Noise and Air Quality Study
for
Marine Corps Air Station Miramar with F-35C

February 2018

Prepared for:

Naval Facilities Engineering Command,
Southwest
1200 Pacific Highway
San Diego, CA 93132-5190
Contract No. N62470-14-D-9003,
Task Order FZ08

(This page intentionally left blank.)

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

ATC	Air Traffic Control
CNEL	Community Noise Equivalent Level
CO	carbon monoxide
dB	decibel
DOD	Department of Defense
EIS	Environmental Impact Statement
FCLP	Field Carrier Landing Practice
HQMC	Headquarters, United States Marine Corps
kPa-s/m^2	kilopascal-seconds per square meter
MAW	Marine Aircraft Wing
MCAS	Marine Corps Air Station
MCIWEST	Marine Corps Installations West
NAVFAC SW	Naval Facilities Engineering Command, Southwest
NMAP	Noisemap
NO_x	oxides of nitrogen
PM	particulate matter
RNM	Rotorcraft Noise Model
ROD	Record of Decision
SDAB	San Diego Air Basin
SDAPCD	San Diego Air Pollution Control District
SO_x	sulfur dioxide
typ	tons per year
U.S.	United States
USMC	United States Marine Corps
VOC	volatile organic compounds

(This page intentionally left blank)

CHAPTER 1
INTRODUCTION

1.1 PURPOSE

Headquarters, United States Marine Corps (HQMC), Marine Corps Installations West (MCIWEST), and Marine Corps Air Station (MCAS) Miramar staffs have planned extensively for the introduction and home basing of the F-35B Lightning II aircraft at MCAS Miramar. On December 9, 2010, the Department of the Navy signed a Record of Decision (ROD) implementing Alternative 1 to base six operational squadrons at MCAS Miramar and five operational squadrons plus one operational test and evaluation (OT&E) squadron at MCAS Yuma (Navy 2010). Since the ROD was issued, changes to the Joint Strike Fighter Program have occurred, including changes to the aircraft series, number of aircraft, and construction requirements. The 2013 Marine Corps Aviation Plan directs two F-35C operational squadrons of 10 aircraft per squadron would be based on the west coast in lieu of two F-35B squadrons. To more accurately represent projected conditions, this analysis includes updated noise signatures and operational data for several aircraft types which became available subsequent to the ROD. This document presents the results of recent noise and air quality studies of the F-35C, to help decision-makers determine the need for supplemental National Environmental Policy Act (NEPA) analysis in accordance with Title 40 Code of Federal Regulations (CFR) 1502.9(c)(1)(i), Marine Corps Order (MCO) P5090.2A Section 12201.6.k, and USMC NEPA Manual Section 6.5.

1.2 F-35 PLANNING HISTORY AT MCAS MIRAMAR

From 2008-2010, an Environmental Impact Statement (EIS) was completed for USMC F-35B West Coast Basing. The ROD for that action was signed in December of 2010, with the decision to base six operational F-35B squadrons at MCAS Miramar.

Since 2010, the USMC has adjusted its plans to include up to four F-35C squadrons in its inventory – two per coast (two each as part of 3rd Marine Aircraft Wing (MAW) on the West Coast in fiscal years 2019-2024 and 2nd MAW on the East Coast in fiscal years 2024-2026) to be able to augment the Navy's carrier air wings as needed. This document analyzes whether basing one or both West Coast F-35C squadrons at MCAS Miramar, in lieu of a corresponding number of F-35B squadrons, would represent a substantial change relevant to environmental concerns.

Additionally, noise modeling data is now available for the F-35B, MV-22B, CH-53E, and KC-130J that was not incorporated into the 2010 noise analysis, so this document also analyzes whether that data constitutes significant new information relevant to environmental concerns and bearing on the Federal Action or its impacts.

1.3 DESCRIPTION OF SCENARIOS COMPARED

This report summarizes the results of noise and air quality studies based on a mix of two F-35C squadrons and four F-35B squadrons while incorporating the latest available noise data for the F-35B, MV-22B, CH-53E, and KC-130J. This is referred to as the "F-35C Scenario". This report also presents the results of updates to the noise study for six F-35B squadrons reflected in the 2010 ROD and EIS. This is referred to as the "Updated ROD Scenario (Noise)." Air emissions data used in the 2010 EIS remain valid for the aircraft studied therein, so the 2010 ROD serves as the baseline for comparison to the F-35C Scenario for purposes of air quality analysis.

1.4 MAJOR PLANNING ASSUMPTIONS

1.4.1 Updated ROD Scenario

- Update KC-130R/T with KC-130J.
- Update MV-22B modeling to use new modeling data (noise data file named "MV22-" vice "MV22B").
- Update CH-53E modeling to use new modeling data (noise data file named "CH53-" vice "CH53E").
- Update F-35B to include F-35B-specific noise data, vice the "best-available" F-35A data used in 2009-2010.
- Everything else stays as close to original as possible for the best comparison. Planning assumptions in the 2010 EIS, unless changed here, remain the same.

1.4.2 F-35C Scenario

- F-35C squadrons would consist of ten aircraft, vice the sixteen modeled for F-35B squadrons.
- F-35B Reserve squadron – flying operations are modeled to be identical to an active-component squadron. For purposes of noise and air quality, there is no difference.
- F-35C scenario also includes KC-130J, MV-22, and CH-53 modeling data as used for Updated ROD Scenario.
- F-35C squadrons would conduct Field Carrier Landing Practice (FCLP) at their home field.
- F-35C FCLP patterns would be controlled by MCAS Miramar Air Traffic Control (ATC) and be very similar to the current FCLP pattern. The landing area, number of aircraft in the pattern at the same time, and other procedures would not change appreciably. The distribution of pattern lengths and turn points were taken from the historical experience of Miramar ATC running an FCLP pattern for the FA-18 series aircraft.

CHAPTER 2
NOISE

2.1 METHODOLOGY

Table 2-1 summarizes the noise model parameters used in this analysis. This analysis utilizes the Department of Defense (DOD) NOISEMAP suite of computer programs (Wyle 1998; Wasmer Consulting 2006) containing the core computational programs called NMAP version 7.3, and Rotorcraft Noise Model (RNM) version 7.2.2. (NMAP version 7.3 was released on 28 March 2017.)

Table 2-1 Noise Modeling Parameters

Software	Analysis	Version
NMAP	Fixed wing aircraft	7.3
RNM	Rotorcraft	7.2.2
Parameter	**Description**	
Receiver Grid Spacing	500 feet in x and y	
Metric	CNEL	
Basis	AAD Operations	
Topography		
Elevation Data Source	U.S. Geological Survey 30 meters NED	
Elevation Grid Spacing	500 feet in x and y	
Impedance Data Source	U.S. Geological Survey Hydrography DLG	
Impedance Grid spacing	500 feet in x and y	
Flow Resistivity of Ground (soft/hard)	225 kPa-s/m^2 / 100,000 kPa-s/m^2	
Modeled Weather (Monthly Averages 2012-2016; November selected)		
Temperature	63 °F	
Relative Humidity	45%	
Barometric Pressure	30.02 in Hg	

Notes: CNEL = Community Noise Equivalent Level; AAD = Average Annual Day; NED = National Elevation Dataset; DLG = Digital Line Graph; kPa-s/m^2 = kilopascal-seconds per square meter; °F = degrees Fahrenheit; in Hg = inches Mercury.
Source: Cardno 2017.

2.2 PRIMARY NOISE METRIC AND MODELING

Noise is defined as unwanted sound that interferes with or disrupts normal human activities; the primary human response to aircraft and other transportation noise is annoyance. The response of different individuals to similar noise events is diverse and is influenced by the type of noise, the perceived importance of the noise, its appropriateness in the setting, the time of day, the type of activity during which the noise occurs, and the sensitivity of the individual to noise.

Per DOD Instruction 4165.57, the DOD uses the Community Noise Equivalent Level (CNEL) noise descriptor to describe the aircraft noise environment around air installations in California. CNEL is the relevant metric used for this study. Aircraft operations are modeled using on annual average day (yearly operations divided by 365 days/year). For CNEL, average daily operations are further divided into three distinct time bands; daytime (7:00 a.m. to 7:00 p.m.), evening (7:00 p.m. to 10:00 p.m.), and night (10:00 p.m. to 7:00 a.m.). Operations that occur outside of daytime hours are weighted by adding 5 decibels (dB)

to operations occurring during the evening hours, and by adding 10 dB to those operations occurring at night. This adjustment gives individual noise events more weight during times when human observers are likely to be more sensitive and therefore more highly annoyed by individual noise events. It is worthy of noting that the time frames for day, evening, and night do not change, and are therefore irrespective of the seasonal fluctuation in daylight. Therefore, it is possible for some evening operations to occur prior to the actual sunset, and for some night operations to occur after sunrise, depending on the season.

NOISEMAP takes into account the effects of sound propagation and includes consideration of terrain elevation, taken from the U.S. Geological Survey National Elevation Dataset, and ground impedance conditions, taken from U.S. Geological Survey Hydrography data. In this case, "soft ground" (e.g., grass-covered ground) is modeled with a flow resistivity of 225 kilopascal-seconds per square meter (kPa-s/m^2) and "hard ground" (in this case, water) is modeled with a flow resistivity of 100,000 kPa-s/m^2. The modeling does not include the effect of shielding of on-base buildings. For ambient temperature, humidity, and pressure, each month was assigned a temperature, relative humidity, and barometric pressure from data available for that month for the years 2012 through 2016 (last full year of data available at the time the study began). NOISEMAP then determined and used the month with the weather values that produced the median results in terms of noise propagation effect, which in this case was the month of November (with the values noted in Table 2-1).

NOISEMAP combines the above information with flight tracks (departure, arrival, closed pattern), flight profiles (altitude, power, airspeed), and the number of aircraft operations for each flight profile (number of times each type of operation occurs by aircraft/track/profile), and data related to ground maintenance run-up of aircraft engines (location/power setting/time in mode) to predict the total noise energy experienced on an average annual day at each of the grid of points on the ground. In this case, as indicated in Table 2-1, that grid spacing was 500 feet. Noise exposure is presented in terms of contours, i.e., lines of equal value, of CNEL. CNEL contours of 65 to 85 dB, presented in 5-dB increments, provide a graphical depiction of the cumulative aircraft noise environment.

This analysis used F-35B data (measured in 2013) for the F-35B (whereas F-35A data, measured in 2008, was used as a surrogate for the F-35B in the 2010 EIS). There have not been measurements of the F-35C at this time, so F-35C operations are modeled using the latest measurements for the F-35A (measured by U.S. Air Force in 2013). The engines are nearly identical, and the F-35C profiles modeled herein are F-35C-specific, per the Karnes Profiles version 3.2, which allow for the F-35C to use slightly different (greater) power settings and speeds that are appropriate for the airframe and its greater weight, wingspan, etc. (Wyle 2015).

2.3 UPDATED ROD SCENARIO

2.3.1 Modeling Data

Table 2-2 details the modeled annual flight operations at MCAS Miramar for the "Updated ROD" scenario. This scenario includes 123,211 flight operations per year, approximately 88% of these are based aircraft, and 42% of those are fighter jets (F-35B). The next three largest numbers of operations are from MV-22 (36% of based aircraft operations), CH-53E (12% of based aircraft operations), and KC-130 (8% of based aircraft operations).

Table 2-2 Flight Operations MCAS Miramar for the "Updated ROD" Scenario

Group	Squadron Name	Notes	Aircraft Type	Departure				Departure to EAF				Instrument Straight-In Arrival				Overhead Break Arrival to RUNWAY				Overhead Break Arrival to PADS				Non-Break Visual Arrival to RUNWAY				Non-Break Visual Arrival to PADS				Arrival from EAF			
				Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total
Based	F-35B - 6 Sqdns		F-35B	16,615	2,077	189	18,881	332	45	-	377	831	104	9	944	11,339	283	9	11,631	1,121	28	-	1,149	3,024	1,512	170	4,706	299	150	-	449	332	42	4	378
Based	F-35C		F-35C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Based	KC-130		KC-130J	663	51	7	721	-	-	-	-	22	5	14	41	522	65	-	587	-	-	-	-	52	10	32	94	-	-	-	-	-	-	-	-
Based	Station C-12		C-12	259	-	-	259	-	-	-	-	175	59	24	258	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Based	CH-53E	1	CH-53E	2,532	392	91	3,015	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	954	157	96	1,207	1,430	235	145	1,810	-	-	-	-
Based	MV-22		MV-22B	9,658	5,361	1,181	16,200	76	39	12	127	877	487	107	1,471	7,884	4,374	970	13,228	-	-	-	-	-	-	-	-	897	501	107	1,505	76	39	12	127
Transient	Air Carrier		UC-35 etc.	891	81	30	1,002	-	-	-	-	891	89	24	1,004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Transient	Mil Fixed-Wing (F-16, F-18 etc.)		FA-18EF	2,546	247	77	2,870	-	-	-	-	512	48	13	573	2,050	193	54	2,297	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Transient	Military Rotary-Wing	2	H-60 etc.	270	76	51	397	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	108	30	20	158	162	46	31	239	-	-	-	-
Based				29,727	7,881	1,468	39,076	408	84	12	504	1,905	655	154	2,714	19,745	4,722	979	25,446	1,121	28	-	1,149	4,030	1,679	298	6,007	2,626	886	252	3,764	408	81	16	505
Transient				3,707	404	158	4,269	-	-	-	-	1,403	137	37	1,577	2,050	193	54	2,297	-	-	-	-	108	30	20	158	162	46	31	239	-	-	-	-
TOTAL				33,434	8,285	1,626	43,345	408	84	12	504	3,308	792	191	4,291	21,795	4,915	1,033	27,743	1,121	28	-	1,149	4,138	1,709	318	6,165	2,788	932	283	4,003	408	81	16	505

Group	Squadron Name	Notes	Aircraft Type	Visual Touch and Go (Conventional)*				Visual Touch & Go (Non-conventional)*				FCLP at NKX*				GCA Box*				TOTAL			
				Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total
Based	F-35B - 6 Sqdns		F-35B	797	109	-	906	1,861	254	-	2,115	1,836	1,836	-	3,672	748	-	-	748	39,135	6,440	381	45,956
Based	F-35C		F-35C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Based	KC-130		KC-130J	4,920	1,836	587	7,343	-	-	-	-	-	-	-	-	245	18	-	263	6,424	1,985	640	9,049
Based	Station C-12		C-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	434	59	24	517
Based	CH-53E	1	CH-53E	5,536	911	561	7,008	-	-	-	-	-	-	-	-	257	53	3	313	10,709	1,748	896	13,353
Based	MV-22		MV-22B	2,713	302	-	3,015	-	-	-	-	-	-	-	-	3,392	377	-	3,769	25,573	11,480	2,389	39,442
Transient	Air Carrier		UC-35 etc.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,782	170	54	2,006
Transient	Mil Fixed-Wing (F-16, F-18 etc.)		FA-18EF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,108	488	144	5,740
Transient	Military Rotary-Wing	2	H-60 etc.	4,552	1,236	566	6,354	-	-	-	-	-	-	-	-	-	-	-	-	5,092	1,388	668	7,148
Based				13,966	3,158	1,148	18,272	1,861	254	-	2,115	1,836	1,836	-	3,672	4,642	448	3	5,093	82,275	21,712	4,330	108,317
Transient				4,552	1,236	566	6,354	-	-	-	-	-	-	-	-	-	-	-	-	11,982	2,046	866	14,894
TOTAL				18,518	4,394	1,714	24,626	1,861	254	-	2,115	1,836	1,836	-	3,672	4,642	448	3	5,093	**94,257**	**23,758**	**5,196**	**123,211**

Notes: 1. 40% of "Non-break visual arrival to Runway" are actually to the Pad on the Runway (from previous modeling).
2. "Non-break visual arrival to Runway" are to Rwy 24 pad.

Source: USMC 2010, Cardno 2017.

(This page intentionally left blank.)

Some aircraft (CH-53E and MV-22B) are modeled with the RNM software module, while the rest are modeled with NMAP (see Section 2.1 for details and versioning, etc.). The outputs of those software modules were then combined into one overall resulting grid to generate the noise contours and other analyses for the "updated ROD" condition.

Figure 2-1 shows all of the modeled static run-up profile locations. Consistent with the flight operations, maintenance run-up activity was modeled on an Average Annual Day basis. Table 2-3 summarizes the run-up operations profiles (each aircraft profile/location used for these static operations is individually represented in the noise model while the table shows only a summary by aircraft type). Note that in the table, a profile being "different" may mean that it is modeled at a different spot on the airfield, have a different heading, or be for a completely different purpose (Cardno 2017).

Table 2-3 Summary of Static Profiles

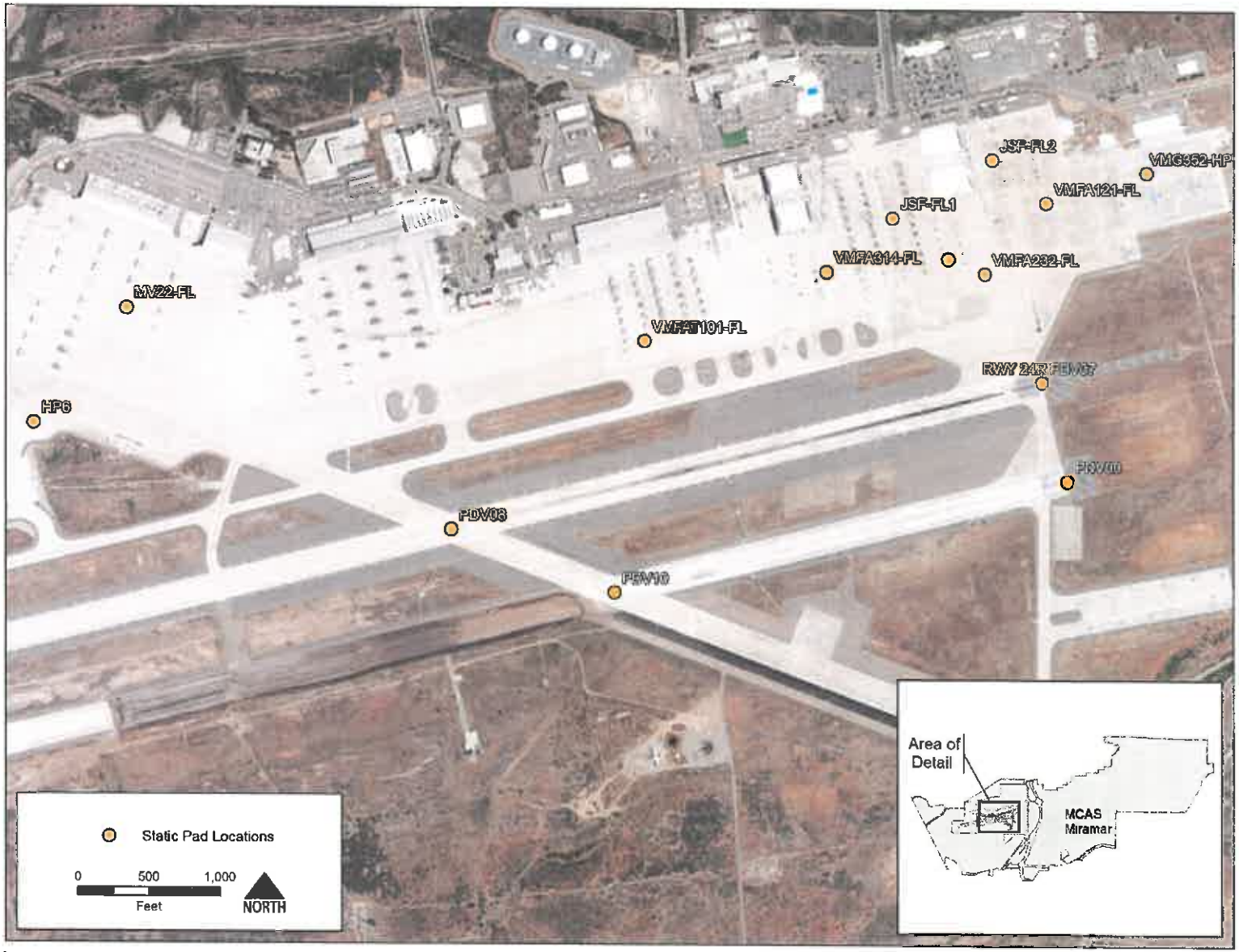
Aircraft Type	# Different Profiles Modeled
KC-130	4
CH-53E	2
MV-22B	2
F-35B/C	30

Note: F-35C static operations are not part of the Updated ROD scenario.
Source: Cardno 2017.

2.3.2 Noise Exposure

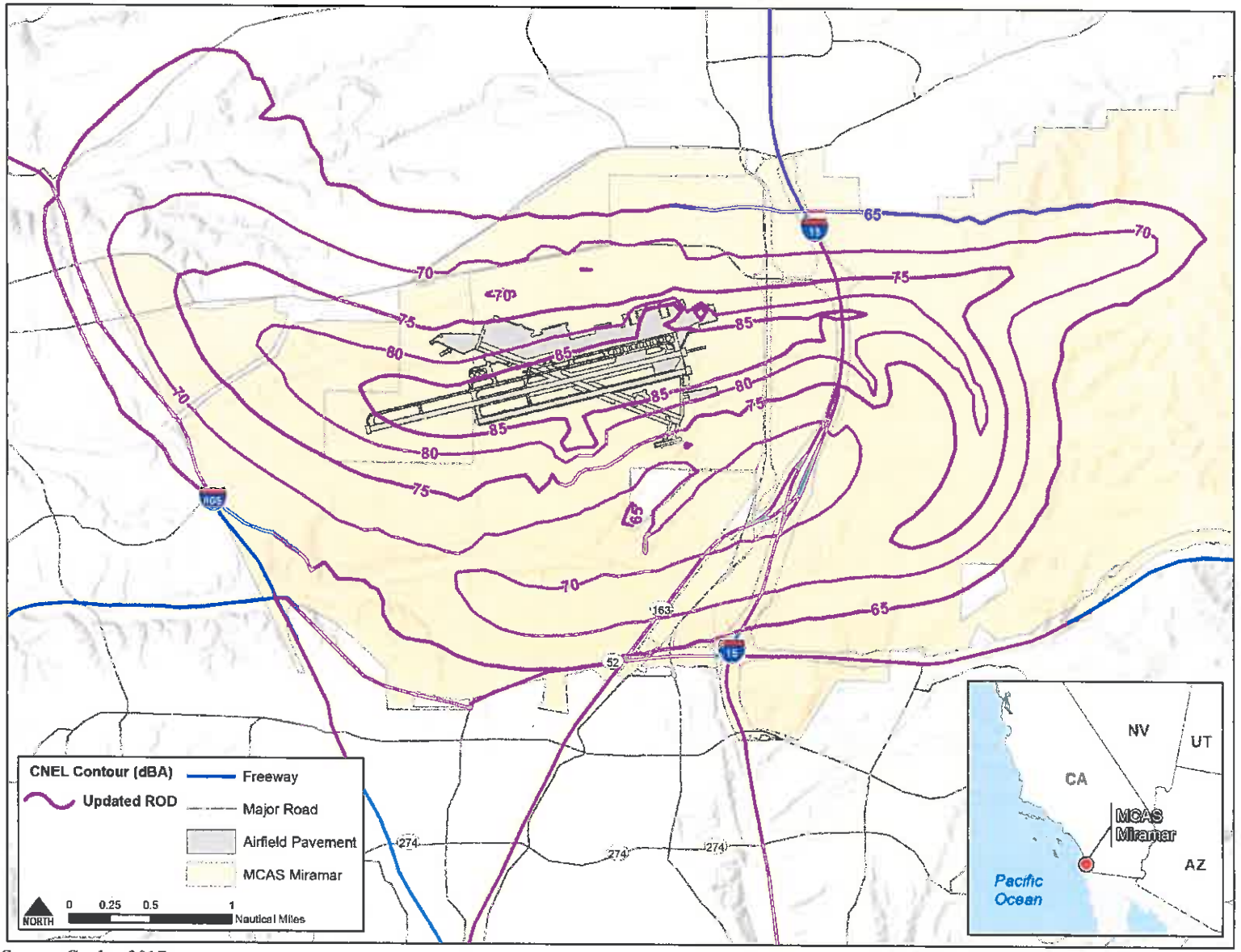
Figure 2-2 shows the resultant 65 dB to 85 dB CNEL contours in 5 dB increments for the Updated ROD Scenario daily aircraft events.

For comparison purposes, Figure 2-3 is provided to show the differences between the Alternative 1 contours in the 2010 EIS (original 2010 ROD) and the contours resulting from the changes modeled as the Updated ROD scenario in this document.



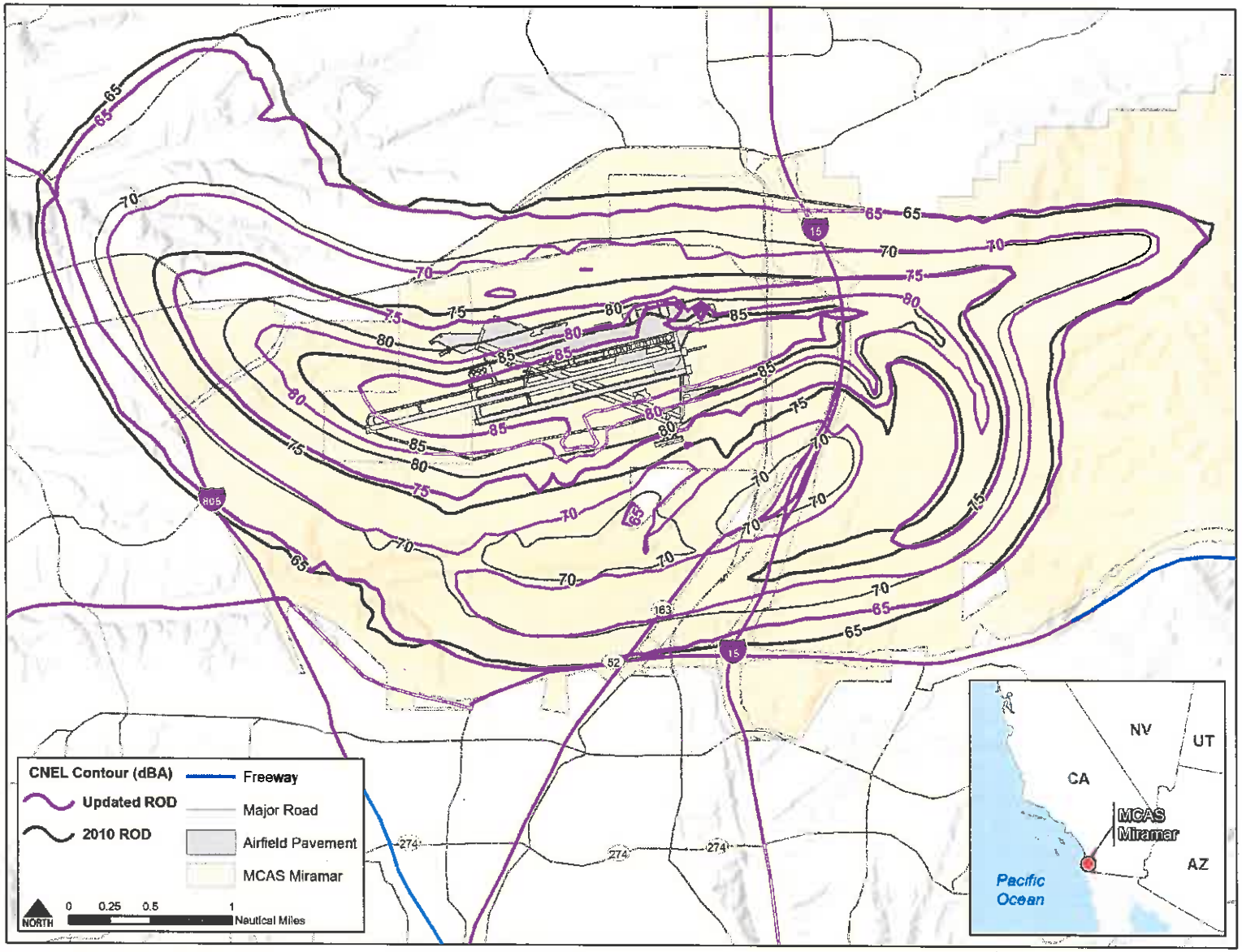
Source: Cardno 2017.

Figure 2-1 Modeled Static Run-Up Profile Locations



Source: Cardno 2017.

Figure 2-2 CNEL Contours for the Updated ROD Scenario



Source: USMC 2010, Cardno 2017.

Figure 2-3 CNEL Contours for the Updated ROD Scenario Compared to the 2010 EIS Alternative 1

2.4 F-35C SCENARIO

2.4.1 Modeling Data

Table 2-4 details the modeled annual flight operations at MCAS Miramar for the "F-35C" scenario. This scenario includes 120,148 flight operations per year, approximately 87% of these are based aircraft, and 40% of those are fighter jets (F-35B and F-35C). The other aircraft in the model do not change. The overall numbers are a bit lower in this scenario, due to the F-35C squadrons being made up of ten aircraft, versus the sixteen aircraft modeled for the F-35B squadrons they replace. The flight operations for the F-35C are very similar to those of the F-35B, minus all the short takeoff, vertical landing (STOVL) operations. Additionally, the F-35C is modeled as if it would conduct all of its FCLP operations on runway 24L, just as the FA-18C does currently.

Some aircraft (CH-53E and MV-22B) are modeled with the RNM software module, while the rest are modeled with NMAP (see Section 2.1 for details and versioning, etc.). The outputs of those software modules were then combined into one overall resulting grid to generate the noise contours and other analyses for the "F-35C" scenario.

(This page intentionally left blank.)

Table 2-4 Flight Operations MCAS Miramar for the "F-35C" Scenario

Group	Squadron Name	Notes	Aircraft Type	Departure				Departure to EAF				Instrument Straight-In Arrival				Overhead Break Arrival to RUNWAY				Overhead Break Arrival to PADS				Non-Break Visual Arrival to RUNWAY				Non-Break Visual Arrival to PADS				Arrival from EAF			
				Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total
Based	F-35B - 4 Sqdns		F-35B	11,077	1,385	126	12,587	221	30	-	251	554	69	6	629	7,559	189	6	7,754	747	19	-	766	2,016	1,008	113	3,137	199	100	-	299	221	28	3	252
Based	F-35C		F-35C	3,531	442	39	4,012	-	-	-	-	173	22	2	197	2,665	74	3	2,741	-	-	-	-	692	346	35	1,074	-	-	-	-	-	-	-	-
Based	KC-130		KC-130J	663	51	7	721	-	-	-	-	22	5	14	41	522	65	-	587	-	-	-	-	52	10	32	94	-	-	-	-	-	-	-	-
Based	Station C-12		C-12	259	-	-	259	-	-	-	-	175	59	24	258	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Based	CH-53E	1	CH-53E	2,532	392	91	3,015	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	954	157	96	1,207	1,430	235	145	1,810	-	-	-	-
Based	MV-22		MV-22B	9,658	5,361	1,181	16,200	76	39	12	127	877	487	107	1,471	7,884	4,374	970	13,228	-	-	-	-	-	-	-	-	897	501	107	1,505	76	39	12	127
Transient	Air Carrier		UC-35 etc.	891	81	30	1,002	-	-	-	-	891	89	24	1,004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Transient	Mil Fixed-Wing (F-16, F-18 etc)		FA-18EF	2,546	247	77	2,870	-	-	-	-	512	48	13	573	2,050	193	54	2,297	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Transient	Military Rotary-Wing	2	H-60 etc.	270	76	51	397	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	108	30	20	158	162	46	31	239	-	-	-	-
Based				27,719	7,631	1,444	36,794	297	69	12	378	1,801	642	153	2,596	18,630	4,701	979	24,310	747	19	-	766	3,714	1,521	277	5,512	2,526	836	252	3,614	297	67	15	379
Transient				3,707	404	158	4,269	-	-	-	-	1,403	137	37	1,577	2,050	193	54	2,297	-	-	-	-	108	30	20	158	162	46	31	239	-	-	-	-
TOTAL				31,426	8,035	1,602	41,063	297	69	12	378	3,204	779	190	4,173	20,680	4,894	1,033	26,607	747	19	-	766	3,822	1,551	297	5,670	2,688	882	283	3,853	297	67	15	379

Group	Squadron Name	Notes	Aircraft Type	Visual Touch and Go (Conventional)*				Visual Touch & Go (Non-conventional)*				FCLP at NKX*				GCA Box*				TOTAL			
				Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total	Day	Eve	Night	Total
Based	F-35B - 4 Sqdns		F-35B	531	73	-	604	1,241	169	-	1,410	1,224	1,224	-	2,448	499	-	-	499	26,090	4,293	254	30,637
Based	F-35C		F-35C	554	76	-	629	-	-	-	-	2,083	1,285	78	3,446	156	-	-	156	9,854	2,244	157	12,255
Based	KC-130		KC-130J	4,920	1,836	587	7,343	-	-	-	-	-	-	-	-	245	18	-	263	6,424	1,985	640	9,049
Based	Station C-12		C-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	434	59	24	517
Based	CH-53E	1	CH-53E	5,536	911	561	7,008	-	-	-	-	-	-	-	-	257	53	3	313	10,709	1,748	896	13,353
Based	MV-22		MV-22B	2,713	302	-	3,015	-	-	-	-	-	-	-	-	3,392	377	-	3,769	25,573	11,480	2,389	39,442
Transient	Air Carrier		UC-35 etc.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,782	170	54	2,006
Transient	Mil Fixed-Wing (F-16, F-18 etc.)		FA-18EF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,108	488	144	5,740
Transient	Military Rotary-Wing	2	H-60 etc.	4,552	1,236	566	6,354	-	-	-	-	-	-	-	-	-	-	-	-	5,092	1,388	668	7,148
Based				14,254	3,197	1,148	18,599	1,241	169	-	1,410	3,307	2,509	78	5,894	4,549	448	3	5,000	79,084	21,810	4,360	105,254
Transient				4,552	1,236	566	6,354	-	-	-	-	-	-	-	-	-	-	-	-	11,982	2,046	866	14,894
TOTAL				18,806	4,433	1,714	24,953	1,241	169	-	1,410	3,307	2,509	78	5,894	4,549	448	3	5,000	**91,066**	**23,856**	**5,226**	**120,148**

Notes: 1. 40% of "Non-break visual arrival to Runway" are actually to the Pad on the Runway (from previous modeling).
2. "Non-break visual arrival to Runway" are to Rwy 24 pad.
Source: USMC 2010, Cardno 2017.

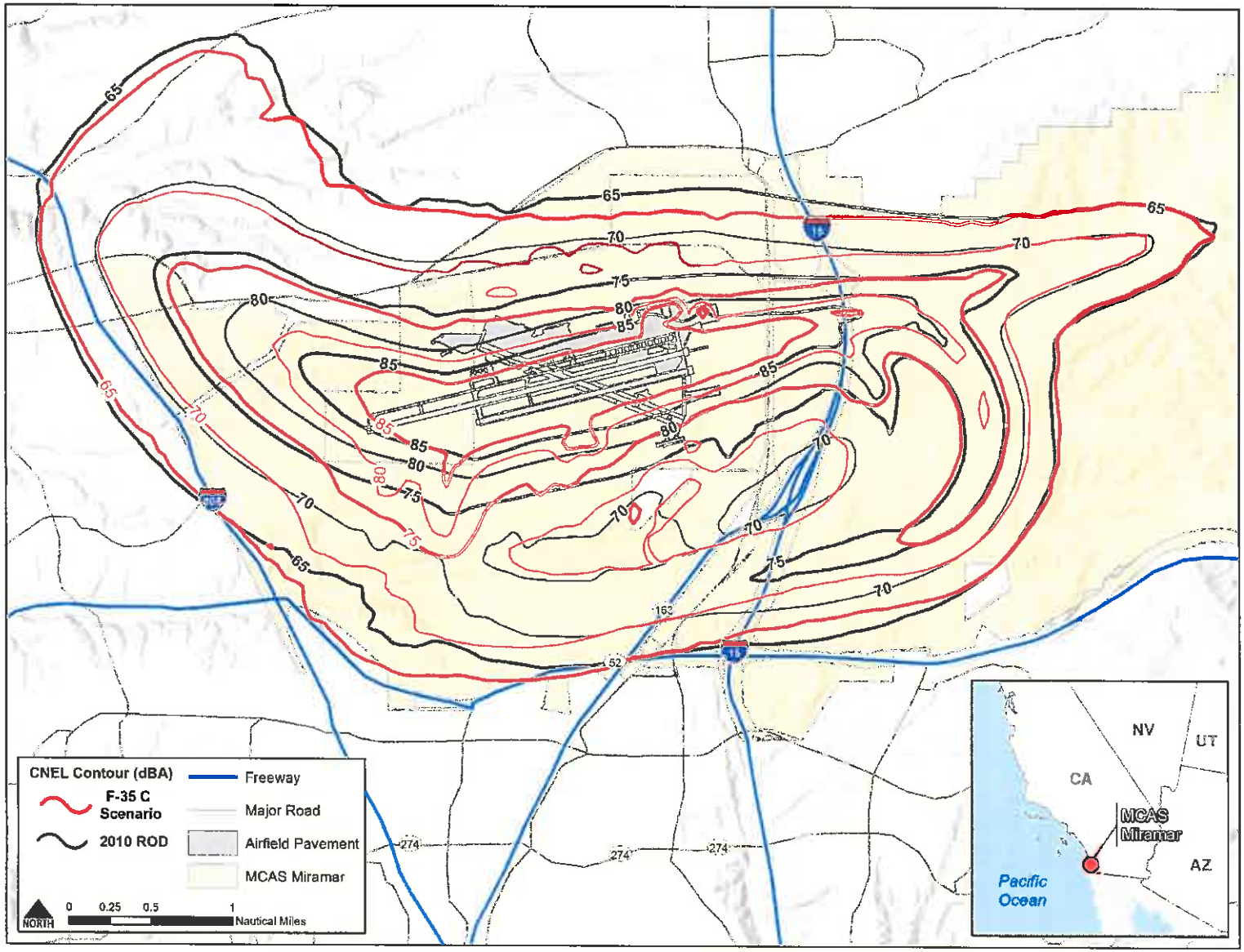
›nally left blank.)

Static operations are the same as in the "Updated ROD" scenario, with two adjustments – the total number of F-35 aircraft is smaller, so the profiles that are common to both the F-35B and F-35C are reduced appropriately. The second adjustment is that the F-35B requires separate profiles for the lift fan, and these are also reduced proportionally. F-35C squadrons are comprised of 10 aircraft, vice 16 for F-35B squadrons, because an F-35C squadron supports a Carrier Strike Group (CSG), whereas F-35B squadron supports a CSG and an Amphibious Ready Group concurrently.

2.4.2 Noise Exposure

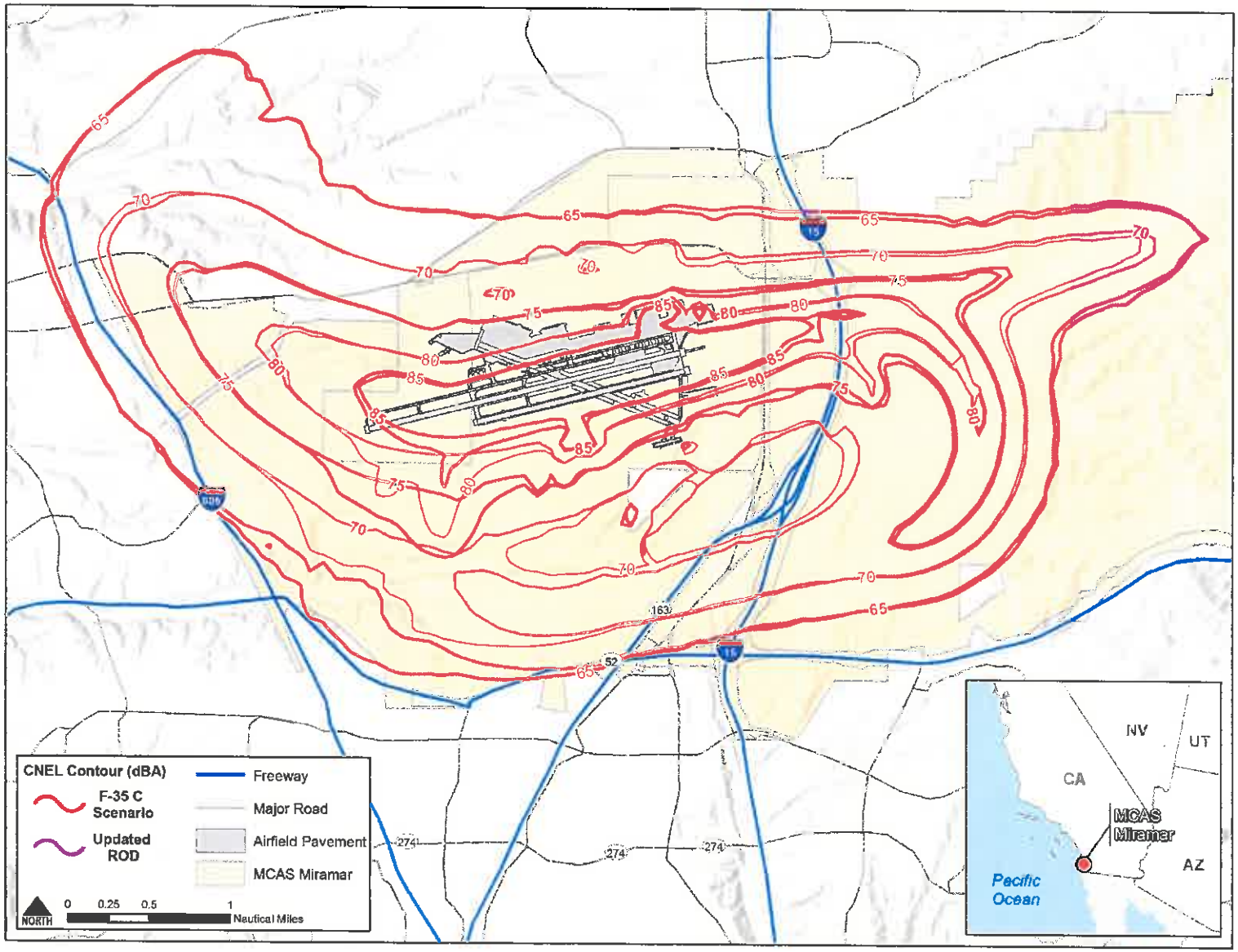
Figure 2-4 shows the resultant 65 dB to 85 dB CNEL contours in 5 dB increments for the F-35C scenario, compared to Alternative 1 (six F-35B squadrons) from the 2010 EIS (selected in the 2010 ROD). This has the effect of showing a direct comparison between the noise impacts considered in the ROD, and the noise impacts reflecting substitution of two 10-plane F-35C squadrons for two 16-plane F-35B squadrons, incorporating the latest noise data for the F-35B, MV-22B, CH-53E, and KC-130J.

For informational purposes, Figure 2-5 is provided to show how the F-35C scenario would compare to the updated ROD.



Source: USMC 2010, Cardno 2017.

Figure 2-4 CNEL Contours: F-35C Scenario Compared to 2010 EIS Alternative 1



Source: Cardno 2017.

Figure 2-5 CNEL Contours: F-35C Scenario Compared to Updated ROD Scenario

(This page intentionally left blank.)

CHAPTER 3
AIR QUALITY

Air emissions associated with F-35 aircraft based at MCAS Miramar were examined to identify the net emissions resulting from implementing the "F-35C Scenario" as compared to the original emissions estimated for Alternative 1 in the 2010 EIS, which was adopted in the 2010 ROD.

3.1 AIR QUALITY METHODOLOGY

Emissions were calculated for the installation using an F-35 worksheet with the Karnes 2 profiles used in the 2010 EIS, developed and published in *Detailed Description of F-35A/B/C Flight Profiles, US Air Force, US Navy and US Marine Corps Airfield Noise Studies, Version: Karnes 2* (Wyle 2009). Flight operations were obtained from Air Quality data Miramar.xls, provided by Geoff Olander, Cardno. USMC provided flight hours used for calculating engine maintenance run-ups. Ground support equipment, transients, and ground-vehicle emissions were not included because they are assumed to be unaffected by the F-35C Scenario.

3.2 AIR QUALITY SETTING

MCAS Miramar is located in the San Diego Air Basin (SDAB), which is in moderate nonattainment of National Ambient Air Quality Standards for ozone. Ozone is created through the photochemical reaction of volatile organic compounds (VOC) and oxides of nitrogen (NO_x), so the San Diego Air Pollution Control District (SDAPCD) has established *de minimis* levels above which General Conformity requirements are applicable per the Federal Clean Air Act. The *de minimis* level for VOC is 100 tons per year (tpy), as is the *de minimis* level for NOx. Additionally The SDAB is a "maintenance" area for carbon monoxide (CO), and the SDAPCD has set 100 tpy as the *de minimis* level for CO.

The 2010 EIS showed that Alternative 1 (adopted in the 2010 ROD) would improve air quality relative to the legacy F/A-18 baseline, reducing CO emissions by 1,627 tpy, NO_x emissions by 55 tpy, VOC emissions by 573 tpy, particulate matter (PM_{10}) emissions by 211 tpy, and particulate matter ($PM_{2.5}$) emissions by 206 tpy.

3.3 RESULTS

Results displayed in Table 3-1 indicate that the replacement of 32 F-35B aircraft with 20 F-35C aircraft at MCAS Miramar would further reduce emissions of CO, NO_x, sulfur dioxide (SO_2), and particulate matter. Small increases in CO and VOC emissions (81 tpy and 5 tpy respectively) would be below *de minimis* levels. Moreover, compared to the legacy F/A-18 baseline, the F-35B Scenario cuts VOC emissions by 568 tpy, and CO emissions by 1546 tpy. Appendix A contains the Air Quality calculations.

Table 3-1 Summary of Comparison of 2010 ROD and "F-35C Scenario", MCAS Miramar Annual Emissions

Activity	Metric Tons	Tons				
	CO_2	CO	NOx	VOCs	SO_2	PM
Proposed "F-35C Scenario"	**51,191**	**166**	**184**	**8**	**17**	**2**
Baseline "2010 ROD"						
F35B Operations	102,485	79.28	309	3.18	32.22	2.89
Engine Maintenance	5,955	5.54	37.40	0.19	4.13	0.23
Baseline "2010 ROD" Total	**98,375**	**84.82**	**346.4**	**3.37**	**36.35**	**3.12**
Net Change	**-47,184**	**81**	**-163**	**5**	**-19**	**-1**
de Minimis	NA	100	100	100	NA	NA
Exceedance?	-	No	No	No	-	-

Notes: CO_2 = carbon dioxide; CO = carbon monoxide; NOx = nitrogen oxides; VOCs = volatile organic compounds SO_2 = sulfur dioxide; PM = particulate matter.

CHAPTER 4
REFERENCES

Cardno. 2017. NOISEMAP 7 output files, March-August.

USMC. 2010. *Final Environmental Impact Statement for the West Coast Basing of the F-35B*. October.

USMC. 2017. *Marine Aviation Plan*. January.

Wasmer Consulting. 2006. *BaseOps 7.3 User's Guide*, Fred Wasmer and Fiona Maunsell, Wasmer Consulting.

Wyle. 1998. *NMAP 7.0 User's Manual. Wyle Research Report WR 98-13*, Czech and Plotkin, November.

Wyle. 2009. *Detailed Description of F-35A/B/C Flight Profiles, US Air Force, US Navy and US Marine Corps Airfield Noise Studies, Version: Karnes 2.*

Wyle. 2014. *Discussion of Noise and Its Effect on the Environment WR 13-11*, Czech, Plotkin, Sharp, and Rachami, January.

Wyle. 2015. *WR 15-01 F-35A/B/C Flight Profiles (Karnes3.2) for U.S. Air Force, U.S. Navy, and U.S. Marine Corps Airfield Noise and Air Studies*. January.

(This page intentionally left blank.)

CHAPTER 5
LIST OF PREPARERS AND CONTRIBUTORS

This report was prepared by Cardno under the direction of NAVFAC SW, HQMC, MCIWEST, and MCAS Miramar. Professional contributors are listed below.

NAVFAC SW
Ryan Maynard, USMC Integrated Product Team, Project Manager
Robert Henderson, Navy Region Southwest Encroachment Office

HQMC
Major D'Ambrogi, HQMC Aviation - F-35 Strategy & Integration
Ron Lamb HQMC, National Environmental Policy Act Specialist
Brian Wottowa, HQMC Aviation - Logistics Support Branch (ASL-35)

MCIWEST
Zak Likins, Regional Planning Manager

MCAS Miramar
Kristin Camper, Community Plans and Liaison Office
Tony Guinn, Airfield Manager/Asst. Airfield OPSO
David Norton, F35 Program, 1st MAW G5, 3rd MAW G3
LtCol Robinson, Executive Officer
Susan Van Winkle, Assistant Environmental Director

Cardno
Stella Acuña, Project Manager, 29 years' experience
B.A., Environmental Design and Planning

Leslie Hamilton, Air Quality Specialist, 29 years' experience
B.A., Chemistry

Geoff Olander, LtCol USMC (Ret), Noise Specialist, 28 years' experience
B.S., Mechanical Engineering

Jacqueline Clark, Graphics, 10 years' experience
B.S., Business Administration

(This page intentionally left blank.)

APPENDIX A
AIR QUALITY CALCULATIONS

(This page intentionally left blank.)

Table A-1. Emissions for Proposed F-35B Short Take Off Verticle Landing (STOVL) Flight Operations Using the Karnes 2 Profiles

The sheet evaluates flight emissions from four 16-plane squadrons of F-35B aircraft.

Profile	Type	Number of Profiles	Flight Emissions (lb/operation)					
			CO_2	CO	NO_x	HC	SO_2	PM
P1-Max Afterburner Takeoff then Mil Climb	Departure	2,889	5,269,004	17,440.48	23,341.63	< 194.447	1,587.77	1,291.00
P2-Mil Takeoff, Mil Climb	Departure	2,889	3,479,656	420.10	27,150.36	< 3.398	1,048.56	111.18
P3-F-35B Short Takeoff (STO)	Departure	7,061	10,851,308	1,289.57	85,567.39	< 10.781	3,269.94	347.66
	Subtotal	*12,839*						
P11-F-35B Overhead Break/Carrier Break Arrival to Slow Landing (SL)	Arrival	8,007	14,071,204	4,269.40	54,552.17	< 103.143	4,240.23	357.68
P15-F-35B Straight-in Arrival to Slow Landing (SL)	Arrival	3,766	4,588,559	1,478.74	17,949.39	< 38.625	1,382.72	117.24
P17-F-35B Straight-in Arrival to Vertical Landing (VL)	Arrival	1,066	2,316,727	559.80	12,451.20	< 11.740	698.12	65.31
	Subtotal	*12,839*						
P5-F-35B Conventional Landing from "Pattern"	Pattern	604	426,045	109.72	1,754.52	< 1.930	128.38	10.89
P7-F-35B Rolling Vertical Landing (RVL) from "Pattern"	Pattern	1,409	1,773,128	367.87	9,390.46	< 4.992	534.32	49.05
P23-F-35B Touch and Go/Carrier Pattern for Conventional Landings (Takeoff Portion)	Pattern	604	438,820	59.32	3,208.52	< 0.509	132.23	13.94
P25-F-35B STOVL Pattern Takeoff Portion (Austere Ops)	Pattern	1,409	664,052	83.87	5,011.80	< 0.614	200.11	21.39
P26-IFR Pattern	Pattern	250	1,467,178	441.60	5,839.99	< 11.817	442.12	38.14
F-35B Annual Emissions in pounds per year		**29,954**	**45,345,684**	**26,520.47**	**246,217.43**	**< 381.996**	**13,664.51**	**2,423.48**
F-35B Annual Emissions in tons per year			**22,673**	**13.3**	**123.1**	**0.2**	**6.8**	**1.2**

Reference:

JSF Emissions Package_2011-12-28.xls. Received from Flint Webb, SAIC (Leidos), 2012.

Table A-2. Emissions for Proposed F-35C Carrier Variant (CV) Flight Operations Using the Karnes 2 Profiles

This sheet evaluates flight emissions from two 10-plane squadrons of F-35C aircraft.

Profile	Type	Number of Profiles	Flight Emissions (lb/operation)					
			CO_2	CO	NO_x	HC	SO_2	PM
P1-Max Afterburner Takeoff then Mil Climb	Departure	903	1,657,684	5,503.86	7,060.12	< 61.365	499.53	406.80
P2-Mil Takeoff, Mil Climb	Departure	3,109	3,746,095	506 44	27,365.19	< 4 290	1,128 85	119 77
	Subtotal	*4,012*						
P10-F-35C Overhead Break/Carrier Break Arrival	Arrival	2,742	4 780.579	1,512 99	17,755 38	< 38 337	1,440 58	121 66
P14-F-35A/B/C Straight-in Arrival (NMAP & AAM)	Arrival	1,271	1,373,747	488.53	4,953.22	< 13.570	413.97	34.72
	Subtotal	*4,013*						
P22-F-35C Touch and Go/Carrier Pattern*	Pattern	2,038	4,356,588	935.51	22,480.91	< 13.758	1,312.82	122.27
P26-IFR Pattern*	Pattern	78	446,134	141 88	1,698 76	< 4 046	134 44	11 64
F-35C Annual Emissions in pounds per year		**10,141**	**16,360,827**	**9,089.22**	**81,313.58**	**< 135.366**	**4,930.19**	**816.86**
F-35C Annual Emissions in tons per year			**8,180**	**4.5**	**40.7**	**0.1**	**2.5**	**0.4**

*Pattern operations are counted as 2 operations.

Reference:

JSF Emissions Package_2011-12-28.xls. Received from Flint Webb, SAIC (Leidos), 2012.

Table A-3. Emissions from Proposed Action Ground Operations for F-35B/C

This sheet evalautes the F-35B and F-35C ground operation emissions prior to and after flight.

F-35B Ground Operations Emissions - Departure (w/o Bump Up)

Mode/Starting Point for Leg	Power	Time (min)	Emissions (lb)					
			CO_2	CO	NOx	HC	SO_2	PM
IPP Use	Main Engine Start	0.58	4	0.00	0.01	< 0.000	0.00	0.00
Start/Warm Up	GI (10% ETR)	6.00	647	3.74	0.43	< 0.098	0.19	0.02
Unstick	35% ETR	0.08	32	0.01	0.10	< 0.000	0.01	0.00
Taxi	GI (10% ETR)	6.00	649	3.69	0.43	< 0.097	0.20	0.02
Unstick	35% ETR	0.08	32	0.01	0.10	< 0.000	0.01	0.00
Taxi to position & hold	GI (10% ETR)	0.50	54	0.31	0.04	< 0.008	0.02	0.00
Number of F-35B Departures:	**12,839**	**169988.36**	**18,211,306**	**99,734**	**14,248**	**2,615**	**5,474**	**458**
	Annual Emissions in tons per year		**9,106**	**49.9**	**7.1**	**1.3**	**2.7**	**0.2**

F-35B Ground Operations Emissions - Arrival (w/o Bump Up)

Mode/Starting Point for Leg	Power	Time (min)	Emissions (lb)					
			CO_2	CO	NOx	HC	SO_2	PM
Rollout to taxiway	FI (15% ETR)	0.55	100	0.10	0.16	< 0.005	0.03	0.00
Weapon check	GI (10% ETR)	3.00	323	1.87	0.21	< 0.049	0.10	0.01
Unstick	35% ETR	0.08	34	0.01	0.11	< 0.000	0.01	0.00
Taxi	GI (10% ETR)	3.00	326	1.92	0.22	< 0.048	0.10	0.01
Hot refuel	GI (10% ETR)	7.00	754	4.37	0.50	< 0.114	0.23	0.02
Unstick	35% ETR	0.08	34	0.01	0.11	< 0.000	0.01	0.00
Taxi to park & shutdown	GI (10% ETR)	0.60	65	0.36	0.04	< 0.010	0.02	0.00
Number of F-35B Arrivals:	**12,839**	**183,803.12**	**21,002,690**	**109,754**	**17,274**	**2,903**	**6,329**	**527**
	Annual Emissions in tons per year		**10,501**	**54.9**	**8.6**	**1.5**	**3.2**	**0.3**

F-35C Ground Operations Emissions - Departure

Mode/Starting Point for Leg	Power	Time (min)	Emissions (lb)					
			CO2	CO	NOx	HC	SO2	PM
IPP Use	Main Engine Start	0.58	4	0.00	0.01	< 0.000	0.00	0.00
Start/warm-up	Ground Idle (10% ET	6.00	615	4.99	0.31	< 0.110	0.19	0.02
Unstick	35% ETR	0.08	31	0.01	0.09	< 0.000	0.01	0.00
Taxi/Weapon Check	Ground Idle (10% ET	6.00	617	4.83	0.32	< 0.108	0.19	0.02
Unstick	35% ETR	0.08	31	0.01	0.09	< 0.000	0.01	0.00
Taxi to position & hold	Ground Idle (10% ET	0.50	51	0.40	0.03	< 0.009	0.02	0.00
Number of F-35C Departures:	**4,012**	**13.24**	**5,416,701**	**41,128**	**3,471**	**913**	**1,628**	**138**
	Annual Emissions in tons per year		**2,708**	**20.6**	**1.7**	**0.5**	**0.8**	**0.1**

F-35C Ground Operations Emissions - Arrival

Mode/Starting Point for Leg	Power	Time (min)	Emissions (lb)					
			CO2	CO	NOx	HC	SO2	PM
Rollout to taxiway	Flight Idle (15% ETR)	0.55	98	0.11	0.15	< 0.005	0.03	0.00
Weapon check	Ground Idle (10% ET	3.00	308	2.50	0.16	< 0.055	0.09	0.01
Unstick	35% ETR	0.08	32	0.01	0.10	< 0.000	0.01	0.00
Taxi	Ground Idle (10% ET	3.00	310	2.38	0.16	< 0.054	0.09	0.01
Hot refuel	Ground Idle (10% ET	7.00	718	5.83	0.36	< 0.128	0.22	0.02
Unstick	35% ETR	0.08	32	0.01	0.10	< 0.000	0.01	0.00
Taxi to park & shutdown	Ground Idle (10% ET	0.60	62	0.48	0.03	< 0.011	0.02	0.00
Number of F-35C Arrivals:	**4,013**	**14.31**	**6,258,110**	**45,405**	**4,273**	**1,016**	**1,886**	**160**
	Annual Emissions in tons per year		**3,129**	**22.7**	**2.1**	**0.5**	**0.9**	**0.1**

Reference:

JSF Emissions Package_2011-12-28.xls. Received from Flint Webb, SAIC (Leidos), 2012.

Table A-4. Proposed Action Maintenance Built In Test (MBIT) Emissions

This sheet evaluates air emissions from engine maintenance activities for F-35B and F-35C aircraft.

MBIT Operating Time		Engine Flight Hours	HS/LT + GIDLE MBIT, Emissions (lb)					
			CO_2	CO	NO_x	HC	SO_2	PM
STOVL, HS/LT MBIT Operating Time (min/KEFH)	11.42	16,000	215,680	790.06	323.23	< 19.731	64.99	5.52
STOVL, GIDLE MBIT Operating Time (min/KEFH)	75.10							
		Tons/Year	107.8	0.4	0.2	0.0	0.0	0.0
CV, HS/LT MBIT Operating Time (min/KEFH)	8.38	6,000	46,583	201.37	77.38	< 4.226	14.04	1.21
CV, GIDLE MBIT Operating Time (min/KEFH)	38.10							
		Tons/Year	23.3	0.1	0.0	0.0	0.0	0.0

Reference:

JSF Emissions Package_2011-12-28.xls. Received from Flint Webb, SAIC (Leidos), 2012.

Table A-5. Total Annual Propsed Action Emissions for the F-35 Variants

Profile		Number	Parameter	Annual Emissions (lb)					
				CO_2	CO	NO_X	HC	SO_2	PM
F-35B	Flight Operations	29953.5	Profiles	45,345,684	26,520.47	246,217.43	< 404.916	13,664.51	2,423.48
	Ground Operations (w/o Bump Up) - Departure	12,839	Departures	18,211,306	99,734.35	14,248.08	< 2771.833	5,473.52	457.76
	Ground Operations (w/o Bump Up) - Arrival	12,839	Arrivals	21,002,690	109,753.61	17,273.59	< 3077.374	6,328.97	527.06
	MBIT: High Speed Low Thrust (HS/LT) + Ground Idle (GIDLE)	16,000	Engine Hours	215,680	790.06	323.23	< 20.915	64.99	5.52
F-35C	Flight Operations	10,141	Profiles	16,360,827	9,089.22	81,313.58	< 143.488	4,930.19	816.86
	Ground Operations - Departure	4,012	Departures	5,416,701	41,127.73	3,470.73	< 968.296	1,627.76	138.44
	Ground Operations - Arrival	4,013	Arrivals	6,258,110	45,404.51	4,272.50	< 1077.299	1,885.82	159.63
	MBIT: High Speed Low Thrust (HS/LT) + Ground Idle (GIDLE)	6,000	Engine Hours	46,583	201.37	77.38	< 4.479	14.04	1.21
Total Emissions per year (pounds)				**112,857,580**	**332,621**	**367,197**	**8,469**	**33,990**	**4,530**
Total Emissions (tons)				**56,429**	**166.3**	**183.6**	**8.5**	**17.0**	**2.3**

(This page intentionally left blank.)