

[d] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

Table 13.2.1-2. Ubiquitous Silt Loading Default Values with Hot Spot Contributions from Anti-Skid Abrasives (g/m^2)

ADT Category	< 500	500-5,000	5,000-10,000	> 10,000
Ubiquitous Baseline g/m^2	0.6	0.2	0.06	0.03 0.015 limited access
Ubiquitous Winter Baseline Multiplier during months with frozen precipitation	X4	X3	X2	X1
Initial peak additive contribution from application of antiskid abrasive (g/m^2)	2	2	2	2
Days to return to baseline conditions (assume linear decay)	7	3	1	0.5

Table B-7: Estimated Increase in PM Emissions from Personnel Travel to the Sites on Paved Roads

Site	Activity	# personnel	RT miles	days per event	events per year	VMT, total	PM_{10}, ton/year	$PM_{2.5}$, ton/year
North Launch Area 1	Missile, Rocket, and Aerial Target Drone Launch	100	20	3	0	0	-	-
	Missile, Rocket, and Aerial Drone Target Set-up (No Launch)	100	20	3	5	30000	0.04	0.01
	C5ISRT Exercise	100	20	60	1	120000	0.2	0.04
	C5ISRT Exercise	100	20	10	28	560000	0.8	0.19
North Launch Area 1 - Total						**710,000**	**1.0**	**0.2**
North Launch Area 2	Missile, Rocket, and Aerial Target Drone Launch	100	20	3	10	60000	0.1	0.02
	Missile, Rocket, and Aerial Target Drone Launch	100	20	40	1	80000	0.1	0.03
	Missile, Rocket, and Aerial Drone Target Set-up (No Launch)	100	20	3	5	30000	0.04	0.01
	Artillery	40	20	4	2	6400	0.01	0.002
	C5ISRT Exercise	100	20	60	1	120000	0.2	0.04
	C5ISRT Exercise	100	20	10	6	120000	0.2	0.0
	Bivouac	300	20	10	8	480000	0.7	0.2
North Launch Area 2 - Total						**896,400**	**1.3**	**0.3**
South Launch Area	Missile, Rocket, and Aerial Target Drone Launch	100	20	3	2	12000	0.02	0.004
	Missile, Rocket, and Aerial Target Drone Launch	100	20	40	1	80000	0.11	0.028
	Missile, Rocket, and Aerial Drone Target Set-up (No Launch)	100	20	3	5	30000	0.04	0.01
	C5ISRT Exercise	100	20	60	1	120000	0.2	0.04
	C5ISRT Exercise	100	20	10	16	320000	0.4	0.1
South Launch Area - Total						**562,000**	**0.8**	**0.2**
Palai Olani	Parachute Operations (Personnel Insertion)	15	20	1	15	4500	0.006	0.002
	Bivouac (unit, medium, large)	300	20	10	5	300000	0.420	0.103
	Helicopter/Tilt-Rotor Landing Zone (LZ) Operations (off airport surface)	15	20	1	11	3300	0.005	0.001
	Amphibious Operations - Small Boat Operations	15	20	1	17	5100	0.0071	0.0018
	Amphibious Operations - Swimmer Insertion/Extraction)	15	20	1	1	300	0.0004	0.0001
Palai Olani - Total						**313,200**	**0.4**	**0.1**
Waiapuaa Bay	Amphibious Operations - Raid	40	20	3	1	2400	0.003	0.001
	Amphibious Operations - Small Boat Operations	15	20	1	17	5100	0.007	0.002
	Amphibious Operations - Swimmer Insertion/Extraction)	15	20	1	1	300	0.0004	0.0001
Waiapuaa Bay - Total						**7,800**	**0.0**	**0.0**
Missile Defense Agency Hard Stand	C5ISRT Exercise	100	20	60	1	120000	0.168	0.041
	C5ISRT Exercise	100	20	10	7	140000	0.196	0.048
	Bivouac (unit, medium, large)	300	20	10	3	180000	0.252	0.062
MDA Hard Stand - Total						**440,000**	**0.6**	**0.2**
Airfield Bivouac Area	Bivouac (unit, medium, large)	300	20	10	21	1260000	1.8	0.4
Alternate Bivouac Area	Bivouac (unit, medium, large)	300	20	10	1	60000	0.1	0.02
Forward Arming and Refueling Point Areas	Forward Arming and Refueling Point (FARP) Operations	15	20	10	19	57000	0.1	0.02
Unmanned Aircraft System Launch Area	Small Unmanned Aircraft Systems (sUAS) and Counter-Unmanned Aircraft Systems (UAS) Operations	15	20	1	43	12900	0.02	0.004
Ground Maneuver Area	Ground maneuver	40	20	1	21	16800	0.02	0.01

B.1.2 Emissions from Munitions Activities

Available emissions factors (AP-42, *Compilation of Air Pollutant Emission Factors*) or other published sources were used to estimate the emissions. These factors were then multiplied by the net weight of the explosive and the number of items that were used per year. This calculation provides estimates of annual emissions.

$$Emissions = EXP/YR \times EF$$

Where:

Emissions = annual ordnance emissions

EXP/YR = number of explosives, propellants, and pyrotechnics items used per year

EF = air pollutant emissions factor per item

Table B-8 and Table B-9 present the emission factors, references, and the estimated emissions from munition activities.

Table B-8: Munitions Emission Factors and References

Munitions Information				Emission Factor (lb/lb NEW)								Emission Factor (lb/item)						
Munition Type	Munition	Component	Net Explosive Weight (lb NEW)	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO_2	Reference	Emission Factor Assumptions and Comments	CO	NO_x	VOC	PM_{10}	$PM_{2.5}$	SO_2	CO_2
BOMB	MK82 INERT	spotting charge	3							Hawaii-Southern California Training and Testing Final EIS/OEIS, October 2018	Assume Spotting Charge	0.26						
LRG PROJ	155MM ILL		6							AP-42 Chapter 15, Table 15.4.1-1 EMISSION FACTORS FOR THE USE OF DODIC D505, M485A2 155-MM ILLUMINATION ROUND (PROJECTILE)		0.026	0.094	0.0015	3		0.0027	1.8
MED PROJ	30MM		0.03							AP 42, Chapter 15, Table 15.2.1-1 EMISSION FACTORS FOR THE USE OF DODIC B129, M789 30-MM HIGH EXPLOSIVE DUAL PURPOSE		8.60E-04	2.00E-04		3.90E-03	2.50E-03	0.00E+00	4.40E-03
SMOKE POT	ABC-M5 30-POUND HC SMOKE POT		1.10	2.50E-02	8.40E-05	1.00E+00	5.60E-01	1.40E-04	1.50E-02	AP 42, Chapter 15, Table 15.7.6-1, EMISSION FACTORS FOR THE USE OF DODIC K866, ABC-M5 30-POUND HC SMOKE POT	Net Explosive Weight for Smokey Sam is from Hazard Classification of United States Military Explosives and Munitions, Revision 15, June 2012	0.0275	0.0000924	0.000594	1.1	0.616	0.000154	0.0165
MISSILE	AGM-84		215	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	6.30E-01	AP 42, Chapter 15, Table 15.9.1-1, DODIC M023, M112 Demolition Block Charge	Assume similar to C-4 emissions. Net Explosive Weight for AGM -84 is from Hazard Classification of United States Military Explosives and Munitions, Revision 15, June 2012	4.515	1.3545		4.515	3.225	0.0258	135.45
Rocket	2.75" RKT Inert	INERT Warhead	Neg.	5.60E-02	7.10E-03	6.10E-02	3.80E-02			Hawaii-Southern California Training and Testing Final EIS/OEIS, October		Negligible emissions						

Table B-9: Estimated Increase in Munitions Emissions

Site	Activity	Munition Type	Number per Activity	Activity/Year	Total items per year	Emissions Factors in tons/Year						
						NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$	CO_2e (MT/year)
North Launch Area 2	Missile, Rocket, and Aerial Target Drone Launch	Missile	17	10	170	0.1151325	0.002193	0.383775		0.38	0.27	10.445
North Launch Area 2	Missile, Rocket, and Aerial Target Drone Launch	Smokey Sam Launches			400	1.848E-05	3.08E-05	0.0055	0.000003	0.22	0.1232	0.003
North Launch Area 2	Artillery	155-millimeter (mm) projectiles	300	2	600	0.0282	0.00081	0.0078	0.00045	0.90	0.00	0.490
South Launch Area	Missile, Rocket, and Aerial Target Drone Launch	Missile	17	2	34	0.0230265	0.000439	0.076755		0.08	0.05	2.089
Kaula Island	Air-to-Ground Gunnery Exercise (GUNEX)	30 mm projectiles	800	10	8000	0.0008	0.0000	0.0034		0.02	0.01	0.02
Kaula Island	Air-to-Ground Gunnery Exercise (GUNEX)	Inert 2.75-inch Rockets										
Kaula Island	Air-to-Ground Bombing Exercise (BOMBEX)	Inert Bomb	1	19	19			0.00247				

B.1.3 Emissions from Vessel Activities

Landing Craft Air-Cushioned (LCAC) emissions were estimated using the Microsoft Access-based Navy and MSC Engine Emissions Calculator, Version April 2024 (Naval Sea Systems Command, 2024). Combat Rubber Raiding Craft (CRRC) emissions were based on the information in the Atlantic Fleet Training and Testing Final EIS/OEIS, September 2018.

Tables B-10 and B-11 and Figure B-1 present the emission factors and estimated increase in vessels emissions.

Table B-10: Vessel Emission Factors and References

Ship/Boat Type	Acronym	Vessel Total Emissions, lb/hour							EF Reference
		NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$	CO_2	
Landing Craft Air-Cushioned	LCAC	114.64	0.00	17.64	4.41	2.20	2.20	20693	Navy and MSC Marine Engine Fuel Consumption and Emission Calculator (see screenshot)
Combat Rubber Raiding Craft	CRRC	0.9538	0.0005	0.02242	0.0128	0.0289	0.0289	87.23	Atlantic Fleet Training and Testing Final EIS/OEIS, September 2018

EIS

Tab I Table 1. Ship and Boat Emission Factors (continued)

Ship/Boat Type	Acronym	Emissions Factors (lb/hr) Propulsion Engines + Generators						Engine model[1]	Engines	Use[1]
		HC	CO	NO_x	SO_x	$PM_{10/2.5}$	CO^2			
Landing Craft Air Cushion	LCAC	0.35	1.23	2.93	0.38	0.25	668	T-62T-60-7	2	80 HP
								TF40B	4	3955 HP
Landing Craft Utility	LCU/LCM	0.52	36.21	44.95	3.11	1.57	1,683.91	2- Detroit 12V-71 Diesel engines, twin shaft, 680 hp sustained, used for both LCU and LCM data		
Amphibious Assault Vehicle	AAV-2	0.82	0.76	6.22	1.25	0.26		Detroit Diesel 8V-53T (P-7), Cummins VT 400 903 (P-7A1)		
Mark V	MK V	6.85	27.20	84.43	10.96	3.81	5,395	2x 2285 HP MTU 12V396 TE94 engines		
Rigid Inflatable Boat (zodiac)	RIB-4	0.06	0.34	9.14	1.44	0.15	1,163.88	Dual Caterpillar 3126 DITA, 6 in-line cylinder diesel, turbocharged, aftercooled.		470 HP x2
Combat Rubber Raiding Craft	CRRC	0.0128	0.2242	0.9538	0.0005	0.0289	87.23	55	HP 2-stroke engine	gas diesel EFs for small craft
High Speed Maneuverable Surface Target	HSMST	203.98	496.660	7.100	0.200	0.300	466.84	200	HP - 2 Mercury Optimax outboards	24.6 lb/hr fuel use jp-5
River Command Boat	RCB	1.12	2.81	27.40	4.08	0.66	1591	850	HP X 2	43.5 lb/hr fuel use diesel
River Assault Boat	RAB	0.58	1.46	14.18	2.11	0.34	838	440	HP X 2	22.9 lb/hr fuel use diesel
River Patrol Boat	RPB	0.58	1.46	14.18	2.11	0.34	838	440	HP X 2	22.9 lb/hr fuel use diesel
SEAARK	PB	0.56	1.39	13.54	2.02	0.33	739	420	HP X 2	20.2 lb/hr fuel use

F470 = CRRC

[1] Data from Navy and MSC Marine Engine Fuel Consumption & Emissions Calculator, US Navy, October 2016

U.S. Navy Vessel Emission Data

Generated on 05/27/2024 at 07:04:19 PM

by Navy and MSC Marine Engine Fuel Consumption and Emission Calculator

Vessel Set Totals

	kg NOx	kg SOx	kg CO	kg CO2	kg HC	kg PM
All Crafts Total	52	0	8	9,386	2	1

	kg NOx	kg SOx	kg CO	kg CO2	kg HC	kg PM
All Boat Total	0	0	0	0	0	0

	kg NOx	kg SOx	kg CO	kg CO2	kg HC	kg PM
All Vessel Set Total	52	0	8	9,386	2	1

Vessel 1 of 1

Craft LCAC 75 **Type** LCAC **Propulsion** Gas Turbine

Description

Name LANDING CRAFT, AIR CUSHION **Status** Active **Tycom** PS **OpSponsor** N85

Service US Navy **SLM** 377, 307H **UIC** 21969

DecommDate **PeraCode** S/S SDO

Homeport Camp Pendleton, CA **PlanYard** Puget Sound (DET) Boston, Boston, MA **Command** Assault Craft Unit Five

Engine: T-62T-40-7 **HP:** 80 **Cycles:** **Use:** SSGTG **No Engines:** 2

Engine: TF40B **HP:** 3955 **Cycles:** **Use:** MPGT **No Engines:** 4

Analysis Parameters

Hrs Underway 1 **Fuel Sulfur %** 0.0015

Analysis Results

Engine Model	HP	Cycles	Use	No. Eng	GPH/Engine	kg NOx	kg SOx	kg CO	kg CO2	kg HC	kg PM
T-62T-40-7	80		SSGTG	2	14.6	1	0	1	303	0	0
TF40B	3955		MPGT	4	219	51	0	8	9,084	1	1
Vessel Total						52	0	8	9,386	2	1

Figure B-1: Vessel Emission Factors

Table B-11: Estimated Increase in Vessel Emissions

Site	Activity	Number of Vessels	Number of Training Hours per day (within 3 NM)	Number of Days per Event	Number of Events per year	Total hours per year	Total Pounds per Year							
							NOx	SOx	CO	VOC	HAPs	PM10	PM2.5	CO2e
Palai Olani	Amphibious Operations - Small Boat Operations	4	8	1	17	544	518.87	0.27	121.96	6.96		15.72	15.72	47,453
Waiapuaa Bay	Amphibious Operations - Raid	4	2	3	1	24	2,751.37	-	423.29	105.82		52.91	52.91	496,622
Waiapuaa Bay	Amphibious Operations - Small Boat Operations	4	8	1	17	544	518.87	0.27	121.96	6.96		15.72	15.72	47,453

		Total tons per Year							
		NOx	SOx	CO	VOC	HAPs	PM10	PM2.5	CO2e (MT)
Palai Olani	Amphibious Operations - Small Boat Operations	0.26	0.00	0.06	0.00	-	0.01	0.01	22
Waiapuaa Bay	Amphibious Operations - Raid	1.38	-	0.21	0.05	-	0.03	0.03	225
Waiapuaa Bay	Amphibious Operations - Small Boat Operations	0.26	0.00	0.06	0.00	-	0.01	0.01	22
					0.06			0.04	**268**

B.1.4 Generator Emissions

Emissions were estimated for 2-kilowatt Mobile Electric Power (MEP)-531A and the 60-kilowatt MEP-1070 Military Diesel Generators. Table B-12, Table B-13, and Table B-14 present the estimated daily emissions for each type of generator and the total increase in generator emissions for each site.

Table B-12: Estimated Emissions – MEP-531A

Engine Specifications - Yanmar L48AE-DEG Diesel engine						
Tier	2					
Horsepower	4.2					
Generator Rating, Kw	2					
kW (engine)	2.2	The generator kW and the engine kW in a generator set are related but not directly equal due to several factors including mechanical and electrical efficiencies. Used an efficiency of 90% to convert generator kW to engine kW.				
Fuel Consumption (gal/hr)	0.33	**From equipment specification**				
Number of Engines	1					
KW to HP	0.7457	kw/hp				
g to lbs	453.592	grams/lb				
Days per year						
Hours per day	24					
Pollutants	**Emission Factor (g/kW-hr)**	**Total Hourly Emissions (lbs)**	**Total Daily Emissions (lbs)**			
NOx	7.1250	0.0349	0.84			
CO	8.0000	0.0392	0.94			
HC	0.3750	0.0018	0.04			
PM	0.8000	0.0039	0.09			
SOx	-	0.0236	0.57			
Emissions are based on Tier 2 Standards - see screenshot						
Equations:						
Pollutant hourly emissions (lb/h	**Emission Factor (g/bhp-hr)*engine horsepower (hp)/453.592(g/lb)**					
Reference for % NOx and HC in NOx+NMHC: Bay Area AQMD Policy, June 28, 2004, CARB Emission Factors for CI Diesel Engines – Percent HC in Relation to NMHC + NOx (https://www.baaqmd.gov/~/media/Files/Engineering/policy_and_procedures/Engines/EmissionFactorsforDieselEngines.ashx)						
Sulfur content						
0.5%	by mass	Diesel	Maximum allowable fuel sulfure content: §11-60.1-38 Sulfur oxides from fuel combustion.			
0.33	Fuel Consumption (gal/hr)					
7.10	Fuel density, lb/gal					
0.0236	lb/hr of SOx	Per engine				
22.58	lb CO_2e/gal diesel	See Tab "GHG Emission Factors"				
180.49	lb CO_2e/day					

Table B-13: Estimated Emissions – MEP-1070

MEP-1070						
Engine Specifications - Cummins QSB4.5 Tier III						
Tier	3					
Horsepower	109					
Generator Rating, Kw	60					
kW (engine)	66.7	The generator kW and the engine kW in a generator set are related but not directly equal due to several factors including mechanical and electrical efficiencies. Used an efficiency of 90% to convert generator kW to engine kW.				
Fuel Consumption (gal/hr)	3.00	See equipment specification https://www.marcorsyscom.marines.mil/Portals/105/PfM/LCES/ES/Power%20Team/Mobile%20Power/Info%20Sheets/GENERATORSET60KW60HZAMMPSSKIDMOUNTED.pdf?ver=2018-11-13-150411-423				
Number of Engines	1					
KW to HP	0.7457	kw/hr				
g to lbs	453.592	grams/lb				
Days per year						
Hours per day	24					
Pollutants	**Emission Factor (g/kW-hr)**	**Total Hourly Emissions (lbs)**	**Total Daily Emissions (lbs)**			
NOx	3.8000	0.5585	13.40			
CO	5.0000	0.7349	17.64			
HC	0.2000	0.0294	0.71			
PM	0.3000	0.0441	1.06			
SOx	-	0.2130	5.11			
Equations:						
Pollutant hourly emissions (lb/h	**Emission Factor (g/bhp-hr)*engine horsepower (hp)/453.592(g/lb)**					
Reference for % NOx and HC in NOx+NMHC: Bay Area AQMD Policy, June 28, 2004, CARB Emission Factors for CI Diesel Engines – Percent HC in Relation to NMHC + NOx (https://www.baaqmd.gov/~/media/Files/Engineering/policy_and_procedures/Engines/EmissionFactorsforDieselEngines.ashx)						
Sulfur content						
0.5%	by mass	Diesel	Maximum allowable fuel sulfure content: §11-60.1-38 Sulfur oxides from fuel combustion.			
3.00	Fuel Consumption (gal/hr)					
7.10	Fuel density, lb/gal					
0.2130	lb/hr of SOx	Per engine				
22.58	lb CO_2e/gal diesel	See Tab "GHG Emission Factors"				
1626	lb CO_2e/day					

Table B-14: Estimated Increase in Generator Emissions for Each Site

Site/Activity	Number of Generator	Number of Days per Activity	Number of Activities per year	Total Generator Emissions, Ton/yr						CO_2 emissions, MT/year	Annual Fuel Consumption, gal/year
				NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$		
North Launch Area 1 - Missile, Rocket, and Aerial Drone Target Set-up (No Launch)	2	3	5	0.20	0.08	0.26	0.01	0.02	0.02	22	2160
North Launch Area 1 - C5ISRT Exercise	3	60	1	1.21	0.46	1.59	0.06	0.10	0.10	133	12960
North Launch Area 1 - C5ISRT Exercise	3	10	28	5.63	2.15	7.41	0.30	0.44	0.44	620	60480
North Launch Area 2 - Missile, Rocket, and Aerial Target Drone Launch	3	3	10	0.60	0.23	0.79	0.03	0.05	0.05	66	6480
North Launch Area 2 - Missile, Rocket, and Aerial Target Drone Launch	3	40	1	0.80	0.31	1.06	0.04	0.06	0.06	89	8640
North Launch Area 2 - Missile, Rocket, and Aerial Drone Target Set-up (No Launch)	2	3	5	0.20	0.08	0.26	0.01	0.02	0.02	22	2160
North Launch Area 2 - C5ISRT Exercise	3	60	1	1.21	0.46	1.59	0.06	0.10	0.10	133	12960
North Launch Area 2 - C5ISRT Exercise	3	10	6	1.21	0.46	1.59	0.06	0.10	0.10	133	12960
North Launch Area 2 - Bivouac (unit, medium, large)	2	10	8	0.07	0.05	0.08	0.00	0.01	0.01	13	1279
South Launch Area - Missile, Rocket, and Aerial Drone Target Set-up (No Launch)	2	3	5	0.20	0.08	0.26	0.01	0.02	0.02	22	2160
South Launch Area - C5ISRT Exercise	3	60	1	1.21	0.46	1.59	0.06	0.10	0.10	133	12960
South Launch Area - C5ISRT Exercise	3	10	16	3.22	1.23	4.23	0.17	0.25	0.25	354	34560
Palai Olani - Bivouac (unit, medium, large)	2	10	5	0.67	0.26	0.88	0.04	0.05	0.05	74	7200
MDA Hard Stand - C5ISRT Exercise	3	60	1	1.21	0.46	1.59	0.06	0.10	0.10	133	12960
MDA Hard Stand - C5ISRT Exercise	3	10	7	1.41	0.54	1.85	0.07	0.11	0.11	155	15120
MDA Hard Stand - Bivouac (unit, medium, large)	2	10	3	0.03	0.02	0.03	0.00	0.00	0.00	5	480
Airfield Bivouac Area - Bivouac (unit, medium, large)	2	10	21	0.18	0.12	0.20	0.01	0.02	0.02	34	3357
Alternate Bivouac Area - Bivouac (unit, medium, large)	2	10	1	0.01	0.01	0.01	0.00	0.00	0.00	2	160
Forward Arming and Refueling Point Areas	1	10	19	0.08	0.05	0.09	0.00	0.01	0.01	16	1518
Unmanned Aircraft System Launch Area	1	10	43	0.18	0.12	0.20	0.01	0.02	0.02	35	3437
Total				**19.50**	**7.60**	**25.56**	**1.03**	**1.56**	**1.56**	**2,192**	**213,990**

B.1.5 Aircraft Emissions

The increase in fixed-wing and rotary aircraft emissions were estimated for Forward Arming and Refueling Point, Helicopter/Tilt-Rotor Landing Zone operations, and Air-to-Ground Gunnery and Bombing Exercises. Emission factors for most military engines were obtained from the Navy's Aircraft Environmental Support Office memoranda. For those aircraft for which engine data were unavailable from Aircraft Environmental Support Office, emission factors from Air Emissions Guide for Air Force Mobile Source, June 2023, were used. Tables B-15 through B-19 present the aircraft assumptions for the air quality analysis, aircraft emission factors, and increase in aircraft emissions for each operation.

Table B-15: Aircraft Operational Assumptions

Service	Annual of FARP Exercises	Total FARP Exercise Duration (days)	Aircraft Type	Number of aircraft refueled (by type, per day)	Refueling Duration per single aircraft (hours)	Annual Hours Spent with Engines on Refueling at FARP		Annual Landings Associated with FARP Activities	Annual Takeoffs Associated with FARP Activities
Navy	3	1	P-8	2	0.5	12		6	6
			FA-18/F-35	8	0.5	12		24	24
Marine Corps	4	5	KC-130	1	0.5	10		20	20
			MV-22B	40	0.4	320		800	800
Army	9	2	CH-47	1	0.5	9		18	18
			AH-64	16	0.5	144		288	288
Air Force	4	2	Tanker	1	0.5	4		8	8
			Fighter	8	0.5	32		64	64
						543		1228	1228

Notes:
1. FARP operations per DoD Handbook Aircraft Refueling Handbook for Navy/Marine Corps Aircraft (MIL-HDBK-844A(AS) 30 Dec 2003 and specific aircraft NATOPS
2. FARP location for planning: N22.038/W159.782
3. Assume 2 aircraft refueling at any one time.

PMRF LBT EA Landing Zone Operations (LZ Fire Pit) Assumptions for AQ and Noise Impacts Assessment

Service	Annual of LZ Exercises	Total LZ Exercise Duration (days)	Aircraft Type	Number of aircraft using LZ (by type, per day)	LZ Use Duration per single aircraft (hours)	Annual Hours Spent with Engines on, at (on deck) or above (sling load hover) LZ Fire Pit		Annual Landings Associated with LZ Fire Pit Activities	Annual Takeoffs Associated with LZ Fire Pit Activities
Marine Corps	4	2	MV-22B	4	0.4	12.8		32	32
Army	6	2	CH-47	4	0.4	19.2		48	48
						32		80	80

Notes:
1. LZ Fire Pit operations per MCWP 3-11.4 Helicopterborne Operations and MCRP 4-11.3E, Multiservice Helicopter Sling Load
2. LZ Fire Pit location (center) N22.046/W159.799
3. Assume 1 aircraft in the LZ at any one time.

Table B-16: Aircraft Emission Factors

Aircraft Engine Emissions Indices/Factors and Sources

General information							Emissions Factors (lb/operation)							References
Aircraft	Engine Model	Engines (#)	Fuel Flow (lb/hr) /Engine	Fuel Flow (lb/operation)	Fuel Flow (gal/operation)	Mode	CO	NOx	VOC	SOx	$PM_{2.5}$	PM_{10}	CO_2	Source of Emissions Indices Information
P-8	CFM56-7B27 (2)	2		4672	687	Single P-8 LTO with Straight In Arrival	21.58	68.57	2.44	1.73	1.10	1.10	14,770	AESO Memorandum Report No. 2017-09 April 2017, Table 1
P-8	CFM56-7B27 (2)	2		921	135	Idle (for 30 minutes per refueling operation)	16.49	4.42	1.80	0.34	0.06	0.06	2,911	AESO Memorandum Report No. 2017-09 April 2017, Table 1
FA-18E/F	F414-GE-400 (2)	2		2612	384	Single F/A-18E/F LTO with Straight In Arrival	265.30	31.08	80.16	0.97	18.21	18.21	7,824	AESO Memorandum Report No. 9815 I, June 2017, Table 5
FA-18E/F	F414-GE-400 (2)	2		696	102	Idle (for 30 minutes per refueling operation)	68.33	2.21	52.29	0.26	8.80	8.80	2,069	AESO Memorandum Report No. 9815 I, June 2017, Table 5
FA-18E/F	F414-GE-400 (2)	2		696	102	Approach (used for estimating GHG for	68.33	2.21	52.29	0.26	8.80	8.80	2,069	AESO Memorandum Report No. 9815 I, June 2017, Table 5
KC-130	T56-A-16	4				Single KC-130 LTO	4.97	14.20	1.29	1.83	1.02	1.13	5,497	ACAM Model, one LTO for one Aircraft, No maintenance emissions included
KC-130	T56-A-16	4		1512	222	Idle (for 30 minutes per refueling operation)	8.54	9.60	2.12	0.56	1.13	1.25	4,861	Air Emissions Guide for Air Force Mobile Sources, June 2023, Table 2-9. Aircraft Engine Emission Factors for Criteria Pollutants , Table 2-3. GHG Emission Factors for Aircraft Engines
MV-22B	T406-AD-400 (2)	2		1577	232	Vertical Takeoff (Conversion mode) + Landing w/Break (Airplane mode)	5.52	12.92	0.09	0.58	2.17	2.17	5,078	AESO Memorandum Report No. 9946 Revision G May 2017, Table ES-1 VOC = THC x 1.16 x 1.15
MV-22B	T406-AD-400 (2)	2		288	42	Idle (for 0.4 hour per refueling operation)	2.56	1.18	0.04	0.11	0.45	0.45	928	AESO Memorandum Report No. 9946 Revision G May 2017, Table 1 VOC = THC x 1.16 x 1.15
CH-47 (modeled as H-46)	T58-GE-16 (2)	2		366	54	Single H-46 LTO	21.37	1.07	7.83	0.14	1.36	1.36	1,131	AESO Memorandum Report No. 9816 Revision G December 2015, Table 1
CH-47 (modeled as H-46)	T58-GE-16 (2)	2		167	25	Idle (for 30 minutes per refueling operation)	20.26	0.25	8.76	0.06	0.85	0.85	487	AESO Memorandum Report No. 9816 Revision G December 2015, Table 1
CH-47 (modeled as H-46)	T58-GE-16 (2)	2		630	93	Hover (for one hours for GUNEX)	9.68	2.68	1.56	0.23	1.12	1.12	2,005	AESO Memorandum Report No. 9816 Revision G December 2015, Table 1
AH-64 (modeled as H-60)	T700-GE-401C (2)	2		661	97	Single H-60 LTO	12.31	3.36	1.58	0.24	2.34	2.34	2,110	AESO Memorandum Report No. 9929 Revision D December 2019 , Table S-1
AH-64 (modeled as H-60)	T700-GE-700 (2)	2		134	20	Idle (for 30 minutes per refueling operation)	6.20	0.45	0.07	0.05	0.18	0.20	431	To match engine information, used Air Emissions Guide for Air Force Mobile Sources, June 2023, Table 2-9. Aircraft Engine Emission Factors for Criteria Pollutants , Table 2-3. GHG Emission Factors for Aircraft Engines
Air Force Tanker - Modeled as KC-135	J57-P-22	4				Single KC-135 LTO	90.30	15.93	91.32	3.06	2.30	2.56	9,200	ACAM Model, one LTO for one Aircraft, No maintenance emissions included
Air Force Tanker - Modeled as KC-135	J57-P-22	4		2174	320	Idle (for 30 minutes per refueling operation)	128.81	5.39	128.33	0.80	14.94	16.61	6,989	Air Emissions Guide for Air Force Mobile Sources, June 2023, Table 2-9. Aircraft Engine Emission Factors for Criteria Pollutants , Table 2-3. GHG Emission Factors for Aircraft Engines
Air Force Fighter - Modeled as FA-18E/F	F414-GE-400 (2)	2		2612	384	Single F/A-18E/F LTO with Straight In Arrival	265.30	31.08	80.16	0.97	18.21	18.21	7,824	AESO Memorandum Report No. 9815 I, June 2017, Table 5
Air Force Fighter - Modeled as FA-18E/F	F414-GE-400 (2)	2		696	102	Idle (for 30 minutes per refueling operation)	68.33	2.21	52.29	0.26	8.80	8.80	2,069	AESO Memorandum Report No. 9815 I, June 2017, Table 5

Table B-17: Increase in Aircraft Emission - LZ Fire Pit

					Emissions (lb/operation)						
Aircraft	Annual of FARP Exercises	Total FARP Exercise Duration (days)	Annual LTOs	Number of aircraft refueled (by type, per day)	**CO**	**NOx**	**VOC**	**SOx**	**$PM_{2.5}$**	**PM_{10}**	**CO_2**
MV-22B (LTO)	4	2	32	4	176.64	413.44	2.99	18.67	69.44	69.44	162,492
MV-22B (Operation)	4	2		4	82.0224	37.69344	1.23	3.41	14.47	14.47	29,685
CH-47 (modeled as H-46) (LTO)	6	2	48	4	1025.76	51.36	375.91	6.50	65.28	65.28	54,264
CH-47 (Operation)	6	2		4	972.3408	11.86368	420.27	2.97	40.56	40.56	23,383
				Total, lbs./year	2256.763	514.3571	800.3964	31.54768	189.7501	189.7501	269822.93
				Total, tons/year	1.13	0.26	0.40	0.02	0.09	0.09	
				MT/year							122

Table B-18: Increase in Aircraft Emission - FARP

					Emissions (lb/operation)						
Aircraft	Annual of FARP Exercises	Total FARP Exercise Duration (days)	Annual LTOs	Number of aircraft refueled (by type, per	**CO**	**NOx**	**VOC**	**SOx**	**$PM_{2.5}$**	**PM_{10}**	**CO_2**
P-8 (LTO)	3	1	6	2	129.48	411.42	14.63	10.37	6.60	6.60	88,618
P-8 (Refueling)	3	1		2	98.9154	26.5248	10.80	2.04	0.38	0.38	17,468
FA-18E/F (LTO)	3	1	24	8	6367.2	745.92	1923.72	23.19	437.04	437.04	187,776
FA-18E/F (Refueling)	3	1		8	1639.999	53.11872	1254.96	6.18	211.14	211.14	49,661
KC-130 (LTO)	4	5	20	1	99.36	284.08	25.80	36.60	20.32	22.52	109,944
KC-130 (Refueling)	4	5		1	170.856	192.024	42.34	11.19	22.68	25.10	97,211
MV-22B (LTO)	4	5	800	40	4416	10336	74.70	466.79	1736.00	1736.00	4,062,288
MV-22B (Refueling)	4	5		40	2050.56	942.336	30.74	85.25	361.73	361.73	742,118
CH-47 (modeled as H-46) (LTO)	9	2	18	1	384.66	19.26	140.97	2.44	24.48	24.48	20,349
CH-47 (modeled as H-46) (Refueling)	9	2		1	364.6278	4.44888	157.60	1.11	15.21	15.21	8,769
AH-64 (modeled as H-60) (LTO)	9	2	288	16	3545.28	967.68	453.74	70.44	673.92	673.92	607,579
AH-64 (Refueling)	9	2		16	1784.494	129.6691	19.30	14.28	51.33	57.12	124,059
Air Force Tanker - Modeled as KC-135 (LTO)	4	2	8	1	722.4	127.424	730.59	24.50	18.42	20.46	73,600
Air Force Tanker - Modeled as KC-135 (Refueling)	4	2		1	1030.476	43.13216	1026.65	6.44	119.48	132.87	55,909
Air Force Fighter - Modeled as FA-18E/F (LTO)	4	2	64	8	16979.2	1989.12	5129.92	61.85	1165.44	1165.44	500,735
Air Force Fighter - Modeled as FA-18E/F (Refueling)	4	2		8	4373.33	141.6499	3346.57	16.48	563.04	563.04	132,429
				Total, lbs./year	44156.84	16413.81	14383.03	839.1583	5427.195	5453.043	6878513.4
				Total, tons/year	22.08	8.21	7.19	0.42	2.71	2.73	
				MT/year							3,120

Table B-19: Increase in Aircraft Emission - Kaula Island

				Emissions (lb/operation)						
Aircraft	**Annual # of Air-to-Ground Gunnery Exercises (GUNEX)**	**Annual # of Air-to-Ground Bombing Exercise (BOMBEX)**	**Annual LTOs**	**CO**	**NOx**	**VOC**	**SOx**	**$PM_{2.5}$**	**PM_{10}**	**CO_2**
FA-18E/F (LTO)		19	19	5040.7	590.52	1522.95	18.36	345.99	345.99	148,656
CH-47 (modeled as H-46) (LTO)	10		10	213.7	10.7	78.32	1.35	13.60	13.60	11,305
CH-47 (modeled as H-46) (Hover for one hours for GUNEX)	10			96.831	26.775	15.6492	2.331	11.214	11.214	20,047
			Total, lbs./year	5351.23	628.00	1616.91	22.05	370.80	370.80	180,007
			Total, tons/year	2.68	0.31	0.81	0.01	0.19	0.19	
			MT/year							82

B.1.6 Estimated Emissions for the Proposed Action

Table B-20 presents the estimated emissions for each site. Table B-21 presents the estimated emissions for PMRF Barking Sands and Kaula Island. Table B-22 shows the estimated total Hazardous Air Pollutant Emissions for the Proposed Action.

Table B-20: Estimated Increase in Emissions by Site

Site/Emissions	Total Increase in Emissions, ton/year						CO_2e MT/year
	NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$	
North Launch Area 1	7.27	2.69	12.71	0.62	49.95	5.64	1,083
North Launch Area 2	4.51	1.59	10.12	0.53	50.33	5.76	849
South Launch Area	4.78	1.77	8.37	0.41	34.68	3.90	714
Palai Olani	1.27	0.27	3.58	0.55	0.60	0.27	343
Waiapuaa Bay	1.64	0.00	0.31	0.06	0.63	0.10	250
Missile Defense Agency Hard Stand	2.77	1.02	5.60	0.29	16.80	1.96	477
Airfield Bivouac Area	0.50	0.12	6.27	0.45	1.80	0.46	540
Alternate Bivouac Area	0.02	0.01	0.30	0.02	0.09	0.02	26
Forward Arming and Refueling Point Areas	8.31	0.47	22.45	7.22	7.48	3.21	3,161
Unmanned Aircraft System Launch Area	0.19	0.12	0.27	0.01	2.15	0.24	41
Ground Maneuver Area	0.00	0.00	0.08	0.01	0.02	0.01	7
Kaula Island	0.315	0.01	2.68	0.81	0.201	0.20	111

Table B-21: Estimated Increase in Emissions for each Location

Site/Emissions	Total Increase in Emissions, ton/year						CO_2e MT/year
	NO_x	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$	
PMRF Barking Sands	31.24	8.05	70.05	10.18	164.54	21.56	7,491
Kaula Island	0.31	0.011	2.68	0.81	0.20	0.20	111
Total	**31.55**	**8.06**	**72.73**	**10.99**	**164.74**	**21.76**	**7,602**

Table B-22: Estimated Total Increase in HAP Emissions for the Proposed Action

	Increase in HAP Emissions, Ton/yr						
Pollutant	**Aircraft**	**Vessel**	**Military Vehicle**	**POV**	**Generators**	**Total**	**Main Contributing Activity**
1,3 Butadiene	0.00007		0.00010	0.02156	0.00002	0.0218	Personnel Commute
2,2,4-Trimethylpentane		0.0000002	0.00028	0.06048	0.000000	0.0608	Personnel Commute
Acetaldehyde	0.00018	0.0000003	0.00011	0.02455	0.00008	0.0249	Personnel Commute
Acrolein	0.00010	0.0000001	0.00003	0.00599	0.00000	0.0061	Personnel Commute
Benzene	0.00007	0.0000001	0.00040	0.08818	0.00002	0.0887	Personnel Commute
Ethylbenzene	0.00001		0.00018	0.03832	0.00000	0.0385	Personnel Commute
Formaldehyde	0.00052	0.0000013	0.00023	0.05045	0.00019	0.0514	Personnel Commute
Hexane		0.0000001	0.00016	0.03593	0.00000	0.0361	Personnel Commute
Methanol	0.00008					0.00008	Aircraft
Naphthalene	0.00002	0.0000009	0.00000	0.00105	0.00000	0.0011	Personnel Commute
Phenol	0.00003					0.00003	Personnel Commute
Propanal	0.00003	0.0000000	0.00001	0.00165	0.00005	0.0017	Personnel Commute
Styrene	0.00001		0.00014	0.03054	0.00000	0.0307	Personnel Commute
Toluene	0.00003	0.0000001	0.00086	0.18743	0.00001	0.1883	Personnel Commute
Xylenes (Mixed Isomers)	0.00002	0.0000000	0.00069	0.15135	0.00000	0.1521	Personnel Commute

B.1.7 Receptors

Identification of receptors, including sensitive receptors, is important to the air quality impact analysis. Sensitive receptors are individuals in hospitals, schools, daycare facilities, elderly housing convalescent facilities, or other sites who are more susceptible to adverse effects of exposure to air pollutants. Table B-23 presents the location and distance of the closest receptor and closest sensitive receptor relative to each site.

Table B-23: Distances to Closest Receptors

Site	Closest Receptor			Closest Sensitive Receptor		
	Name	Direction	Distance, mile	Name	Direction	Distance, mile
North Launch Area 1	Polihale State Park	N	<0.1	Polihale State Park	N	<0.1
North Launch Area 2	Polihale State Park	NE	1	Polihale State Park	NE	1
South Launch Area	Kokole Point	SW	0.2	Kokole Point	SW	0.2
Palai Olani	Mana Japanese Cemetery	SW	0.7	Kekaha Elementary School	SE	6.7
Waiapuaa Bay	Barking Sand Beach Cottages	NW	0.1	Barking Sand Beach Cottages	NW	0.1
Missile Defense Agency Hard Stand	Shenanigans Restaurant	NW	0.6	Kekaha Elementary School	SE	3.1
Airfield Bivouac Area	Kauai Veteran's Eternal Memorial	NE	0.1	Kekaha Elementary School	SE	6.0
Alternate Bivouac Area	Mana Japanese Cemetery	SW	1.0	Kekaha Elementary School	SE	6.7
Forward Arming and Refueling Point Areas	Mana Japanese Cemetery	SW	0.1	Kekaha Elementary School	SE	6.2
Unmanned Aircraft System Launch Area	Barking Sand Beach Cottages	SE	0.6	Barking Sand Beach Cottages	SE	0.6
Ground Maneuver Area	Polihale State Park	N	<0.1	Polihale State Park	N	<0.1
Kaula Island	No receptor as the island has no human population. It is accessible only with permission from the U.S. Navy.					

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