AIRCRAFT NOISE ENVIRONMENTAL MANAGEMENT RESOURCE BOOK

148TH FIGHTER WING
DULUTH INTERNATIONAL AIRPORT, MINNESOTA

NOVEMBER 2005

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ACRONYMS

148 FG	148th Fighter Group
148 FW	148th Fighter Wing
179 FIS	179th Fighter Interceptor Squadron
AFCEE	Air Force Center for Environmental Excellence
AICUZ	Air Installation Compatible Use Zone
CP	closed pattern
dBA	A-weighted sound level measured in decibels
DNL	Day-Night Average A-Weighted Sound Level
DoD	Department of Defense
Duluth IAP	Duluth International Airport
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FICAN	Federal Interagency Committee on Aviation Noise
FICON	Federal Interagency Committee on Noise
FICUN	Federal Interagency Committee on Urban Noise
ILS	instrument landing system
INM	Integrated Noise Model
JSF	Joint Strike Fighter
MNANG	Minnesota Air National Guard
MOA	military operations area
MSA	Metropolitan Statistical Area
MSL	Mean Sea Level
Part 77	Federal Aviation Regulation Part 77, *Objects Affecting Navigable Airspace*
Part 150	Federal Aviation Regulation Part 150, *Airport Noise Compatibility Planning*
RPZ	runway protection zone
SEL	Sound Exposure Level
SFO	simulated flamed out
UFC	Unified Facilities Criteria
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
U>S>	United States

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SECTION 1
INTRODUCTION

1.1 PURPOSE FOR THIS RESOURCE BOOK

This Resource Book was prepared to document aircraft noise and land use for the 148th Fighter Wing (148 FW) and its F-16C mission. The data is based on the Wing's October 2004 operation of fifteen F-16C fighter aircraft. Additionally, the Resource Book presents noise impacts for three potential 148 FW fighter aircraft operation conditions. The data is available for use in subsequent National Environmental Policy Act environmental impact analysis process documentation related to 148 FW mission changes. The information in this Resource Book is for Air National Guard and 148 FW internal planning purposes only. It is not releasable to the public until incorporated into an environmental impact statement or environmental assessment.

1.2 HISTORY OF THE DULUTH INTERNATIONAL AIRPORT AND THE 148TH FIGHTER WING

DULUTH INTERNATIONAL AIRPORT

The City of Duluth purchased the original property for the airport in 1929 from St. Louis County. The airport was constructed on 640 acres of land with two 2,650-foot sod runways. Subsequently, in 1930, the airfield was dedicated as a public airport. The airport was called the Williamson-Johnson Municipal Airport until 1963, at which time it was renamed Duluth International Airport (Duluth IAP) (Duluth 2005).

After World War II, the United States (U.S.) Air Force (USAF) constructed permanent and semi-permanent facilities on land leased from the City of Duluth. Beginning in 1948, the Minnesota Air National Guard (MNANG) built permanent facilities on the east end of the field. The USAF has since phased out its facilities, but the MNANG continues its operations (Duluth 2005).

In 1942, the three existing runways were paved. Each runway was 4,000 feet long, 150 feet wide, and at nearly equal angles from each other, 30, 90, and 130 degrees. They were identified as runways 3-21, 9-27, and 13-31 respectively. The United States Army Corps of Engineers extended runway 9-27 and Runway 3-21 to 5,699 feet in 1945. The USAF extended Runway 9-27 to 9,000 feet with a 1,000-foot overrun in 1951. Runway 9-27 was completely rebuilt in 1956 and further extended in 1966 to 10,152 feet in length (Duluth 2005).

The original terminal building was built in 1954, south of Runway 9-27, on the west side of Runway 3-21 and served the airport for nearly 20 years. The terminal floor area was 14,200 square feet with 280 parking spaces (Duluth 2005).

In 1974, a new Terminal Building and U.S. Customs, International Arrivals Building, were completed east of Runway 3-21 and opened for operation. Runway 13-31 was shortened to 2,578 feet to accommodate construction of an addition to the International Arrivals building. This resulted in Runway 13-31 being closed as a runway due to obstructions. Runway 13-31 was subsequently re-striped in 1980, decreasing its width to 75 feet, for use as a taxiway only. In 1989, the new Terminal building and the adjacent structures were connected to form one enclosure. The original terminal building was then converted for use as offices for general aviation, the Federal Aviation Administration (FAA), and the U.S. Weather Bureau (Duluth 2005).

148TH FIGHTER WING

The 148th Fighter Wing (FW) is an F-16 equipped, general purpose fighter unit tasked to support worldwide war plans, contingency operations, the Homeland Security/Homeland Defense mission, and to ensure air sovereignty of North America by providing surveillance, attack warning, and attack assessment. It also executes air superiority and both defensive and offensive counter air missions, and maintains a 24-hour/365 day a year U.S. Northern Command alert force at their home station.

The Duluth IAP encompasses approximately 2,000 acres and the 148 FW facilities are located on leased property at several locations in the vicinity of the east-west runway (Runway 09-27). The 148 FW base is located on the east side of the airport. The City of Duluth owns Runway 09-27 and supporting taxiways. Ownership of the remaining airport property is divided among the federal government, the State of Minnesota, and the City of Duluth. The USAF Air Combat Command, which conducted activities at the airport from 1959 until 1981, no longer operates any facilities at the airport.

The 179th Fighter Interceptor Squadron (179 FIS) was established at the Duluth IAP in September 1948 and was assigned the F-51D “Mustang” aircraft. Construction of the present MNANG Base also began at this time. The unit was activated during the Korean War for 21 months. In 1954, The 179 FIS received the F-94A/B aircraft, which was replaced with the supersonic F-94C “Starfire” in April 1957. The unit began flying the F-89J “Scorpion” in July 1959.

The 179 FIS was redesignated the 148th Fighter Group (148 FG) in July 1960 and continued to fly the F-89J aircraft. The unit flew the F-102 “Delta Dart” from 1967 to 1971 and then, for the next five years flew the F-101 “Voodoo” aircraft. The 148 FG was redisignated as the 148th Tactical Reconnaissance Group in 1976 and was assigned the RF-4C aircraft. In October 1983 the unit returned to an air defense mission with the arrival of the F-4D “Phantom” aircraft and the unit was renamed the 148th Fighter Interceptor Group. The unit received the first of 18 F-16ADF “Falcon” aircraft in July 1990, which is still flown by the unit. In June 1992 the unit was redesignated as the 148 FG and then, in 1995, renamed as the 148 FW. Table 1-1 lists the chronology of aircraft conversions and recent unit deployments.

Table 1-1 Summary of 148th Fighter Wing Aircraft Conversions and Recent Unit Deployments

Aircraft Conversion	Year	Deployments/Country	Year
Unit established, F-51D	September 1948	Air Sovereignty Alert at Duluth IAP	1983 to present
F-51 to F-94A/B	April 1954	Air Sovereignty Alert at Tyndall AFB	1992 to 2002
F-94A/B to F-94C	April 1957	Balad AB, Iraq	2005
F-94C to F-89J	July 1959	--	--
F-89J to F-102	1967	--	--
F-102 to F-101	1971	--	--
F-101to RF-4C	1976	--	--
RF-4C to F-4D	1983	--	--
F-4D to F-16	July 1990	--	--

SECTION 2
AIRCRAFT FLIGHT TRACK AND AIRCRAFT MAINTENANCE RUNUP DATA

Aircraft operations data were collected by interviewing 148 FW pilots and aircraft maintenance personnel, air traffic control tower personnel, and the Duluth IAP manager in October 2004. The data were verified through reviews by individuals from the interviewed organizations, with final validation occurring on February 25, 2005. This section contains general airfield data and specific aircraft operations, flight track, and fight profile data for 148 FW F-16C, transient military, general aviation, and Duluth IAP air carrier, air taxi, and air cargo operations. The section also contains the aircraft maintenance runup data for the 148 FW. The aircraft and aircraft maintenance engine runup data in this section were used to produce the noise contours used for the analyses in this Resource Book.

2.1 GENERAL AIRFIELD DATA

Table 2-1 contains in formation on the date of data collection, the magnetic declination, airfield elevation, and average monthly temperature and relative humidity. Table 2-2 contains the magnetic heading, length, glide slope used for the noise study, and the latitude and longitude of the runway ends. Table 2-3 lists the climatological data for Duluth IAP.

Table 2-1 Duluth International Airport Data

Installation:	Duluth IAP, MN
Date:	January 2005
Magnetic Declination:	2.0°E
Airfield Elevation:	1,428’ MSL
Temperature:	39°
Humidity:	71%

Table 2-2 Duluth International Airport Runway Data

Runway Data					
Runway	Magnetic		Glide	Departure Threshold	
Number	Heading	Length	Slope	Latitude	Longitude
03	030°	5,699 feet	3.0°	46°50.146 N	92°11.295 W
21	210°	5,699 feet	3.0°	46°50.945 N	92°10.580 W
09	091°	10,152 feet	3.0°	46°50.547 N	92°13.217 W
27	271°	10,152 feet	3.0°	46°50.481 N	92°10.786 W

Table 2-3 Climatological Data

Climatological Data		
Month	**Average Temperature (F)**	**Average Relative Humidity (%)**
January	10	66
February	15	61
March	25	60
April	39	50
May	52	48
June	60	55
July	66	54
August	63	58
September	54	59
October	43	56
November	28	65
December	14	69

The above information is taken from the Operational Climatic Data Summary for Duluth IAP, prepared by AFCCC/DOS. Table 2-4 presents the averaged temperature and humidity data for Duluth IAP.

Table 2-4 Averaged Temperature and Humidity Data

Temperature Data averaged:	1973	to	1996
Humidity Data averaged:	1973	to	1996

Temperature and relative humidity affect the sound absorption capabilities of the air. Using the average monthly temperature and average monthly relative humidity, the air absorption coefficient for each month is calculated and ranked from largest to smallest. The air absorption coefficient that falls in the middle of this ranking (the median) is the coefficient chosen to represent the typical sound absorption conditions at the installation. For this installation, the results are as follows: Table 2-5 lists the absorption coefficient data for Duluth IAP.

Table 2-5 Absorption Coefficient Data for Duluth International Airport

The Median Absorption Coefficient is the coefficient for the month of:		April
Standard Temperature is	39°	(Average temperature for month with median absorption coefficient)
Standard Relative Humidity is	71%	(Average relative humidity for month with median absorption coefficient)

2.2 148TH FIGHTER WING AIRCRAFT OPERATIONS DATA

The 148 FW had 15 F-16C aircraft and 32 pilots in October 2004. The following table contains information associated with annual 148 FW deployments. Only the departures to the deployment location and the arrivals returning from the deployment were used for noise modeling at Duluth IAP. Table 2-6 lists 148 FW deployment information.

Table 2-6 148th Fighter Wing Deployment Information

Deployment Information	
annual 2-week deployments	3
sorties per deployed flying day	12
flying days per deployment	10
annual sorties during deployment	360
aircraft per deployment	6
flying hours during deployment	504
Annual 148 FW Departures to/Arrivals from Deployment	
Departures: 18 (1% of total annual departures)	
Arrivals: 18 (1% of total annual arrivals)	

Table 2-7 lists sortie duration, flying days, flying hours, and the annual sorties at Duluth IAP for 148 FW aircraft.

Table 2-7 148th Fighter Wing Sortie and Flying Days Information

148 FW Sortie and Flying Days/Hours Information	
avg. sortie duration (hours)	1.4
flying days every 2 weeks	9
annual flying days at Duluth	234
annual flying hour program	4,000
flying hours during deployment	504
annual flying hours at Duluth	3,496
total annual sortie requirement	2,857
annual sorties during deployment	360
annual sorties at Duluth IAP	2,544
(annual sorties includes 47 local sorties by non-148 FW F-16s; see Section 2.3)	

Table 2-8 lists the annual arrivals and departures based on the preceding sortie information.

Table 2-8 148th Fighter Wing Annual Day/Night Arrival Data

Annual Day/Night Arrivals				
			day	night
annual night arrivals	100	local sortie arrivals	2,444	100
annual day arrivals	2,444	deployment sortie arrivals	18	0
annual departures	2,544	local sortie departures	2,544	0
nighttime is 2200-0700		deployment sortie departures	18	0

There are four basic arrival types: straight-in (visual or instrument); straight-in simulated flamed out (SFO); overhead SFO; and initial to overhead. Table 2-9 identifies the types and number of events for each arrival type.

Table 2-9 148th Fighter Wing Arrival Profiles and Events per Arrival Type

Arrival Profiles and Events per Arrival Type			
ILS straight-in	events	initial to overhead	events
arrival	1	arrival to initial	1
full stop landing	1	break	1
straight-in SFO	events	low approach	0.5
SFO arrival	1	closed pattern SFO	0.5
low approach	1	low approach	0.5
closed pattern	1	closed pattern	0.5
full stop landing	1	full stop landing	1
overhead SFO	events		
SFO	1		
low approach	1		
closed pattern	1		
full stop landing	1		

Table 2-10 contains specific information related to arrivals.

Table 2-10 148th Fighter Wing Arrival Information

all night arrivals (2200-0700) are ILS straight-in
50% of initial to overhead arrivals are full stop on arrival
50% of initial to overhead arrivals have closed pattern SFO followed by closed pattern full stop
all other arrivals are ILS straight-in full stop
all other departures are straight-out
initial to overhead breaks are to the right
SFOs are to north side of runway 09/27
closed patterns are right turns

Table 2-11 lists the percents of arrivals and departures from/to the respective military operations area (MOA) and the annual arrival and departures based on the percents.

Table 2-11 148th Fighter Wing Arrivals from and Departures to Military Operations Areas

Departures to/Arrivals from:	
Volk	10%
Beaver MOA	25%
Big Bear MOA	25%
Snoopy MOA	40%

Annual Arrivals from:	day	night
Volk	244	10
Beaver MOA	611	25
Big Bear MOA	611	25
Snoopy MOA	978	40
other arrivals	18	0
total	2,462	100

Annual Departures to:	day	night
Volk	254	0
Beaver MOA	636	0
Big Bear MOA	636	0
Snoopy MOA	1,018	0
other straight-out	18	0
total	2,562	0

Table 2-12 details the average daily departures and arrivals, the percents of runway use, the percents of use for the various arrivals, and afterburner use. Afterburner use varies throughout the year and the use rate for the noise modeling reflects an average day over the course of a year. Average daily operations are determined by using 234 flying days per year.

Table 2-12 148th Fighter Wing Average Daily Arrivals, Departures, Runway Use, and Afterburner Use

Average Daily Arrivals from:				Average Daily Departures to:			
	day	night	total		day	night	total
Volk	1.042735	0.042735	1.08547	Volk	1.08547	0	1.08547
Beaver MOA	2.611111	0.106838	2.717949	Beaver MOA	2.717949	0	2.717949
Big Bear MOA	2.611111	0.106838	2.717949	Big Bear MOA	2.717949	0	2.717949
Snoopy MOA	4.179487	0.17094	4.350427	Snoopy MOA	4.350427	0	4.350427
other arrivals	0.076923	0	0.076923	other straight out	0.076923	0	0.076923
total	10.52137	0.42735	10.94872	total	10.94872	0	10.94872

Runway Use:			% of Arrivals:		Afterburner on Departure:	
runway	arrival	departure	ILS straight-in	30%	On:	70%
9	30%	20%	straight-in SFO	15%	Off:	30%
27	70%	80%	overhead SFO	15%		
			initial to overhead	40%		

The closed pattern data in Table 2-13 are based on the information in the two preceding tables. A closed pattern event is one full closed pattern and includes the full event from takeoff to landing. Thus, there are two operations per closed pattern event (*i.e.*, one takeoff and one landing) and the event data in the table is doubled to determine aircraft operations.

Table 2-13 148th Fighter Wing Closed Pattern Information

Annual Arrivals on which Closed Patterns are Flown:		
sortie type	arrivals	
straight-in SFO	367	
overhead SFO	367	
initial to overhead	978	
Annual Closed Patter Events by Sortie Type and Closed Pattern Type:		
sortie type	SFO cp	normal closed pattern
straight-in SFO	0	367
overhead SFO	0	367
initial to overhead	489	489
total	489	1,223
Average Daily Closed Pattern Events (No Nighttime 2200-0700):		
cp type	events	
SFO cp	2.08974	
normal cp	5.22650	
total	7.31624	
Closed Pattern Runway Use:		
Runway 9	30%	
Runway 27	70%	

Table 2-14 contains a description of each flight track and lists the flight track identification codes for the individual flight tracks. The codes are from the noise model files and correspond to the individual flight track figures in Appendix B.

Table 2-14 148th Fighter Wing Flight Track Descriptions

Flight Track Codes and Descriptions	
Track ID	Track Description
27AE	other arrivals straight-in ILS from east
27AE	straight-in ILS from Big Bear MOA
27AE	straight-in SFO from Big Bear MOA
27AC	overhead SFO from Big Bear MOA
27AD	overhead to initial from Big Bear MOA
27AF	straight-in ILS from Snoopy MOA
27AG	straight-in SFO from Snoopy MOA
27AH	overhead SFO from Snoopy MOA
27AI	overhead to initial from Snoopy MOA
27AF	straight-in ILS from Beaver MOA
27AG	straight-in SFO from Beaver MOA
27AH	overhead SFO from Beaver
27AI	overhead to initial from Beaver MOA
27AN	straight-in ILS from Volk
27AO	straight-in SFO from Volk
27AP	overhead SFO from Volk
27AQ	overhead to initial from Volk
09AE	other arrivals straight-in ILS from west
09AA	straight-in ILS from Big Bear MOA
09AB	straight-in SFO from Big Bear MOA
09AC	overhead SFO from Big Bear MOA
09AD	overhead to initial from Big Bear MOA
09AF	straight-in ILS from Snoopy MOA
09AG	straight-in SFO from Snoopy MOA
09AH	overhead SFO from Snoopy MOA
09AI	overhead to initial from Snoopy MOA
09AE	straight-in ILS from Beaver MOA
09AE	straight-in SFO from Beaver MOA
09AL	overhead SFO from Beaver
09AM	overhead to initial from Beaver MOA
09AN	straight-in ILS from Volk
09AO	straight-in SFO from Volk
09AP	overhead SFO from Volk
09AQ	overhead to initial from Volk
27DA	south departure to Big Bear MOA no AB
27DA	south departure to Big Bear MOA with AB
27DI	north departure to Big Bear MOA no AB
27DI	north departure to Big Bear MOA with AB
27DJ	south departure to Volk no AB
27DJ	south departure to Volk with AB
27DB	straight-out west departure no AB
27DB	straight-out west departure with AB

Table 2-14 148th Fighter Wing Flight Track Descriptions (*continued*)

Flight Track Codes and Descriptions	
Track ID	Track Description
27DC	departure to Beaver MOA no AB
27DC	departure to Beaver MOA with AB
27DD	radar trail departure to Snoopy MOA no AB
27DD	radar trail departure to Snoopy MOA with AB
27DG	visual departure to Snoopy MOA no AB
27DG	visual departure to Snoopy MOA with AB
09DH	departure to Beaver MOA no AB
09DH	departure to Beaver MOA with AB
09DA	visual departure to Snoopy MOA no AB
09DA	visual departure to Snoopy MOA with AB
09DB	IFR departure to Snoopy MOA no AB
09DB	IFR departure to Snoopy MOA with AB
09DC	departure to Volk no AB
09DC	departure to Volk with AB
09DF	straight-out east departure no AB
09DF	straight-out east departure with AB
09DF	straight-out east departure/Big Bear MOA departure no AB
09DF	straight-out east departure/Big Bear MOA departure with AB
27C1	SFO closed pattern (right turn)
27C2	standard closed pattern (left turn)
09C1	SFO closed pattern (left turn)
09C2	standard closed pattern (left turn)

Table 2-15 lists the average daily 148 FW operations used in the noise modeling. Appendix B contains the individual track/profile figures. 50 percent of the departures to Snoopy MOA are IFR/radar trail and 50 percent are visual. Likewise, 50 percent of the departures to Big Bear MOA from Runway 27 turn north and back to the east and 50 percent turn to the south and then back to the east.

Table 2-15 148th Fighter Wing Average Daily Flight Track Use

Average Day 148 FW F-16C Aircraft Operations (15 Aircraft Condition)					
note: all F-16 departures have 5 seconds at AB or military power, respectively, before brake release					
			operations		
	profile ID	track ID	day	night	total
	16AD	27AE	0.0538	0.2991	0.3529
	16AD	27AE	0.5483	0	0.5483
	16AB	27AEB	0.2742	0	0.2742
	16AC	27AC	0.2742	0	0.2742
	16A9	27AD	0.7311	0	0.7311
subtotal Big Bear MOA arrivals			1.8816	0.2991	2.1807
	16AF	27AF	0.8777	0	0.8777
	16AG	27AG	0.4388	0	0.4388
	16AI	27AH	0.4388	0	0.4388

Table 2-15 148th Fighter Wing Average Daily Flight Track Use (*continued*)

Average Day 148 FW F-16C Aircraft Operations (15 Aircraft Condition)					
note: all F-16 departures have 5 seconds at AB or military power, respectively, before brake release					
			operations		
	profile ID	track ID	day	night	total
	16AJ	27AI	1.1703	0	1.1703
subtotal Snoopy MOA arrivals			2.9256	0	2.9256
	16AF	27AF	0.5483	0	0.5483
	16AG	27AG	0.2742	0	0.2742
	16AI	27AH	0.2742	0	0.2742
	16AJ	27AI	0.7311	0	0.7311
subtotal Beaver MOA arrivals			1.8278	0	1.8278
	16AO	27AN	0.219	0	0.219
	16AP	27AO	0.1095	0	0.1095
	16AQ	27AP	0.1095	0	0.1095
	16AR	27AQ	0.292	0	0.292
subtotal Volk arrivals			0.7300	0	0.7300
subtotal runway 27 arrivals			7.365	0.2991	7.6641
	16A2	09AE	0.0231	0.1282	0.1513
	16AS	09AA	0.235	0	0.235
	16AT	09AB	0.1175	0	0.1175
	16AU	09AC	0.1175	0	0.1175
	16AV	09AD	0.3133	0	0.3133
subtotal Big Bear MOA arrivals			0.8064	0.1282	0.9346
	16AW	09AF	0.3762	0	0.3762
	16AX	09AG	0.1881	0	0.1881
	16AY	09AH	0.1881	0	0.1881
	16AZ	09AI	0.5015	0	0.5015
subtotal Snoopy MOA arrivals			1.2539	0	1.2539
	16AH	09AE	0.235	0	0.235
	16A2	09AE	0.1175	0	0.1175
	16A3	09AL	0.1175	0	0.1175
	16A4	09AM	0.3133	0	0.3133
subtotal Beaver MOA arrivals			0.7833	0	0.7833
	16A5	09AN	0.0938	0	0.0938
	16A6	09AO	0.0469	0	0.0469
	16A7	09AP	0.0469	0	0.0469
	16A8	09AQ	0.1251	0	0.1251
subtotal Volk arrivals			0.3127	0	0.3127
subtotal runway 09 arrivals			3.1563	0.1282	3.2845
subtotal arrivals			10.5213	0.4273	10.9486
	16DA	27DA	0.3262	0	0.3262
	16DB	27DA	0.761	0	0.761

Table 2-15 148th Fighter Wing Average Daily Flight Track Use (*continued*)

Average Day 148 FW F-16C Aircraft Operations (15 Aircraft Condition)					
note: all F-16 departures have 5 seconds at AB or military power, respectively, before brake release					
			operations		
	profile ID	track ID	day	night	total
	16D1	27DI	0.3262	0	0.3262
	16D2	27DI	0.761	0	0.761
	16D3	27DJ	0.2605	0	0.2605
	16D4	27DJ	0.6079	0	0.6079
	16DC	27DB	0.0185	0	0.0185
	16DD	27DB	0.0431	0	0.0431
	16DE	27DC	0.6523	0	0.6523
	16DF	27DC	1.5221	0	1.5221
	16DG	27DD	0.5221	0	0.5221
	16DH	27DD	1.2181	0	1.2181
	16DM	27DG	0.5221	0	0.5221
	16DN	27DG	1.2181	0	1.2181
subtotal runway 27 departures			8.7592	0	8.7592
	16DW	09DH	0.1631	0	0.1631
	16DX	09DH	0.3805	0	0.3805
	16DO	09DA	0.1305	0	0.1305
	16DP	09DA	0.3045	0	0.3045
	16DQ	09DB	0.1305	0	0.1305
	16DR	09DB	0.3045	0	0.3045
	16DS	09DC	0.0651	0	0.0651
	16DT	09DC	0.152	0	0.152
	16DU	09DF	0.0046	0	0.0046
	16DV	09DF	0.0108	0	0.0108
	16DU	09DF	0.1631	0	0.1631
	16DV	09DF	0.3805	0	0.3805
subtotal runway 09 departures			2.1897	0	2.1897
subtotal departures			10.9489	0	10.9489
	16CA	27C1	1.4628	0	1.4628
	16CB	27C2	3.6585	0	3.6585
subtotal runway 27 closed patterns			5.1213	0	5.1213
	16CC	09C1	0.6269	0	0.6269
	16CD	09C2	1.5679	0	1.5679
subtotal runway 09 closed patterns			2.1948	0	2.1948
subtotal closed patterns			7.3161	0	7.3161
total 148 FW F-16C			28.7863	0.4273	36.5297

Table 2-16 reflects how the aircraft operations for the 15 F-16C condition were adjusted to obtain the aircraft operations and aircraft maintenance engine runup data for the other three aircraft operations conditions that were modeled for this resource book.

Table 2-16 Adjustments for Modeling the 18 F-16C, 24 F-16C, and 18 Joint Strike Fighter Conditions

18 F-16C Condition Use the same flight tracks and profiles as the 15 F-16C condition. Increase the 15 F-16C operations by 20% for the three additional aircraft. Increase F-16C maintenance engine runups by 20% for the three additional aircraft.
24 F-16C Condition Use the same flight tracks and profiles as the 15 F-16C condition. Increase the 15 F-16C operations by 60% for the nine additional aircraft. Increase 15 F-16C maintenance engine runups by 60% for the nine additional aircraft.
18 Joint Strike Fighter Condition Use the same flight tracks and profiles as the 15 F-16C condition. Increase the 15 F-16C operations by 20% for the nine additional aircraft. Increase 15 F-16C maintenance engine runups by 20% for the nine additional aircraft. F-22 noise in NOISEMAP were used to model the JSF.
Other Aircraft Operations in each of the Conditions No change to the transient military, air carrier-air taxi, and general aviation from the 15 F-16C condition for any of the 3 additional conditions.

2.3 TRANSIENT MILITARY AIRCRAFT OPERATIONS DATA

Transient military aircraft operating at Duluth IAP include C-130s from the 133rd Airlift Wing (AW) and 934th AW, other aircraft types that receive service from the 148 FW, and F-16s that interfly training sorties with the 148 FW. Table 2-17 reflects background information for the C-130s.

Table 2-17 C-130 Sortie Data for Operations at Duluth International Airport

C-130 (133 and 934 AWs)
4 to 6 aircraft per month go to Duluth (prefer Rochester) Each aircraft spends 1 to 2 hours at Duluth
Sortie profile at Duluth is multiple approaches--radar, TACAN, ILS, PAR, overhead, and normal closed patterns random steep typically done at Fort Ripley closed patterns per sortie (provided by air traffic control tower personnel): 5--10
estimated radar closed patterns/sortie: 4 estimated visual CP per sortie: 7

Transient KC-135s also accomplish training at Duluth IAP. The KC-135 sortie data were provided by the 148 FW and air traffic control tower personnel provided sortie profile information. Table 2-18 reflects the events per sortie and the annual operations/events for the C-130s and KC-135s.

Table 2-18 C-130 and KC-135 Events and Annual Operations at Duluth International Airport

C-130 (133/934 AW)	events per sortie	events month	events annual	annual operations	KC-135 (profile provided by tower) sorties per year: 34		annual events	annual operations
sorties		4	48	--	sortie profile:			
arrivals	1	4	48	48	arrival	1	34	34
departures	1	4	48	48	departure	1	34	34
closed patterns	6	24	288	576	CP	2	68	136
			total	672			Total	204

Table 2-19 reflects the number of transient military aircraft that were provided service by the 148 FW. Each aircraft (except F-16 "with 148 FW") had a straight-in arrival and straight-out departure, no closed patterns. The "F-16 "with 148 FW" sorties are sorties flown by other F-16 units with the 148 FW, have same profile as local trainer, and were included in the 148 FW local sorties data. The KC-135 closed pattern data were provided by the air traffic control tower personnel.

Table 2-19 Transient Military Aircraft Serviced by the 148th Fighter Wing

Annual Transient Military Aircraft	number of aircraft	notes:
C-17	6	
SW-4	6	included in 133 or 934 trainers (arrival/dept only, no cp)
B-412	1	included in 133 or 934 trainers (arrival/dept only, no cp)
C-130	28	included in 133 or 934 trainers (arrival/dept only, no cp)
KC-135	34	
F-16	47	"with 148 FW" (added to 148 FW local sorties)
F-16	49	not with 148 FW
C-9	2	
C-12	12	included in 133 or 934 trainers (arrival/dept only, no cp)
C-37	2	
KR-35	2	
Helicopters	10	not modeled due to low number and no other helicopters
P-3	2	included in 133 or 934 trainers (arrival/dept only, no cp)
DC-9	1	
C-21	1	
F-15	2	
KC-10	1	
F-14	1	
F-18	13	
total	220	

The transient aircraft were grouped based on factors such as size, number and type of engines, airspeeds, etc. The aircraft type with the greatest number of sorties is used for noise modeling and is at the top of the column listing the sorties for the various aircraft. Table 2-20 reflects the transient groupings for noise modeling and the number of annual aircraft for the aircraft group.

Table 2-20 Transient Military Aircraft Groupings for Noise Modeling

Transient Aircraft Groupings			
F-16	sorties	C-17	sorties
F-16	49	C-17	6
F-18	13	C-9	2
F-14	1	C-37	2
F-15	2	KR-35	2
total	65	DC-9	1
C-130	sorties	KC-10	1
C-130	28	C-21	1
SW-4	6	total	15
B-412	1		
C-12	12		
P-3	2		
total	49		

Table 2-21 contains the annual and average daily events for transient military aircraft based on the information and data in the preceding tables.

Table 2-21 Annual and Average Daily Events for Transient Military Operations

Annual Transient Military Events					
			closed patterns		
	arrivals	departures	radar	visual	total
C-130 (133/934)	48	48	288	0	384
other C-130	49	49	0	0	98
total C-130	97	97	288	0	482
KC-135	34	34	68	0	136
F-16	65	65	0	0	130
C-17	15	15	0	0	30
total	211	211	356	0	778
Average Busy Day Transient Military Events					
			closed patterns		
	arrivals	departures	radar	visual	total
C-130 (133/934)	0.2051	0.2051	1.2308	0	1.641
other C-130	0.2094	0.2094	0	0	0.4188
total C-130	0.4145	0.4145	1.2308	0	2.0598
KC-135	0.1453	0.1453	0.2906	0	0.5812
F-16	0.2778	0.2778	0	0	0.5556
C-17	0.0641	0.0641	0	0	0.1282
total	0.9017	0.9017	1.5214	0	3.3248
assume same number of days per year as 148 FW: 234 days					
assume all daytime					

Table 2-22 lists the average daily transient aircraft operations. Runway use is 50 percent Runway 09 and 50 percent Runway 27.

Table 2-22 Transient Military Aircraft Average Daily Flight Track Use

Transient Military Average Daily Operations						
			operations			
	profile ID	track ID	day	night	total	track description
C-130	13DB	09DF	0.2073	0	0.2073	straight-out
departures	13DA	27DB	0.2073	0	0.2073	straight-out
subtotal departures			0.4146	0.0000	0.4146	
arrivals	13AE	09AE	0.2073	0.0000	0.2073	straight-in
	13AA	27AE	0.2073	0.0000	0.2073	straight-in
subtotal arrivals			0.4146	0	0.4146	
closed patterns	13C1	09C2	0.6154	0	0.6154	left turn normal closed pattern
	13C2	27C2	0.6154	0	0.6154	right turn normal closed pattern
subtotal closed patterns			1.2308	0.0000	1.2308	
subtotal C-130			2.0600	0.000	2.0600	
KC-135	35DB	09DF	0.0727	0	0.0727	straight-out
departures	35DA	27DB	0.0727	0	0.0727	straight-out
subtotal departures			0.1454	0.0000	0.1454	
arrivals	35AE	09AE	0.0727	0.0000	0.0727	straight-in
	35AA	27AE	0.0727	0.0000	0.0727	straight-in
subtotal arrivals			0.1454	0	0.1454	
closed patterns	35C1	09C2	0.1453		0.1453	left turn normal closed pattern
	35C2	27C2	0.1453		0.1453	right turn normal closed pattern
subtotal closed patterns			0.2906	0.0000	0.2906	
subtotal KC-135			0.5814	0.000	0.5814	
F-16	T6DB	09DF	0.1389	0	0.1389	straight-out
departures	T6DA	27DB	0.1389	0	0.1389	straight-out
subtotal departures			0.2778	0.0000	0.2778	
arrivals	T6AE	09AE	0.1389	0.0000	0.1389	straight-in
	T6AA	27AE	0.1389	0.0000	0.1389	straight-in
subtotal arrivals			0.2778	0	0.2778	
subtotal F-16			0.5556	0.0000	0.5556	
C-17	17DB	09DF	0.0321	0	0.0321	straight-out
departures	17DA	27DB	0.0321	0	0.0321	straight-out
subtotal departures			0.0642	0.0000	0.0642	
arrivals	17AE	09AE	0.0321	0.0000	0.0321	straight-in
	17AA	27AE	0.0321	0.0000	0.0321	straight-in
subtotal arrivals			0.0642	0	0.0642	
subtotal C-17			0.1284	0.0000	0.1284	
total transient military			3.3254	0.0000	3.3254	

2.4 GENERAL AVIATION AIRCRAFT OPERATIONS DATA

The general aviation aircraft operations data in Table 2-23 were derived from the Duluth IAP air traffic control tower data.

Table 2-23 General Aviation Aircraft Operations at Duluth International Airport

Annual General Aviation Operations		
Arrival and Departure Operations	Arrival Operations	Departure Operations
26,969	13,485	13,485
Closed Pattern: 14,946		

Air traffic control tower personnel provided the information in Table 2-24 concerning the general aviation aircraft types and the percents of the total operations by each type.

Table 2-24 General Aviation Aircraft Types and Closed Pattern Distribution

General Aviation Aircraft Types Distribution	
SR-22	50%
C-172	15%
King Air	25%
Learjet	10%
General Aviation Aircraft Closed Pattern Distribution	
SR-22	77%
C-172	23%

Table 2-25 reflects the annual and average daily general aviation events by the aircraft types based on the preceding information. Average daily operations are based on 365 days per year. The closed pattern (CP) data reflect one CP event which consists of one takeoff and one landing, or 50 percent of the total 14,946 annual closed pattern operations. Closed pattern noise modeling is based on the complete closed pattern event rather than the individual takeoff and landing.

Table 2-25 Annual and Average Daily General Aviation Events

Annual General Aviation Events				
	arrival	dept	CP	total
SR-22	6,743	6,743	5,754	19,240
C-172	2,023	2,023	1,719	5,765
King Air	3,371	3,371	0	6,742
Learjet	1,349	1,349	0	2,698
total	13,486	13,486	7,473	34,445
no closed patterns for King Air and Learjet all daytime				
Average Daily General Aviation Events				
	arrival	dept	CP	total
SR-22	18.4740	18.4740	15.7644	52.7124
C-172	5.5425	5.5425	4.7096	15.7946
subtotal	24.0165	24.0165	20.4740	68.507
King Air	9.2356	9.2356	0	18.4712
Learjet	3.6959	3.6959	0	7.3918
total	36.9480	36.9480	20.4740	94.3700

Air traffic control tower personnel provided the information in Table 2-26 concerning runway use by general aviation aircraft types.

Table 2-26 General Aviation Aircraft Runway Use

General Aviation Aircraft Runway Use	
Runway 09-27	80%
Runway 09	50%
Runway 27	50%
Runway 03-21	20%
Runway 03	70%
Runway 21	30%

Table 2-27 reflects the average daily general aviation aircraft operations by flight track and profile. The track ID and profile ID are from the NOISEMAP files. The Cessna 172 was used to model both the SR-22 and C-172 since both are small, single-engine aircraft.

Table 2-27 General Aviation Aircraft Average Daily Flight Track Use

General Aviation Average Daily Operations	profile ID	track ID	operations day	operations night	operations total	track description
Cessna 172	SPDC	03DA	3.3623	0	3.3623	straight-out
departures	SPDD	21DA	1.4410	0	1.441	straight-out
	SPDB	09DF	9.6066	0	9.6066	straight-out
	SPDA	27DB	9.6066	0	9.6066	straight-out
departure subtotal			24.0165	0.0000	24.0165	
arrivals	SPAD	03AA	3.3623	0.0000	3.3623	straight-in
	SPAC	21AA	1.4410	0.0000	1.4410	straight-in
	SPAB	09AE	9.6066	0.0000	9.6066	straight-in
	SPAA	27AE	9.6066	0.0000	9.6066	straight-in
arrival subtotal			24.0165	0	24.0165	
	SPC2	09C3	10.2370	0	10.2370	left turn closed pattern
	SPC1	27C3	10.2370	0	10.2370	right turn closed pattern
closed pattern subtotal			20.4740	0.0000	20.4740	
subtotal C-172			68.5070	0.000	68.5070	
King Air	KADC	03DA	1.2930	0	1.293	straight-out
departures	KADD	21DA	0.5541	0	0.5541	straight-out
	KADB	09DF	3.6942	0	3.6942	straight-out
	KADA	27DB	3.6942	0	3.6942	straight-out
departure subtotal			9.2355	0.0000	9.2355	
arrivals	KAAD	03AA	1.2930	0.0000	1.2930	straight-in
	KAAC	21AA	0.5541	0.0000	0.5541	straight-in
	KAAB	09AE	3.6942	0.0000	3.6942	straight-in
	KAAA	27AE	3.6942	0.0000	3.6942	straight-in
arrival subtotal			9.2355	0	9.2355	
subtotal King Air			18.4710	0.000	18.4710	
Lear Jet	LJDC	03DA	0.5174	0	0.5174	straight-out
departures	LJDD	21DA	0.2218	0	0.2218	straight-out
	LJDB	09DF	1.4784	0	1.4784	straight-out

Table 2-27 General Aviation Aircraft Average Daily Flight Track Use (*continued*)

General Aviation Average Daily Operations						
			operations			
	profile ID	track ID	day	night	total	track description
	LJDA	27DB	1.4784	0	1.4784	straight-out
departure subtotal			3.6960	0.0000	3.696	
arrivals	LJAD	03AA	0.5174	0.0000	0.5174	straight-in
	LJAC	21AA	0.2218	0.0000	0.2218	straight-in
	LJAB	09AE	1.4784	0.0000	1.4784	straight-in
	LJAA	27AE	1.4784	0.0000	1.4784	straight-in
arrival subtotal			3.6960	0	3.6960	
subtotal Learjet			7.3920	0.0000	7.3920	
total general aviation			94.3700	0.0000	94.3700	

2.5 DULUTH INTERNATIONAL AIRPORT AIR CARRIER AND AIR TAXI OPERATIONS DATA

Table 2-28 contains the daily scheduled air carrier and air taxi arrival and departure data by aircraft type as of September 20, 2004. The schedules were obtained from the Duluth IAP website.

Table 2-28 Weekly Air Carrier and Air Taxi Arrival and Departure Data

Duluth IAP Air Carrier-Air Taxi									
departures									
time	aircraft	Sun	Mon	Tue	Wed	Thur	Fri	Sat	total
0525	SAAB	1	1	1	1	1	1	1	7
0635	CRJ	1	1	1	1	1	1	1	7
0700	A320	--	1	1	1	1	1	1	6
0820	DC-9	--	1	1	1	1	1	1	6
0820	A320	1	--	--	--	--	--	--	1
0910	SAAB	--	1	1	1	1	1	--	5
1015	CRJ	1	1	1	1	1	1	1	7
1135	CRJ	1	1	1	1	1	1	1	7
1255	DC-9	1	1	1	1	1	1	1	7
1505	CRJ	1	1	1	1	1	1	1	7
1655	DC-9		1	1	1	1	1	1	6
1655	RJ85	1	--	--	--	--	--	--	1
1840	CRJ	1	1	1	1	1	1	1	7
		9	11	11	11	11	11	10	74
arrivals									
time	aircraft	Sunday	Monday	Tuesday	Wed	Thursday	Friday	Saturday	total
0837	SAAB	--	1	1	1	1	1	--	5
0945	CRJ	1	1	1	1	1	1	1	7
1110	CRJ	1	1	1	1	1	1	1	7
1215	DC-9	1	1	1	1	1	1	1	7
1435	CRJ	1	1	1	1	1	1	1	7
1602	DC-9	--	1	1	1	1	1	1	6

Table 2-28 Weekly Air Carrier and Air Taxi Arrival and Departure Data (*continued*)

Duluth IAP Air Carrier-Air Taxi									
time	aircraft	Sunday	Monday	Tuesday	Wed	Thursday	Friday	Saturday	total
1602	RJ85	1	--	--	--	--	--	--	1
1810	CRJ	1	1	1	1	1	1	1	7
1955	CRJ	1	1	1	1	1	1	1	7
2015	SAAB	1	1	1	1	1	1	1	7
2144	A320	1	1	1	1	1	1	1	7
2248	DC-9	1	1	1	1	1	1	--	6
		10	11	11	11	11	11	9	74

Table 2-29 summarizes the above daily schedule into weekly and annual arrival and departure operations.

Table 2-29 Summary of Weekly and Annual Scheduled Air Carrier and Air Taxi Arrivals and Departures

Weekly Scheduled Air Carrier-Air Taxi							
arrivals				departures			
aircraft	day	night	total	aircraft	day	night	total
SAAB	5	7	12	SAAB	12	0	12
CRJ	28	7	35	CRJ	35	0	35
A320	7	0	7	A320	7	0	7
DC-9	19	0	19	DC-9	13	6	19
RJ85	1	0	1	RJ85	1	0	1
total	60	14	74	total	68	6	74
Annual Scheduled Air Carrier-Air Taxi							
arrivals				departures			
aircraft	day	night	total	aircraft	day	night	total
SAAB	260	364	624	SAAB	624	0	624
CRJ	1,456	364	1,820	CRJ	1,820	0	1,820
A320	364	0	364	A320	364	0	364
DC-9	988	0	988	DC-9	676	312	988
RJ85	52	0	52	RJ85	52	0	52
total	3,120	728	3,848	total	3,536	312	3,848

Table 2-30 presents other air carrier-air taxi aircraft information provided by air traffic control tower personnel.

Table 2-30 Other Air Carrier and Air Taxi Information

Other Air Carrier-Air Taxi		
FedEx (all daytime)		
B727	weekly	annual
arrivals	5	260
dept	5	260
Bemidji Air (all daytime)		
Queen Air	weekly	annual

Table 2-30 Other Air Carrier and Air Taxi Information (*continued*)

Other Air Carrier-Air Taxi		
FedEx (all daytime)		
arrivals	10	520
dept	10	520
Duluth Jet (all daytime)		
Bus Jet	weekly	annual
arrivals	5	260
dept	5	260

Table 2-31 combines the scheduled air carrier-air taxi and other air carrier-air taxi.

Table 2-31 Combined Air Carrier, Air Taxi, and other Air Carrier and Air Taxi Operations

Combined Annual Air Carrier-Air Taxi	
scheduled air taxi	4,888
scheduled air carrier	2,808
other air taxi	1,560
other air carrier	520
total	9,776

Table 2-32 reflects aircraft groupings and the annual and average busy day air carrier-air taxi operations. Average busy day operations are based on 365 days per year. Aircraft were grouped based on factors such as size, number and type of engines, airspeeds, etc.

Table 2-32 Air Carrier and Air Taxi Aircraft Groupings and Annual Operations by Aircraft Groupings

Aircraft Groupings				
SAAB	CRJ	DC-9	B727	A320
SAAB Queen Air	CRJ RJ85 Duluth Jet	DC-9	B727	A320

Annual Air Carrier-Air Taxi Operations by Grouped Aircraft							
		arrivals			departures		
	day	night	total	day	night	total	total
SAAB	780	364	1,144	1,144	0	1144	2,288
CRJ	1,768	364	2,132	2,132	0	2132	4,264
B727	260	0	260	260	0	260	520
A320	364	0	364	364	0	364	728
DC-9	988	0	988	676	312	988	1,976
total	4,160	728	4,888	4,576	312	4,888	9,776
SAAB	2.1370	0.9973	3.1343	3.1342	0	3.1342	6.2685
CRJ	4.8438	0.9973	5.8411	5.8411	0	5.8411	11.6822
B727	0.7123	0.0000	0.7123	0.7123	0	0.7123	1.4246
A320	0.9973	0.0000	0.9973	0.9973	0	0.9973	1.9946
DC-9	2.7068	0.0000	2.7068	1.8521	0.8548	2.7069	5.4137
total	11.3972	1.9946	13.3918	12.5370	0.8548	13.3918	26.7836

Table 2-33 contains the runway use data provided by air traffic control tower personnel for air carrier and air taxi aircraft. The table also reflects the aircraft within the air carrier and air taxi classifications.

Table 2-33 Air Carrier and Air Taxi Runway Use

Air Taxi Runway Use		Air Carrier Runway Use		Air Carrier Aircraft	Air Taxi Aircraft
Runway 09-27	80%	Runway 09	50%	DC-9	CRJ
Runway 09	50%	Runway 27	50%	B727	SAAB
Runway 27	50%			A320	
Runway 03-21	20%				
Runway 03	70%				
Runway 21	30%				

Table 2-34 contains the average busy day operations for air carrier and air taxi aircraft. Air traffic control tower personnel indicated there are no operations between 2400 and 0600 hours.

Table 2-34 Average Daily Flight Track Use for Air Carrier and Air Taxi Aircraft

Air Carrier, Air Taxi, and Air Cargo Average Daily Operations				operations			
		profile ID	track ID	day	night	total	track description
SF 340							
departures		SADC	03DA	0.4388	0	0.4388	straight-out
		SADD	21DA	0.1881	0	0.1881	straight-out
		SADB	09DF	1.2537	0	1.2537	straight-out
		SADA	27DB	1.2537	0	1.2537	straight-out
subtotal departures				3.1343	0.0000	3.1343	
arrivals		SAAD	03AA	0.2992	0.1396	0.4388	straight-in
		SAAC	21AA	0.1282	0.0598	0.1880	straight-in
		SAAB	09AE	0.8548	0.3989	1.2537	straight-in
		SAAA	27AE	0.8548	0.3989	1.2537	straight-in
subtotal arrivals				2.1370	0.9972	3.1342	
subtotal SF 340				5.2713	0.997	6.2685	
B727							
departures	50%	27DI	09DF	0.1781	0	0.1781	straight-out
	50%	27DH	09DE	0.1781	0.0000	0.1781	right turn after takeoff
	50%	27DA	27DB	0.1781	0	0.1781	straight out
	50%	27DC	27DM	0.1781	0	0.1781	left turn after takeoff
subtotal departures				0.7124	0.0000	0.7124	
arrivals	50%	27AE	09AE	0.1781	0.0000	0.1781	straight-in
	50%	27AC	09AJ	0.1781	0	0.1781	visual 2.4 mile final
	50%	27AB	27AE	0.1781	0	0.1781	straight-in
	50%	27AA	27AJ	0.1781	0	0.1781	visual right 270 to final
subtotal arrivals				0.7124	0.0000	0.7124	
subtotal air cargo B727				1.4248	0.000	1.4248	
A 320							
departures	50%	32DI	09DF	0.2493	0	0.2493	straight-out

Table 2-34 Average Daily Flight Track Use for Air Carrier and Air Taxi Aircraft (*continued*)

Air Carrier, Air Taxi, and Air Cargo Average Daily Operations				operations			
		profile ID	track ID	day	night	total	track description
	50%	32DH	09DE	0.2493	0.0000	0.2493	right turn after takeoff
	50%	32DA	27DB	0.2493	0	0.2493	straight out
	50%	32DC	27DM	0.2493	0	0.2493	left turn after takeoff
subtotal departures				0.9972	0	0.9972	
arrivals	50%	32AE	09AE	0.2493	0.0000	0.2493	straight-in
	50%	32AC	09AJ	0.2493	0	0.2493	visual 2.4 mile final
	50%	32AB	27AE	0.2493	0	0.2493	straight-in
	50%	32AA	27AJ	0.2493	0	0.2493	visual right 270 to final
subtot arr				0.9972	0.0000	0.9972	
subtotal A 320				1.9944	0.000	1.9944	
Regional Jet/Cessna Business Jet							
departures		CJDC	03DA	0.8178	0	0.8178	straight-out
		CJDD	21DA	0.3505	0	0.3505	straight-out
		CJDB	09DF	2.3364	0	2.3364	straight-out
		CJDA	27DB	2.3364	0	2.3364	straight-out
subtotal departures				5.8411	0.0000	5.8411	
arrivals		CJAD	03AA	0.6781	0.1396	0.8177	straight-in
		CJAC	21AA	0.2906	0.0598	0.3504	straight-in
		CJAB	09AE	1.9375	0.3989	2.3364	straight-in
		CJAA	27AE	1.9375	0.3989	2.3364	straight-in
subtotal arrivals				4.8437	0.9972	5.8409	
subtotal Regional Jet				10.6848	0.997	11.6820	
DC-9							
departures	50%	C9DI	09DF	0.4630	0.2137	0.6767	straight-out
	50%	C9DH	09DE	0.4630	0.2137	0.6767	right turn after takeoff
	50%	C9DA	27DB	0.4630	0.2137	0.6767	straight out
	50%	C9DC	27DM	0.4630	0.2137	0.6767	left turn after takeoff
subtotal departures				1.8520	0.8548	2.7068	
arrivals	50%	09AE	09AE	0.6767	0.0000	0.6767	straight-in
	50%	C9AC	09AJ	0.6767	0	0.6767	visual 2.4 mile final
	50%	C9AB	27AE	0.6767	0	0.6767	straight-in
	50%	C9AA	27Aj	0.6767	0	0.6767	visual right 270 to final
subtotal arrivals				2.7068	0.0000	2.7068	
subtotal DC-9				4.5588	0.855	5.4136	
total air carrier-air taxi-air cargo				23.9341	2.8492	26.7833	

2.6 148TH FIGHTER WING AIRCRAFT MAINTENANCE ENGINE RUNUP OPERATIONS DATA

To the maximum extent possible, aircraft maintenance engine runup locations have been established by the 148 FW to minimize noise for people on the Base and for those in the surrounding communities. Engine ground runup locations are located on the specific aircraft parking aprons, the alert area, and at the engine test cell. Figure 2.1 depicts the location of the runup pads. Aircraft maintenance engine runups occur 234 days per year. Tables 2-35 through 2-38 summarize the F-16 engine runup activity by the 148 FW. Northwest Airlines has a maintenance facility on the north side of the airport. No runup data were provided during data collection in October 2004. During the September 2005 meeting, airport management indicated that runups are being accomplished. Northwest Airlines will be contacted in future noise modeling efforts to determine if they are doing runups.

Table 2-35 Runup Summary for Alert Facility

Engine Ground Runup Summary					
Profile ID:	Power	# of eng.	Daily Ops per Pad		Duration in
Runup Pad: alert	Setting	running	Daytime	Nighttime	Seconds
Aircraft Type: F-16C	70%	1	0.444444	0	1800
Engine Type: F100-220E	75%	1	0.444444	0	8
Type of runup: hot cock					
Frequency: 2 times per week					
All daytime					
Aircraft heading: 180 degrees					
Suppression: no					

Table 2-36 Runup Summary for Flightline

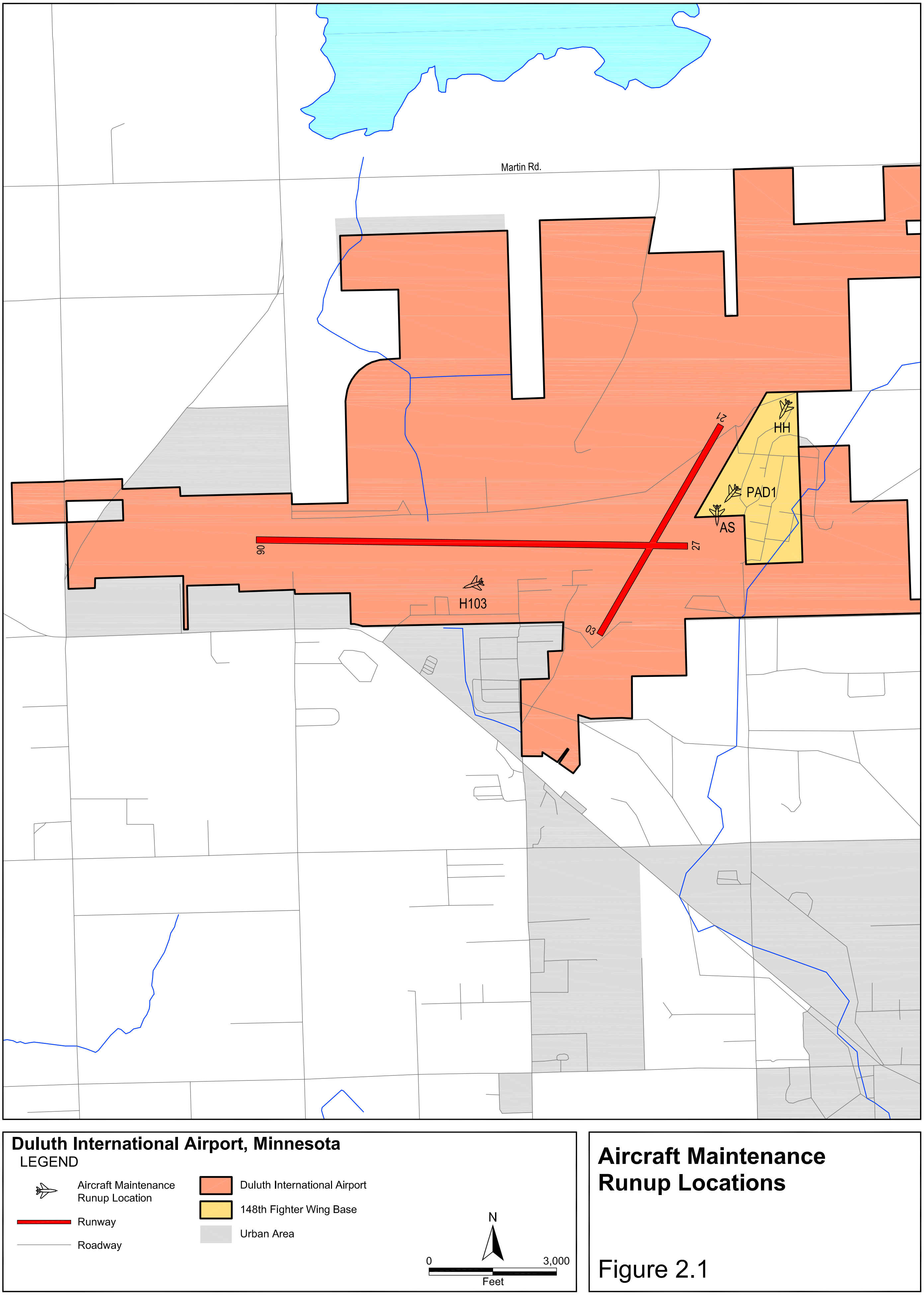
Engine Ground Runup Summary					
Profile ID:	Power	# of eng.	Daily Ops per Pad		Duration in
Runup Pad: flight line	Setting	running	Daytime	Nighttime	Seconds
Aircraft Type: F-16C	70%	1	0.444444	0	600
Engine Type: F100-220E	75%	1	0.444444	0	5
Type of runup: ground maintenance runup					
Frequency: 2 times per week					
All daytime					
aircraft heading: 220 degrees					
Suppression: no					

Table 2-37 Runup Summary for Pad 103

Engine Ground Runup Summary					
Profile ID:	Power	# of eng.	Daily Ops per Pad		Duration in
Runup Pad: 103	Setting	running	Daytime	Nighttime	Seconds
Aircraft Type: F-16C	70%	1	0.051282	0	2640
Engine Type: F100-220E	75%	1	0.051282	0	5
	80%	1	0.051282	0	60
Type of runup:: ground maintenance runup					
Frequency: 1 time per month					
All daytime					
aircraft heading: 250 degrees					
Suppression: no					

Table 2-38 Runup Summary for Hush House

Engine Ground Runup Summary					
Profile ID:	Power	# of eng.	Daily Ops per Pad		Duration in
Runup Pad: HH	Setting	running	Daytime	Nighttime	Seconds
Aircraft Type: F-16C	65%	1	0.444444	0	3000
Engine Type: F100-220E	78%	1	0.444444	0	456
	82%	1	0.444444	0	456
	89%	1	0.444444	0	456
Type of Runup: hush house	AB	1	0.444444	0	126
Frequency: 2 times per week					
All daytime					
aircraft heading:					
Suppression: yes					



744212 DULUTH–RUNUP.DWG

Aircraft Maintenance Runup Locations

Figure 2.1

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SECTION 3
AIRCRAFT NOISE CONTOURS AND NOISE EXPOSURE DATA

This section contains a composite figure depicting the individual flight tracks and the noise contours based on the aircraft operations data collected in October 2004 and the contours for three other aircraft operations conditions.

Four operations conditions were identified for noise modeling during the October 2004 data collection. The four conditions are: the 2004 operations condition for 15 F-16C aircraft; the 18 F-16C aircraft condition; the 24 F-16C aircraft condition; and the 18 Joint Strike Fighter (JSF) aircraft condition. The aircraft operations for the 18 and 24 F-16C and the 18 JSF conditions are prorated based on the 2004 operations, flight track, and profile condition associated with 15 F-16C aircraft.

The section also contains information concerning noise exposure within the various noise exposure zones for the four aircraft operations conditions, as well as the Day-Night Average A-Weighted Sound Level (DNL) and Sound Exposure Level (SEL) at analysis points around the airport. The Department of Defense (DoD) NOISEMAP (Version 7.296) computer modeling program and the DNL metric were used to define the noise zones for the four aircraft operations conditions contained in this document. Air Force guidance is to use NOISEMAP F-22 noise data to model JSF operations because the model does not contain JSF data.

3.1 AIRCRAFT GROUND TRACKS AND NOISE CONTOURS

Figure 3.1 depicts the arrival aircraft ground tracks, Figure 3.2 shows the departure tracks, and Figure 3.3 presents the closed pattern ground tracks based on the data collected in October 2004. The ground tracks in the three figures were used to model all the aircraft operations conditions. (Appendix B contains the flight tracks and profiles for each of the aircraft types modeled.) Figures 3.4, 3.5, 3.7, and 3.9, respectively, show the noise contours for the 15, 18, and 24 F-16C aircraft and the 18 JSF aircraft conditions based on the operations associated with the 15 F-16C aircraft condition. Figures 3.6, 3.8, and 3.10, respectively, compare the 18 and 24 F-16 aircraft and the 18 JSF conditions with the noise contours from the 15 F-16C condition.

3.2 COMPUTERIZED NOISE EXPOSURE MODELS

The Air Force adopted the NOISEMAP computer program to describe noise impacts created by aircraft operations. NOISEMAP is one of two USEPA-approved computer programs; the other is the Integrated Noise Model (INM) used by the Federal Aviation Administration (FAA) for noise analysis at civil airports. The NOISEMAP and INM programs are similar; however, INM does not contain noise data for all military aircraft.

NOISEMAP is a suite of computer programs and components developed by the Air Force to predict noise exposure in the vicinity of an airfield due to aircraft flight, maintenance, and ground runup operations. The components of NOISEMAP are:

- BASEOPS is the input module for NOISEMAP and is used to enter detailed aircraft track and profile and ground maintenance operational data.

- NOISEFILE is a comprehensive database of measured military and civil aircraft noise data. Aircraft operational information is matched with the noise measurements in the NOISEFILE after the detailed aircraft flight and ground maintenance operational data have been entered into BASEOPS.
- NMAP is the computational module in NOISEMAP. NMAP takes BASEOPS input and uses the NOISEFILE database to calculate noise levels caused by aircraft events at specified grid points in the airbase vicinity. The output of NMAP is a series of georeferenced data points, specific grid point locations, and corresponding noise levels.
- NMPLOT is the program for viewing and editing the sets of georeferenced data points. NMPLOT plots the NMAP output in a noise contour grid that can be exported as files that can be used in mapping programs for analyzing the noise impacts.

3.3 SINGLE EVENT SOUND METRICS

Appendix A contains detailed background information on single event sound metrics, averaged noise metrics, noise analysis methodology, sleep disturbance, effects of sound on structures, annoyance, and speech disruption.

Sound exposure level, which is a measure of the physical energy of the noise event and accounts for both intensity and duration, is used for single event noise analysis. Table 3-1 provides SEL values for 148 FW F-16 aircraft and the 18 JSF aircraft at a distance of 1,000 feet from the aircraft. The maximum sound level would typically be 5 to 10 A-weighted sound level measured in decibels (dBA) below the SEL value or aircraft overflight. SEL is used when discussing sleep disturbance and maximum sound level is used for effects on structures.

Table 3-1 Sound Exposure Level at 1,000 Feet from the Aircraft

Aircraft Type	Sound Exposure Level (dBA)
F-16	109
Joint Strike Fighter	114

Note: At nominal takeoff thrust and airspeed and at a slant distance of 1,000 feet from the aircraft.

3.4 DAY-NIGHT AVERAGE SOUND LEVEL AND SOUND EXPOSURE LEVEL AT ANALYSIS POINTS

The primary source of noise in the vicinity of Duluth AIP is airfield operations. Section 2 contains the aircraft operations for the four operations conditions. Figure 3.1 shows the aircraft ground tracks and Figures 3.4, 3.5, 3.7, and 3.9, respectively, depict the noise exposure area for the 15, 18, and 24 F-16 aircraft and the 18 JSF conditions. Residences and public use facilities such as schools, libraries, hospitals, churches, and nursing homes are more sensitive to noise than those in other types of facilities because the activities that take place in these structures require lower sound levels and, for that reason, are used as analysis points. Table 3-2 lists the DNL and outdoor F-16 and JSF SEL values at the analysis points. The flight tracks and profiles are the same for all noise modeling conditions.

Table 3-2 Baseline DNL and F-16C and Joint Strike Fighter SEL at Analysis Points, 148 FW, Duluth IAP

		DNL (dBA)				SEL (dBA)	
Code	Analysis Point	15 F-16C Condition	18 F-16C Condition	24 F-16C Condition	JSF Condition	F-16	JSF
CCem	Canosia Cemetery	54	55	56	61	94	105
CJHRC	Chris Jensen Health & Rehabilitation Center	35	35	35	44	89	97
GCh	Gethsemane Church	67	68	69	73	109	115
HHS	Hermantown High School	60	61	62	64	102	106
JCem	Jewish Cemetery	50	51	52	67	89	110
MHM	Miller Hill Mall	45	45	45	54	84	97
PLS	Pike Lake School	50	51	52	60	94	105
WHA	Woodland Hills Academy	41	42	43	51	88	96
SMCem	Sunrise Memorial Cemetery	53	54	55	63	94	105

Note: NOISEMAP determines the SEL for the 18 noisiest flight track events affecting the analysis point. The analysis point code and description correspond to the point as reflected on the noise contour and aircraft ground track figures. There may be minor differences when comparing the DNL for a point from the table to the DNL for the point as depicted on the noise contour figure. This difference is a result of small misalignments during the process of printing the noise contours on top of the background map.

3.5 DAY-NIGHT AVERAGE NOISE

Figures 3.4, 3.5, 3.7, and 3.9, respectively, depict the noise exposure area for the 15, 18, and 24 F-16 aircraft and the JSF conditions. Table 3-3 lists the off-airport acres, and the number of residences, the number of people within the DNL 65 dBA and greater noise exposure area for the 15, 18, and 24 F-16C and the JSF conditions, respectively, and the estimated number of people who might be highly annoyed by noise at those levels for the four aircraft operations conditions.

Elevated noise levels can interfere with speech, cause annoyance or communication difficulties, and disrupt sleep. Based on a variety of studies, there is a good probability of frequent speech disruption at DNL 75 dBA. This level produces ratings of “barely acceptable” for intelligibility of spoken communication (AIHA 1996).

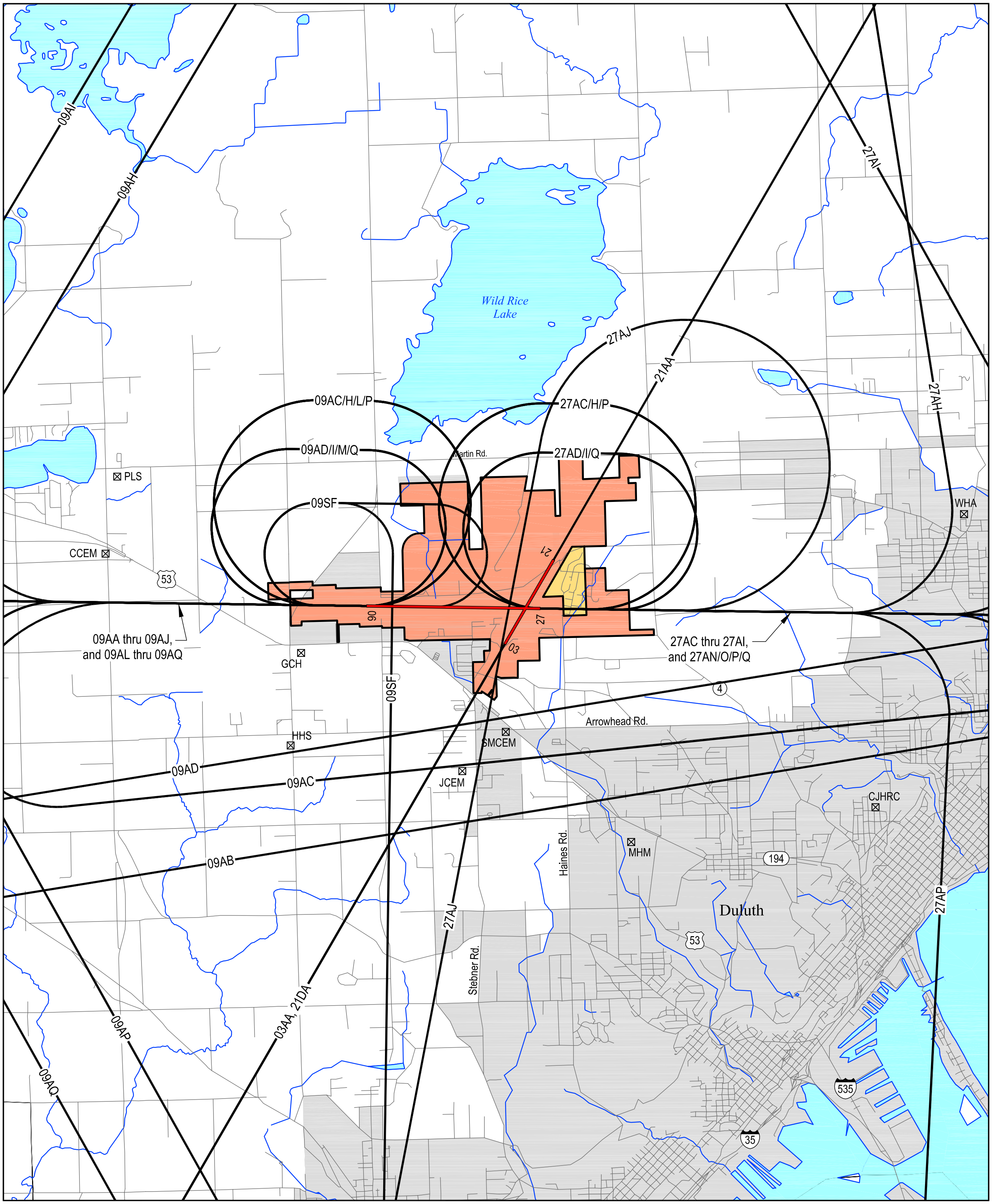
Table 3-3 Off-Airport Noise Exposure, Duluth International Airport

	DNL Interval (dBA)				
Category	65-69	70-74	75-79	80+	Total
15 F-16C Aircraft Operations Condition					
Acres	1,154	234	18	6	1,412
Residences	192	24	1	0	217
People	423	24	0	0	447
People Highly Annoyed	93	9	0	0	102
18 F-16C Aircraft Operations Condition					
Acres	1,332	302	30	5	1,669
Residences	235	44	1	0	280
People	520	39	1	0	560
People Highly Annoyed	114	14	1	0	129
142					
Acres	1,640	440	54	8	2,259
Residences	311	69	2	0	382

Table 3-3 Off-Airport Noise Exposure, Duluth International Airport (*continued*)

	DNL Interval (dBA)				
Category	**65-69**	**70-74**	**75-79**	**80+**	**Total**
People	670	74	2	0	746
People Highly Annoyed	147	27	1	0	175
18 Joint Strike Fighter Aircraft Operations Condition					
Acres	5,333	1,770	404	40	7,547
Residences	945	229	32	2	1,208
People	1,755	495	54	1	2,315
People Highly Annoyed	386	183	29	1	599

Note: Appendix A contains detailed information concerning determination of the persons who would be highly annoyed. Population data used to determine the number of people within a noise zone were obtained from the United States Census Bureau 2000 census. It was assumed that population was equally distributed within a census tract area to estimate affected population. Using the noise contour information, the number of acres of land in each noise zone (*i.e.,* DNL 65-70 dBA, 70-75 dBA, 75-80 dBA, and 80 dBA and greater) were divided by the number of acres of land in each census block to determine the portion of the census tract within each noise zone. The population total in each block-group was then multiplied by this ratio to estimate affected population within each zone. People highly annoyed were determined by multiplying the total number of people in the noise zone times the higher percent number for the interval in Table A-2 in Appendix A.



744212 DULUTH–AGT.DWG

Duluth International Airport, Minnesota

LEGEND

black line	Flight Track	orange fill	Duluth International Airport
red line	Runway	yellow fill	148th Fighter Wing Base
grey line	Roadway	grey fill	Urban Area
⊠	Points of Interest		

N

0 8,000
Feet

Arrival Aircraft Ground Tracks

Figure 3.1

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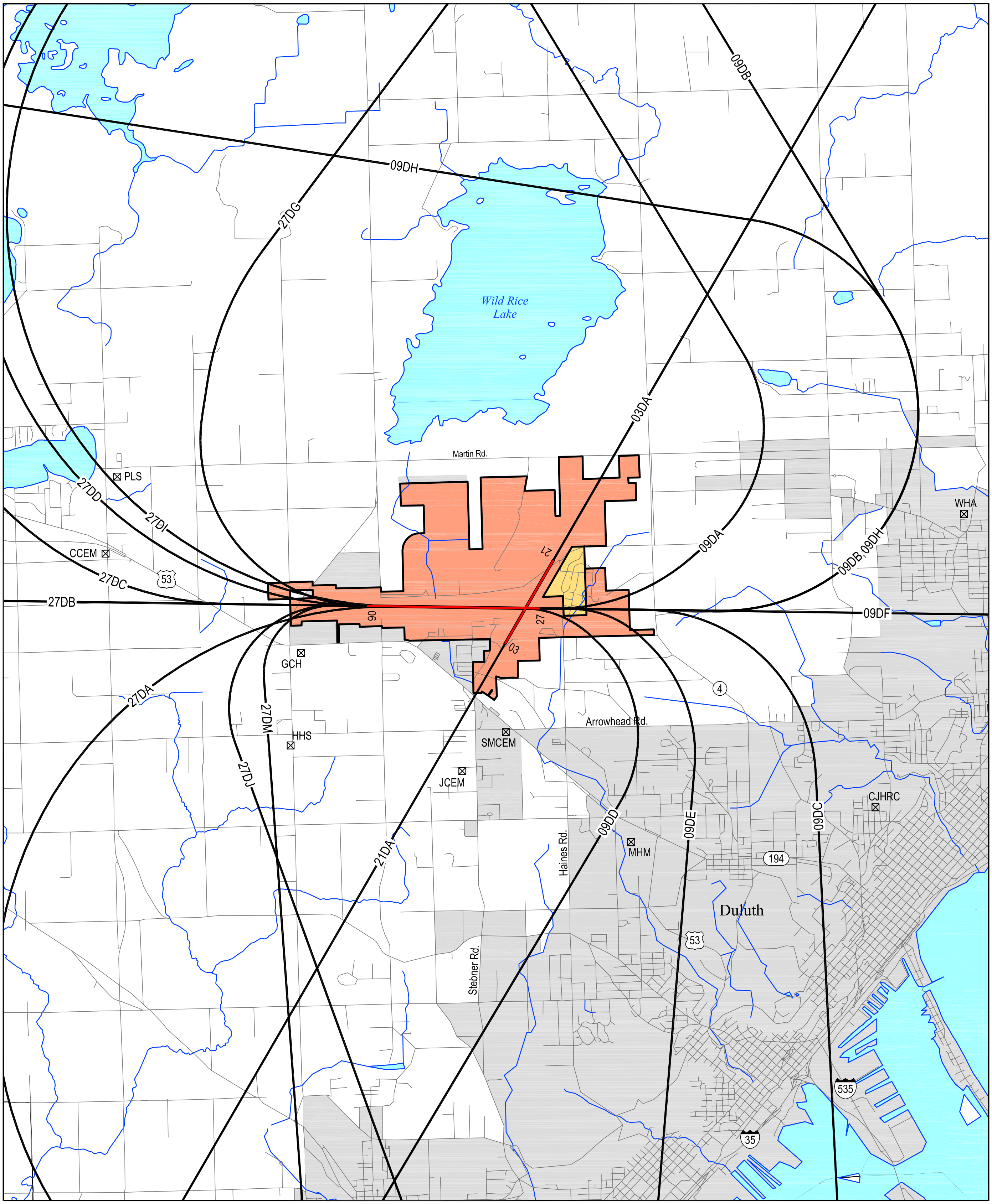

744212 DULUTH-AGT.DWG

Duluth International Airport, Minnesota

LEGEND

- Flight Track
- Runway
- Roadway
- Points of Interest
- Duluth International Airport
- 148th Fighter Wing Base
- Urban Area

N

0 — 8,000 Feet

Departure Aircraft Ground Tracks

Figure 3.2

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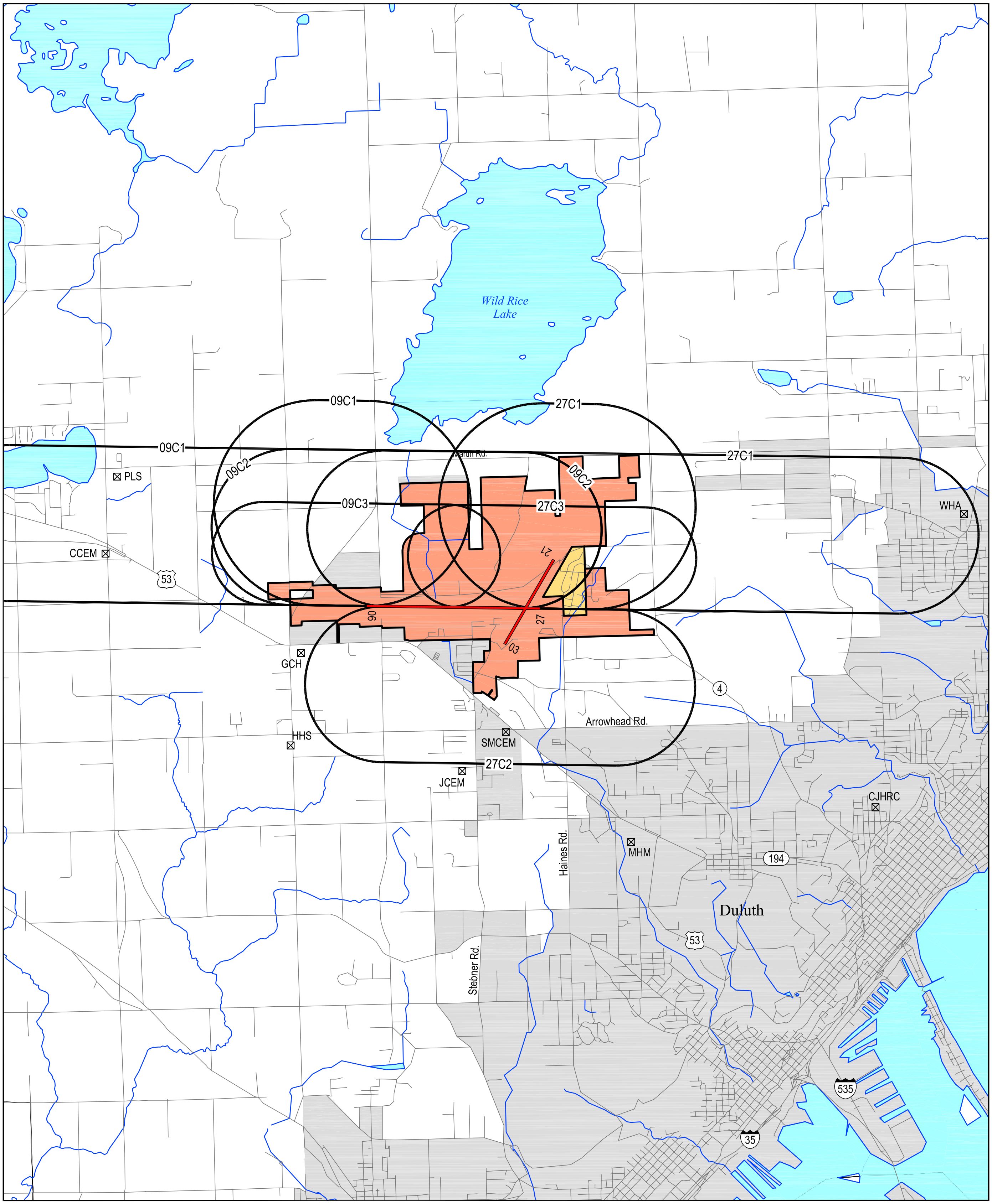

744212 DULUTH-CPGT.DWG

Duluth International Airport, Minnesota

LEGEND

- Flight Track
- Runway
- Roadway
- Points of Interest
- Duluth International Airport
- 148th Fighter Wing Base
- Urban Area

N

0 8,000 Feet

Closed Pattern Aircraft Ground Tracks

Figure 3.3

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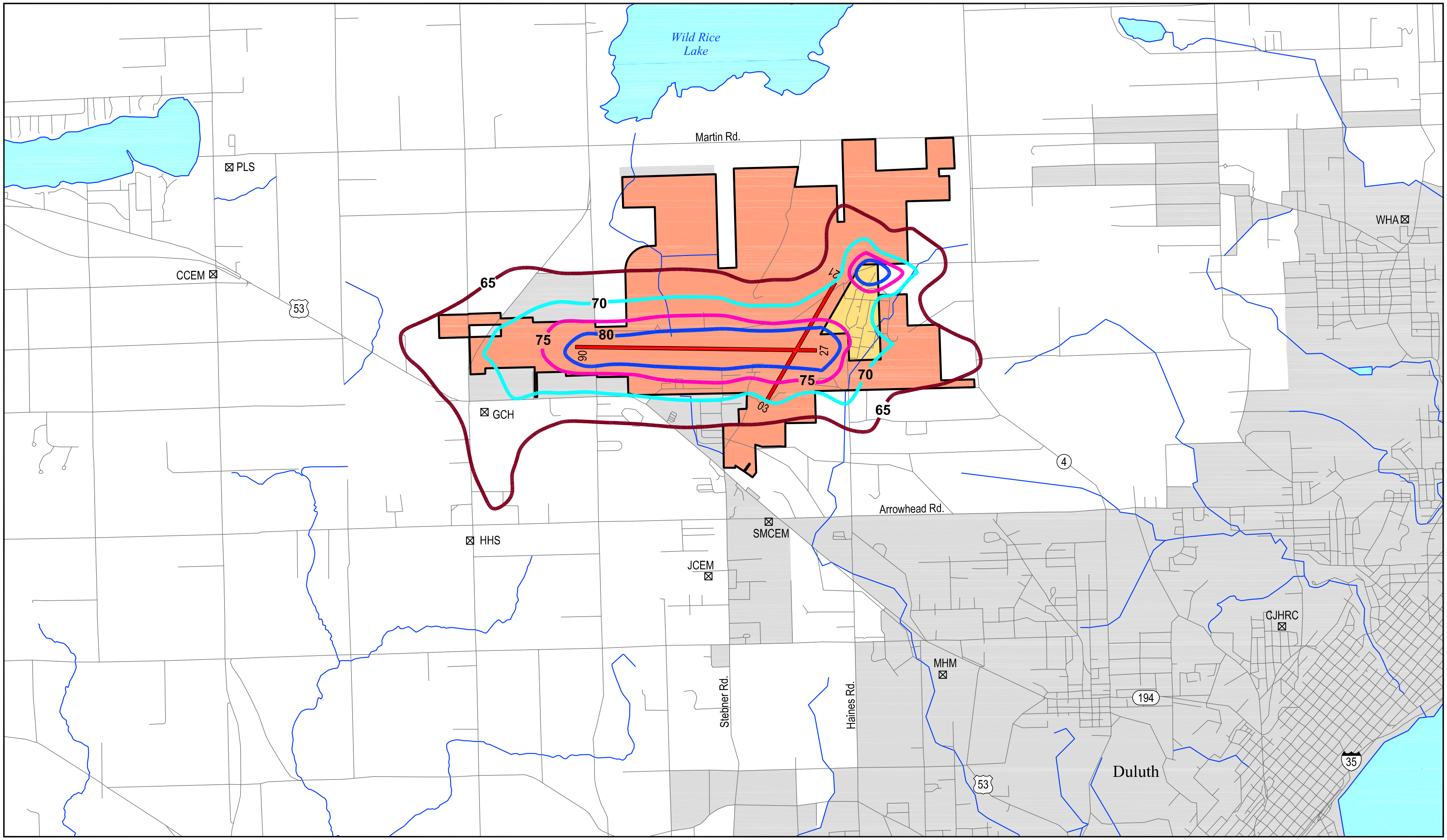
744212 DULUTH-15F16-NC.DWG



Duluth International Airport, Minnesota

LEGEND

- DNL 65 dBA Contour
- DNL 70 dBA Contour
- DNL 75 dBA Contour
- DNL 80 dBA Contour
- Runway
- Roadway
- Points of Interest
- Duluth International Airport
- 148th Fighter Wing Base
- Urban Area

N

0 6,000 Feet

Average Busy Day Noise Contours for 15 F-16C Aircraft

Figure 3.4

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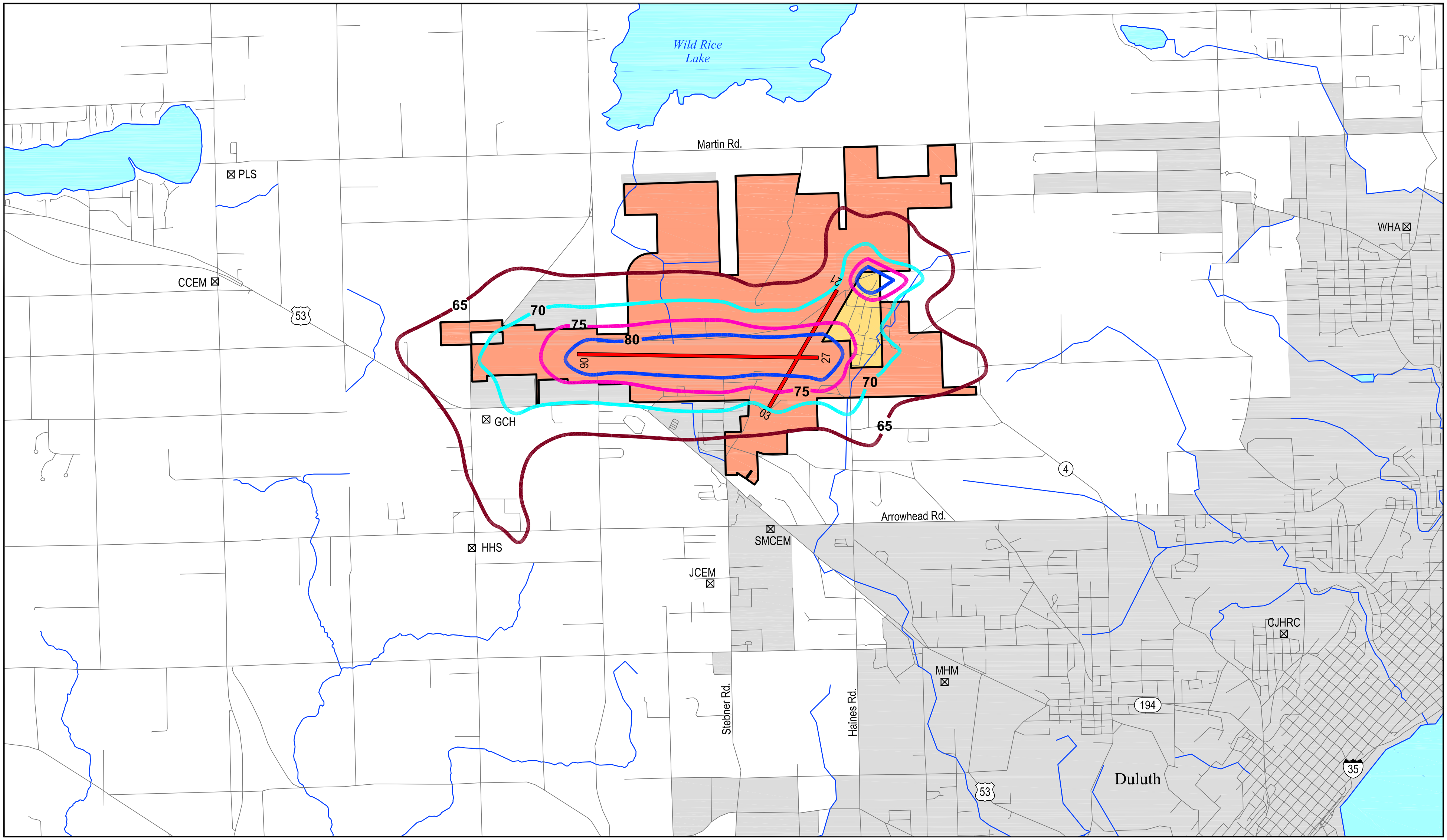
744212 DULUTH-18F16-NC.DWG



Duluth International Airport, Minnesota

LEGEND

- DNL 65 dBA Contour
- DNL 70 dBA Contour
- DNL 75 dBA Contour
- DNL 80 dBA Contour
- Runway
- Roadway
- ⊠ Points of Interest
- Duluth International Airport
- 148th Fighter Wing Base
- Urban Area

N

0 6,000
Feet

Average Busy Day Noise Contours for 18 F-16C Aircraft

Figure 3.5

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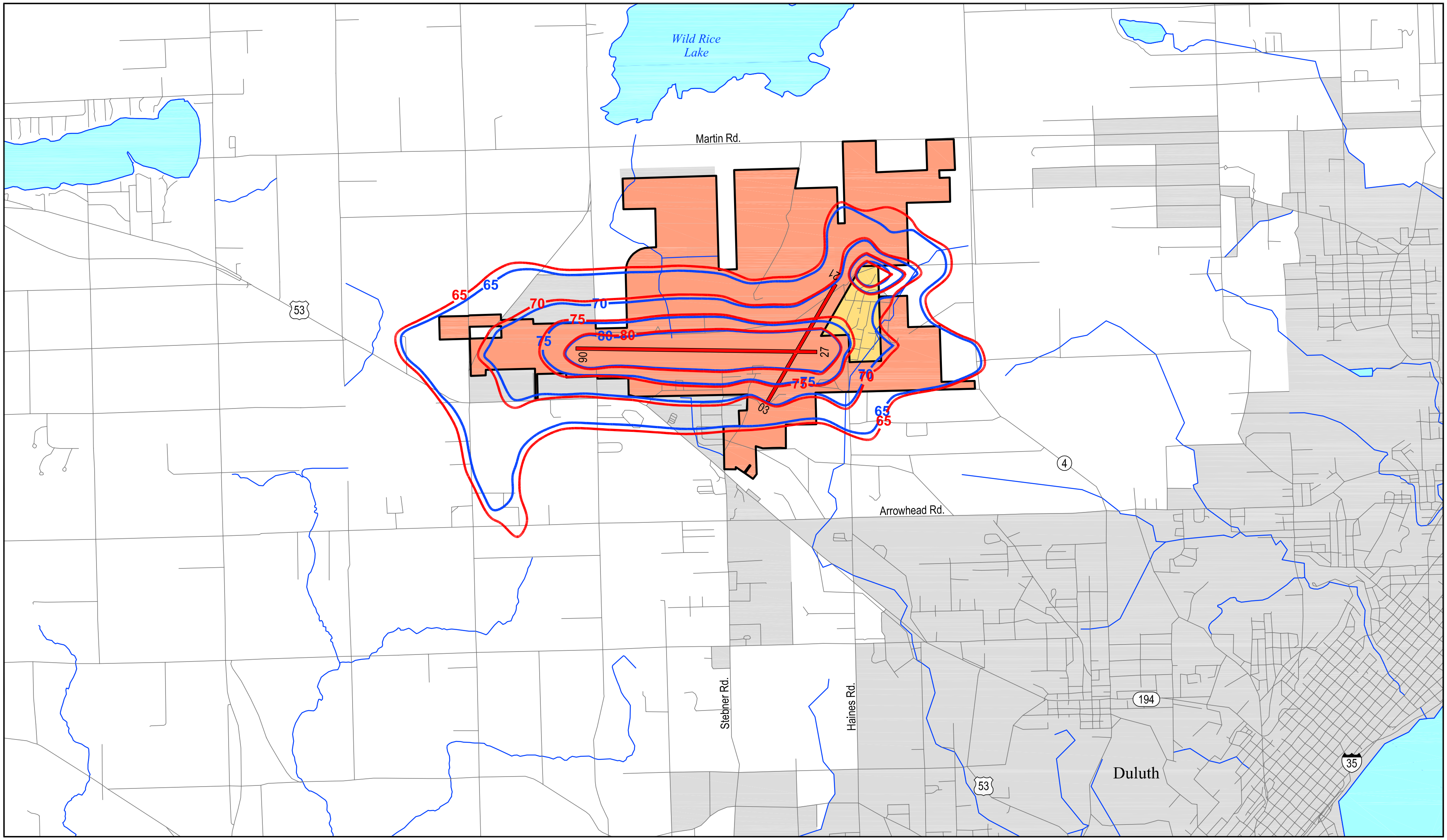
744212 DULUTH–COMP1.DWG



Duluth International Airport, Minnesota

LEGEND

- 15 F-16C Noise Contour
- 18 F-16C Noise Contour
- Runway
- Roadway
- Duluth International Airport
- 148th Fighter Wing Base
- Urban Area

N

0 6,000 Feet

Comparison of 15 F-16C and 18 F-16C Noise Contours

Figure 3.6

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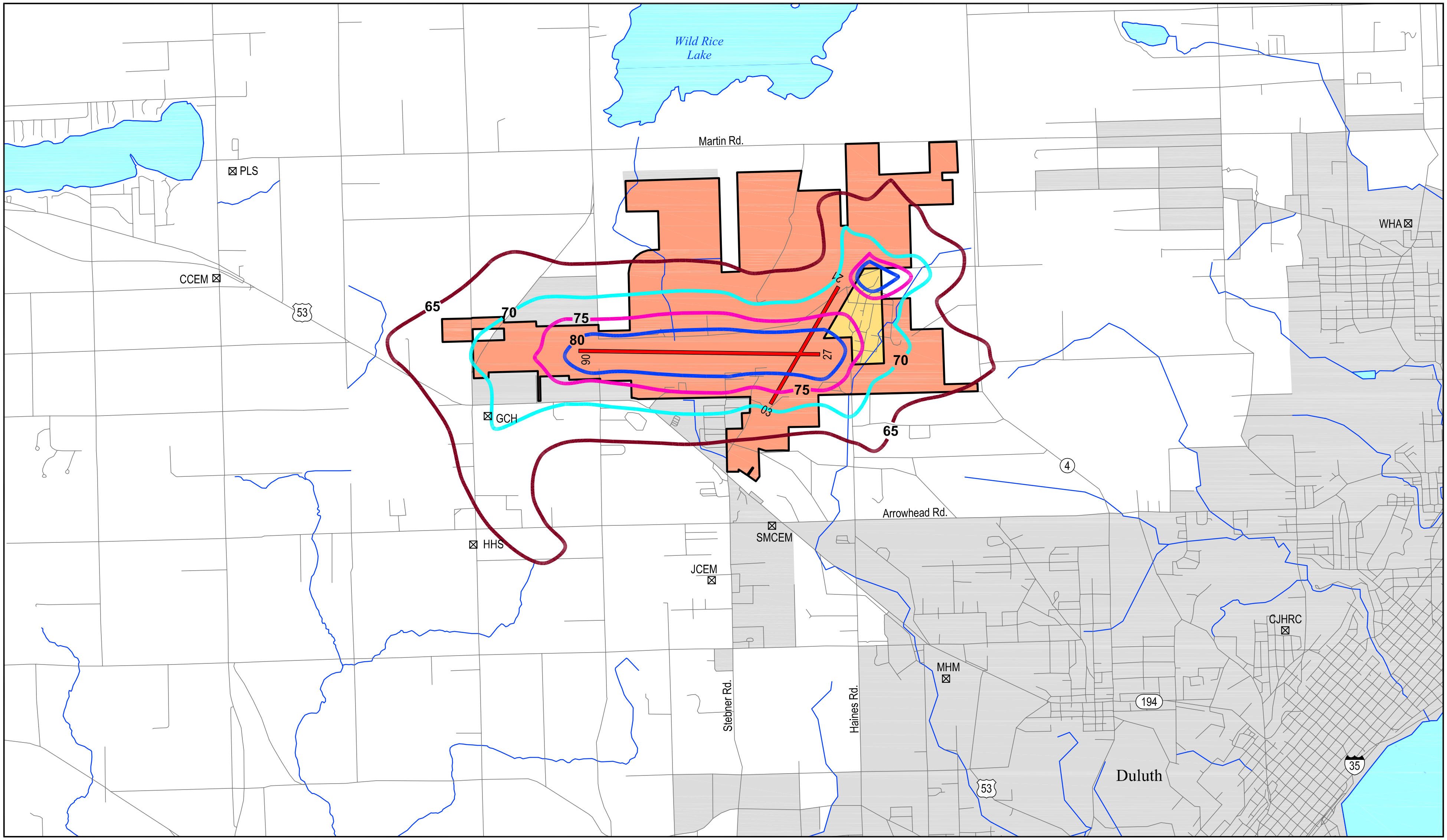
744212 DULUTH–24F16–NC.DWG



Duluth International Airport, Minnesota

LEGEND

- DNL 65 dBA Contour
- DNL 70 dBA Contour
- DNL 75 dBA Contour
- DNL 80 dBA Contour
- Runway
- Roadway
- ⊠ Points of Interest
- Duluth International Airport
- 148th Fighter Wing Base
- Urban Area

N

0 6,000
Feet

Average Busy Day Noise Contours for 24 F-16C Aircraft

Figure 3.7

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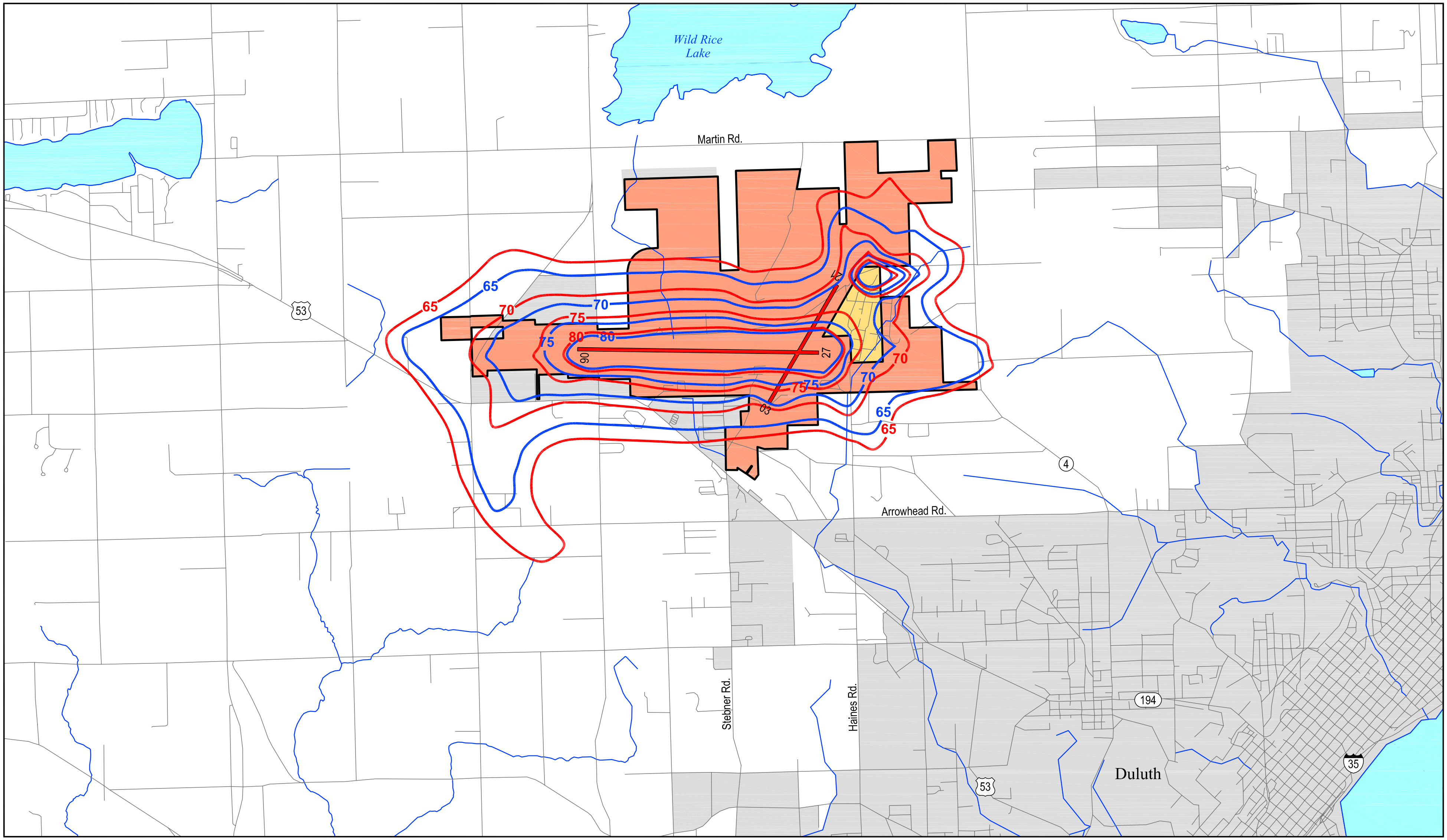

Duluth International Airport, Minnesota

LEGEND

- 15 F-16C Noise Contour
- 24 F-16C Noise Contour
- Runway
- Roadway
- Duluth International Airport
- 148th Fighter Wing Base
- Urban Area

N

0 6,000 Feet

Comparison of 15 F-16C and 24 F-16C Noise Contours

Figure 3.8

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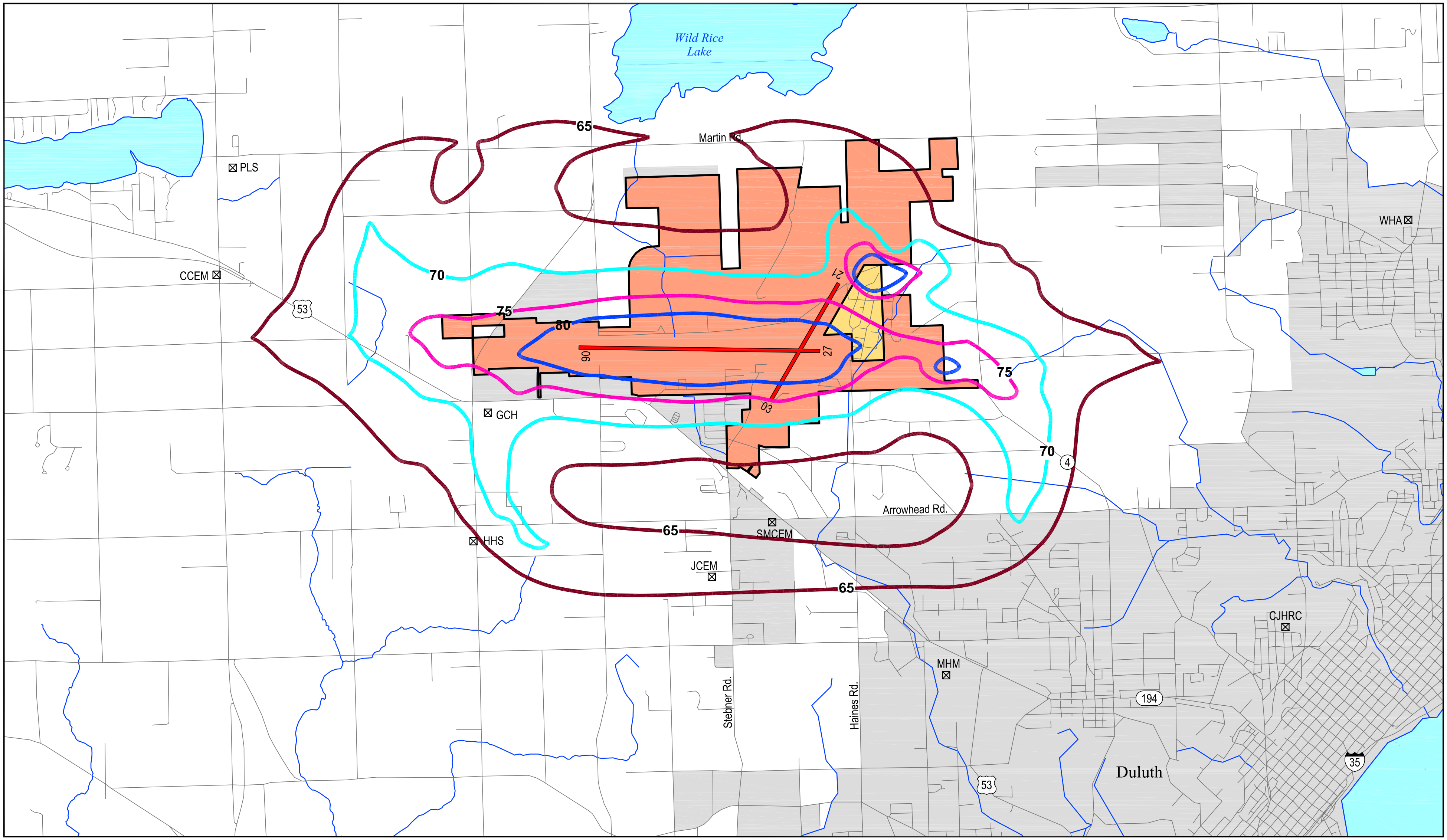
744212 DULUTH–18JSF–NC.DWG



Duluth International Airport, Minnesota

LEGEND

- DNL 65 dBA Contour
- DNL 70 dBA Contour
- DNL 75 dBA Contour
- DNL 80 dBA Contour
- Runway
- Roadway
- ⊠ Points of Interest
- Duluth International Airport
- 148th Fighter Wing Base
- Urban Area

N

0 6,000
Feet

Average Busy Day Noise Contours for 18 Joint Strike Fighter Aircraft

Figure 3.9

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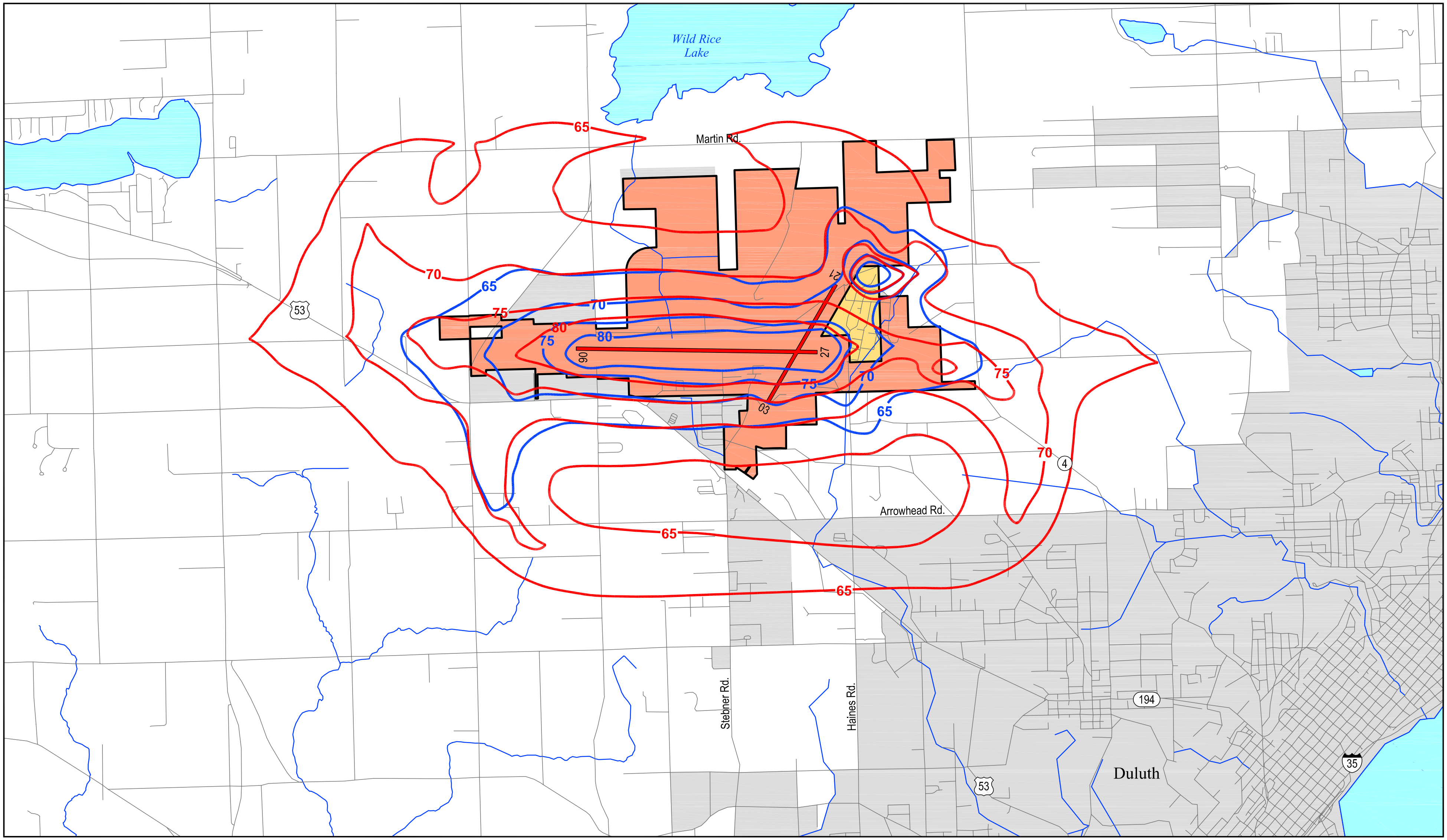
744212 DULUTH–COMP3.DWG



Duluth International Airport, Minnesota

LEGEND

- 15 F-16C Noise Contour
- 18 JSF Noise Contour
- Runway
- Roadway
- Duluth International Airport
- 148th Fighter Wing Base
- Urban Area

N

0 6,000 Feet

Comparison of 15 F-16C and 18 Joint Strike Fighter Noise Contours

Figure 3.10

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SECTION 4
HEIGHT OBSTRUCTION CRITERIA

4.1 HEIGHT AND OBSTRUCTIONS GUIDE

4.1.1 General

Unlike military installations which use Unified Facilities Criteria (UFC) 3-260-01, *Airfield and Heliport Planning and Design*, for guidance concerning height obstruction criteria, civil airports such as Duluth IAP use Federal Aviation Regulation (FAR) Part 77, *Objects Affecting Navigable Airspace*, to determine if an object constitutes an obstruction to air navigation.

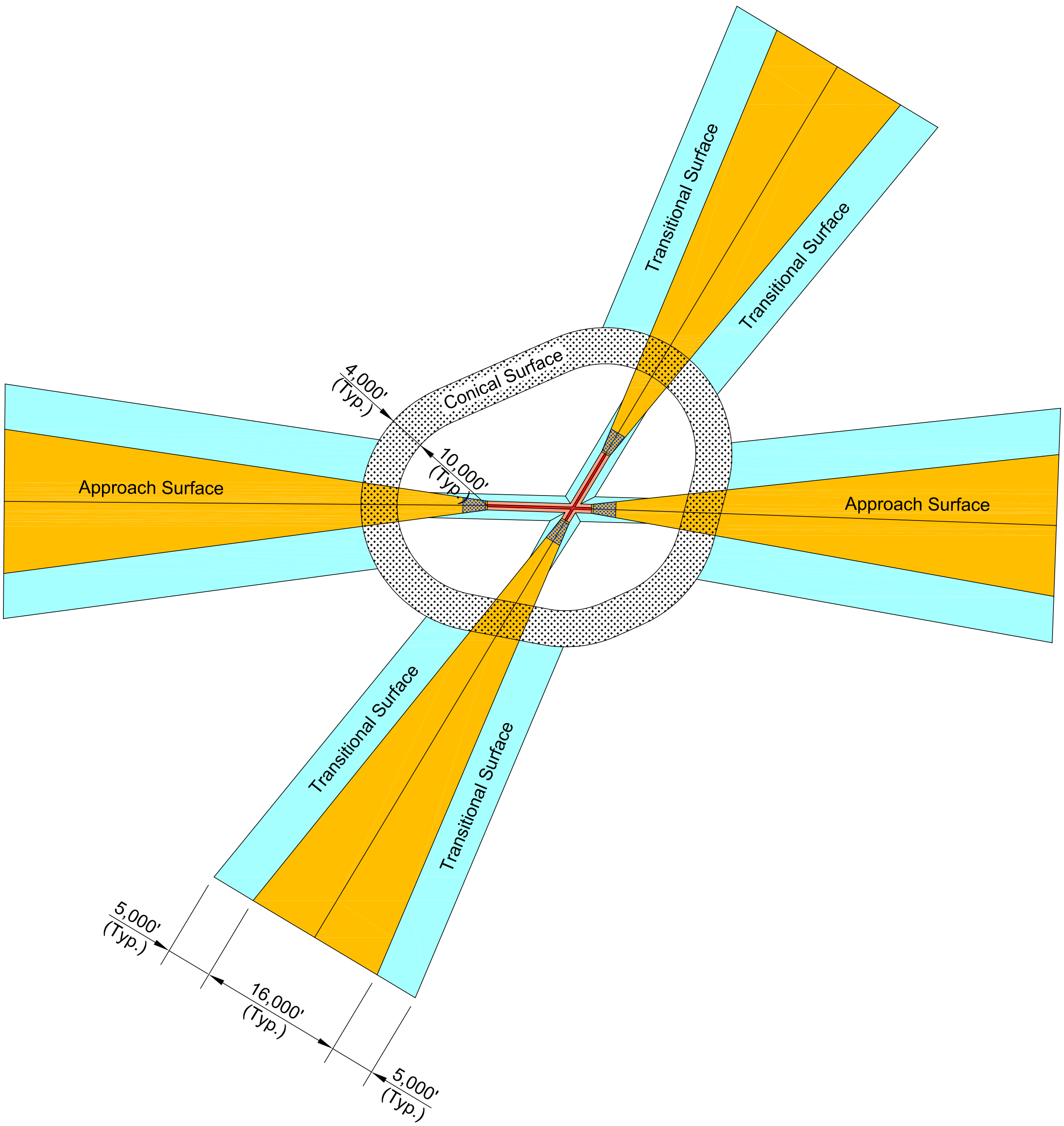
4.1.2 Civil Airport Imaginary Surfaces

Part 77, Subpart C, establishes civilian airport airspace imaginary surfaces in the space around airfields in relation to runways. These surfaces are used to control obstacles that could be an obstruction to air navigation. Figure 4.1 depicts the imaginary surfaces for a civilian airport. The imaginary surfaces in the figure do not specifically depict those for Duluth IAP, but rather show the surfaces as they apply to a civil airport with more than one runway. The following paragraphs contain definitions of the runway airspace imaginary surfaces for civil airports:

- Horizontal Surface—This imaginary surface is a horizontal plane 150 feet above the established airfield elevation, the perimeter of which is constructed by swinging arcs of specified radii from the center of each end of the runway and connecting the adjacent arcs by lines tangent to those arcs. The radius for runways designated as utility or visual is 5,000 feet and the radius for all other runways is 10,000 feet.
- Conical Surface—This imaginary surface extends outward and upward from the outer periphery of the horizontal surface for a horizontal distance of 4,000 feet at a slope of 20:1.
- Primary Surface—This imaginary surface is longitudinally symmetrically centered on the runway, extending 200 feet beyond each runway end. The width of the primary surface is 1,000 feet for precision instrument runways.
- Approach Surface—This imaginary surface is symmetrically centered longitudinally on the extended runway centerline and extending outward and upward from each end of the primary surface. An approach surface is applied to each end of each runway based on the type of approach available or planned for that runway end. The inner end of the approach surface is the same width as the primary surface and it expands uniformly to a width of 16,000 feet for a precision instrument runway. The approach surface extends for a horizontal distance of 10,000 feet at a slope of 50 to 1 with an additional 40,000 feet at a slope of 40 to 1 for precision instrument runways.
- Transitional Surface—This imaginary surface extends outward and upward at right angles to the runway centerline and extended runway centerline at a slope of 7:1 from the sides of the primary surface and from the sides of the approach surfaces.

4.1.3 Runway Protection Zone

UFC 3-260-01 establishes clear zones at the ends of the runways for military airports. However, FAA guidance does not establish clear zones at civil airports. Instead, FAA Advisory Circular 150/5300-13, *Airport Design*, establishes runway protection zones (RPZ) at civil airports. A RPZ is comparable to a clear zone and is established to enhance the protection of people and property. The dimensions for a RPZ for a precision instrument approach runway from which large aircraft operate are: 2,500 feet long; 1,000 feet wide at the inner end, which is 200 feet from the runway end; and 1,750 feet wide at the outer end. The total area of the RPZ is 78.914 acres.



Note:
The purpose of this figure is to show the imaginary surfaces for a typical civilian airport as defined in Part 77.

744212 TRUAX-IMSUR.DWG

LEGEND

- Runway
- Primary Surface
- Transitional Surface
- Approach Surface
- Conical Surface
- Runway Protection Zone

Civilian Airport Imaginary Surfaces

Figure 4.1

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SECTION 5
LAND USE COMPATIBILITY AND RECOMMENDATIONS

5.1 INTRODUCTION

Land use planning and control is a dynamic, rather than a static process. The specific characteristics of land use determinants will always reflect, to some degree, the changing conditions of the economic, social, and physical environment of a community, as well as changing public concern. The planning process accommodates this fluidity in which decisions are normally not based on boundary lines, but rather on more generalized area designations.

5.2 LAND USE PLANNING

The DoD Air Installation Compatible Use Zone (AICUZ) program establishes the guidance for land use planning around Air Force installations. Land use incompatibility under the AICUZ program considers two factors, noise and safety. The AICUZ program does not apply to the 148 FW since it operates at a civil airfield. The FAA's FAR Part 150, *Airport Noise Compatibility Planning*, is a land use compatibility planning program that is comparable to the DoD AICUZ program. Part 150 contains guidance for the FAA program and identifies land use compatibility based only on noise and not safety. FAA Advisory Circular 150/5300-13 contains the guidance for safety in land use planning (see Section 4.1.3). Additionally, Part 77, Subpart C (see Section 4), establishes airspace imaginary surfaces that control obstructions to air navigation, thereby influencing safety at and around civil airports.

5.2.1 Federal Aviation Administration Part 150

Federal Aviation Regulation Part 150, *Airport Noise Compatibility Planning*, provides a means for civilian airports to accomplish comprehensive noise reduction goals. Part 150 is a federal program appropriating aviation-generated funds for the purpose of aircraft noise mitigation measures in communities surrounding an airport (including sound insulation). However, the ability for an airport authority to use Part 150 funds or any aviation generated funds for the purpose of noise mitigation hinges upon completion and federal acceptance of approved noise mitigation measures proposed in a Part 150 study.

A Part 150 study: assesses the noise environment; prepares forecasts of aviation operations; identifies land uses within the area surrounding the airport; and explores ways to mitigate land use incompatibility conflicts. In other words, the purpose of Part 150 is to reduce the number of people affected by noise, consistent with airport operations.

The Part 150 process provides airport operators with the procedures, standards and methodology governing the development, submission, and review of airport Noise Exposure Maps (typically referred to as noise contours) and airport Noise Compatibility Programs. Part 150 prescribes specific standards for the following:

- Establishing a nationally uniform system of describing aircraft noise and noise exposure to eliminate confusion resulting from the use of different descriptors in different communities.

- Describe land use compatibility criteria to guide local communities, while recognizing that these criteria will be influenced by local policies and factors.

- Provide technical assistance to airport operators and other governmental agencies in preparing, executing and implementing the noise compatibility program.

5.2.2 Duluth International Airport Part 150

The most recent Part 150 for Duluth IAP was finalized in 1996 and Figure 5.1 depicts the noise contours from the document for that year. Figures 5.2, 5.3, 5.4, and 5.5, respectively, compare the 1989 Part 150 contours with the noise contours for the 15 F-16C, 18 F-16C, 24 F-16C, and 18 JSF operations conditions. Since the document was completed in 1996, it is likely the data and noise modeling were accomplished one or two years prior to the year in which the Part 150 was finalized because noise modeling is completed early in the Part 150 preparation process and before any land use compatibility analysis is accomplished. The Part 150 process also is a planning document and, in that respect, the document contains noise contours for 1996 and 2001 based on the operations projected for those years at the time the Part 150 was prepared. Given the time that has elapsed since the Part 150 was prepared and the data collection and analysis in this report, the Part 150 contours for 2001 are presented and are used for comparison with the aircraft operations conditions in this Resource Book. Changes that have occurred between the time the noise modeling was accomplished for the 19969 Part 150 and the four conditions modeled in this Resource Book include:

- The 148 FW's mission change from air defense to a general purpose fighter unit which changed arrival and departure profiles and increased the number of afterburner takeoffs;
- Changes in the types and levels of commercial aircraft that operate at the airport;
- The change in the level of general aviation operations at the airport;
- Addition, elimination, and modification of aircraft flight tracks to correspond with changes in flying operations; and
- Technical improvements to the computer noise modeling program.

Airport management indicated in the September 2005 review meeting that the Part 150 will be updated, possibly in 2006.

5.3 LAND USE CATEGORIES

The Duluth IAP was originally established in a relatively undeveloped area in Saint Louis County, Minnesota. The airport is located on approximately 288 acres in the northwest corner of the City of Duluth with Runway 09-27 extending into the northeast corner of the City of Hermantown. The majority of the population growth in St. Louis County since 1990 has occurred in Duluth and the small cities and townships surrounding Duluth. During the past 15 years, Duluth's growth has been occurring primarily to the west and north of the city. The areas to the north, west, and northwest of Duluth have developed into suburban residential communities.

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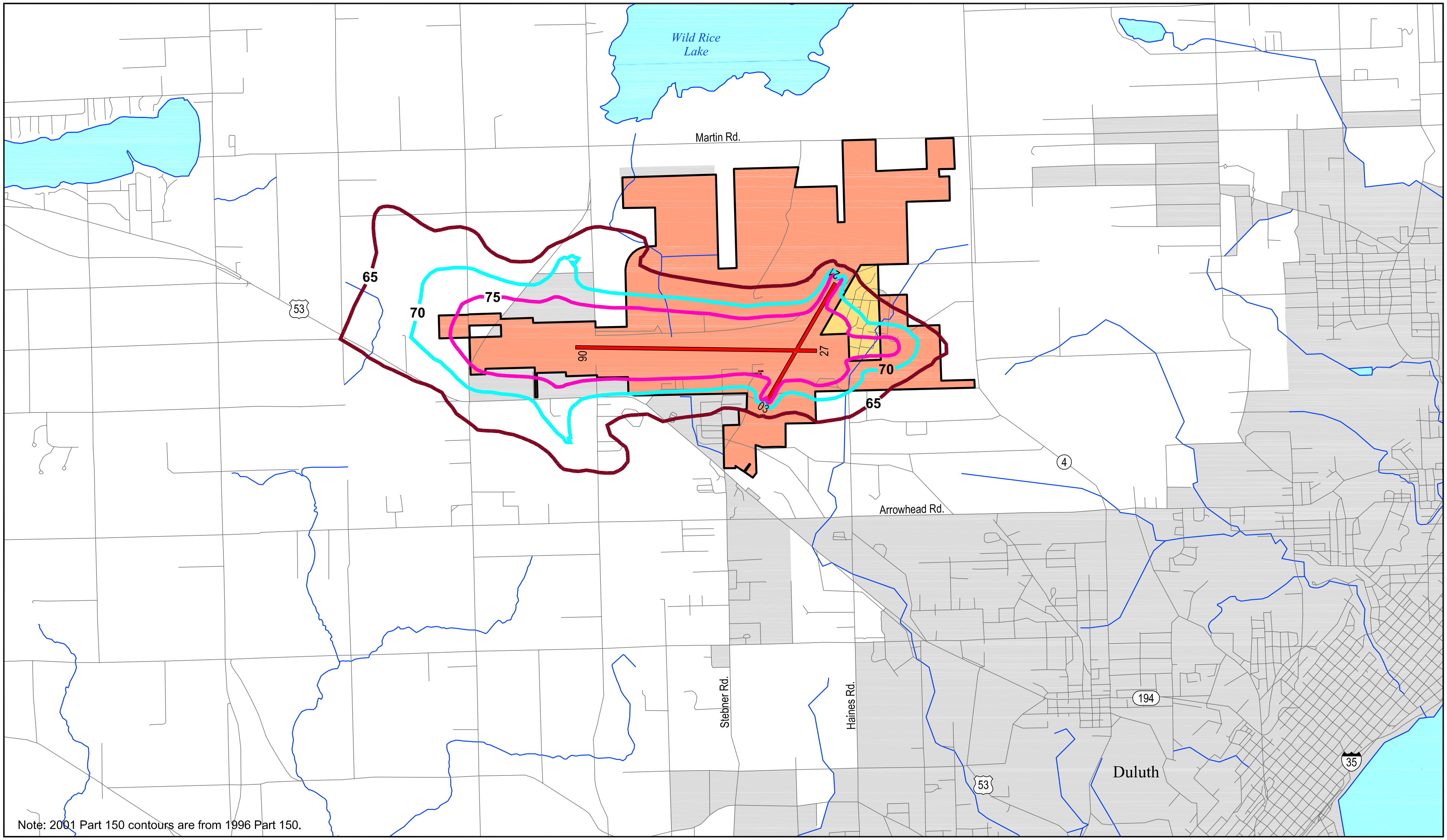

Note: 2001 Part 150 contours are from 1996 Part 150.

Duluth International Airport, Minnesota

LEGEND

DNL 65 dBA Contour	Runway
DNL 70 dBA Contour	Roadway
DNL 75 dBA Contour	
Duluth International Airport	
148th Fighter Wing Base	
Urban Area	

Source:
ACSG Duluth International Airport Layout Plan - June, 2000

N

0 6,000
Feet

Part 150 Noise Contours for 2001

Figure 5.1

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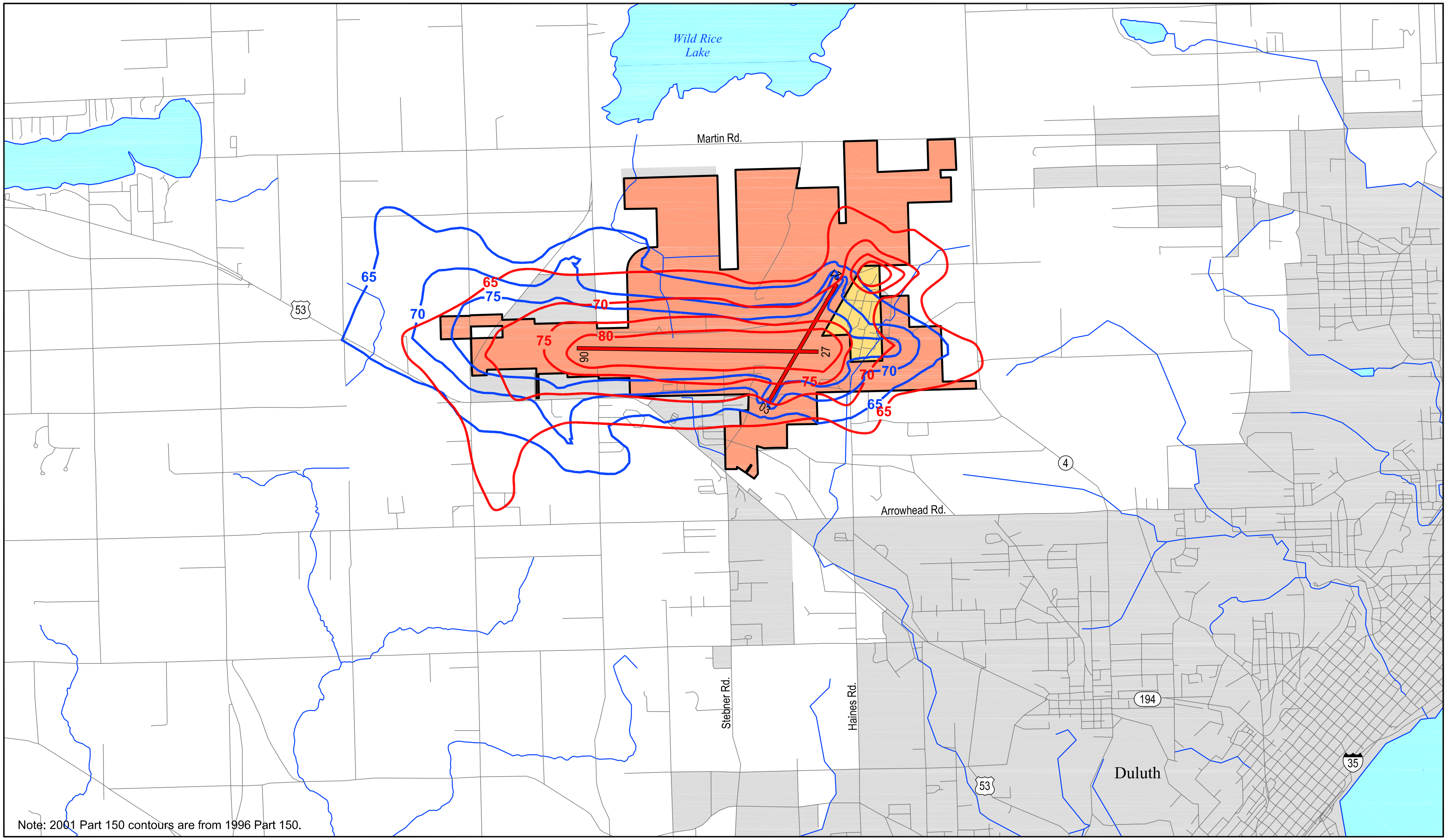

Duluth International Airport, Minnesota

LEGEND

- 2001 Part 150 Noise Contour
- 15 F-16C Noise Contour
- Runway
- Roadway
- Duluth International Airport
- 148th Fighter Wing Base
- Urban Area

Comparison of 15 F-16C and 2001 Part 150 Noise Contours

Figure 5.2

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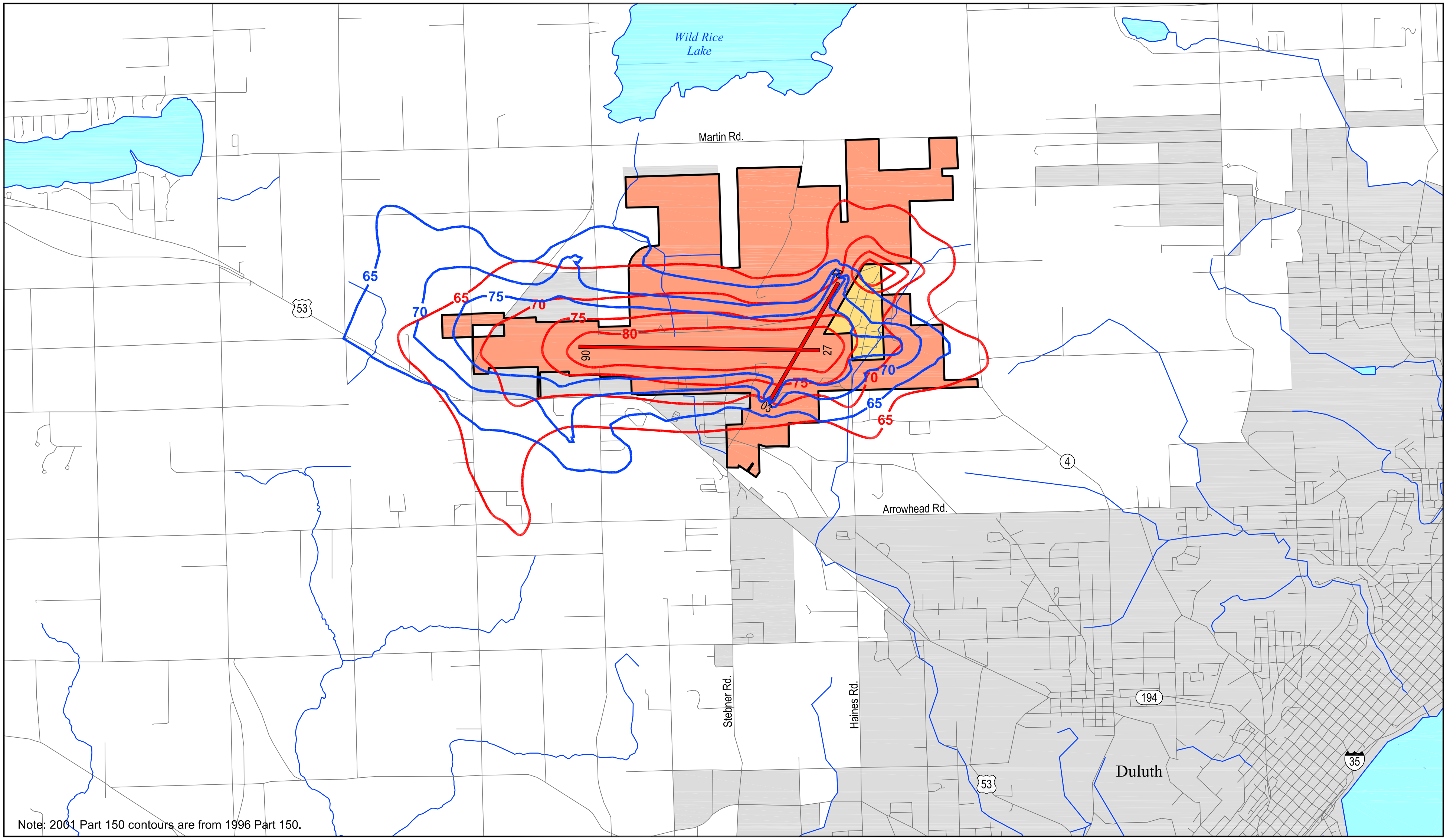

Duluth International Airport, Minnesota

LEGEND

- 2001 Part 150 Noise Contour
- 18 F-16C Noise Contour
- Runway
- Roadway
- Duluth International Airport
- 148th Fighter Wing Base
- Urban Area

N

0 6,000 Feet

Comparison of 18 F-16C and 2001 Part 150 Noise Contours

Figure 5.3

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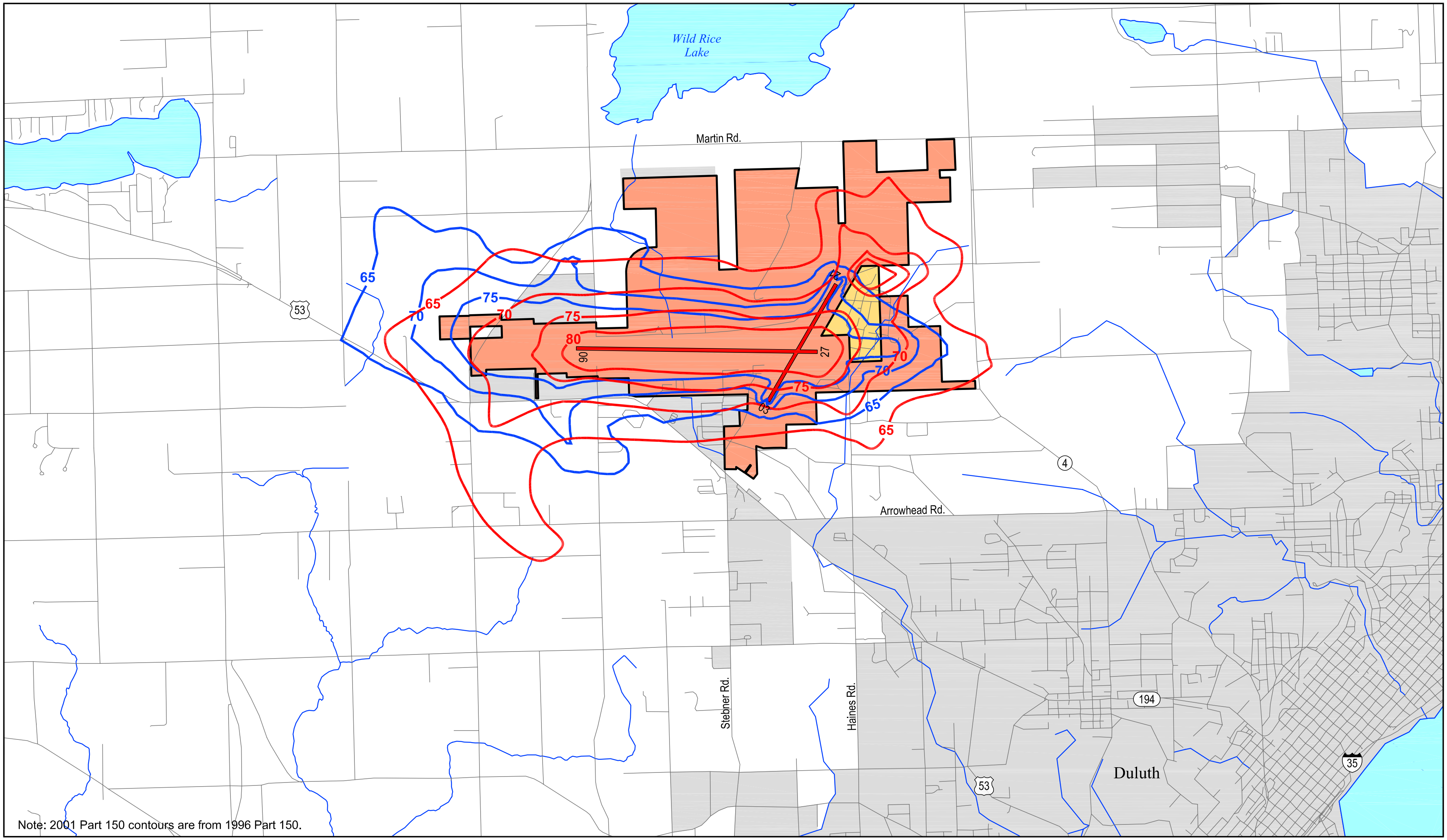

Note: 2001 Part 150 contours are from 1996 Part 150.

Duluth International Airport, Minnesota

LEGEND

- 2001 Part 150 Noise Contour
- 24 F-16C Noise Contour
- Runway
- Roadway
- Duluth International Airport
- 148th Fighter Wing Base
- Urban Area

N

0 6,000 Feet

Comparison of 24 F-16C and 2001 Part 150 Noise Contours

Figure 5.4

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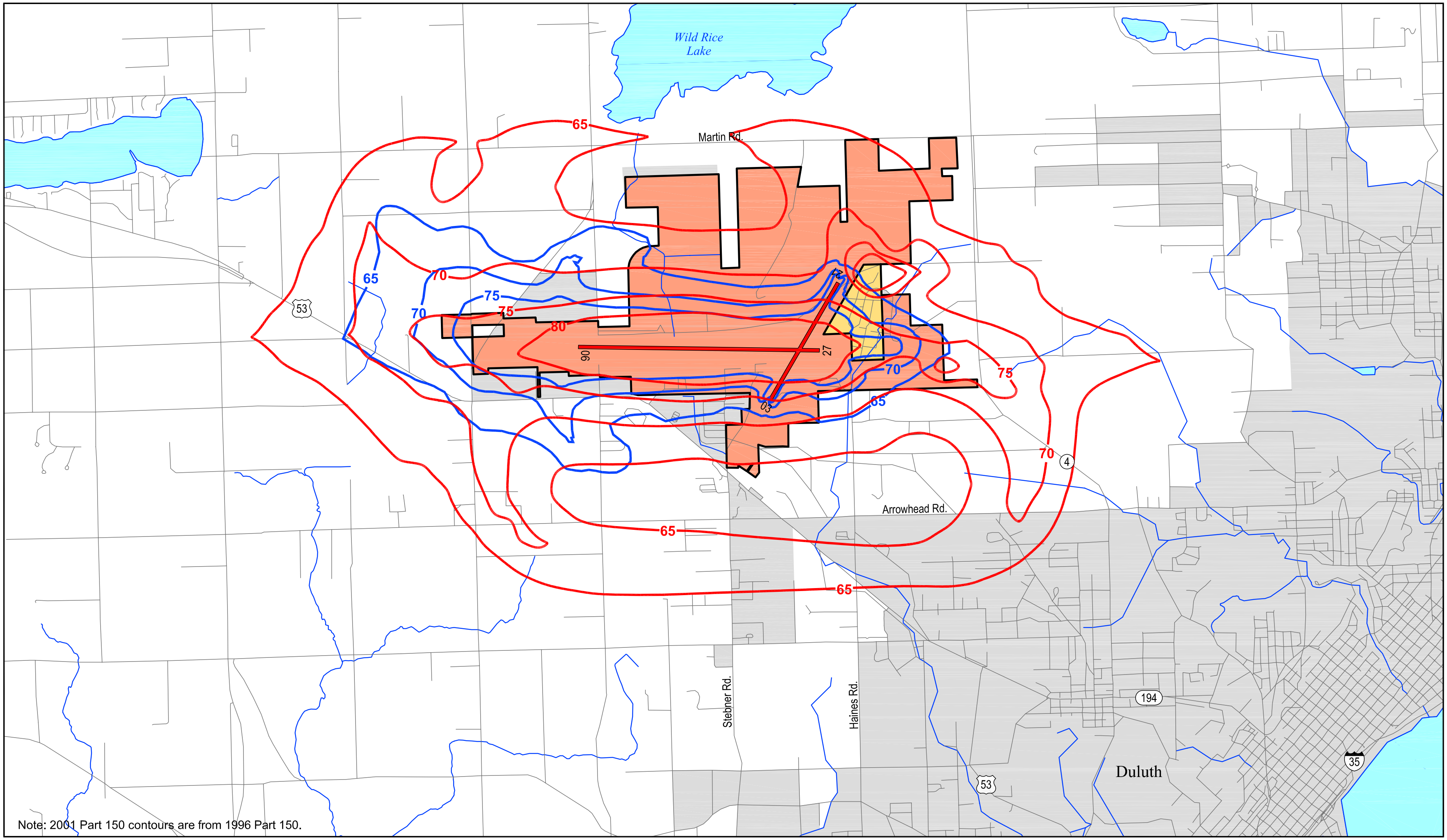

Note: 2001 Part 150 contours are from 1996 Part 150.

Duluth International Airport, Minnesota

LEGEND

- 2001 Part 150 Noise Contour
- 18 JSF Noise Contour
- Runway
- Roadway
- Duluth International Airport
- 148th Fighter Wing Base
- Urban Area

N

0 6,000 Feet

Comparison of 18 Joint Strike Fighter and 2001 Part 150 Noise Contours

Figure 5.5

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For the purpose of this Resource Book, existing land uses have been classified into one of the following five categories:

Residential: This category includes all types of residential activity, such as single and multi-family residences and mobile homes, at a density greater than one dwelling unit per acre.

Commercial: This category includes offices, retail, restaurants and other types of commercial establishments.

Manufacturing and Production: This category includes manufacturing, warehousing, and other similar uses.

Public: This category includes publicly owned lands and/or land to which the public has access, including military reservations and training grounds, public buildings, schools, churches, cemeteries, and hospitals.

Recreational: This category includes land areas designated for recreational activity including parks, wilderness areas and reservations, conservation areas, and areas designated for trails, hikes, camping, etc.

The land use categories used for this analysis are general in nature. The categories do not encompass all of the existing land uses, but group broad categories into easily analyzed groups. However, land uses such as open space and sensitive areas such as wetlands, bogs, and swamps have been omitted. Zoning is a better indicator of what future uses will be impacted due to noise than existing land use.

5.4 EXISTING LAND USE

Figure 5.6 shows existing land uses in the vicinity of Duluth IAP and the contours for the 15 F-16 operations condition. The land surrounding Duluth IAP is located within the City of Duluth, the City of Hermantown to the south and west, Canosia Township to the northwest, and Rice Lake Township to the northeast. The majority of the land surrounding Duluth IAP can be characterized as commercial-light industrial development, with areas of rural residential and undeveloped land to the north.

The area north of Duluth IAP is mostly open space with some industrial and residential uses. This area contains the Northwest Airlines Maintenance Facility and has been identified for future industrial/manufacturing development. A number of single-family homes are located along Martin Road between Lavaque Road and Rice Lake Road with one small area of light industrial use. This area has seen little growth because of the lack of utilities and the presence of numerous wetlands.

Land to the west of Duluth IAP and north of U.S. Highway 53 is mostly open space and residential. Much of this area falls within the runway safety area, and has associated development restrictions. The area south of U.S. Highway 53 is predominantly commercial.

The area south of Duluth IAP consists of predominantly commercial and light industrial uses with some open space and a trailer park. This area is a preferred location of aviation related businesses and the redevelopment of buildings from the former Air Force Base which was immediately south of Runway 09-27. The Airport Road/Airport Approach Road/Stebner Road loop serves this area and the Federal Prison Camp. This area is also the location of Cirrus Designs, an aircraft manufacturer specializing in smaller private aircraft. The connection of Airport Road with Airport Approach Road and the removal of some of the former airbase buildings have opened this area for more light industrial and manufacturing development.

The area east of Duluth IAP is a mix of residential, commercial, industrial and open space. The land east of Rice Lake Road is relatively undeveloped with scattered residential areas and a former auto salvage yard. The Western Lake Superior Sanitary District (WLSSD) Industrial Landfill and the former Duluth Dump Site #2 are located west of Rice Lake Road. The area directly east of Runway 09-27 along Rice Lake Road is mostly open space due to its proximity to the runway. A 200 acre industrial park is located to the southeast along Haines and Airport roads.

Figure 5.6 presents the existing land uses for the area that surrounds Duluth IAP and within the DNL 65 dB and greater noise exposure area. Table 5.1 summarizes the off-airport acreage by land use category exposed to noise levels of DNL 65 dB and greater for the 15, 18, and 24 F-16C and the 18 JSF aircraft conditions.

Table 5-1 Generalized Existing Land Use Within DNL 65 dB and Greater Noise Exposure Area (Off-Airport)

Land Use Category	15 F-16C Condition	18 F-16C Condition	24 F-16C Condition	Joint Strike Fighter Condition
Residential	570	703	1,148	4,980
Public	147	156	176	272
Commercial	554	612	684	1,254
Manufacturing and Production	131	159	229	499
Recreational	105	136	0	625
Total	1,529	1,788	2,259	7,630

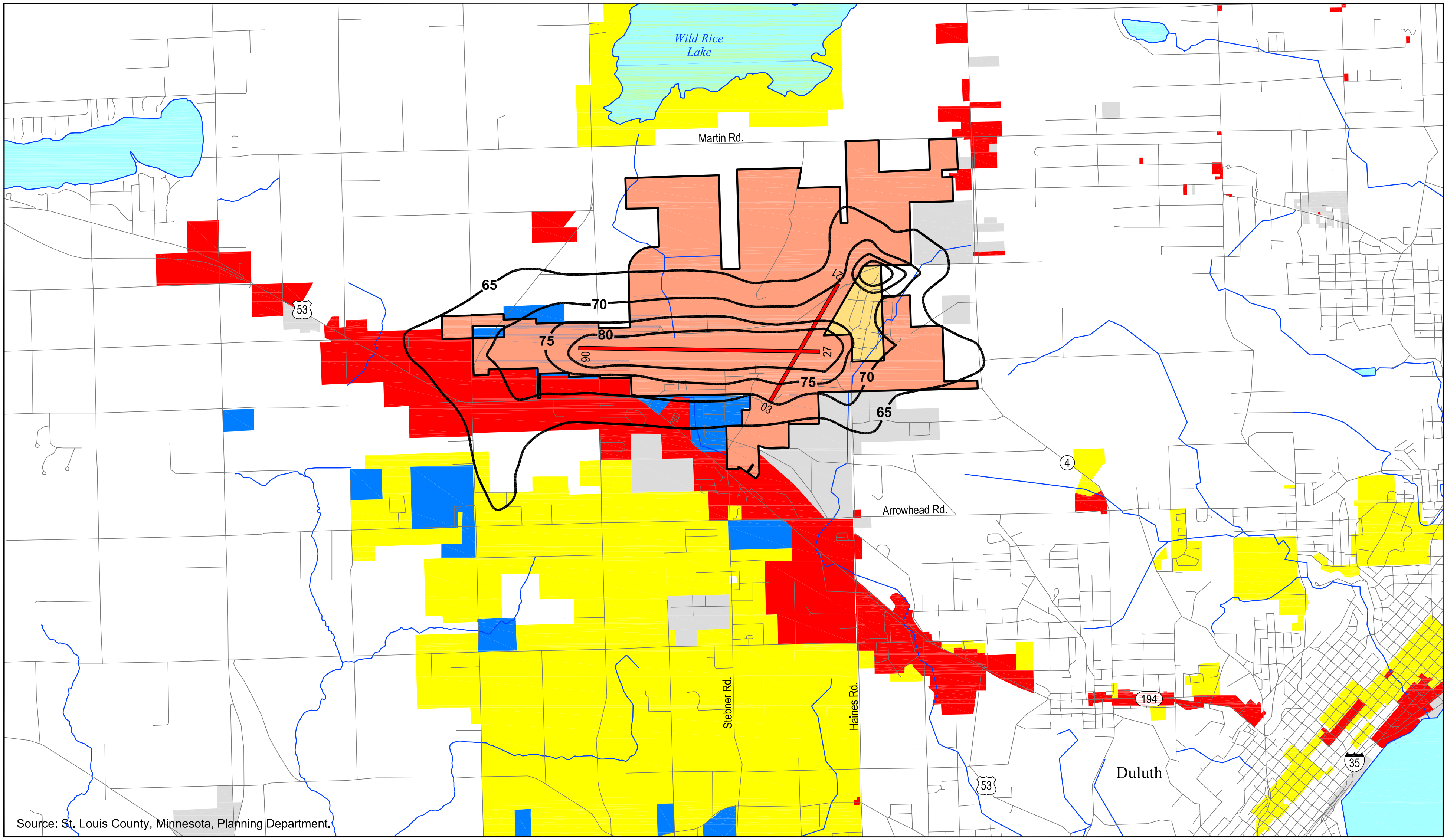
Note: Data reflect acres with the land use category.

5.5 CURRENT ZONING

Local governments and planning agencies have developed a strong working relationship with Duluth IAP in matters of development planning. The jurisdictions surrounding the Duluth IAP have created a Joint Zoning Board to regulate the use of property in the vicinity of the airport. The jurisdictions forming the Duluth IAP Joint Zoning Board are the cities of Duluth and Hermantown, Canosia and Rice Lake townships, and St. Louis County. The Duluth IAP Zoning Ordinance was created by the Joint Zoning Board was adopted in 1988 and revised in 1996.

The Airport Zoning ordinance restricts the height of buildings and objects and regulates the use of property in the vicinity of Duluth IAP. Airspace obstruction zoning is accomplished through the use of the Airspace Zones that are associated with the imaginary surfaces described in Section 4. No tree shall be allowed to grow or structure built that would penetrate any of the Imaginary Surfaces.

744212 DULUTH–GELU.DWG



Duluth International Airport, Minnesota

LEGEND

- Residential
- Commercial
- Manufacturing and Production
- Public
- Runway
- Roadway
- DNL Noise Contour
- Duluth International Airport
- 148th Fighter Wing Base

N

0 6,000 Feet

Generalized Existing Land Use

Figure 5.6

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Land use regulation is accomplished through the creation of the airport Safety Zones. Minnesota Rule 8800.2400 established these zones which were created to protect the general public on the ground and provide space for emergency landings for aircraft. Use restrictions are associated with each zone and are more restrictive near areas of aircraft operation (*e.g*., the ends of each runway). Limitations to the types of land uses and the density of structures in these areas provide for safer airport operation. The Airport Zoning Ordinance describes the location of each Safety Zone and the types of uses and densities that are allowed. The Duluth IAP Zoning Ordinance takes precedence over the zoning ordinances of the four adjacent jurisdictions.

The Airport Zoning Ordinance contains six maps that make up the official Airport Zoning Map and include the Imaginary Surfaces Plan, the Imaginary Surfaces Sections, Height Limitation Zoning Plan, Land Use Safety Zones, Detailed Land Use Safety Zones, and Land Ownership – Safety Zones A & B of Runway 3.

In addition, the Airport Zoning ordinance includes information on non-conforming uses, permits, variances and administration. The ordinance also established a Board of Adjustment which consists of one member from the cities of Duluth and Hermantown, the Duluth Airport Authority, and the townships of Rice Lake and Canosia. The Board of Adjustment hears and decides appeals and grants variances, with decisions made by majority vote.

Local jurisdictions recognize the importance of maintaining the capability of Duluth IAP by protecting it from urban encroachment. Continued maintenance of the land use restrictions currently in place will ensure the viability of Duluth IAP while helping to inform the owners of affected properties of the land use restrictions.

Analysis of the current zoning maps for these jurisdictions was performed to determine the acreage of each zoning designation within the DNL 65 dB and greater noise area. For this analysis, zoning designations were generalized into residential, public, commercial, manufacturing and production, and recreational categories. Table 5.2 provides a breakdown of the off-airport generalized zoning within the DNL 65 dB and greater noise area for the 15, 18, and 24 F-16C and the 18 JSF aircraft conditions.

Table 5-2 Current Zoning Within DNL 65 dB and Greater Noise Exposure Area (Off-Airport)

Zoning Category	15 F-16C Condition	18 F-16C Condition	24 F-16C Condition	Joint Strike Fighter Condition
Residential	570	703	1,148	4,980
Public	147	156	176	272
Commercial	554	612	684	1,254
Manufacturing and Production	131	159	229	499
Recreational	105	136	0	625
Total	1,529	1,788	2,257	7,630

Note: Data reflect acres with the zoning category.

5.6 INCOMPATIBLE LAND USES

Part 150 states that, in those areas where the DNL values are 65 dB or greater, the airport operator should identify land uses and determine land use compatibility in accordance with the standards in the Pars. Table 5.3, which is taken from Part 150, describes compatible land use information for several land uses as a function of DNL values. The ranges of values in Table 5.3 reflect the statistical variability for the responses of large groups of people to noise. Any particular level might not accurately assess an individual's perception of an actual noise environment. Compatible or incompatible land use is determined by comparing the predicted DNL values at a site with the values given. Adjustments or modification of the descriptions of the land use categories may be desirable after consideration of specific local conditions.

The compatibility designations in Table 5.3 generally refer to the major use of the site. If other uses with greater sensitivity to noise are permitted by local government at a site, a determination of compatibility must be based on that use which is most adversely affected by noise. When appropriate, noise level reduction through incorporation of sound attenuation into the design and construction of a structure may be necessary to achieve compatibility. For the purpose of compliance with Part 150, all land uses are considered to be compatible with noise levels less than DNL 65 dBA. Local needs or values may dictate further delineation base on local requirements or determinations.

5.6.1 Incompatible Land Uses for 15 F-16C Aircraft Condition

Table 5.4 shows land use incompatibility as it is applied to existing land use within the Duluth IAP area of influence for the 15 F-16C aircraft condition. For a land use area to be considered compatible, it must meet criteria for its category for noise as shown in Table 5.3. The compatibility guidelines shown in Table 5.3 were combined with the existing land use data presented on Figure 5.6 to determine the off-airport land use compatibility associated with aircraft operations at Duluth IAP. Results of this analysis are shown numerically in Table 5.4 and graphically on Figure 5.7.

Table 5-3 Land Use Compatibility with Day-Night Average Sound Levels

	Yearly Day-Night Average Sound Level (DNL) in Decibels (dBA)					
Land Use	**Below 65**	**65-69**	**70-74**	**75-79**	**80-85**	**Over 85**
Residential						
Residential, other than mobile homes and transient lodgings	Y	N(1)	N(1)	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N(1)	N(1)	N(1)	N	N
Public Use						
Schools	Y	N(1) 1	N(1)	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Government services	Y	Y	25	30	N	N
Transportation	Y	Y	Y(2)	Y(3)	Y(4)	Y(4)
Parking	Y	Y	Y(2)	Y(3)	Y(4)	N
Commercial Use						
Offices, business, and professional	Y	Y	25	30	N	N
Wholesale and retail – building materials, hardware, and farm equipment	Y	Y	Y(2)	Y(3)	Y(4)	N

Table 5-3 Land Use Compatibility with Day-Night Average Sound Levels (*continued*)

	Yearly Day-Night Average Sound Level (DNL) in Decibels (dBA)					
Land Use	**Below 65**	**65-69**	**70-74**	**75-79**	**80-85**	**Over 85**
Retail trade – general	Y	Y	25	30	N	N
Utilities	Y	Y	Y(2)	Y(3)	Y(4)	N
Communication	Y	Y	25	30	N	N
Manufacturing and Production						
Manufacturing, general	Y	Y	Y(2)	Y(3)	Y(4)	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y(6)	Y(7)	Y(8)	Y(8)	Y(8)
Livestock farming and breeding	Y	Y(6)	Y(7)	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
Recreational						
Outdoor sports arenas and spectator sports	Y	Y(5)	Y(5)	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts, and camps	Y	Y	Y	N	N	N
Golf courses, riding stables and water recreation	Y	Y	25	30	N	N

Numbers in parentheses refer to notes.

KEY TO TABLE

SLUCM	*Standard land use coding manual*
Y	*Yes. Land use and related structures compatible without restrictions.*
N	*No. Land use and related structures are not compatible and should be prohibited.*
NLR	*Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.*
25, 30, or 35	*Land used and related structures generally compatible; measures achieve NLR or 25, 30, or 35 dB must be incorporated into design and construction of structure.*

NOTES FOR TABLE

(1) Where the community determines that residential or school uses must be allowed, measures to achieve outdoor to indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide an NLR of 20 dB; thus, the reduction requirements are often stated as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of NLR criteria will not eliminate outdoor noise problems.
(2) Measures to achieve NLR of 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.
(3) Measures to achieve NLR of 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.
(4) Measures to achieve NLR of 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.
(5) Land use compatible provided special sound reinforcement systems are installed.
(6) Residential buildings require an NLR of 25.
(7) Residential buildings require an NLR of 30.
(8) Residential buildings not permitted.

Table 5-4 Off-Airport Incompatible Land Use for the 15 F-16C Aircraft Condition

Category	Off-Airport Acreage within Noise Zones (dBA)				Total
	65-69	70-74	75-79	80+	
Residential	366	156	26	22	570
Public	101	45	0	0	146
Commercial	0	103	0	0	103
Manufacturing and Production	0	0	0	0	0
Recreational	0	0	0	0	0
Total	467	317	33	23	819

The only incompatible land use types at noise levels between DNL 65-69 dBA are residential and some public uses without NLR materials. Approximately 366 acres of areas designated for residential uses exist in the DNL 65-69 dBA noise zone to the northwest, south, and east of Duluth IAP. The residential uses to the south (approximately 37 acres) consist primarily of mobile-home parks and a subdivision located south of U.S. Highway 53 and east of Ugstad Road. The residential uses to the northwest and east consist primarily of single-family homes and smaller subdivisions. An additional 156 acres of residential land exist within the DNL 70-74 dBA noise zone to the north, south, and east of Duluth IAP. Since these homes were generally constructed prior to the 1980s, they are assumed to not have been designed or constructed to provide a significant level of outside to inside NLR. Residential uses with the DNL 65-69 dBA noise zone would be conditionally compatible upon incorporation of the appropriate amount of NLR.

Commercial land uses become incompatible at noise levels between DNL 70-74 dBA. At these noise levels, NLR of 25 dBA should be incorporated into the design and construction for new buildings. Existing commercial uses occur in both the DNL 70-74 dBA and DNL 75-79 dBA noise zones. The majority of these uses are located along Miller Trunk Highway (U.S. Highway 53).

5.6.2 Incompatible Land Uses for 18 F-16C Aircraft Condition

Table 5.5 shows land use incompatibility as it is applied to existing land use within the Duluth IAP area of influence for the 18 F-16C aircraft condition. The majority of affected residential uses are located to the south and southwest in the area of Arrowhead and Ugstad roads to the southwest and between U.S. Highway 53 and the airport property boundary to the south. This condition affects approximately 703 acres of residential land. Although approximately 61 acres are located in the DNL 75 dBA and greater noise exposure area, only one existing home located immediately northwest of the airport is affected. Results of this analysis are shown numerically in Table 5.5 and graphically on Figure 5.8. Commercial land uses in the DNL 70-80 dBA noise zone are concentrated to the west and south along U.S. Highway 53.

Table 5-5 Off-Airport Incompatible Land Use for the 18 F-16C Aircraft Condition

Category	Off-Airport Acreage within Noise Zones (dBA)				Total
	65-69	70-74	75-79	80+	
Residential	475	167	40	21	703
Public	87	65	4	0	156
Commercial	0	135	0	0	135
Manufacturing and Production	0	0	0	0	0
Recreational	0	0	0	0	0
Total	562	375	56	23	994

5.6.3 Incompatible Land Uses for 24 F-16C Aircraft Condition

Table 5.6 shows land use incompatibility as it is applied to existing land use within the Duluth IAP area of influence for the 24 F-16C aircraft condition. In addition to the exposure described for the 18 F-16C condition, the additionally exposed residential areas in the DNL 65-69 dBA noise zone are located predominantly to the northeast and southwest of Duluth IAP. Additionally exposed residential areas in the DNL 70-74 dBA noise zone occur to the south and west. Commercial land uses in the DNL 70 to 80dBA noise levels are located along U.S. Highway 53. Results of this analysis are shown numerically in Table 5.6 and graphically on Figure 5.9.

Table 5-6 Off-Airport Incompatible Land Use for the 24 F-16C Aircraft Condition

Category	Off-Airport Acreage within Noise Zones (dBA)				Total
	65-69	70-74	75-79	80+	
Residential	678	180	61	26	945
Public	73	93	9	0	175
Commercial	0	204	7	0	211
Manufacturing and Production	0	0	0	0	0
Recreational	0	0	0	0	0
Total	751	481	92	28	1,331

5.6.4 Incompatible Land Uses for Joint Strike Fighter Aircraft Condition

Table 5.7 shows land use incompatibility as it is applied to existing land use within the Duluth IAP area of influence for the 18 JSF aircraft condition. The affected area would extend ¾ of a mile east of CSA 4, along Norton Road to ¾ of a mile west of Lindahl Road, along State Route 194 to the south, ¼ of a mile south of Lavaque Junction Road, and approximately ¼ of a mile north of Martin Road.

Affected residences in the DNL 65-69 dBA noise zone are located in the area west of Route C-297 and south of Martin Road, extending northwestward and southward in an area south of Kruger Road between Lavaque Road and Arlington Avenue. Residential land uses in the DNL 70-74 dBA noise zone would be concentrated to the northwest along the Lavaque by-pass and to the southeast between Kruger and Arrowhead roads. Commercial land uses located in the DNL 70-80 dBA noise exposure area would include those uses along U.S. Highway 53 and a smaller commercial area to the north located near the intersection of

Route C-297 and Samuelson Junction Road. Results of this analysis are shown numerically in Table 5.7 and graphically on Figure 5.10.

Table 5-7 Off-Airport Incompatible Land Use for the Joint Strike Fighter Aircraft Condition

Category	Off-Airport Acreage within Noise Zones (dBA)				Total
	65-69	70-74	75-79	80+	
Residential	3,775	926	218	61	4,980
Public	131	73	66	1	271
Commercial	0	490	161	1	652
Manufacturing and Production	0	0	0	0	0
Recreational	0	0	0	0	0
Total	3,906	1,492	460	67	5,903

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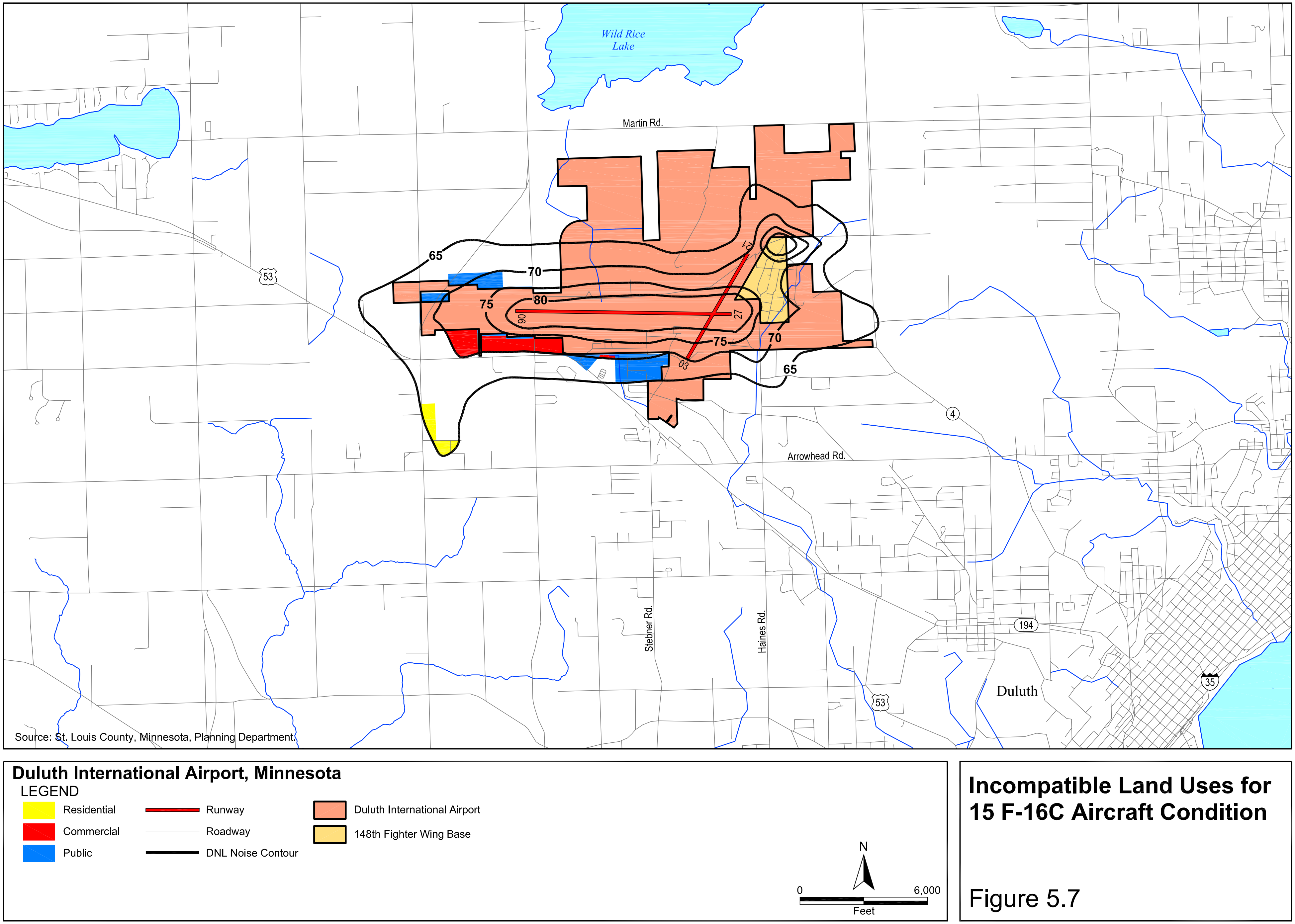

Incompatible Land Uses for 15 F-16C Aircraft Condition

Figure 5.7

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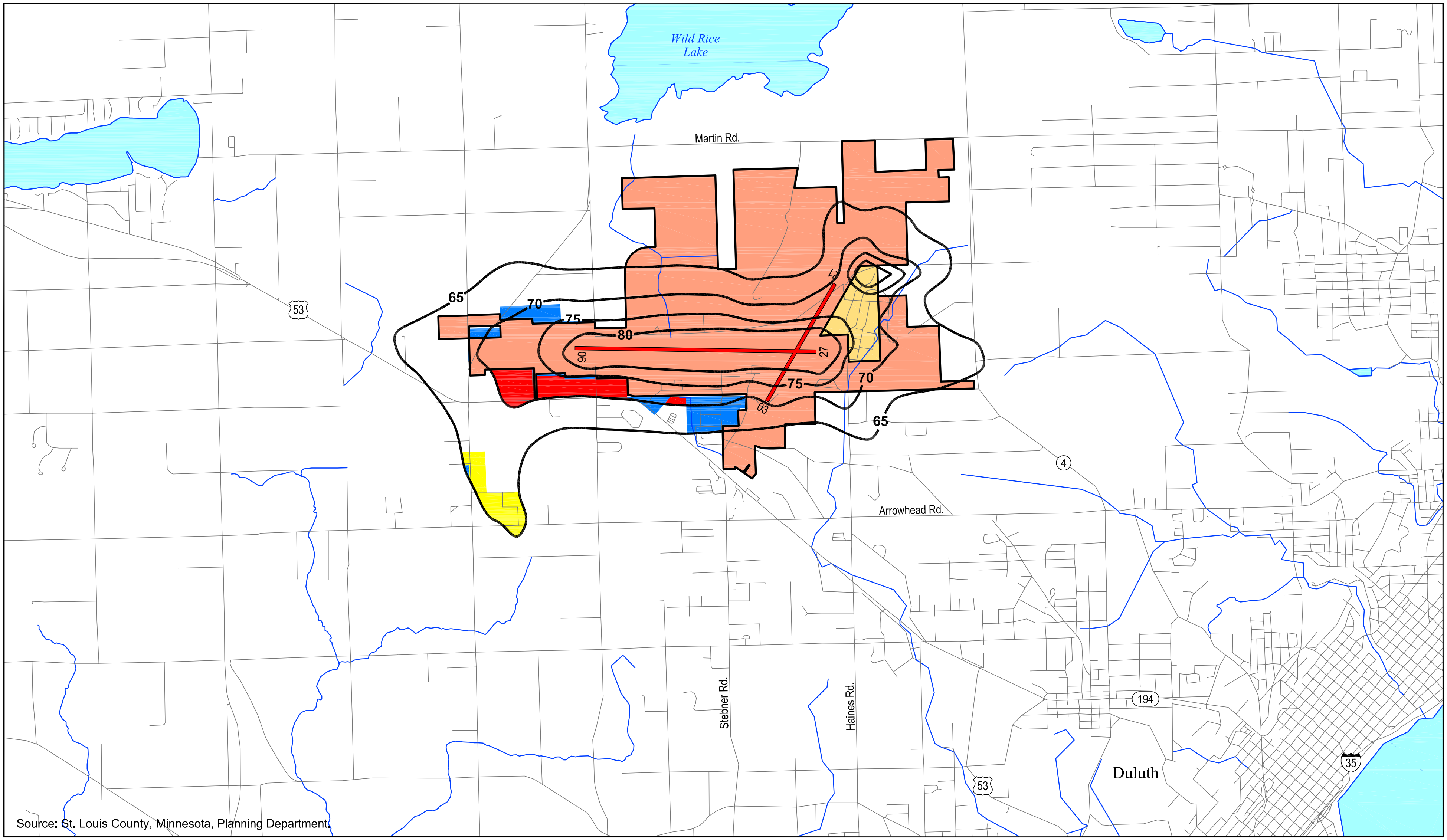

Duluth International Airport, Minnesota

LEGEND

- Residential
- Commercial
- Public
- Runway
- Roadway
- DNL Noise Contour
- Duluth International Airport
- 148th Fighter Wing Base

N

0 6,000 Feet

Incompatible Land Uses for 18 F-16C Aircraft Condition

Figure 5.8

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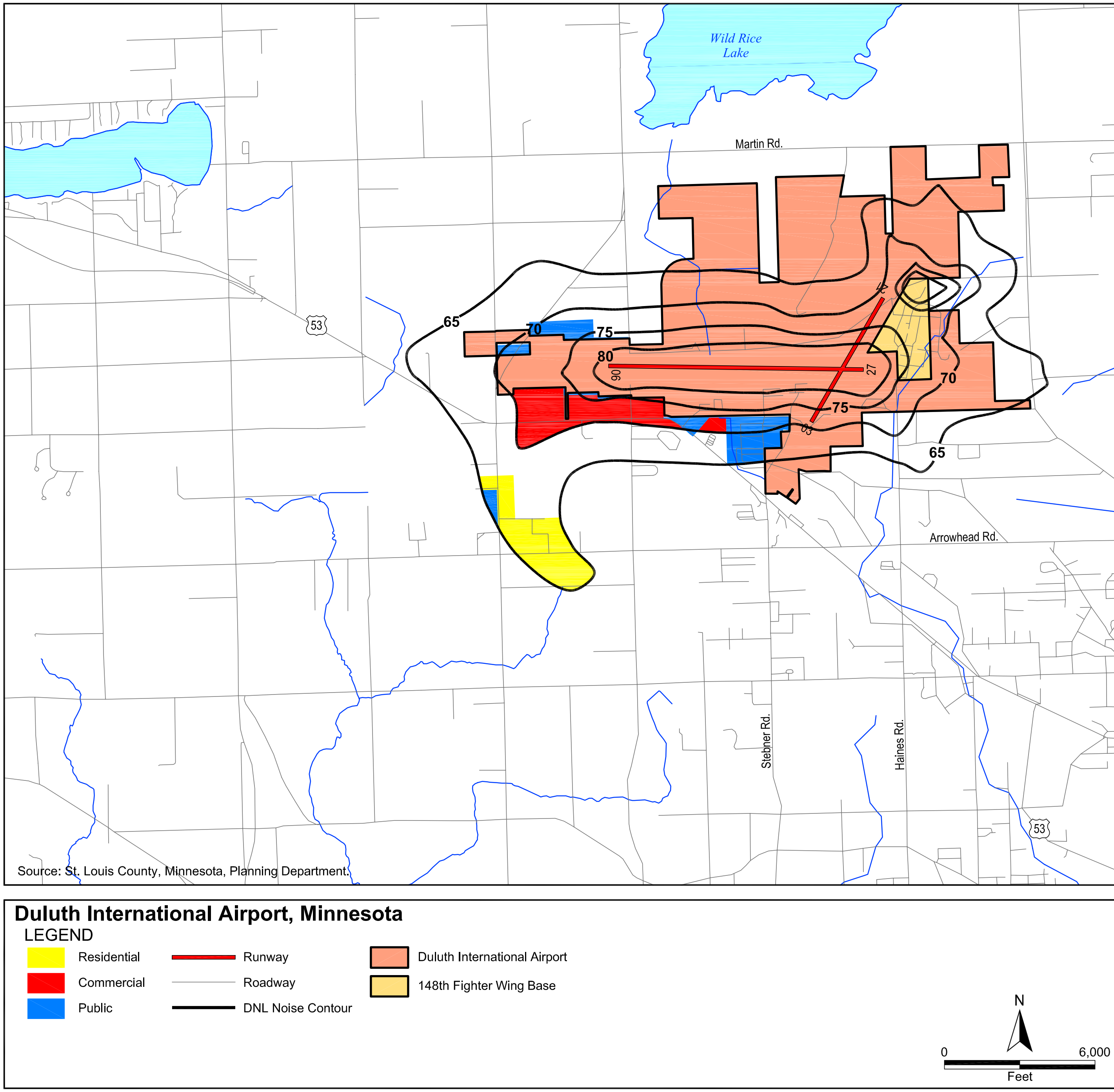

Incompatible Land Uses for 24 F-16C Aircraft Condition

Figure 5.9

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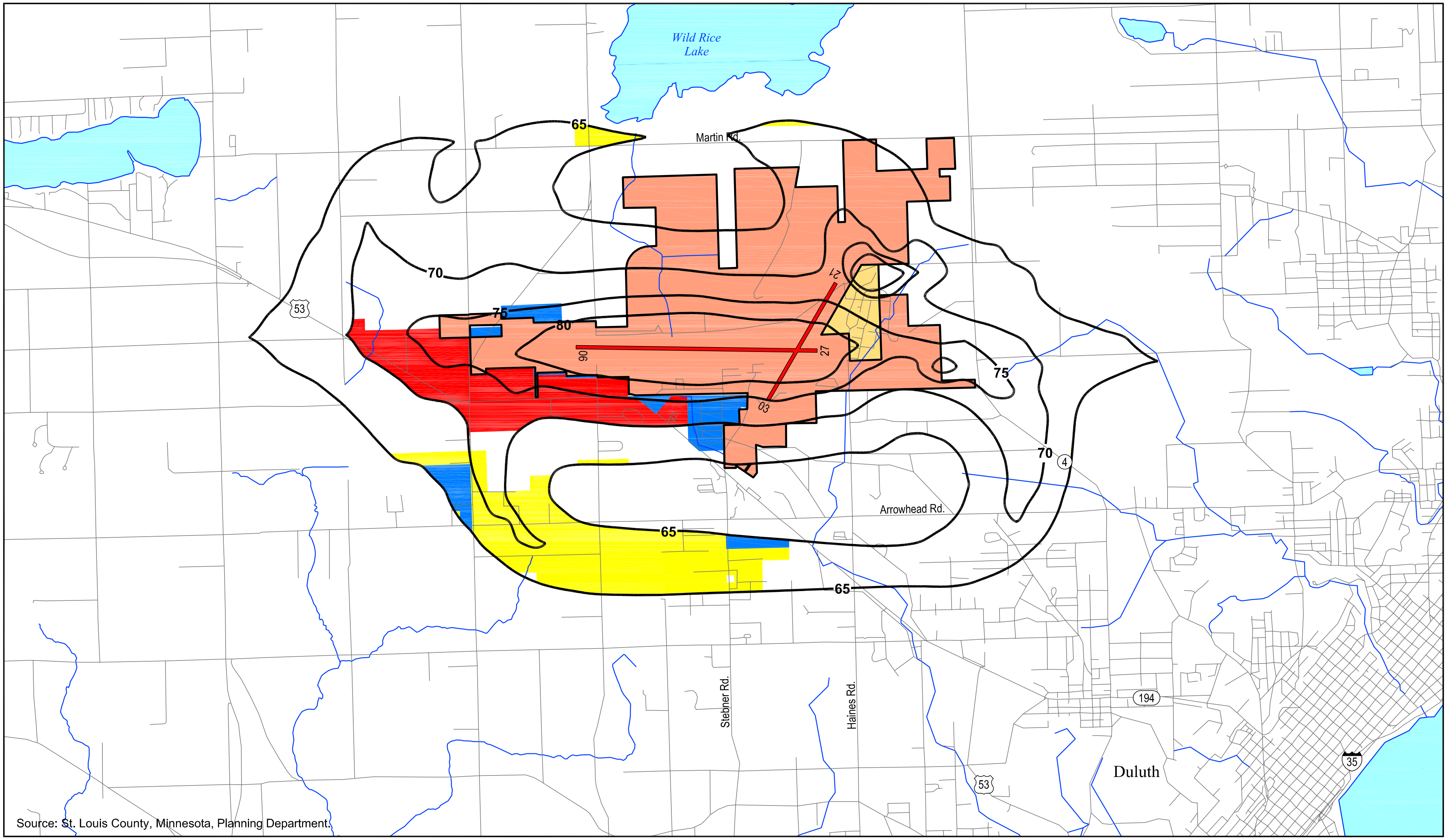

Duluth International Airport, Minnesota

LEGEND

Residential
Commercial
Public
Runway
Roadway
DNL Noise Contour
Duluth International Airport
148th Fighter Wing Base

N
0 6,000
Feet

Incompatible Land Uses for Joint Strike Fighter Aircraft Condition

Figure 5.10

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SECTION 6
ECONOMIC IMPACT

Employment trends are provided for the Duluth-Superior Metropolitan Statistical Area (MSA), which include the cities of Duluth and Hermantown and the townships of Canosia and Rice Lake.

6.1 LOCAL ECONOMIC CHARACTERISTICS

As shown in Table 6-1, the City of Duluth had a population of over 85,000 in 1990. In 2000, the city's population increased to approximately 86,900 persons. The City of Duluth's projected 2010 population is 88,367, an increase of 2,874 since 1990, and 1,449 since 2000. The Duluth-Superior MSA is expected to grow in population during the next decade to over 247,000 by 2010.

Table 6-1 Historic and Projected Population

Area	1990	2000	2010 Projection
Duluth	85,493	86,918	88,367
Hermantown	6,761	7,448	8,205
Canosia	1,743	1,998	2,290
Rice Lake	3,883	4,139	4,412
Duluth-Superior MSA	239,971	243,815	247,721

Sources: US Census Bureau, 2000

The economic census is conducted by the U.S. Census Bureau every 5 years, with the latest published data based on the 1997 survey. Data from the 2002 economic census will be available toward the middle of 2006. In 1997, employment in the Duluth-Superior MSA was estimated to be over 71,000 persons with an annual payroll of over $1.4 billion. The largest employer was the services sector with over 40,000 employees (56 percent of total) which contributed over $735.1 million (51 percent of total) in payroll. Table 6-2 presents the Duluth-Superior MSA employment by sector.

Table 6-2 Duluth-Superior MSA Employment by Sector, 1997

Sector	Employees	Payroll ($1,000)
Utilities	Withheld	Withheld
Manufacturing	6,989	201,235
Wholesale Trade	3,486	110,827
Retail Trade	14,464	217,463
Transportation and Warehousing	2,002	70,550
Finance, Insurance, and Real Estate	4,172	102,868
Services	40,055	735,137
Total	73,368*	1,438,080*

Source: US Census Bureau, Economic Census 1997
*Does not include utility sector information.

6.2 148TH FIGHTER WING IMPACT

The geographic area subject to significant 148 FW-generated economic impacts is defined as the area within a 50-mile radius of Duluth IAP. As a result of payroll expenditures, annual expenses, and the estimated value of indirect jobs in the local area, the 148 FW had an estimated total economic impact of over $75 million in 2003. The majority of this economic impact was due to the payroll, retirement benefits, and contracts provided by the MNANG and Air Force Reserve. The MNANG directly employs over 1,300 personnel with an annual payroll of nearly $35 million. In addition to direct benefits, the MNANG creates an additional economic impact with an estimated 300 indirect jobs in the region. Table 6-3 summarizes annual 148 FW expenditures, and Table 6.4 lists the annual payroll.

Table 6-3 Annual Operating Expenditures

Category		Expenditures ($)
Construction		
Military Construction (FC53)		6,548,879
Operations and Maintenance		20,858,995
Other		2,037,274
	Total	**29,445,148**
Contracts		
Contract Services and Misc.	Total	**716,403**
Other Materials, Equipment , and Supplies		
Supplies and Equipment		1,765,704
Computers and Related Assets		249,212
	Total	**2,014,916**
Grand Total		***32,176,467***

Source: 148th Fighter Wing, Duluth IAP, MN, Economic Impact Analysis, Fiscal Year 2003

Table 6-4 Annual Payroll

Category	Payroll ($)
Traditional Guardsmen	11,416,298
Active Duty Reserves	5,560,107
State Employees	2,811,060
Air Guard Technicians	15,597,600
Total	***35,385,065***

Source: 148th Fighter Wing, Duluth IAP, MN, Economic Impact Analysis, Fiscal Year 2003

SECTION 7
PERSONS AND AGENCIES CONSULTED

The following persons and agencies consulted during preparation of this Aircraft Noise Environmental Management Resource Book.

Brooks Air Force Base, Texas, Headquarters Air Force Center for Environmental Excellence

Vaselka, Thomas Capt (HQ AFCEE/ISA)

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Federal Aviation Administration, Air Traffic Control Tower, Duluth International Airport, Minnesota

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SECTION 8
LIST OF PREPARERS

Name	Degree	Resource	Years of Experience
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Snyder, Shawn		Land Use	
Wallin, John	B.A., Biology M.A., Management	Project Manager; Aircraft Operations; Noise	35

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SECTION 9
REFERENCES

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APPENDIX A
NOISE INFORMATION

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APPENDIX A
NOISE INFORMATION

NOISE METRICS AND ANALYSIS METHODOLOGY

A variety of metrics may be used to assess the impacts of noise. Depending on the specific situation, appropriate analysis may include single event or averaged metrics. Single event metrics are used to assess the potential impacts of noise on structures and animals, and are sometimes used in the assessment of human effects. Sound Exposure Level (SEL), a single event metric, is commonly used to evaluate sleep disturbance. Averaged noise metrics are useful in characterizing the overall noise environment and are primarily used to analyze community (population) exposure to noise. Averaged noise exposure is expressed as the Day-Night Average A-Weighted Sound Level (DNL) metric. The United States Environmental Protection Agency (USEPA) selected DNL as the uniform descriptor of averaged noise exposure. Subsequently, Federal agencies, including the Department of Defense (DoD) and Federal Aviation Administration (FAA), adopted DNL for expressing averaged sound.

Single Event Sound Metrics

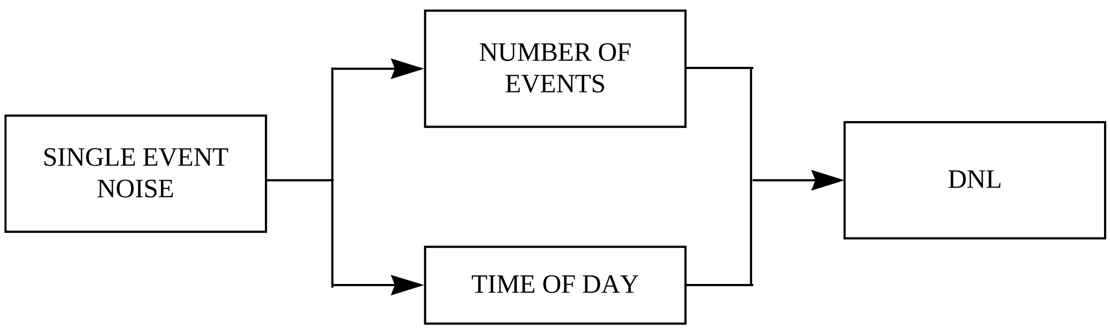
Although the highest A-weighted sound level measured in decibels (dBA) level measured during an event (*i.e*., maximum sound level or L_{max}) is the most easily understood descriptor for a noise event, alone it provides little information. Specifically, it provides no information concerning either the duration of the event or the amount of sound energy. Thus, SEL, which is a measure of the physical energy of the noise event and accounts for both intensity and duration, is used for single event noise analysis. Subjective tests indicate that human response to noise is a function not only of the maximum level, but also of the duration of the event and its variation with respect to time. Evidence indicates that two noise events with equal sound energy will produce the same response. For example, a noise at a constant level of 85 dBA lasting for 10 seconds would be judged to be equally as annoying as a noise event at a constant level of 82 dBA and duration of 20 seconds (*i.e.,* 3 dBA decrease equals one half the sound energy but lasting for twice the time period). This is known as the "equal energy principle." The SEL value represents the A-weighted level of a constant sound with a duration of 1 second, providing an amount of sound energy equal to the event under consideration. By definition, SEL values are referenced to a duration of 1 second and should not be confused with either the average or maximum noise levels associated with a specific event. When an event lasts longer than 1 second, the SEL value will be higher than the L_{max} of the event. The L_{max} would typically be 5 to 10 dBA below the SEL value or aircraft overflights. SEL is used when discussing sleep disturbance and L_{max} is used for effects on structures.

The frequency, sound level, and duration of aircraft overflight noise events depend on variables including aircraft type and model (engine type), aircraft configuration (*i.e.,* flaps, landing gear, *etc*.), engine power setting, aircraft speed, distance between the observer and the aircraft flight track, temperature, humidity, and altitude above sea level. Therefore, extensive noise data are collected for various types of aircraft/engines at different power settings and phases of flight. This database of aircraft noise provides a basis for calculation of average individual-event sound descriptors for specific aircraft operations at any location under varying meteorological conditions. The reference values are adjusted to any location by applying appropriate corrections for the variables.

Averaged Noise Metrics

Single event analysis has a major shortcoming -- single event metrics do not describe the overall noise environment. DNL is the measure of the total noise environment. DNL averages the sum of all aircraft noise producing events over a 24-hour period, with a 10 dBA upward adjustment added to the nighttime events (between 10:00 p.m. and 7:00 a.m.). Figure A.1 depicts the relationship of the single event, the number of events, the time of day, and DNL. This adjustment is an effort to account for increased human sensitivity to nighttime noise events. The summing of sound during a 24-hour period does not ignore the louder single events, it actually tends to emphasize both the sound level and number of those events. The logarithmic nature of the dB unit causes sound levels of the loudest events to control the 24-hour average.

Figure A.1 Day-Night Average A-Weighted Sound Level



DNL is the accepted unit for quantifying annoyance to humans from general environmental noise, including aircraft noise. The Federal Interagency Committee on Urban Noise (FICUN) developed land use compatibility guidelines for noise exposure areas (FICUN 1980). Based upon these FICUN guidelines, the FAA developed recommended land uses in aircraft noise exposure areas. The Air Force uses DNL as the method to estimate the amount of exposure to aircraft noise and predict impacts. Land use compatibility and incompatibility are determined by comparing the predicted DNL level at a site with the recommended land uses.

Noise Analysis Methodology

The noise analysis methodology used for airfield operations in this EA is based on the noise contours produced by the NOISEMAP noise model. NOISEMAP is a suite of computer programs developed by the Air Force to predict noise exposure in the vicinity of an airfield due to aircraft flight, maintenance, and ground run-up operations. Data describing flight tracks and flight profile use, power settings, ground run-up information by type of aircraft/engine, and meteorological variables are assembled and processed for input into NOISEMAP. The model uses this information to calculate SEL and DNL values at points on a regularly spaced grid surrounding the airfield. A plotting program generates contour lines connecting points of equal DNL values in a manner similar to elevation contours shown on topographic maps. Contours are generated as 5 dB intervals beginning at DNL 65 dBA, the maximum level considered acceptable for unrestricted residential use. The contours produced by NOISEMAP are used in averaged noise analysis. While there is no technical reason why a lower level cannot be measured or calculated for comparison purposes, DNL 65 dBA:

Provides a valid basis for comparing and assessing community noise effects; and

Represents a noise exposure level which is normally dominated by aircraft noise and not other community or nearby highway noise sources.

The Air Force adopted the NOISEMAP computer program to describe noise impacts created by aircraft operations. NOISEMAP is one of two USEPA-approved computer programs; the other is the INM used by the FAA for noise analysis at civil airports. The NOISEMAP and INM programs are similar; however, INM does not contain noise data for all military aircraft. For this reason, contours produced by NOISEMAP are used in the day-night average sound analysis sections in this Resource Book.

SLEEP DISTURBANCE

Noise from low-flying aircraft arriving at and departing from an airfield at night may cause sleep disturbance. DNL incorporates consideration of sleep disturbance by assigning a 10 dBA penalty to the SELs of nighttime noise events (10:00 p.m. to 7:00 a.m.). However, single noise events, not average sound levels, correlate better with sleep disturbance.

Studies have estimated the percentage of awakenings that may be experienced by people exposed to different SELs. Based on those studies, the Federal Interagency Committee on Noise (FICON) in 1992 recommended use of an interim dose-response curve to predict the percentage of the exposed population expected to be awakened as a function of the exposure to single-event noise levels expressed in terms of SEL. Since the adoption of the interim curve in 1992, substantial field research has been completed using a variety of test methods and a number of locations. The data from these studies show a consistent pattern, with a smaller percentage of the exposed population expected to be behaviorally awakened than had been shown in laboratory studies.

The Federal Interagency Committee on Aviation Noise (FICAN) (formed in 1993 as recommended by FICON) now recommends a new dose-response curve for predicting awakening. Figure A.2 compares the FICAN recommendation of 1997 to the FICON recommendation of 1992. FICAN takes the conservative position that, because the adopted curve represents the upper limit of the data presented, it should be interpreted as predicting the maximum percentage of the exposed population expected to be awakened. Based on this new position, it is estimated that outdoor SELs of 80 to 100 dBA could result in 4 to 10 percent awakenings in the exposed population. Noise must penetrate the residence to disturb sleep. Interior noise levels are lower than exterior levels due to the attenuation of the sound energy by the structure. The amount of attenuation provided by the building is dependent on the type of construction and whether the windows are open or closed. The approximate national average attenuation factors are 15 dBA for open windows and 25 dBA for closed windows. Twenty dBA is conservatively used to estimate attenuation for a typical dwelling unit (USEPA 1974).

EFFECTS OF NOISE ON STRUCTURES

Possible noise-related impacts on structures should be considered in the context of accepted research results. The recent development of larger commercial and military aircraft has prompted research into the effects of noise vibrations on both modern and historic structures.

Some building materials are more sensitive than others to external pressures and induced vibrations. Windows with large panes of glass are most vulnerable. Plaster walls in frame buildings are susceptible to cracking. Components that are least likely to experience damage are masonry walls of stone, concrete block, adobe, or brick. Appropriate building design can also reduce the possibility of damage from vibration. Research has not proven categorically that old buildings are more vulnerable to vibration than newer buildings, but prudence dictates special consideration be given to unique structures of historical significance. Table A-1 lists the effects of sound on structures.

Table A-1 Effects of Sound on Structures

<table>
<tr><th>dBA</th><th colspan="2">Effects Summary</th></tr>
<tr><td>0-127</td><td rowspan="2">Typical community exposures
(generally below 2 psf)</td><td>No damage to structures
No significant public reaction</td></tr>
<tr><td>127-131</td><td>Rare minor damage
Some public reaction</td></tr>
<tr><td>131-140</td><td colspan="2">Window damage possible, increasing public reaction, particularly at night</td></tr>
<tr><td>140-146</td><td colspan="2">Incipient damage to structures</td></tr>
<tr><td>146-171</td><td colspan="2">Measured booms at minimum altitudes experienced by humans; no injury</td></tr>
<tr><td>185</td><td colspan="2">Estimated threshold for eardrum rupture (maximum overpressure)</td></tr>
<tr><td>194</td><td colspan="2">Estimated threshold for lung damage (maximum overpressure)</td></tr>
</table>

Source: Speakman 1992.

CLASSROOM DISRUPTION

Speech in school classrooms exposed to aircraft noise could become masked or the teacher could stop talking altogether during an aircraft noise event. Teachers may choose to pause their speech to avoid interference with noise when it reaches a level of 60 dBA. Masking of the speech of teachers who do not pause would start about the same level. At levels of 75 dBA, some masking would occur for 15 percent of the specific noise events. Masking would increase to nearly 100 percent at 82 dBA, and pauses would occur for about 80 percent of the specific noise events. Since a marked increase in pauses and masking would occur when levels exceed 75 dBA, this level is sometimes considered to be the level above which teaching would be impaired as a result of disruption of speech communication. However, the effect that the disruption would have on learning is unclear.

DAY-NIGHT AVERAGE NOISE

Noise annoyance is defined by the USEPA as any negative subjective reaction to noise by an individual or group. Table A-2 presents the results of over a dozen studies on the relationship between noise and annoyance levels. This relationship was suggested by Schultz (1978) and was reevaluated (Fidell *et al.* 1988) for use in describing the reaction of people to environmental noise. These data provide a perspective on the level of annoyance that might be anticipated. For example, 12 to 22 percent of people exposed on a long-term basis to DNL of 65 to 70 dBA are expected to be highly annoyed by noise events. The study results summarized in Table A-2 are based on outdoor noise levels.

Table A-2 Theoretical Percentage of Population Highly Annoyed by Noise Exposure

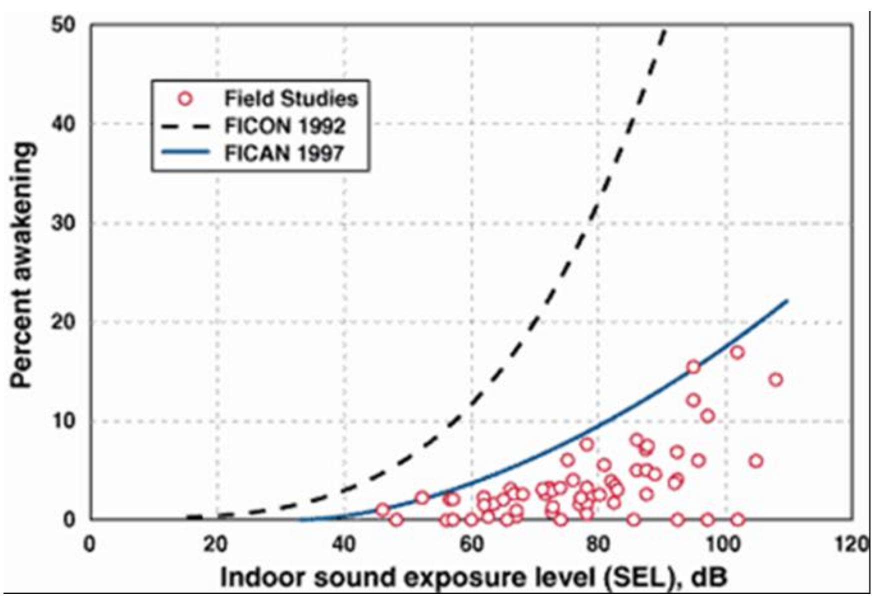
DNL Intervals in dBA	Percentage of Persons Highly Annoyed
<65	<12
65-70	12-22
70-75	22-37
75-80	37-54
>80	61

Note: Noise impacts on individuals vary as do individual reaction to noise. This is a general prediction of the percent community highly annoyed based on environmental noise surveys conducted around the world.

Source: Adapted from NAS 1977

Elevated noise levels can interfere with speech, cause annoyance or communication difficulties, and disrupt sleep. Based on a variety of studies, there is a good probability of frequent speech disruption at DNL 75 dBA. This level produces ratings of "barely acceptable" for intelligibility of spoken communication (AIHA 1996).

Figure A.2 Recommended Sleep Disturbance Dose Response Relationship



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APPENDIX B
AIRCRAFT FLIGHT TRACKS AND PROFILES

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APPENDIX B
AIRCRAFT FLIGHT TRACKS AND PROFILES

The accompanying CD contains figures depicting the aircraft flight tracks and flight profiles used for the noise modeling accomplished for this Resource Book. The following table contains the descriptions for the terms used in the Flight Profile box on each figure.

Legend for Profile Data	
Pt.	**Point along flight track.**
Dist., ft	Cumulative distance along the track from the origin. For arrival tracks, the origin is the arrival threshold of the runway. For departure tracks, the origin is the departure threshold of the runway. For closed patterns, the origin is the departure threshold of the departure runway.
Alt., ft	**Feet above runway elevation.**
Pow	Units used to measure the aircraft's power setting. For example, EPR, RPM, %NC, TIT, horsepower, etc. Power settings are aircraft dependent.
Speed, kt	**Ground speed in knots.**

The following table lists the aircraft for which there are flight track figures.

Aircraft	NOISEMAP Aircraft Designator
A-320	A320
B-727	B-727-1QN7 (Q)
C-130H	C-130H/P/N
KC-135R	C-135B
C-17	C-17
King Air	Cessna 441 TPROP
Regional Jet	Cessna 500
Cessna 172	COMPOS 1985 PISTON
DC-9	DC-9-50D17 (Q)
F-16C	F-16C (F-100-PW-220)
Lear Jet	Lear 25
SF 340	SAAB 340

Note: Some flight track points for which there is data in the table on an arrival and departure figure may not be reflected on the figure. This occurs because the scale on the figures was adjusted to show greater detail. Thus, points farther from the runway may not appear on the figure.

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