



AIR INSTALLATION COMPATIBLE USE ZONE (AICUZ) STUDY

for

Ellsworth Air Force Base, South Dakota

Headquarters Air Combat Command



December 2008

ABBREVIATIONS AND ACRONYMS

12 AF	12th Air Force	Hz	Hertz
28 BMW	28th Bombardment Wing	JLUS	Joint Land Use Study
28 BW	28th Bomb Wing	MPO	Metropolitan Planning Organization
28 OG	28th Operations Group	MSL	mean sea level
34 BS	34th Bomb Squadron	NLR	Noise Level Reduction
37 BS	37th Bomb Squadron	PAA	Primary Authorized Aircraft
ACC	Air Combat Command	SLUCM	Standard Land Use Coding Manual
AFB	Air Force Base	USAF	U.S. Air Force
AFH	Air Force Handbook	USEPA	U.S. Environmental Protection Agency
AFI	Air Force Instruction	UFC	United Facilities Criteria
AICUZ	Air Installation Compatible Use Zone		
APZ	Accident Potential Zone		
ATC	Air Traffic Control		
CFR	Code of Federal Regulations		
CZ	Clear Zone		
dba	A-weighted decibel		
DNL	Day-Night Average A-weighted Sound Level		
DOD	Department of Defense		
FAA	Federal Aviation Administration		
FICUN	Federal Interagency Committee on Urban Noise		
FY	Fiscal Year		
HUD	U.S. Department of Housing and Urban Development		



DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 28TH BOMB WING (ACC)
ELLSWORTH AIR FORCE BASE, SOUTH DAKOTA

MEMORANDUM FOR AREA GOVERNMENTS

FROM: 28 BW/CC
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Ellsworth AFB SD 57706

SUBJECT: Air Installation Compatible Use Zone Study

1. This Air Installation Compatible Use Zone (AICUZ) Study for Ellsworth Air Force Base (AFB) is an update of the AICUZ Study from 1994. The update was initiated because of changes in aircraft operations since the last AICUZ and modifications to the software modeling program made subsequent to the release of the 1994 AICUZ Study. It is a re-evaluation of aircraft noise and accident potential related to US Air Force (USAF) flying operations. This report is designed to aid in the development of local planning mechanisms that will protect public safety and health, as well as preserve the operational capabilities of Ellsworth AFB.
2. The enclosed report contains a summary description of the affected areas around the installation. The report outlines the locations of runway clear zones (CZs), aircraft accident potential zones (APZs), and noise zones, and identifies compatible land use for areas in the vicinity of the installation. It is our hope that this information will be incorporated into community plans, zoning ordinances, subdivision regulations, building codes, and other related documents.
3. The basic objective of the AICUZ Program is to achieve compatible uses of public and private lands in the vicinity of military airfields by controlling incompatible development through local actions. This report provides the information necessary to maximize beneficial use of the land surrounding Ellsworth AFB while minimizing the potential for reduction in the health and safety of the affected public.
4. We greatly value the positive relationship Ellsworth AFB has experienced with its neighbors over the years. As a partner in the process, we have attempted to minimize noise disturbances through such actions as avoiding flights over heavily populated areas. We solicit your cooperation in implementing the recommendations and guidelines presented in this AICUZ report.

A handwritten signature in black ink, reading "Scott A. Vander Hamm".

SCOTT A. VANDER HAMM, Colonel, USAF
Commander



**AIR INSTALLATION COMPATIBLE USE ZONE STUDY
FOR
ELLSWORTH AIR FORCE BASE, SOUTH DAKOTA**

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1. INTRODUCTION

This document is an update to the Ellsworth Air Force Base (AFB) Air Installation Compatible Use Zone (AICUZ) Study completed in 1994. It presents a description of the current noise environment surrounding Ellsworth AFB. It reaffirms the U.S. Air Force (USAF) policy of promoting public health, safety, and general welfare in areas surrounding USAF installations. This study identifies changes in flight operations that have occurred since the last study, and provides current noise zones and compatible use guidelines for land areas surrounding the installation. It is provided to assist the local communities by serving as a tool for future planning and zoning activities.

The changes in the AICUZ are attributed to the following:

- Changes in assigned and transient aircraft operations and profiles since the 1994 AICUZ Study
- Modifications to the Department of Defense (DOD)- approved NOISEMAP software program (USAF undated) made subsequent to the release of the 1994 AICUZ Study.

1.1 Purpose of the AICUZ Study

The purpose of the AICUZ Program is to promote compatible land development in areas subject to aircraft noise and accident potential due to aircraft overflight operations. The program was initiated to protect the public's health, safety, and welfare and to protect military airfields from encroachment by incompatible uses and structures.

Ellsworth AFB straddles Meade and Pennington counties in southwestern South Dakota. The installation is adjacent to the City of Box Elder and is 5 miles northeast of Rapid City. Guidelines for recommended land uses are presented in **Section 3**. These guidelines should be considered in the various planning processes to prevent incompatibility that might compromise the ability of Ellsworth AFB to fulfill its mission requirements. Accident potential and aircraft noise in the vicinity of military airfields should be major considerations in all planning processes.

1.2 Process and Procedure

This AICUZ Study was prepared using the guidelines established by the USAF and described in Air Force Instruction (AFI) 32-7063, *Air Installation Compatible Use Zone Program*, 13 September 2005 (USAF 2005) and Air Force Handbook (AFH) 32-7084, *AICUZ Program Manager's Guide*, 1 March 1999 (USAF 1999). The DOD Instruction 4165.57 describes the procedures by which the AICUZ Program can be defined, including the land use compatibility guidelines for the Accident Potential Zones (APZs). DOD Instruction 4165.57 also gave the AICUZ Program the authority to control the height of structures to ensure that they do not become a hazard to flight



After the events of September 11, 2001, Team Ellsworth once again answered the call by deploying a number of B-1 aircraft in support of Operation Enduring Freedom in Iraq.

This AICUZ provides current noise zones and compatible land use guidelines for areas surrounding the installation.



operations. Please see **Section 3.1** for more information on airspace area controlled for height restrictions. **Appendix A** provides additional information on the USAF AICUZ Program. AFI 32-7063 implemented the policies set forth in DOD Instruction 4165.57. Land use guidelines set forth in AFI 32-7063 reflect recommended compatible land use classifications or coding for those areas impacted by aircraft noise and potential aircraft safety concerns.

The normal human ear can hear frequencies from about 20 Hertz (Hz) to about 20,000 Hz. It is most sensitive to sounds in the 1,000 to 4,000 Hz range. When measuring community response to noise, it is common to adjust the frequency content of the measured sound to correspond to the frequency sensitivity of the human ear. This adjustment is called A-weighting. Sound levels that have been so adjusted are referred to as A-weighted sound levels.

Cumulative noise levels, resulting from multiple single events, are used to characterize effects from aircraft operations. The cumulative Day-Night Average A-weighted Sound Level (DNL) is expressed in A-weighted decibels (dBA) and presented in the form of noise contours. The DNL metric is calculated using the computerized noise model, NOISEMAP. This noise metric incorporates a “penalty” for nighttime noise events to account for increased annoyance. DNL is the energy-averaged sound level measured over a 24-hour period, with a 10-dBA penalty assigned to noise events occurring between 10:00 p.m. and 7:00 a.m. DNL values are obtained by averaging sound exposure level values over a given 24-hour period.

The DNL noise metric incorporates a penalty for late night (10 p.m. to 7 a.m.) noise events to account for increased annoyance.

DNL is a time-averaged noise metric, which takes into account both the noise levels of individual events that occur during a 24-hour period and the number of times those events occur. The logarithmic nature of the decibel unit causes the noise levels of the loudest events to control the 24-hour average. For an example of this characteristic using an aircraft flyover, consider a case in which one flyover occurs during daytime hours creating a sound level of 100 dBA for 1 second. The DNL for this 24-hour period would be 50.6 dBA. If there were 30 flyovers at 100 dBA for 1 second each, the DNL for this 24-hour period would be 65.5 dBA. The averaging of noise over a 24-hour period does not ignore the louder single events and tends to emphasize both the sound levels and number of events. This is the basic concept of a time-averaged sound metric, and specifically the DNL. The actual sound levels that a person hears fluctuate throughout the 24-hour period. DNL is the preferred noise metric of the Federal Aviation Administration (FAA), U.S. Department of Housing and Urban Development (HUD), U.S. Environmental Protection Agency (USEPA), and the DOD for determining land use compatibility in the airport environment. For further information on how DNL is calculated, please see equation A-15 in Appendix A of the 1974 USEPA document *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (USEPA 1974).

DNL noise levels are depicted visually as noise contours that connect points of equal value. These noise contours are drawn in 5 dBA increments from



the airfield, ranging from a DNL of 65 dBA up to 80 dBA, and are overlaid on a map of the airport vicinity. The area encompassed by a noise contour is a noise exposure zone, also referred to as a “noise zone”. Please see **Section 3** for more information on the modeling of noise zones.

This updated AICUZ Study contains guidelines for recommended compatible land uses in relation to APZs (i.e., Clear Zones [CZ] and APZs I and II) and for the following four noise exposure zones:

- DNL of 65 to 69 dBA
- DNL of 70 to 74 dBA
- DNL of 75 to 79 dBA
- DNL of 80+ dBA.

A description of these zones is provided in **Section 3** and **Appendix A**. In addition to providing the recommended guidelines, a detailed land use compatibility analysis is provided in **Section 4** to assist the City of Box Elder, Rapid City, and the counties of Meade and Pennington in determining land uses that are compatible with the local noise environment proximate to Ellsworth AFB.

The DOD-approved NOISEMAP software program (Version 7.3) was used to generate the noise zones presented in this AICUZ Study. The USAF has adopted the NOISEMAP software program, and uses it in predicting noise exposure that would result from aircraft operations in the vicinity of an airfield. The USAF uses NOISEMAP to calculate noise zones in the vicinity of the airfield.

AICUZ land use guidelines reflect land use recommendations for CZs, APZs I and II, and four noise zones. The USAF has no desire to recommend land use regulations that render property economically useless. It does, however, have an obligation to the inhabitants of the Ellsworth AFB environs and to the citizens of the United States to identify ways to protect the people in adjacent areas, as well as the public investment in the installation.

This AICUZ Study was prepared using guidelines established as part of the continuing USAF participation in the local planning process. It is recognized that, as local communities prepare land use plans and zoning ordinances, the USAF has the responsibility of providing input on its activities relating to the community. To support that responsibility, a companion document called a Citizen’s Brochure was created to support public dissemination of the information presented in this AICUZ Study. The Citizen’s Brochure provides a synopsis of this AICUZ Study and offers the local community the opportunity to learn about the AICUZ Program. **Appendices A through E** of this AICUZ Study contain detailed information about the AICUZ Program.



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2. INSTALLATION DESCRIPTION

2.1 Description and Population Data

Ellsworth AFB consists of approximately 5,415 acres in Meade and Pennington counties in southwestern South Dakota (see **Figure 2-1**). The City of Box Elder borders the installation to the south. The center of the City of Box Elder is approximately 7 miles northeast of Rapid City. Consequently, the greatest population density around Ellsworth AFB is to the southwest in Rapid City. In the past several years, populations of the City of Box Elder, Rapid City, and Pennington County have grown at a faster pace than the rest of South Dakota (see **Table 2-1**). From 1990 to 2007, the population of the City of Box Elder grew by almost 600, a 21.5 percent increase, and the population of Rapid City grew by more than 9,400, a 17.3 percent increase. Pennington County grew by almost 15,000, a 18.4 percent increase, and the population of Meade County grew by more than 2,100, a 9.7 percent increase. With the exception of Meade County, the cities and counties surrounding Ellsworth AFB have experienced population growth at a greater pace than the State of South Dakota, which grew by more than 100,200 (a 14.4 percent increase) in the same timeframe.

Rapid City is southwest of Ellsworth AFB.

Table 2-1. U.S. Census Bureau Population Data

	2007 Population Estimate	1990 Population	Percent Increase
City of Box Elder	3,257	2,680	21.5
Rapid City	63,997	54,523	17.3
Meade County	23,999	21,878	9.7
Pennington County	96,280	81,343	18.4
South Dakota	796,214	696,004	14.4

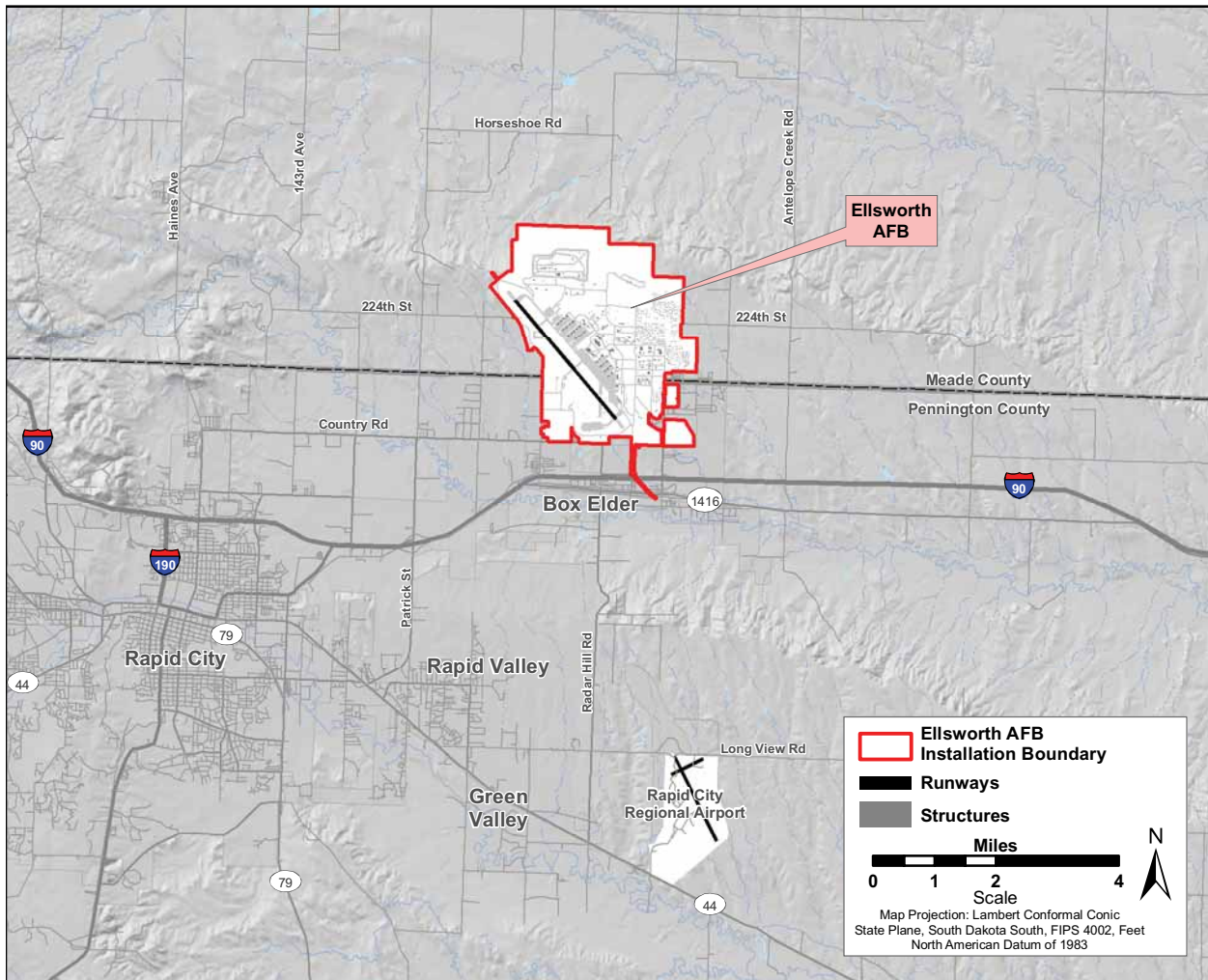
Source: U.S. Census Bureau 2008

Ellsworth AFB is the headquarters for the 28th Bomb Wing (28 BW). The 28 BW is assigned to the 12th Air Force (12 AF), headquartered at Davis-Monthan AFB, Arizona. The 28 BW is a component of Air Combat Command (ACC), headquartered at Langley AFB, Virginia. The 28 BW is the host unit at Ellsworth AFB, and provides all essential base operating support services. The 28 BW is assigned 29 B-1B aircraft. Groups assigned to the wing include the 28th Operations Group (28 OG), 28th Mission Support Group, the 28th Maintenance Group, and the 28th Medical Group. The two squadrons assigned to the 28 OG include the 34th Bomb Squadron (34 BS) and the 37th Bomb Squadron (37 BS).

The airfield at Ellsworth AFB is composed of one runway (Runway 13/31), multiple B-1B aircraft hangers, three run-up locations, and the air traffic control tower. These key areas of the installation are shown on **Figure 2-2**.



The first production B-1 flew in October 1984. The B-1B holds almost 50 world records for speed, payload, range, and time of climb in its class.



Source: ESRI StreetMap USA 2005

Figure 2-1. Ellsworth AFB Vicinity Map

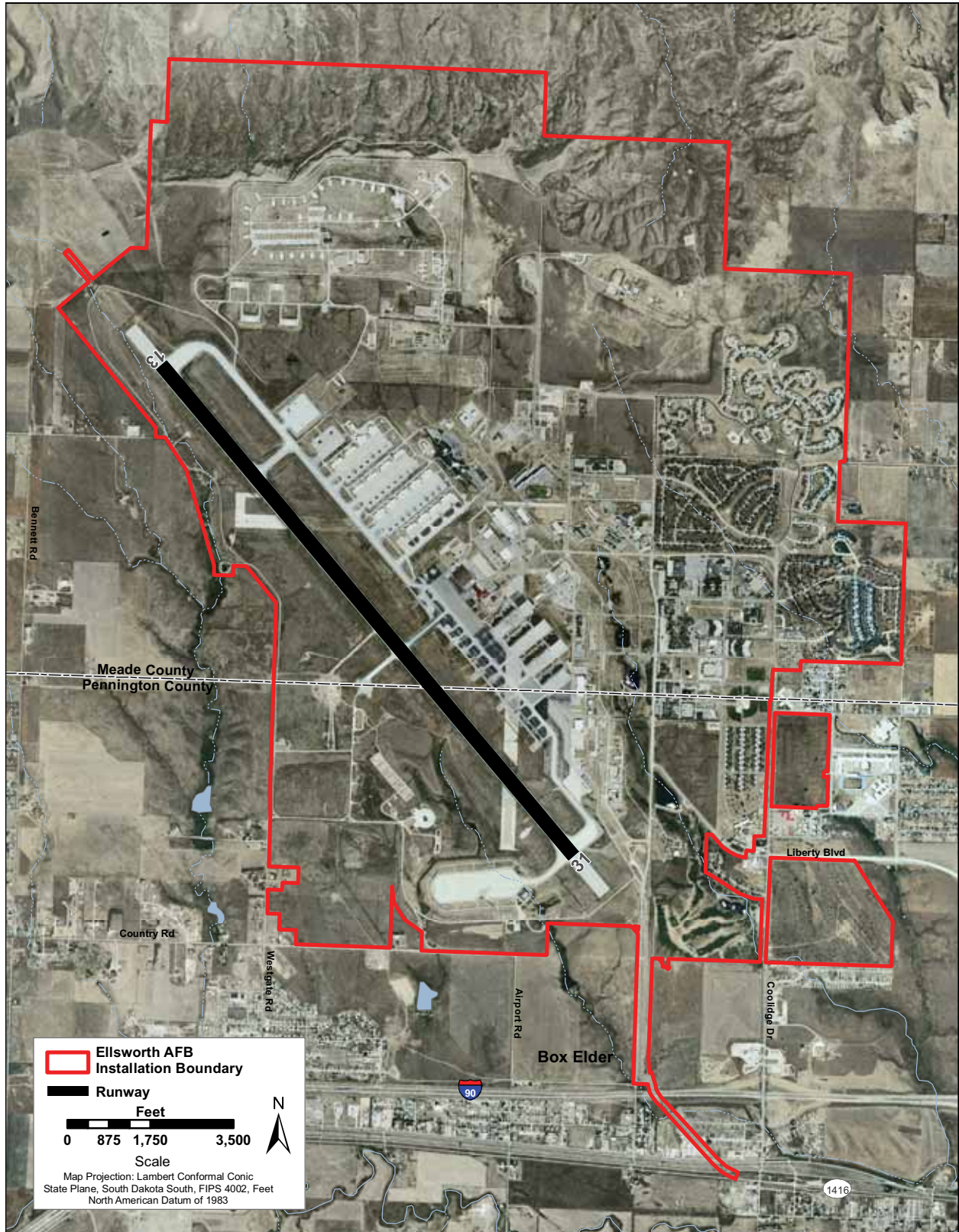


Figure 2-2. Ellsworth AFB Installation Map



2.2 History

Ellsworth AFB, originally Rapid City Army Base, was founded in 1942 in Box Elder, South Dakota, a rural agricultural and mining area. The Rapid City Army Air Base was established as a training area for pilots, navigators, radio operators, and gunners. The airfield was temporarily shut down in September 1946, but operations resumed in March 1947 with the 28th Bombardment Wing (28 BMW) flying B-29 *Superfortress* aircraft under the direction of Strategic Air Command. The B-29 *Superfortress* aircraft were replaced by the B-36 *Peacemaker* aircraft in 1949, which were replaced with the B-52 bombers in 1956.

In 1953, Rapid City Army Base was renamed Ellsworth AFB after Brigadier General Richard E. Ellsworth. The first of the B-1B *Lancer* aircraft arrived at Ellsworth AFB in 1987, replacing the B-52 aircraft. The 12th Air Division moved to Ellsworth AFB in 1988, and was responsible for training B-1B pilots, transient B-52 pilots, and the 28 BMW KC-135 *Stratotanker* aircrews.

In 1990, the 28 BMW became the 28 BW, and the host unit at Ellsworth AFB, assuming all responsibility from the 812th Strategic Support Wing. On 1 June 1992, USAF combined Strategic Air Command and Tactical Air Command to create ACC. ACC is the primary provider of air combat forces to America's warfighting commanders. This changed the mission of the 28 BW from that of strategic bombardment to a mission of worldwide conventional munitions delivery. Today the 28 BW includes the 34 BS and the 37 BS, and is assigned 29 B-1B aircraft.

In its 2005 Base Closure and Realignment Commission Recommendations, the DOD recommended closing Ellsworth AFB and consolidating all B-1B aircraft at Dyess AFB, Texas. Intense lobbying in opposition to this recommendation resulted in a Congressional announcement in August 2005 that ACC will retain the assigned B1-B aircraft at Ellsworth AFB (Minnesota Public Radio 2005).

2.3 Mission

As an ACC installation, Ellsworth AFB fulfills ACC's mission as the primary provider of combat airpower to America's unified combatant commands. The 12 AF, headquartered at Davis-Monthan AFB, Arizona, controls ACC's conventional fighter and bomber forces based in the western United States and has the warfighting responsibility for U.S. Southern Command as well as the U.S. Southern Air Forces. The 28 BW is assigned to the 12 AF. Ellsworth AFB has proven itself as an invaluable component of ACC, which is evident by the successful missions under Operation Allied Force and Operation Enduring Freedom.

The 28 BW's mission statement is to "provide rapid, decisive and sustainable combat air power and expeditionary combat support anytime, anywhere." This is accomplished through the operation of B-1B *Lancer* aircraft.

The history of Ellsworth AFB is important in understanding the fluctuations in the noise environment in the areas surrounding the installation.





The 34 BS and 37 BS operate under the 28 OG. The mission of the 28 OG is to “provide combat-ready aircrews to project global power anytime in support of the Combat Commander’s objectives.” This is accomplished by maintaining combat-ready aircrews, and planning and executing training missions that are essential for attaining versatile power projection and global reach.



2.4 Economic Impact

Table 2-2 shows the factors that influence Ellsworth AFB’s total economic impact on the surrounding area for Fiscal Year (FY) 2006. The installation’s economic impact includes the total gross payroll for Ellsworth AFB personnel, the total actual annual expenditures of the installation, and the estimated annual value of jobs created by Ellsworth AFB.

Table 2-2. Ellsworth AFB’s Economic Impact for FY 2006

Personnel Category	Total Personnel	Total Gross Payroll
Active-Duty Military	3,664	\$147.9M
<i>Subtotal Military Personnel</i>	<i>3,664</i>	<i>\$147.9</i>
Military Dependents	5,079	N/A
Appropriated Fund Civilians	484	\$26.8M
Nonappropriated Fund Civilians and Private Business	527	\$10.0M
<i>Subtotal Nonmilitary Personnel</i>	<i>6,090</i>	<i>\$36.8M</i>
Total Personnel	9,754	\$184.7M
Estimated Annual Value of Jobs Created	\$43.0M	
Total Actual Annual Expenditures	\$85.3M	
Total Economic Impact	\$313.0M	

Source: EAFB 2006

Note: Numbers in the table are rounded.

Approximately 3,664 active-duty military personnel are employed at Ellsworth AFB. Of this amount, 2,011 personnel live off-installation and account for the majority of the personnel that work at Ellsworth AFB. In addition, there are 5,079 active-duty military dependents and 1,011 nonmilitary personnel employed at Ellsworth AFB. Of this amount, 3,673 live off-installation.

Ellsworth AFB is the second largest employer in South Dakota (New York Times 2005). As shown in **Table 2-2**, the total annual payroll for employees at Ellsworth AFB was more than \$184 million in FY 2006. Of this amount, more than \$117.9 million was paid to employees residing off-installation.

In addition to the payroll, the installation’s expenditures in FY 2006 totaled more than \$85 million. Of this total, Ellsworth AFB contributed to the local economy through items such as \$36 million in construction, services such as



service contracts and utilities and ground maintenance for \$12.9 million, and the commissary and the installation's exchange for \$6.3 million. Ellsworth AFB also contributed \$27 million of the total amount of expenditures to health and education, and \$3.1 million for other materials, equipment, temporary off-installation work, and procurement of supplies.

Ellsworth AFB's location in southwestern South Dakota has resulted in the creation of approximately 1,500 indirect jobs in the surrounding area with an estimated annual value of approximately \$43 million. This amount, combined with the installation's gross payroll and annual expenditures, brings the total economic impact of Ellsworth AFB on the surrounding area to more than \$313 million in FY 2006.

2.5 Flying Activity

To describe the relationship between aircraft operations and land use, it is necessary to fully understand the exact nature of flying activities. An inventory has been made of such information for the aircraft based at Ellsworth AFB, where those aircraft fly, how high they fly, how many times they fly over a given area, and at what time of day they operate. Military flying operations are described as a sortie or an operation. A sortie is the entire flight path of a military aircraft that includes the arrival, departure, and any closed pattern activities. An operation is defined as a single aircraft movement, such as an arrival or a departure. A closed pattern accounts for two operations, an arrival and a departure. Pilots commonly use closed patterns to practice takeoffs and landings, and closed patterns usually remain close to the airfield.

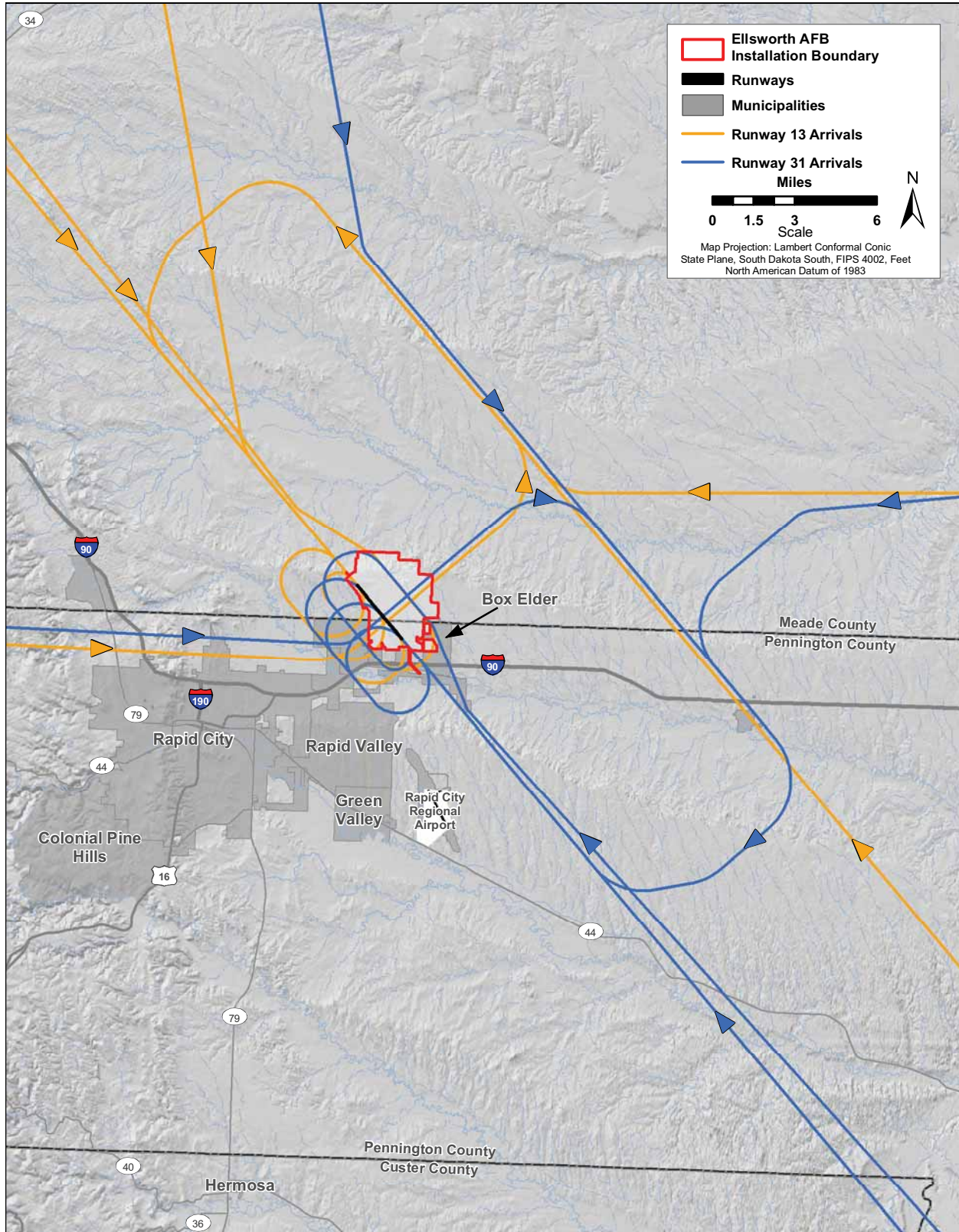
2.5.1 Airfield and Airspace Management

Airfield environs management is concerned with three primary aircraft operational/land use determinants: (1) hazards to operations from land uses (e.g., height obstructions), (2) aircraft noise, and (3) accident potential to land users. Each of these concerns is addressed in conjunction with mission requirements and safe aircraft operation to determine the optimum flight track for each aircraft type. Data for the 2008 AICUZ Study were provided according to flight track (i.e., where they fly), flight profile (i.e., how they fly), flight occurrence (i.e., how often they fly), and ground run-up (i.e., engine maintenance activities). The flight tracks depicted in **Figures 2-3, 2-4, and 2-5** are the result of such airfield management.

Section 3 presents a detailed description of APZs and current noise zones.

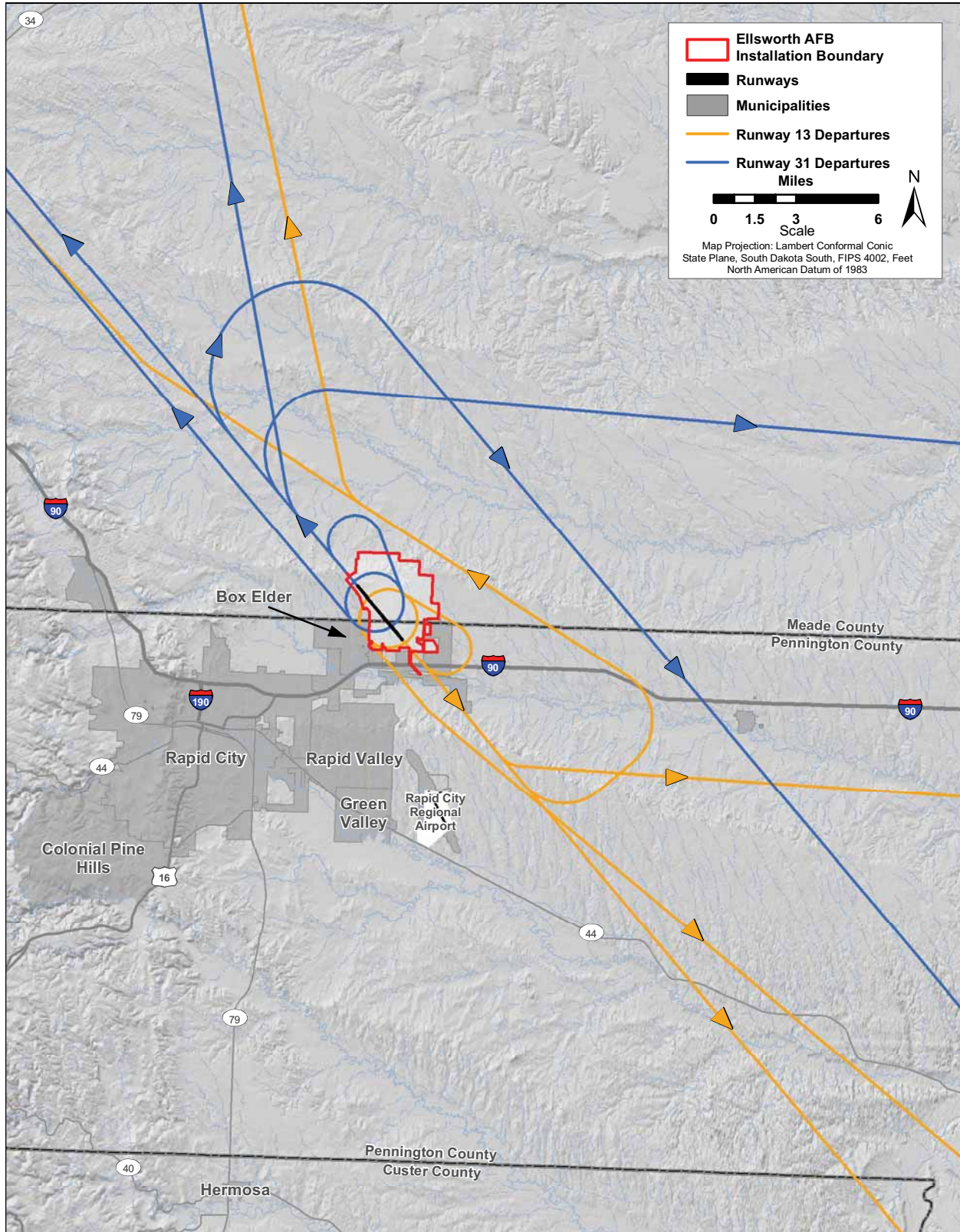
2.5.1.1 Regional Airspace

Ellsworth AFB is approximately 6 miles northwest of Rapid City Regional Airport. Although Ellsworth AFB is a private-use military airport, and Rapid City Regional Airport is a public use airport, they have a shared Class D airspace. Class D airspace can generally be described as a controlled airspace that extends from the surface or a given altitude to a specified higher altitude. At Ellsworth AFB, Class D airspace extends from the surface up to and including 5,800 feet above mean sea level (MSL) with a 5.9-nautical-mile radius from the airport center. Class D airspace for Rapid City Regional



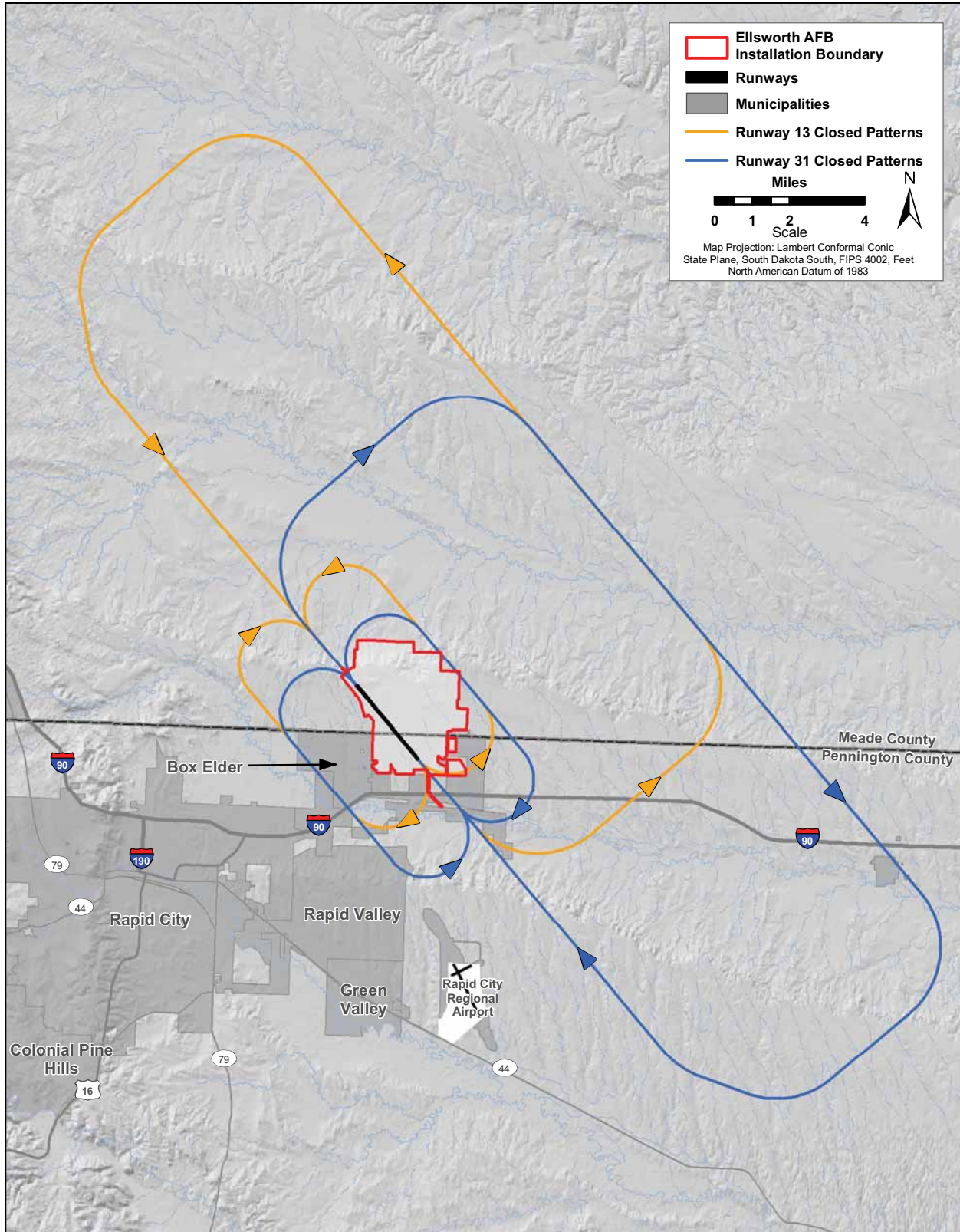
Source of Flight Tracks: e*M, Inc. 2008

Figure 2-3. Arrival Flight Tracks



Source of Flight Tracks: e*M, Inc. 2008

Figure 2-4. Departure Flight Tracks



Source of Flight Tracks: e*M, Inc. 2008

Figure 2-5. Closed Pattern Flight Tracks



Airport extends from the surface up to and including 5,700 feet above MSL with a 4.3-nautical-mile radius. Class D airspace is designed to provide ATC into and out of primary airports that have an operational control tower, radar approach capabilities, and where aircraft operations are periodically at high-density levels. All aircraft operating within Class D airspace are required to maintain two-way radio communication with the ATC facilities. Aircraft arriving and departing from Ellsworth AFB are controlled by the military air traffic control tower at Ellsworth AFB.

2.5.1.2 Ellsworth AFB Airfield

Runway Use. Aircraft operating at Ellsworth AFB utilize Runway 13 approximately 30 percent of the time (i.e., they depart to the south and arrive from the north) and Runway 31 approximately 70 percent of the time (i.e., they depart to the north and arrive from the south). The runway at Ellsworth AFB is shown in **Figure 2-2**.

Flight Patterns. The flight patterns in **Figures 2-3, 2-4, and 2-5** represent the way the B-1B aircraft arrive, depart, and perform closed-pattern operations at Ellsworth AFB. As shown in **Figure 2-3 and 2-4**, aircraft arrive to and depart from Runway 13 and Runway 31 from numerous directions. Closed-pattern flight tracks are flown to the east and west of the airfield; however, the majority of the closed-pattern operations are flown to the east. Flight tracks were designed to prevent Ellsworth AFB aircraft from entering the Rapid City Regional Airport airspace (south of Ellsworth AFB) and to minimize noise exposure to the populated area of Rapid City (southwest of Ellsworth AFB) to the greatest extent possible.

Maintenance Engine Run-ups. Maintenance engine run-ups occur approximately five times per day at Ellsworth AFB. Typically, one maintenance engine run-up is conducted at night (between 10 p.m. and 7 a.m.) and four are conducted during the day (between 7 a.m. and 10 p.m.). The types of maintenance runs at Ellsworth AFB typically include leak checks, operational checks, and troubleshooting runs. Leak checks account for approximately 35 percent of the total number of maintenance runs, operational checks account for approximately 35 percent, and troubleshooting runs account for approximately 30 percent. Most of the engine run-ups at Ellsworth AFB occur at the north end of the ramp in front of the hangars (see **Figure 2-2**). Test cells, used to perform aircraft engine checks where the engine is run at high power to check operating condition and performance of the engine for maintenance purposes, have not been used in more than 3 years at Ellsworth AFB.

Flying activities at Ellsworth AFB have been grouped into two categories: 28 BW and transient operations. Flight track and profile data were updated in January 2008.



2.5.2 28th Bomb Wing Operations

The B-1B aircraft assigned to Ellsworth AFB are flown by the 34 BS and the 37 BS. There are 29 Primary Authorized Aircraft (PAA) at Ellsworth AFB. The 34 BS has 15 PAA and the 37 BS has 14 PAA. The 34 BS and the 37 BS each fly Monday through Friday for 48 weeks per year for a total of 240 flying days per year and approximately 50 daily operations. Please see **Section 2.5** for the definition of an operation. Multiplying 50 daily operations times 240 flying days per year equates to approximately 12,000 operations flown by the 28 BW in 2008.



The multimission-capable B-1B Lancer is the backbone of America's long-range bomber force. It can rapidly deliver massive quantities of precision and nonprecision weapons against any adversary, anywhere in the world, at any time.

As shown on **Table 2-3**, there is an average of 8.40 arrival, 8.40 departure, and 16.80 closed pattern 28 BW operations per day at Ellsworth AFB. Day operations occur from 7:00 a.m. to 10:00 p.m. and night operations occur from 10:00 p.m. to 7:00 a.m. Approximately 69 percent of the operations occur during the day; therefore approximately 31 percent of 28 BW operations occur at night.

Table 2-3. Average Busy Day B1-B Aircraft Operations at Ellsworth AFB

	Arrivals	Departures	Closed Patterns	Total
Day (7 a.m. to 10 p.m.)	5.16	8.04	10.68	34.56
Night (10 p.m. to 7 a.m.)	3.24	0.36	6.12	15.84
Total	8.40	8.40	16.80	50.40

Note: Total daily operations = arrivals + departures + (2 x closed patterns).

2.5.3 Transient Aircraft Operations

Over the course of a year, numerous military transient aircraft arrive, depart, and perform closed pattern operations at Ellsworth AFB. Transient aircraft normally conduct operations at Ellsworth AFB 260 days per year. Military aircraft of any type have the capacity to visit the installation; **Table 2-4** is a representative sample of transient aircraft that visited Ellsworth AFB in 2007.



T-38 aircraft complete approximately 20 percent of all transient aircraft operations at Ellsworth AFB.

The KC-135 and RC-135 were the only transient aircraft modeled with closed pattern operations. Several other aircraft were modeled with overhead patterns including the C-17, F-16, F-18, T-38 and T-6 aircraft. Since such a large variety of transient aircraft frequent Ellsworth AFB, the remaining aircraft that perform transient operations have been grouped under "other."

As shown in **Table 2-4**, there is an average of 2.83 arrival, 2.83 departure, and 1.85 closed pattern transient operations per day at Ellsworth AFB. The vast majority (approximately 98 percent) of all transient operations occur during the day.



Approximately 50 percent of transient aircraft operations utilize a flight track to and from Mount Rushmore. The remaining operations arrive and depart from the airfield from numerous directions. In addition to the transient aircraft operations, there will be a few transient helicopter operations. It is anticipated that for 2 weeks each year UH-60 helicopters will fly 4 operations per day from Ellsworth AFB.

**Table 2-4. Representative Sample of Average Busy Day
Transient Aircraft Operations at Ellsworth AFB**

Aircraft	Arrivals	Departures	Closed Patterns	Total
T-38				
Day (7 a.m. to 10 p.m.)	0.46	0.47	0	0.93
Night (10 p.m. to 7 a.m.)	0.02	0.01	0	0.03
F-18				
Day (7 a.m. to 10 p.m.)	0.30	0.30	0	0.60
Night (10 p.m. to 7 a.m.)	0.01	0.01	0	0.02
KC-135				
Day (7 a.m. to 10 p.m.)	0.26	0.26	1.48	3.48
Night (10 p.m. to 7 a.m.)	0.01	0.01	0	0.02
RC-135				
Day (7 a.m. to 10 p.m.)	0.09	0.09	0.37	0.92
Night (10 p.m. to 7 a.m.)	0	0	0	0
Other				
Day (7 a.m. to 10 p.m.)	1.60	1.64	0	3.24
Night (10 p.m. to 7 a.m.)	0.08	0.04	0	0.12
Total	2.83	2.83	1.85	9.36

Note: Total daily operations = arrivals + departures + (2 x closed patterns).



3. LAND USE CONSTRAINTS AND COMPATIBILITY GUIDELINES

The DOD developed the AICUZ Program for military airfields. Using this program, DOD works to protect aircraft operational capabilities at its installations and to assist local government officials in protecting and promoting the public health, safety, and quality of life. The goal is to promote compatible land use development around military airfields by providing information on aircraft noise exposure and accident potential.

An AICUZ Study describes three basic types of constraints that affect, or result from, flight operations. The first constraint involves areas that the FAA and DOD have identified for height limitations (see Height and Obstruction Criteria in **Appendix D**). USAF obstruction criteria are based upon those contained in 14 Code of Federal Regulations (CFR), Part 77, *Objects Affecting Navigable Airspace*. These obstruction criteria are defined for all military airfields regardless of the current flying mission. The height restrictions are to prevent man-made structures from creating an obstruction that could prevent aircraft from accessing airports or pose an accident hazard. Aircraft approach and depart from airports on a diagonal line that gets farther from the ground as distance from the airport increases. The height obstruction criteria reflect this principle, and permit the placement of taller structures as distance from the airport increases.

The second constraint involves noise zones associated with aircraft operations. Using the NOISEMAP program, DOD produces noise contours showing the noise exposure levels generated by Ellsworth AFB aircraft operations. NOISEMAP was used to visually create continuous contours that connect all points of the same noise exposure level, in much the same way as ground contours on a topographic map visually represent lines of equal elevation. These noise contours are drawn in 5 dBA increments from the airfield, ranging from a DNL of 65 dBA up to 80 dBA, and are overlaid on a map of the airport vicinity. The area encompassed by a noise contour is known as a noise zone. This makes noise zones uniquely suited for making important zoning and land use decisions based on noise exposure. Additional information on noise methodology is contained in **Appendix C** of this report.

The third constraint involves Accident Potential Zones based on statistical analysis of past DOD aircraft accidents. DOD analysis has determined that the areas immediately beyond the ends of runways and along the approach and departure flight paths have significant potential for aircraft accidents. Based on this analysis, DOD developed three zones that have high relative potential for accidents: Clear Zones (CZs) and Accident Potential Zones (APZs) I and II.

3.1 Airspace Area Controlled for Height Restrictions

Airspace area controlled for height restrictions results from the application criteria for height and obstruction clearance in 14 CFR, Part 77 and in USAF design standards. United Facilities Criteria (UFC) 3-260-01 applies to all

Airfield planning is concerned with three primary constraints:

1. *Height obstructions*
2. *Aircraft noise*
3. *Accident potential*

Urban areas around airports are exposed to the possibility of aircraft accidents even with well-maintained aircraft and highly trained aircraft crews.



DOD military facilities in the United States. UFC 3-260-01 stipulates that modifications to existing facilities and construction of new facilities must consider navigable airspace, and could require that a Notice of Proposed Construction or Alteration be submitted to the FAA. The FAA's height obstruction criteria are outlined in the FAA Advisory Circular 150/5300-13, which classifies an obstruction to air navigation as an object of greater height than any of the heights or surfaces presented in 14 CFR Part 77.

14 CFR Part 77 states that the area surrounding a runway must be kept clear of objects that might damage an aircraft and therefore is bounded by imaginary airspace control surfaces that are defined in detail in **Appendix D**. Imaginary airspace control surfaces for Class B airfields such as Ellsworth AFB are shown in **Figure D-1**. The purpose of these imaginary airspace control surfaces is to enhance the safety and efficiency of aircraft operations. These regulations can prevent the construction of structures whose height could compromise the ability of aircraft to land safely, particularly in adverse weather conditions or during military training operations.

Although the FAA sets airspace height restrictions, the FAA does not have the authority to control airspace heights. Therefore, in order to protect the health, safety, and welfare of populations around airfields, the local communities must enforce the height restriction guidelines established by the FAA. This is particularly important for DOD airfields. The FAA can influence civilian airports through funding matters. However, the FAA does not provide funds to DOD airfields; consequently, it is imperative that local communities around DOD airfields enforce the restrictions set for airspace heights.

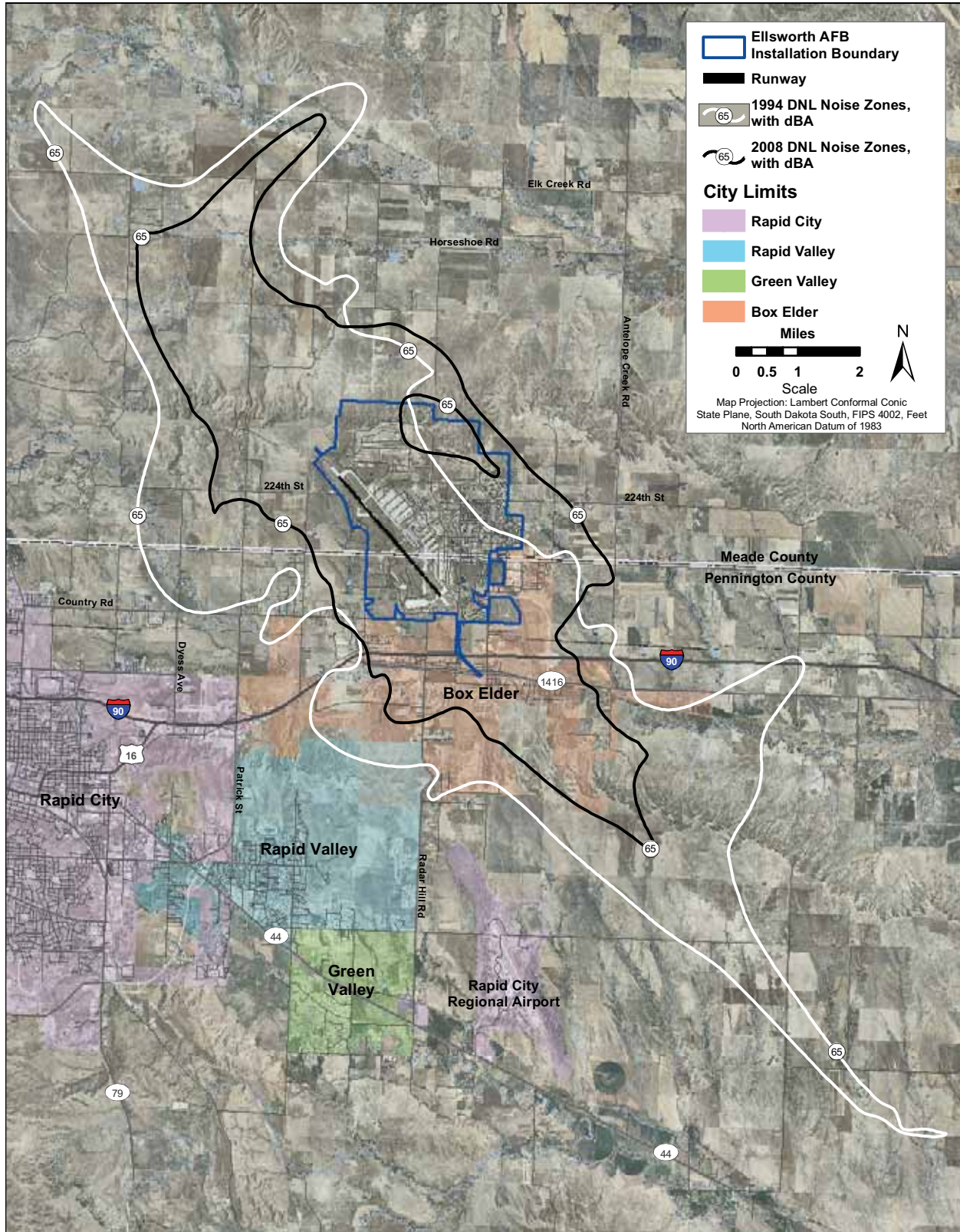
3.2 Noise Zones

3.2.1 Understanding the Historical Noise Environment

The historical noise zones associated with Ellsworth AFB are presented to show how noise exposure has fluctuated over time from varying aircraft-related factors (i.e., aircraft type, number of operations, flight track). This AICUZ Study presents historical noise zones from the 1994 AICUZ Study. Noise zones were developed for the 1994 AICUZ using 1994 noise data (USAF 1994b).

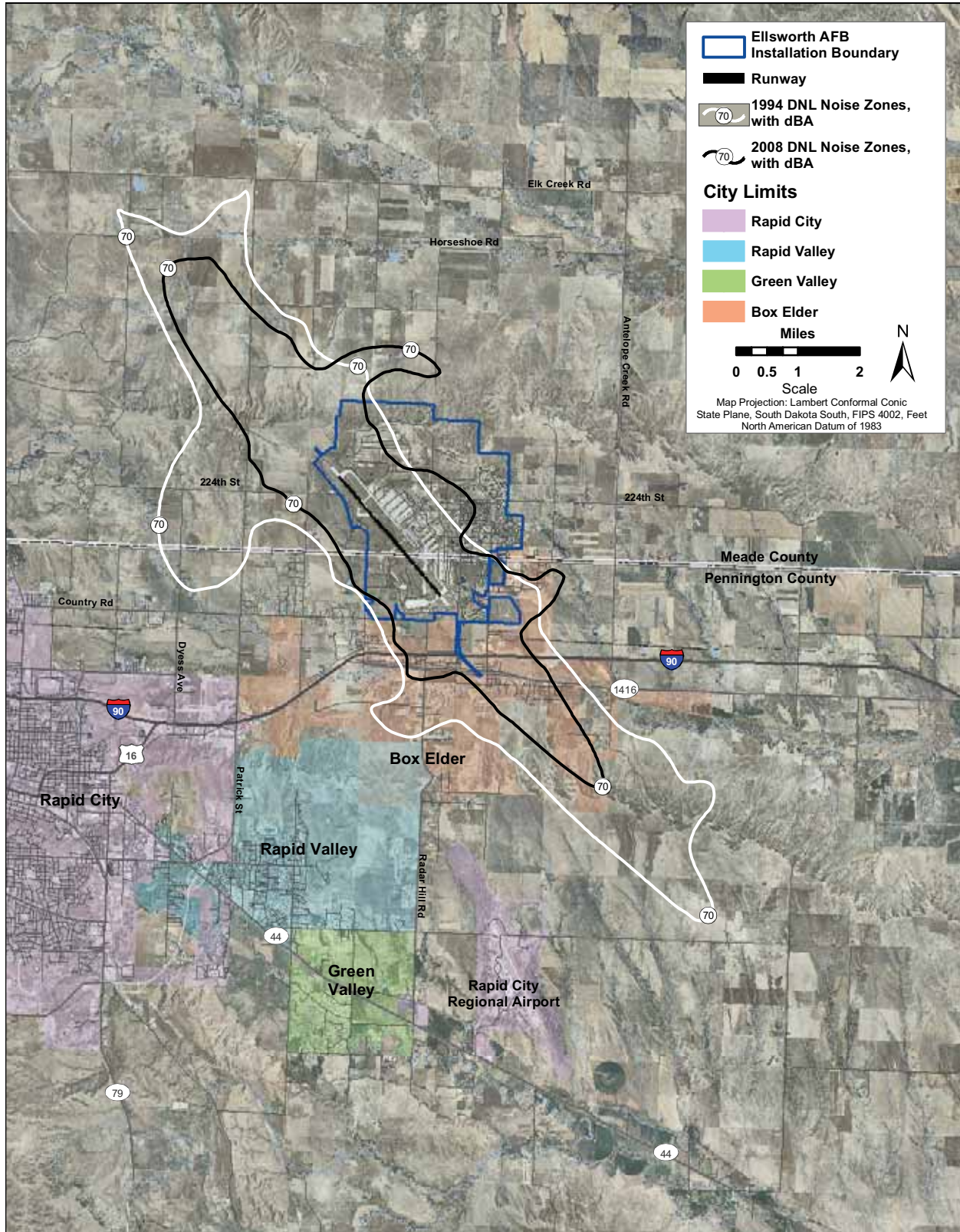
The 1994 and 2008 noise zones are shown to demonstrate the fluctuations in the noise environment since the previous AICUZ Study.

The 1994 and 2008 DNL of 65 dBA, 70 dBA, 75 dBA, and 80+ dBA noise zones were plotted on aerial maps and are shown in **Figures 3-1** through **3-4**. As shown, each noise zone has encompassed different areas over the years. 65 dBA is the noise level where land use planning recommendations begin. As shown on **Figure 3-1**, the 1994 65 dBA noise zone encompasses more land in every direction except to the northeast. This is particularly true to the southeast where the 1994 noise zone encompasses considerably more land than the 2008 noise zone. As shown on **Figure 3-2**, the 2008 70 dBA noise zone encompasses more land on the eastern side of the installation than the 1994 noise zone, but less area to the north, west, and south. As shown on **Figure 3-3**, the 1994 75 dBA noise zone encompasses more land in every direction as compared to the 2008 noise zone, with the exception of a small



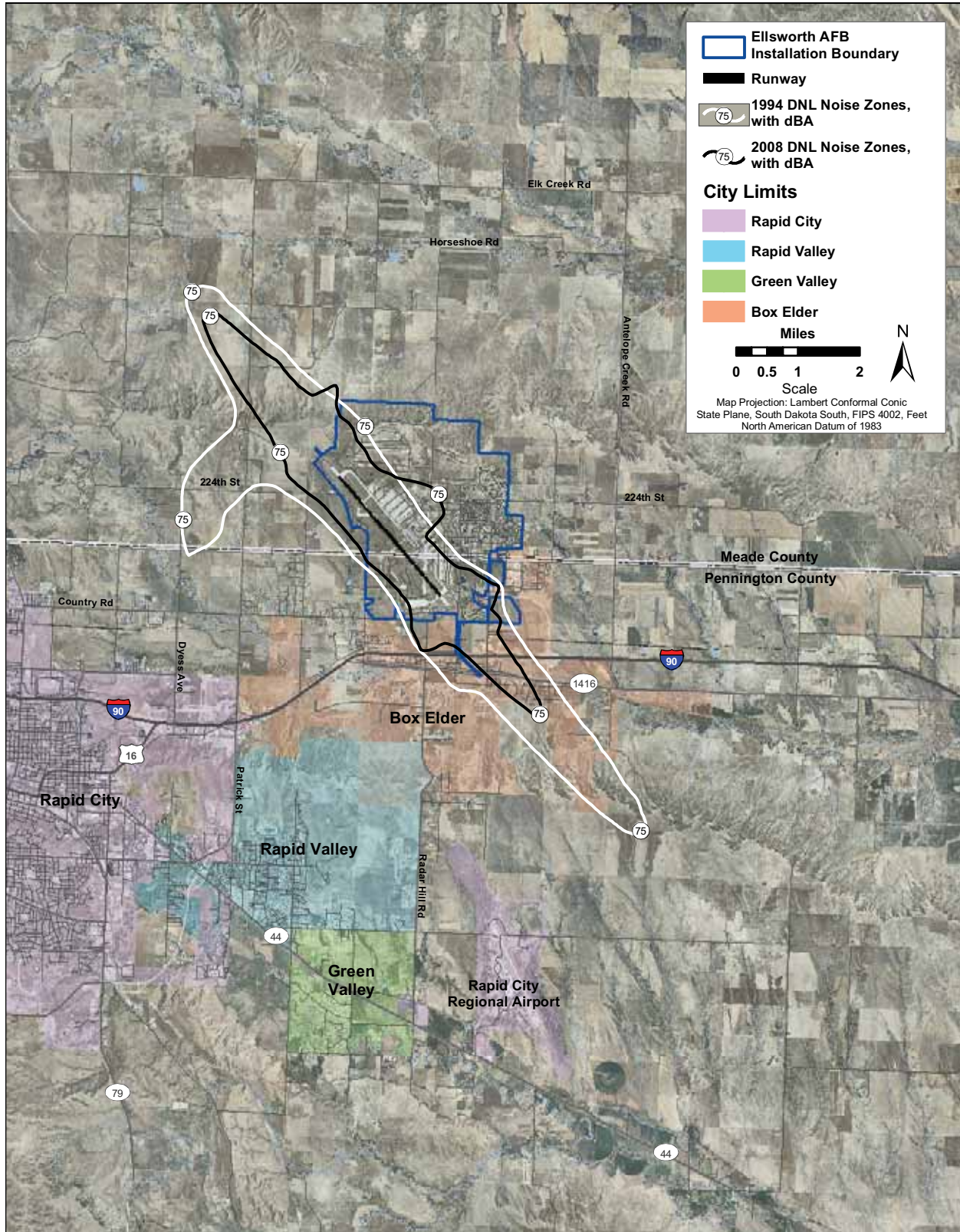
Source of Historic Noise Zones: Ellsworth AFB 1994; 2008 Noise Zones: e*M, Inc 2008.

Figure 3-1. Historical DNL of 65 dBA Noise Zones at Ellsworth AFB



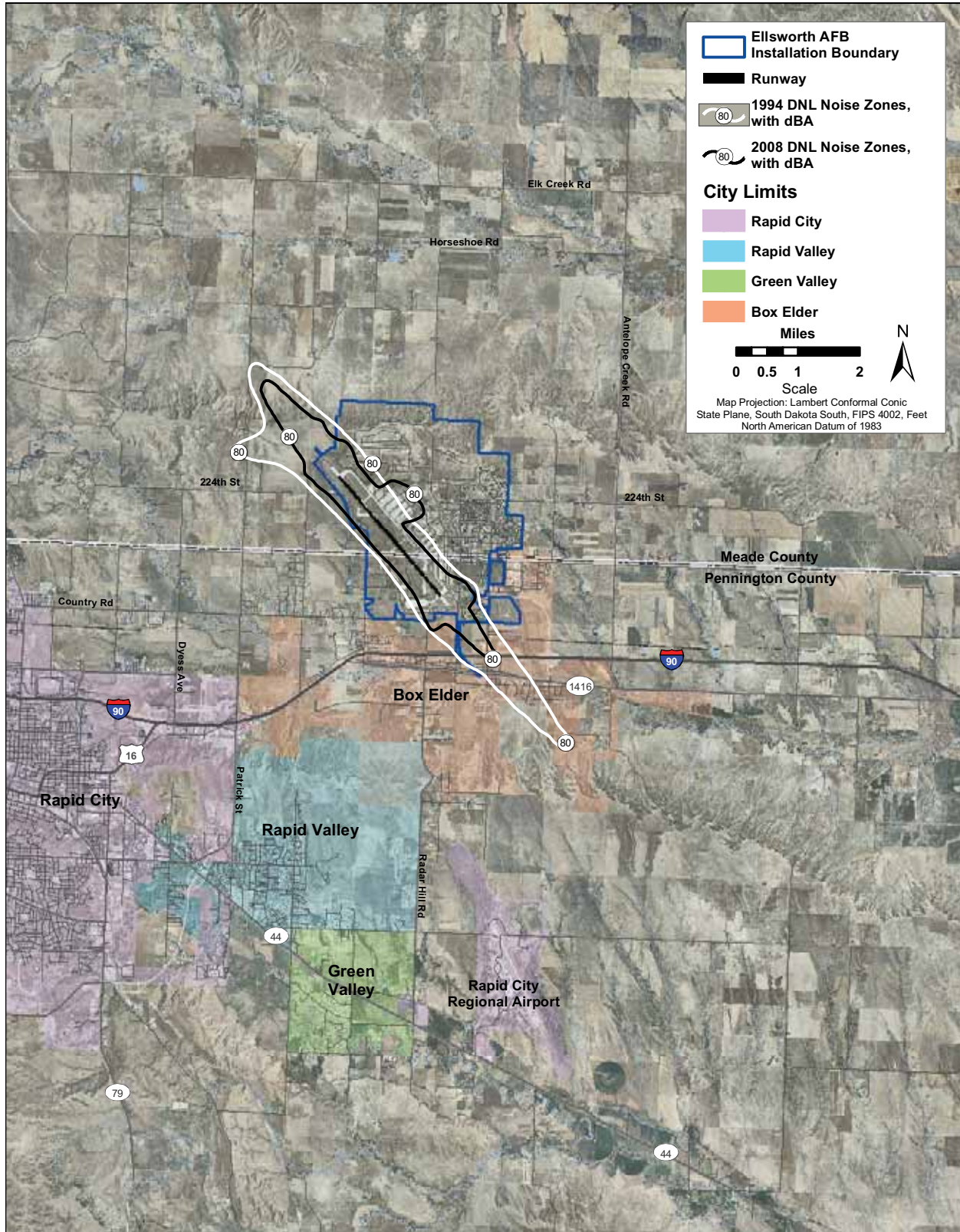
Source of Historic Noise Zones: Ellsworth AFB 1994; 2008 Zones: e²M, Inc 2008.

Figure 3-2. Historical DNL of 70 dBA Noise Zones at Ellsworth AFB



Source of Historic Noise Zones: Ellsworth AFB 1994; 2008 Zones: e²M, Inc 2008.

Figure 3-3. Historical DNL of 75 dBA Noise Zones at Ellsworth AFB



Source of Historic Noise Zones: Ellsworth AFB 1994; 2008 Noise Zones: e²M, Inc 2008.

Figure 3-4. Historical DNL of 80+ dBA Noise Zones at Ellsworth AFB



area to the northeast, and a small area to the east which is within the installation boundary. The 1994 80+ dBA noise zone, as shown on **Figure 3-4**, encompasses more land in every direction with the exception of a small area to the east, which is within the installation boundary. None of the noise zones encompass land in the populated area of Rapid City southwest of the installation.

3.2.2 2008 Noise Zones

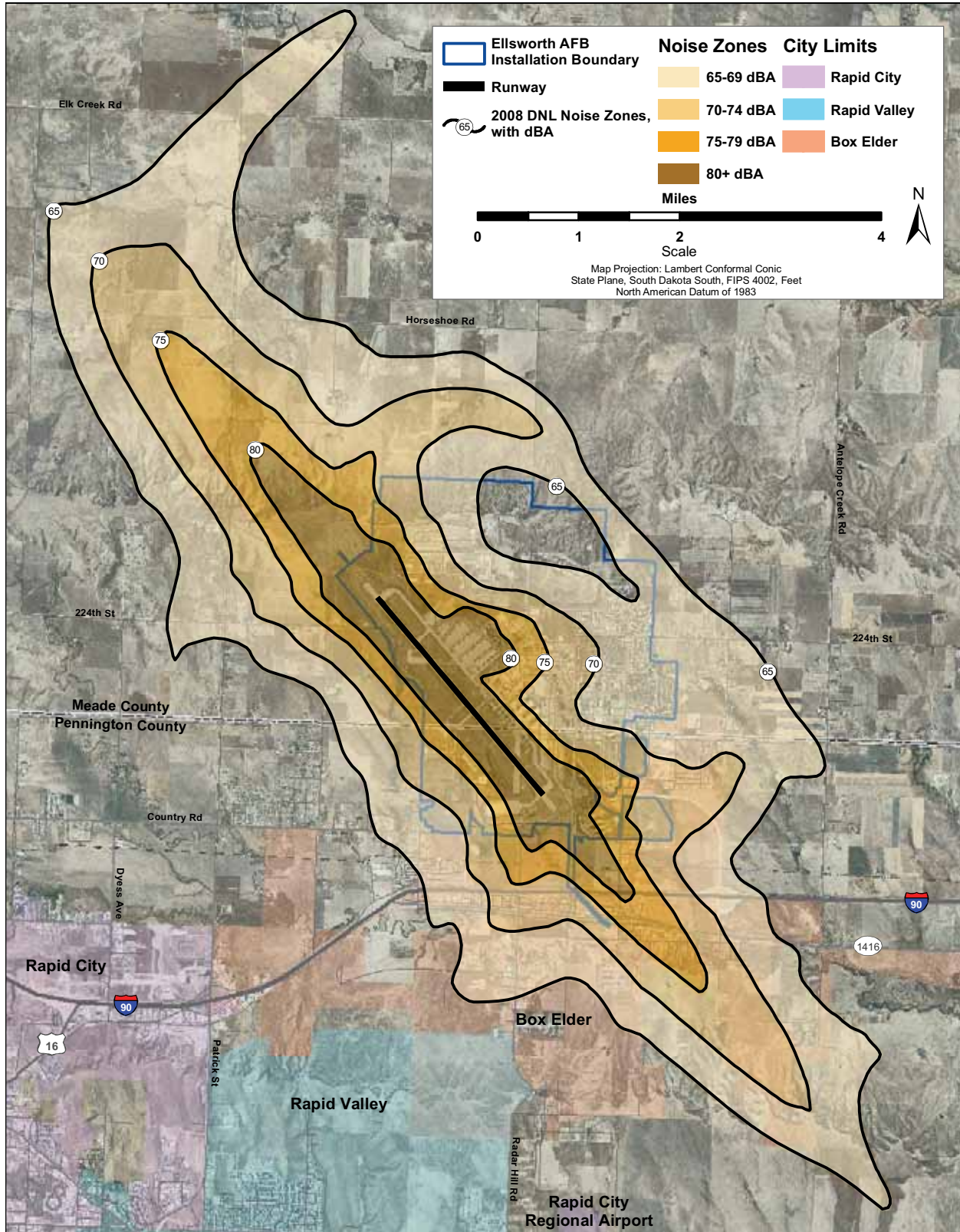
Current noise zones, based on 2008 data, extend northwest and southeast from the runway centerline and parallel the runway, as shown on **Figure 3-5**. All of the noise zones encompass land in the City of Box Elder and in Pennington and Meade counties. The 65 to 74 dBA noise zones extend northwest and then arc to the north. This is because the majority of the flight tracks and training patterns are flown to the northeast of the airfield to avoid entering the Rapid City Regional Airport airspace (south of Ellsworth AFB) and to minimize noise exposure to the populated area of Rapid City (southwest of Ellsworth AFB) to the greatest extent possible. The noise zones do not extend into Rapid City.

3.2.3 Hypothetical Noise Zones

A hypothetical scenario was developed for this AICUZ Study to estimate the noise impacts of possible future missions at Ellsworth AFB. The hypothetical scenario was created by taking the 2008 operational data, which includes all of the B1-B aircraft currently assigned at Ellsworth AFB, and adding estimated operations from the 26 B1-B aircraft that are presently stationed at Dyess AFB, Texas. This hypothetical scenario would result in a 108 percent increase in the number of B1-B aircraft operations. The hypothetical scenario was estimated using the same number of flying days and ratio of daytime and nighttime operations that were used in the creation of the 2008 noise zones. This includes B-1B aircraft flying Monday through Friday for 48 weeks per year, with 69 percent of the operations occurring during the day and 31 percent occurring at night. Hypothetical noise zones are provided for planning purposes and are meant to reinforce the notion that noise zones are not static, but are dependent on aircraft type, number, performance, and flight path. Noise zones also change as a result of mission changes or operations tempo. Although no additional aircraft are scheduled or anticipated at this time, these noise zones are presented to estimate future aircraft operations at Ellsworth AFB.

No increase in the number of aircraft assigned to Ellsworth AFB is projected at this time. Hypothetical noise zones are provided for planning purposes.

As shown on **Figure 3-6**, the hypothetical noise zones would expand in every direction as compared to the 2008 noise zones. The noise zones would encompass additional land to the northwest and southeast of the installation, as well as land parallel to the runway. However, the hypothetical noise zones would encompass the same basic areas around the installation as the historical and 2008 noise zones. The hypothetical noise zones would not expand significantly directly west of the installation and would not impact the population of Rapid City.



Source of Noise Zones: e*MI, Inc 2008.

Figure 3-5. 2008 DNL Noise Zones at Ellsworth AFB

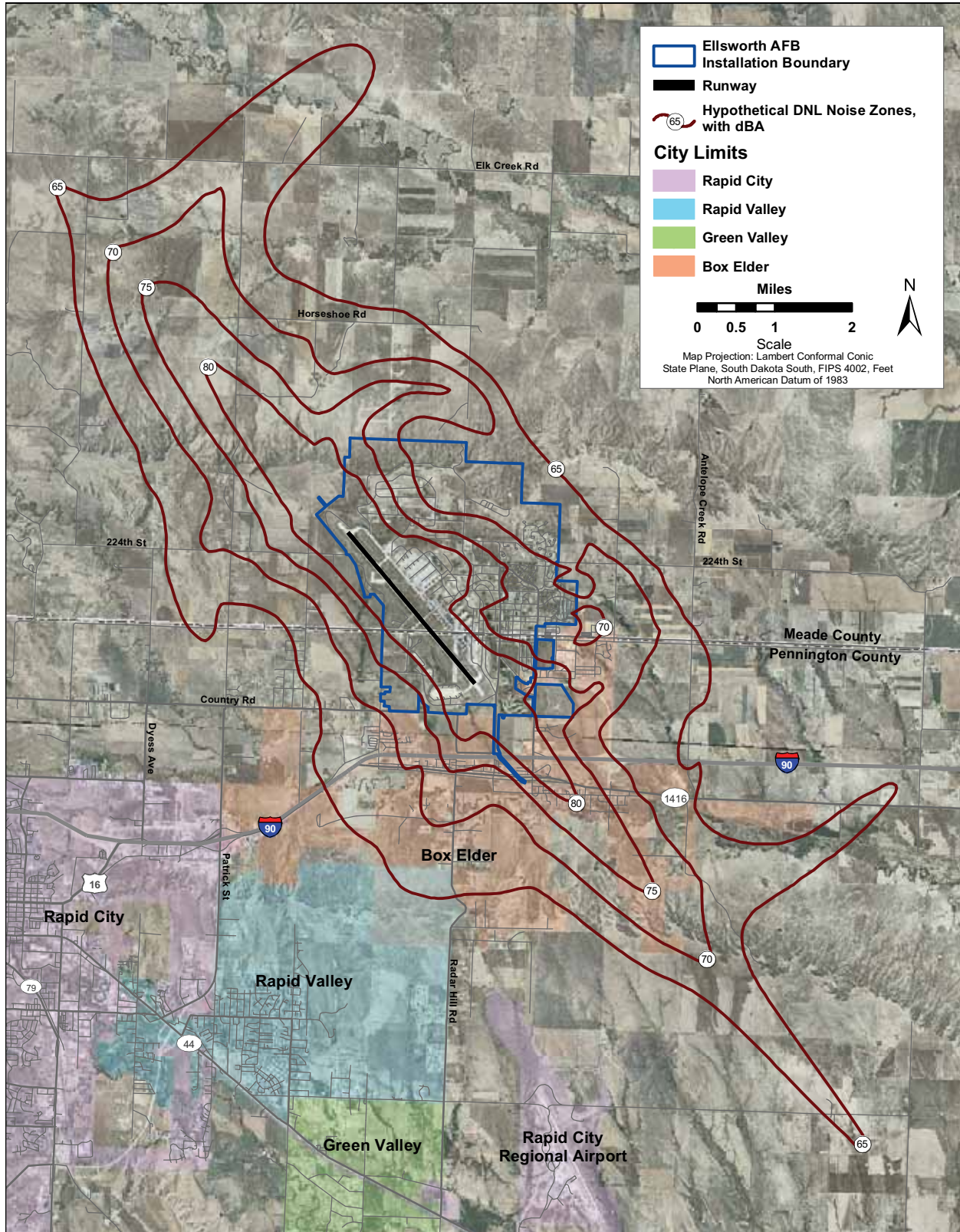


Figure 3-6. Hypothetical DNL Noise Zones at Ellsworth AFB



3.3 Accident Potential Zones

DOD analysis has determined that the areas immediately beyond the ends of runways and along the approach and departure flights paths have significant potential for aircraft accidents. Based on this analysis, DOD developed three zones that have high relative potential for accidents (DODI 1977). The CZ, the area closest to the runway end, is the most hazardous. The overall risk is high enough that DOD generally acquires the land through purchase or easement to prevent development. As shown on **Figure 3-7**, the land within the Ellsworth AFB CZs is either within the installation boundary, or has been acquired via easements by Ellsworth AFB. APZ I is an area beyond the CZ that has significant potential for accidents. APZ II is an area beyond APZ I with a lesser, but still significant, potential for accidents. While aircraft accident potential in APZs I and II does not warrant acquisition by the USAF, land use planning and controls are strongly encouraged in these areas for the protection of the public. Ellsworth AFB has property easements in the majority of the land in the northern APZ I but does not have easements in either APZ II. Ellsworth AFB's CZs encompass areas 3,000 feet wide by 3,000 feet long. APZ I is 3,000 feet wide by 5,000 feet long and APZ II is 3,000 feet wide by 7,000 feet long. Additional information on accident potential is contained in **Appendix B** of this report.

3.4 Land Use Compatibility Guidelines

This AICUZ Study contains general land use guidelines related to safety and noise associated with aircraft operations. **Table 3-1** lists the USAF-recommended land use compatibility guidelines in relation to noise zones and APZs. The information presented in the table is essentially the same as the information published in the June 1980 publication by the Federal Interagency Committee on Urban Noise (FICUN) entitled *Guidelines for Considering Noise in Land Use Planning Control* (FICUN 1980), the *Standard Land Use Coding Manual* (SLUCM) published by the U.S. Urban Renewal Administration (USURA 1965), and the DOD Instruction 4165.57 entitled *Air Installations Compatible Use Zones* (DODI 1977). Each recommended land use compatibility guideline is a combination of criteria listed in the Key and Notes at the end of the table. For example, in SLUCM row No. 11.11, Single units: detached, Y¹ (in APZ II) means land use and related structures are compatible without restriction at a suggested maximum density of one to two dwelling units per acre, possibly increased under a Planned Unit Development where maximum lot coverage is less than 20 percent. However, if Single units: detached are proposed or located in APZ II and the 75 dBA noise zone or higher, since the land use and related structures are not compatible in the 75 dBA noise zone or higher, this land use should be prohibited.

Appendix A discusses land use compatibility with regards to noise zones and APZs.

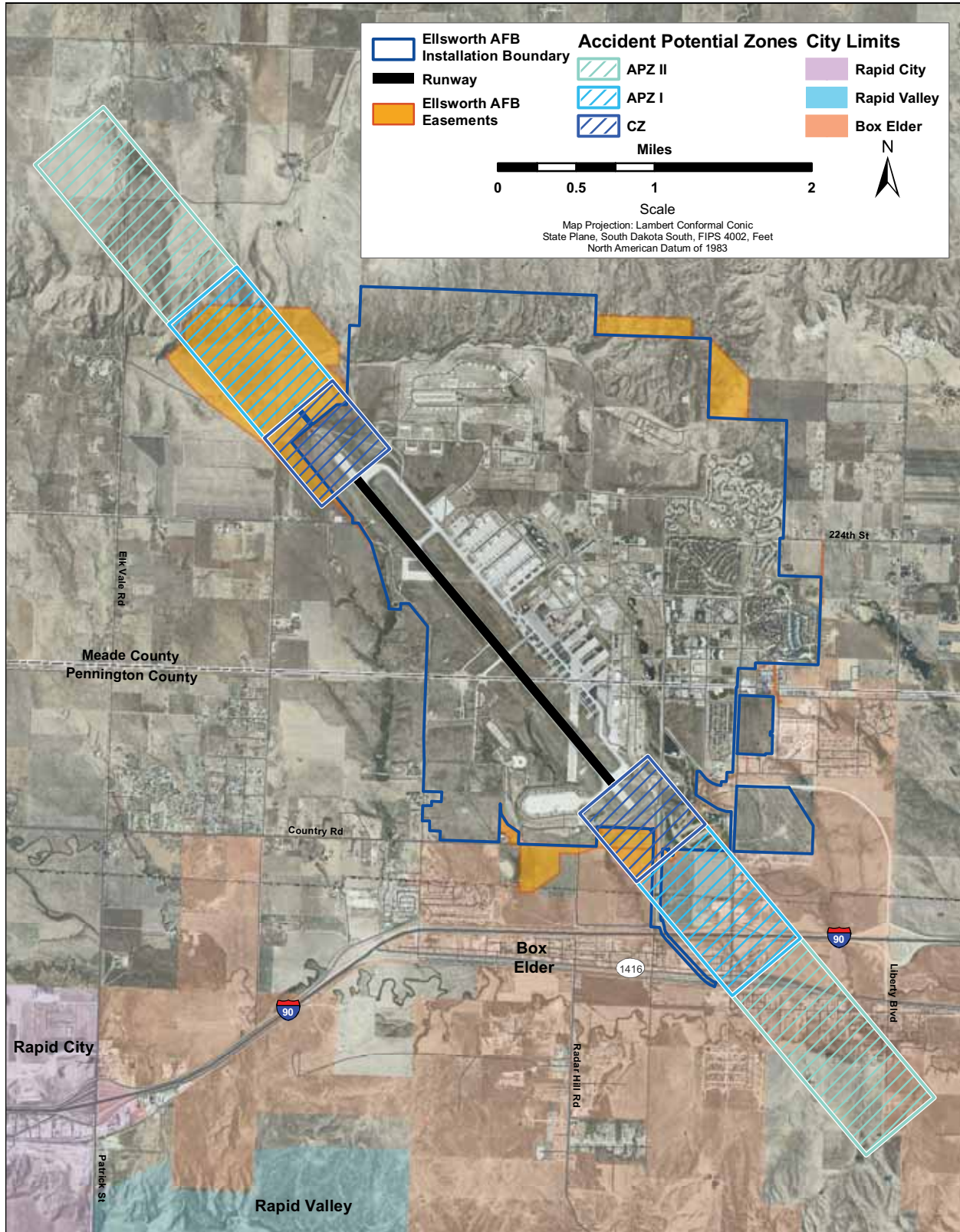


Figure 3-7. Clear Zones and Accident Potential Zones for Ellsworth AFB



Table 3-1. USAF Recommended Land Use Compatibility Guidelines in Relation to APZs and Noise Zones

Land Use		APZs			Noise Zones			
SLUCM No.	Name	CZ	APZ I	APZ II	65–69 dBA	70–74 dBA	75–79 dBA	80+ dBA
10	Residential							
11	Household units							
11.11	Single units: detached	N	N	Y ¹	A ¹¹	B ¹¹	N	N
11.12	Single units: semidetached	N	N	N	A ¹¹	B ¹¹	N	N
11.13	Single units: attached row	N	N	N	A ¹¹	B ¹¹	N	N
11.21	Two units: side-by-side	N	N	N	A ¹¹	B ¹¹	N	N
11.22	Two units: one above the other	N	N	N	A ¹¹	B ¹¹	N	N
11.31	Apartments: walk-up	N	N	N	A ¹¹	B ¹¹	N	N
11.32	Apartments: elevator	N	N	N	A ¹¹	B ¹¹	N	N
12	Group quarters	N	N	N	A ¹¹	B ¹¹	N	N
13	Residential hotels	N	N	N	A ¹¹	B ¹¹	N	N
14	Mobile home parks or courts	N	N	N	N	N	N	N
15	Transient lodgings	N	N	N	A ¹¹	B ¹¹	C ¹¹	N
16	Other residential	N	N	N ¹	A ¹¹	B ¹¹	N	N
20-30	Manufacturing							
21	Food and kindred products: manufacturing	N	N ²	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
22	Textile mill products: manufacturing	N	N ²	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
23	Apparel and other finished products made from fabrics, leather, and similar materials: manufacturing	N	N	N ²	Y	Y ¹²	Y ¹³	Y ¹⁴
24	Lumber and wood products (except furniture): manufacturing	N	Y ²	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
25	Furniture and fixtures: manufacturing	N	Y ²	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
26	Paper and allied products: manufacturing	N	Y ²	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
27	Printing, publishing, and allied industries	N	Y ²	Y	Y	Y ¹²	Y ¹³	Y ¹⁴



Land Use		APZs			Noise Zones			
SLUCM No.	Name	CZ	APZ I	APZ II	65–69 dBA	70–74 dBA	75–79 dBA	80+ dBA
20-30	Manufacturing (continued)							
28	Chemicals and allied products: manufacturing	N	N	N ²	Y	Y ¹²	Y ¹³	Y ¹⁴
29	Petroleum refining and related industries	N	N	N	Y	Y ¹²	Y ¹³	Y ¹⁴
31	Rubber and misc. plastic products: manufacturing	N	N ²	N ²	Y	Y ¹²	Y ¹³	Y ¹⁴
32	Stone, clay, and glass products manufacturing	N	N ²	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
33	Primary metal industries	N	N ²	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
34	Fabricated metal products: manufacturing	N	N ²	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
35	Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks: manufacturing	N	N	N ²	Y	A	B	N
39	Miscellaneous manufacturing	N	Y ²	Y ²	Y	Y ¹²	Y ¹³	Y ¹⁴
40	Transportation, communications, and utilities							
41	Railroad, rapid rail transit, and street railroad transportation	N ³	Y ⁴	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
42	Motor vehicle transportation	N ³	Y	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
43	Aircraft transportation	N ³	Y ⁴	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
44	Marine craft transportation	N ³	Y ⁴	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
45	Highway and street right-of-way	N ³	Y	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
46	Automobile parking	N ³	Y ⁴	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
47	Communications	N ³	Y ⁴	Y	Y	A ¹⁵	B ¹⁵	N
48	Utilities	N ³	Y ⁴	Y	Y	Y	Y ¹²	Y ¹³
49	Other transportation communications and utilities	N ³	Y ⁴	Y	Y	A ¹⁵	B ¹⁵	N
50	Trade							
51	Wholesale trade	N	Y ²	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
52	Retail trade: building materials, hardware, and farm equipment	N	Y ²	Y	Y	Y ¹²	Y ¹³	Y ¹⁴



Land Use		APZs			Noise Zones			
SLUCM No.	Name	CZ	APZ I	APZ II	65–69 dBA	70–74 dBA	75–79 dBA	80+ dBA
50	Trade (continued)							
53	Retail trade: general merchandise	N	N ²	Y ²	Y	A	B	N
54	Retail trade: food	N	N ²	Y ²	Y	A	B	N
55	Retail trade: automotive, marine craft, aircraft, and accessories	N	Y ²	Y ²	Y	A	B	N
56	Retail trade: apparel and accessories	N	N ²	Y ²	Y	A	B	N
57	Retail trade: furniture, home furnishings, and equipment	N	N ²	Y ²	Y	A	B	N
58	Retail trade: eating and drinking establishments	N	N	N ²	Y	A	B	N
59	Other retail trade	N	N ²	Y ²	Y	A	B	N
60	Services							
61	Finance, insurance, and real estate services	N	N	Y ⁶	Y	A	B	N
62	Personal services	N	N	Y ⁶	Y	A	B	N
62.4	Cemeteries	N	Y ⁷	Y ⁷	Y	Y ¹²	Y ¹³	Y ^{14,21}
63	Business services	N	Y ⁸	Y ⁸	Y	A	B	N
64	Repair services	N	Y ²	Y	Y	Y ¹²	Y ¹³	Y ¹⁴
65	Professional services	N	N	Y ⁶	Y	A	B	N
65.1	Hospitals, nursing homes	N	N	N	A*	B*	N	N
65.1	Other medical facilities	N	N	N	Y	A	B	N
66	Contract construction services	N	Y ⁶	Y	Y	A	B	N
67	Governmental services	N	N	Y ⁶	Y*	A*	B*	N
68	Educational services	N	N	N	A*	B*	N	N
69	Miscellaneous services	N	N ²	Y ²	Y	A	B	N
70	Cultural, entertainment, and recreational services							
71	Cultural activities (including churches)	N	N	N ²	A*	B*	N	N
71.2	Nature exhibits	N	Y ²	Y	Y*	N	N	N
72	Public assembly	N	N	N	Y	N	N	N



Land Use		APZs			Noise Zones			
SLUCM No.	Name	CZ	APZ I	APZ II	65–69 dBA	70–74 dBA	75–79 dBA	80+ dBA
70	Cultural, entertainment, and recreational services (continued)							
72.1	Auditoriums, concert halls	N	N	N	A	B	N	N
72.11	Outdoor music shell, amphitheaters	N	N	N	N	N	N	N
72.2	Outdoor sports arenas, spectator sports	N	N	N	Y ¹⁷	Y ¹⁷	N	N
73	Amusements	N	N	Y ⁸	Y	Y	N	N
74	Recreational activities (including golf courses, riding stables, water recreation)	N	Y ^{8,9,10}	Y	Y [*]	A [*]	B [*]	N
75	Resorts and group camps	N	N	N	Y [*]	Y [*]	N	N
76	Parks	N	Y ⁸	Y ⁸	Y [*]	Y [*]	N	N
79	Other cultural, entertainment, and recreational activities	N	Y ⁹	Y ⁹	Y [*]	Y [*]	N	N
80	Resources production and extraction							
81	Agriculture (except livestock)	Y ¹⁶	Y	Y	Y ¹⁸	Y ¹⁹	Y ²⁰	Y ^{20,21}
81.5 to 81.7	Livestock farming and animal breeding	N	Y	Y	Y ¹⁸	Y ¹⁹	Y ²⁰	Y ^{20,21}
82	Agriculture-related activities	N	Y ⁵	Y	Y ¹⁸	Y ¹⁹	N	N
83	Forestry activities and related services	N ⁵	Y	Y	Y ¹⁸	Y ¹⁹	Y ²⁰	Y ^{20,21}
84	Fishing activities and related services	N ⁵	Y ⁵	Y	Y	Y	Y	Y
85	Mining activities and related services	N	Y ⁵	Y	Y	Y	Y	Y
89	Other resources production and extraction	N	Y ⁵	Y	Y	Y	Y	Y

Source: DODI 1977, FICUN 1980, and USURA 1965

Key:

SLUCM = Standard Land Use Coding Manual, USURA.

Y = Yes – Land uses and related structures are compatible without restriction.

N = No – Land use and related structures are not compatible and should be prohibited.

Y^x = Yes with restrictions – Land use and related structures generally compatible; see notes indicated by the superscript.

N^x = No with exceptions – See notes indicated by the superscript.

NLR = Noise Level Reduction (NLR) (outdoor to indoor) to be achieved through incorporation of noise attenuation measures into the design and construction of the structures.

**Key: (continued)**

A, B, or C = Land use and related structures generally compatible; measures to achieve NLR for A (DNL of 65–69 dBA), B (DNL of 70–74 dBA), C (DNL of 75–79 dBA) need to be incorporated into the design and construction of structures.

A*, B*, and C* = Land use generally compatible with NLR; however, measures to achieve an overall noise level reduction do not necessarily solve noise difficulties and additional evaluation is warranted. See appropriate notes below.

* = The designation of these uses as “compatible” in this zone reflects individual Federal agencies and program considerations of general cost and feasibility factors, as well as past community experiences and program objectives. Localities, when evaluating the application of these guidelines to specific situations, might have different concerns or goals to consider.

Notes:

1. Suggested maximum density of 1 to 2 dwelling units per acre, possibly increased under a Planned Unit Development where maximum lot coverage is less than 20 percent.
2. Within each land use category, uses exist where further deliberating by local authorities might be needed due to the variation of densities in people and structures. Shopping malls and shopping centers are considered incompatible use in any accident potential zone (CZ, APZ I, or APZ II).
3. The placement of structures, buildings, or aboveground utility lines in the CZ is subject to severe restrictions. In a majority of the CZs, these items are prohibited. See AFI 32-7060, *Interagency and Intergovernmental Coordination for Environmental Planning* (USAF 1994a), and Air Force Joint Manual 32-8008, *Airfield and Heliport Planning Criteria* (DOD 1994), for specific guidance.
4. No passenger terminals and no major aboveground transmission lines in APZ I.
5. Factors to be considered: labor intensity, structural coverage, explosive characteristics, and air pollution.
6. Low-intensity office uses only. Meeting places, auditoriums, and the like are not recommended.
7. Excludes chapels.
8. Facilities must be low-intensity.
9. Clubhouse not recommended.
10. Areas for gatherings of people are not recommended.
11. (a) Although local conditions might require residential use, it is discouraged in DNL of 65–69 dBA noise zone and strongly discouraged in DNL of 70–74 dBA noise zone. The absence of viable alternative development options should be determined and an evaluation should be conducted prior to approvals indicating a demonstrated community need for residential use would not be met if development were prohibited in these zones.
(b) Where the community determines the residential uses must be allowed, measures to achieve outdoor to indoor NLR for the DNL of 65–69 dBA noise zone and the DNL of 70–74 dBA noise zone should be incorporated into building codes and considered in individual approvals.
(c) NLR criteria will not eliminate outdoor noise problems. However, building location and site planning, and design and use of berms and barriers can help mitigate outdoor exposure, particularly from near ground level sources. Measures that reduce outdoor noise should be used whenever practical in preference to measures that only protect interior spaces.
12. Measures to achieve the same NLR as required for facilities in the DNL of 65–69 dBA noise zone 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.
13. Measures to achieve the same NLR as required for facilities in the DNL of 70–74 dBA noise zone 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.
14. Measures to achieve the same NLR as required for facilities in the DNL of 75–79 dBA noise zone 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.
15. If noise-sensitive, use indicated NLR; if not, the use is compatible.
16. No buildings.
17. Land use is compatible provided special sound reinforcement systems are installed.
18. Residential buildings require the same NLR as required for facilities in the DNL of 65–69 dBA noise zone.
19. Residential buildings require the same NLR as required for facilities in the DNL of 70–74 dBA noise zone.
20. Residential buildings are not permitted.
21. Land use is not recommended. If the community decides the use is necessary, personnel should wear hearing protection devices.



Ambient Sound Levels. The ambient noise level in a quiet suburban residential area in the daytime is a DNL of about 50 dBA, which increases to 60 dBA for an urban residential area, and 80 dBA for the downtown area of a major city in the daytime (USEPA 1974). Studies of community annoyance in response to numerous types of environmental noise show that DNL correlates well with human annoyance. Most people are exposed to DNL sound levels of 50 to 55 dBA or higher on a daily basis. **Table 3-2** presents the percentages of people that would be projected to be “highly annoyed” when exposed to various levels of noise measured in DNL. This table presents the results of more than a dozen studies of the relationship between noise and annoyance levels. The data shown provide a perspective on the level of annoyance that might be anticipated. For example, 12 to 22 percent of persons exposed on a long-term basis to a DNL of 65 to 69 dBA are expected to be highly annoyed by noise events.

Table 3-2. Percentage of Population Highly Annoyed by Noise Zones

DNL Noise Zones	Percentage of Persons Highly Annoyed	
	<i>Low</i>	<i>High</i>
65–69 dBA	12	22
70–74 dBA	22	36
75–79 dBA	36	54
80+ dBA	>54	

Source: Finegold et al. 1994

3.5 Participation in the Planning Process

As local communities prepare their land use plans, the USAF must be ready to provide additional data and information. At Ellsworth AFB, the 28th Civil Engineer Squadron’s planning department should be contacted regarding planning matters as they might affect, or be affected by, activities at Ellsworth AFB. Planners from this office will also participate in AICUZ public releases and hearings, and educate local communities and their officials about the AICUZ Program.

Please visit
<http://www.ellsworth.af.mil/>
 for information on how to
 contact personnel at the
 installation.



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4. LAND USE ANALYSIS

4.1 Introduction

Land use planning and control is a dynamic, rather than 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 that decisions are normally not based on boundary lines, but rather on more generalized area designations.

Computer technology enables Ellsworth AFB to more precisely display its flight tracks and noise zones for land use planning purposes. This same technology allows the installation a means to communicate the extent to which Ellsworth AFB's region of impact extends into the City of Box Elder, Rapid City, Pennington County, and Meade County. For the purposes of this study, existing land uses within the 2008 noise zones (see **Figure 4-1**) have been classified into the following categories:

- **Commercial:** Offices, retail, restaurants, businesses, and other types of commercial activity.
- **Industrial:** Areas and the facilities they contain that are owned or used for industrial purposes, such as manufacturing, warehousing, and other similar uses.
- **Open-Space/Low-Density:** Undeveloped land areas, forested land, agricultural land, grazing areas, water or wetland areas, and areas with residential activity at densities less than or equal to one dwelling per acre.
- **Public/Semi-Public:** Publicly owned lands or lands to which the public has access, such as public buildings or institutional facilities.
- **Recreational:** Land areas designated for recreational activity, including local parks; wilderness areas and reservations; conservation areas; and areas designated for trails, hikes, camping, and other similar uses.
- **Residential:** 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.
- **Transportation:** Major transportation features including roads, freeways, interstates, and railroads.
- **Ellsworth AFB:** Area within the current Ellsworth AFB installation boundary.

Research on aircraft accident potential, noise, and land use compatibility is ongoing at a number of Federal and other agencies. These studies and all other compatibility guidelines must not be considered inflexible standards. They are the framework within which land use compatibility questions can be addressed and resolved.

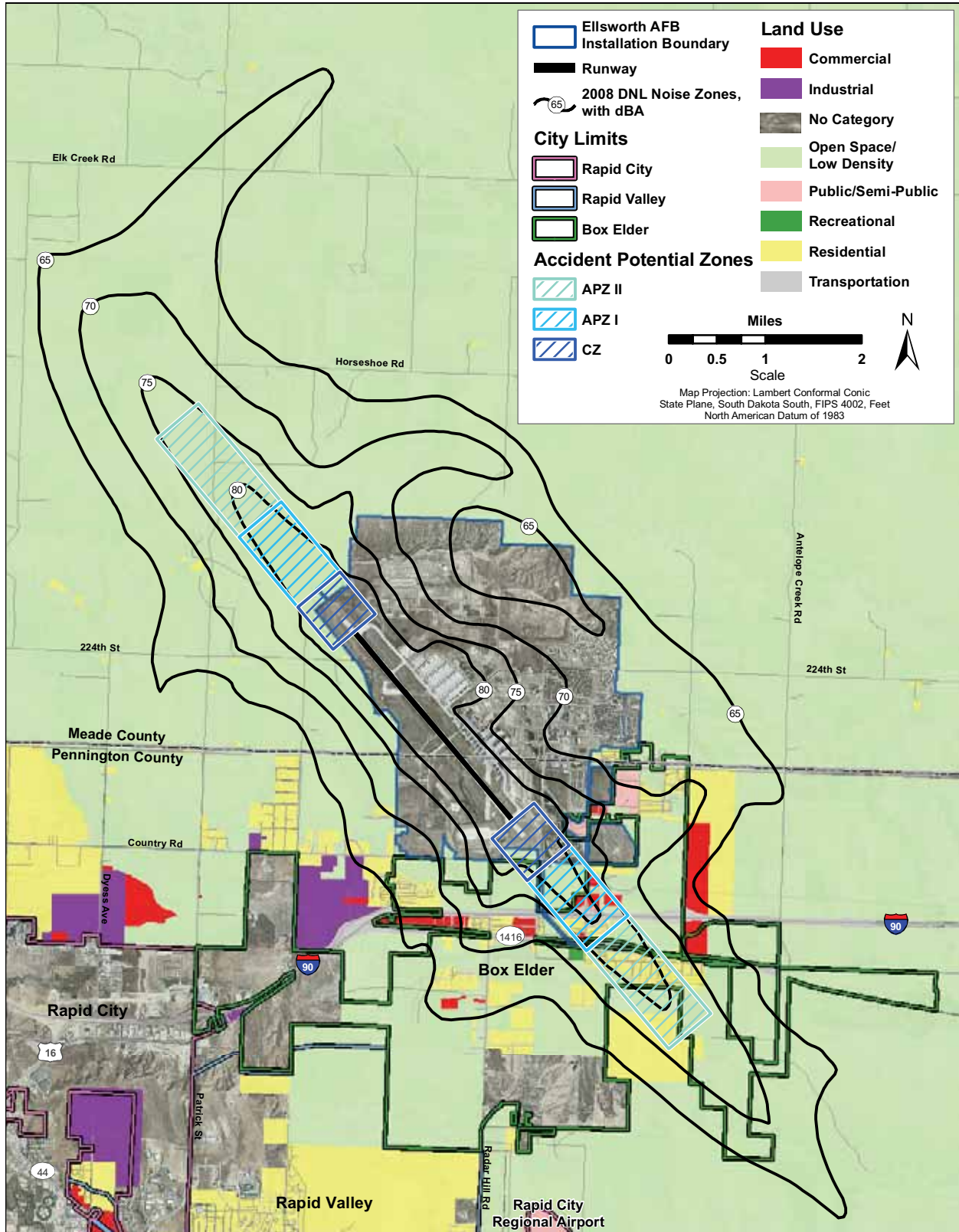


Figure 4-1. 2008 DNL Noise Zones and APZs on Land Use Map



4.2 Current Land Use

Ellsworth AFB was originally developed in a rural area in Pennington and Meade counties, South Dakota. Since the 1940s, growth in several communities, including Rapid City and Box Elder, has increased thereby impacting the land use surrounding the installation. Current land use surrounding Ellsworth AFB is mixed with the majority of the development southwest of the installation in Rapid City. Most of the development adjacent to the installation, within the 2008 noise zones, is in Pennington County south of the installation.

The 2008 noise zones and APZs from aircraft operations at Ellsworth AFB are depicted on a land use map and are shown in **Figure 4-1**. The land use illustrated on this map consists of 2003 data from Pennington County (Pennington County 2003a) and National Land Use Cover Data from 2001 (NLCD 2001). The National Land Use Cover Data were used for the areas of Pennington County where no land use data existed and for all of Meade County. Meade County did not have land use data available at the time this report was completed.

The amount of land within the installation boundary that is encompassed by the 2008 noise zones is labeled as Ellsworth AFB in **Table 4-1**. The remaining land uses shown in **Table 4-1** and discussed in the following paragraphs consists of property outside the installation boundary. The majority of the land encompassed by the 65 to 80+ dBA noise zones consists of open space/low density use and land within the installation boundary. However, residential and public/semi-public land uses are present in every noise zone. There are 768 acres of residential land in the 65 to 69 dBA noise zone, 430 acres in the 70 to 74 dBA noise zone, 135 acres in the 75 to 79 dBA noise zone, and 1 acre in the 80+ dBA noise zone for a total of 1,334 acres of residential land inside the 65 to 80+ dBA noise zones. Public/semi-public use includes 28 acres in the 65 to 69 dBA noise zone, 40 acres in the 70 to 74 dBA noise zone, 22 acres in the 75 to 79 dBA noise zone, and 3 acres in the 80+ dBA noise zone for a total of 93 acres within the 65 to 80+ dBA noise zones. Furthermore, there are 13 acres of recreational land use in the 70 to 74 dBA noise zone. Additional land uses include commercial, industrial, and transportation.

4.2.1 City of Box Elder

As shown on **Figure 4-1**, the City of Box Elder is adjacent to Ellsworth AFB, south of the installation boundary. All of the noise zones encompass land within Box Elder. Land within Box Elder consists of open space/low density use with residential and commercial use along the major transportation routes. There is a public/semi-public parcel within southern APZ I and the 80+ dBA noise zone that contains the Emmanuel Baptist Church. There are also public/semi-public parcels adjacent to the southeastern installation boundary that include the South Dakota Air/Space Museum, which is northeast of the southern CZ, and multiple components of the Douglas School District (including Carrousel Pre-School, Francis Case



Table 4-1. Land Use Acreage in Relation to 2008 Noise Zones

Noise Zone	Land Use Category	Acres
65–69 dBA	Ellsworth AFB	1,299
	Commercial	226
	Industrial	7
	Open Space/Low Density	8,451
	Public/Semi-Public	28
	Residential	768
	Transportation	235
	<i>Subtotal</i>	11,014
70–74 dBA	Ellsworth AFB	1,197
	Commercial	44
	Open Space/Low Density	3,880
	Public/Semi-Public	40
	Recreational	13
	Residential	430
	Transportation	199
	<i>Subtotal</i>	5,803
75–79 dBA	Ellsworth AFB	828
	Commercial	34
	Open Space/Low Density	1,545
	Public/Semi-Public	22
	Residential	135
	Transportation	134
	<i>Subtotal</i>	2,698
80+ dBA	Ellsworth AFB	1,532
	Commercial	13
	Open Space/Low Density	689
	Public/Semi-Public	3
	Residential	1
	Transportation	24
	<i>Subtotal</i>	2,262
Total		21,777

and Badger Clark Elementary Schools, Douglas Middle and High Schools, and multiple school offices). These public facilities are south of the border that divides Meade and Pennington counties. Land within the southern APZs consists of residential, open space/ low density, public/semi-public, and commercial use. Land encompassed by the 80+ dBA noise zone consists of residential, open space/low density, transportation, and commercial use.

4.2.2 Rapid City

Rapid City is southwest of Ellsworth AFB and the City of Box Elder. Land in Rapid City consists of residential, open space/low density, industrial, commercial, and public/semi-public use.



The 2008 noise zones do not encompass land within the boundaries of Rapid City. However, the northeastern boundary of Rapid City is approximately 2 miles southwest of the 2008 65 to 69 dBA noise zone. In addition, the 65 to 69 dBA noise zone is about 0.50 miles from the boundary of Rapid Valley. Rapid Valley is a census-designated place and is considered an unincorporated suburb of Rapid City. As discussed in **Section 3.2.1**, noise exposure levels have fluctuated over time from varying aircraft-related factors. As shown in **Figure 3-1**, the 1994 65 to 69 dBA noise zone encompassed land within Rapid Valley. Consequently, Rapid City and Rapid Valley planners should consider the fluctuations in the noise zones before making land use decisions.

4.2.3 Pennington County

Land outside of the City of Box Elder and Rapid City within Pennington County consists of large tracts of open space/low-density use with residential parcels closer to the urban areas. Consequently, the majority of the land in Pennington County, outside of the City of Box Elder, within the AICUZ environs consists of open space/low density use with smaller amounts of residential use.

4.2.4 Meade County

Meade County is approximately 2 miles north of Interstate 90. Meade County consists almost entirely of open space/low-density land use, with small pockets of residential use surrounding the installation. As shown on **Figure 4-1**, land use within the 2008 noise zones and APZs in Meade County consists primarily of open space/low-density use with pockets of residential land in the 65 to 74 dBA noise zones. In addition, a small parcel of residential land is within the 80+ dBA noise zone; this parcel is adjacent to the western portion of the installation, directly south of the northern CZ.

4.3 Land Use Planning

4.3.1 Joint Land Use Study

The *Ellsworth Air Force Base Joint Land Use Study* (JLUS), prepared under contract with the Black Hills Council of Local Governments with financial support from the DOD Office of Economic Adjustment, was published in June 1995. The JLUS was a cooperative land use planning effort between Ellsworth AFB and the surrounding jurisdictions that include the City of Box Elder, Rapid City, Pennington County, and Meade County (USAF 1995). One of the primary goals of developing the JLUS was to provide recommendations pertaining to the current land use in the AICUZ environs that would facilitate the creation of compatible zoning ordinances by local jurisdictions. It was anticipated that the updated zoning ordinances would promote uses of land adjacent to and surrounding Ellsworth AFB that would be compatible with future missions (USAF 1995).

The Mission Statement of the 1995 JLUS is "[to] identify, analyze, and to the extent possible, resolve encroachment issues associated with the development of the surrounding area" (USAF 1995).

The JLUS recommendations are provided in the Recommended Environs Land Use Plan section, which is based upon noise zones and APZs presented



in the Ellsworth AFB 1994 AICUZ Study and the Transportation Network Planning Study (USAF 1995). The Recommend Environs Land Use Plan component of the JLUS recommends the “elimination of residential structures within the noise contours, Accident Potential Zones and floodway” in the areas directly south of the installation in the City of Box Elder (USAF 1995). The JLUS stated that there were incompatible land uses adjacent to Ellsworth AFB within the 65 to 80+ dBA noise zones. In addition, there were residential and commercial incompatible uses in southern APZ I and II.

In addition, the transportation recommendation included construction of a new interchange for Interstate 90, with roads connecting the interchange to the installation and to Highway 230 (Ellsworth Road). Opening of the new interchange on October 1, 2005, resulted in the relocation of incompatible residential land use to the vicinity of the interchange, about 1 mile east of Ellsworth AFB (South Dakota 2006).

One of the recommendations published in the JLUS was to assist the local jurisdictions in reducing future occurrences of incompatible land uses through the enactment or enforcement of zoning ordinances. The Box Elder Planning and Zoning Commission, the Board of County Commissioners for Pennington County, and the Rapid City Planning Commission have enacted zoning ordinances that regulate land use adjacent to Ellsworth AFB (see **Section 4.5**). Meade County does not currently have zoning ordinances (Meade County Times Tribune 2007).

The JLUS also recommended that height restriction regulations should be established and maintained in order to provide unobstructed approach and departure operations at Ellsworth AFB as outlined in the 1994 AICUZ Study, which is based upon Federal Aviation Regulation Part 77, Subpart C. Additionally, the JLUS recommended that land use overlay legislation be amended to allow for control of airfield encroachment to prevent incompatible land use.

4.3.2 City of Box Elder

The *City of Box Elder Comprehensive Plan: Goal and Policies* was written in 2002 and serves as a guide for policy decisions relating to the physical growth and economic development of Box Elder. The Comprehensive Plan strives to maintain and promote “a development pattern, which provides direction for responding to the demands of the future” while limiting residential densities in areas affected by noise and flood hazards (City of Box Elder 2002). The Comprehensive Plan includes goals, objectives, and actions to guide land use decisions and the location of future land uses (see **Section 4.7** for more information on future land use). Elements addressed within the Comprehensive Plan include urban development, neighborhoods, housing, economic development, transportation, energy, the environment, citizen involvement, and the plan implementation and review process. The City of Box Elder recognizes the special relationship it has with Ellsworth AFB due the installation’s proximity and economic impact upon the city.



4.3.3 Rapid City

The Rapid City Area Metropolitan Planning Organization (MPO) has produced a Future Land Use Plan to provide guidelines for land use and future growth of the city (Rapid City 1999). This Plan unites 14 neighborhoods within Rapid City under the goal of linking communities, encouraging development in compatible areas, and maintaining and promoting economic growth. Rapid City has a mix of land uses ranging from industrial, commercial, and residential. Agricultural land use exists on the fringes of the city.

4.3.4 Pennington County

The land use for Pennington County is driven by the Pennington County zoning districts, which are published in the *Pennington County Comprehensive Plan* (Pennington County 2003b). One of the primary goals for future land use in the Comprehensive Plan is to protect and provide continued compatible land uses for residential and prime agricultural lands. The Comprehensive Plan proposes a series of objectives to accomplish this goal. The goals applicable to Ellsworth AFB include the following:

- Provide for stable neighborhoods by minimizing adverse effects from conflicting land uses
- Transition between types of land uses, especially between conflicting land uses, shall be orderly and efficient through the use of buffers such as increased setbacks, open space, fencing, and landscaping.

4.3.5 Meade County

Land use data for Meade County were not available at the time this study was completed.

4.4 Current Zoning

Figure 4-2 illustrates the zoning applicable to the area surrounding Ellsworth AFB, utilizing 2003 zoning data from Pennington County (Pennington County 2003c). Meade County does not currently have zoning regulations. The 2008 noise zones encompass land within the City of Box Elder, but are east of the densely populated area of Rapid City. The majority of the land encompassed by the 2008 noise zones is not zoned.

Most of the land within the 65 to 74 dBA noise zones is unzoned. However, south and east of the installation in Pennington County, land is zoned agricultural. To the west of the installation, land is zoned agricultural, residential, and industrial. Land within the 75 to 80+ dBA noise zones is primarily unzoned, although some property is zoned agricultural.

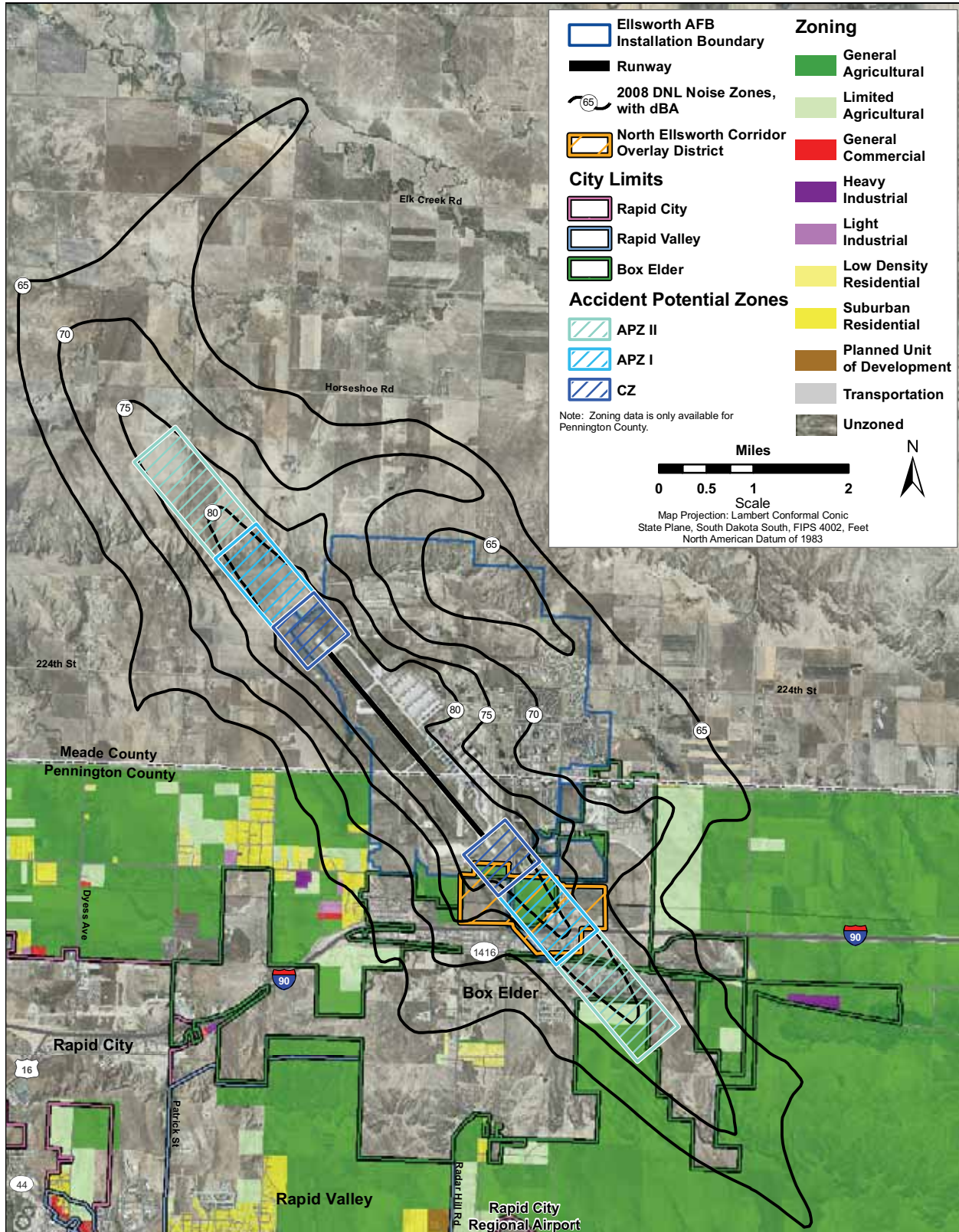


Figure 4-2. 2008 DNL Noise Zones and APZs on Zoning Map



4.4.1 City of Box Elder

Zoning data for the City of Box Elder were not available at the time this study was completed.

4.4.2 Rapid City

Most of the land zoned residential is southeast of the city center, in the southern portion of Rapid Valley, which is a suburb of Rapid City. This area also includes parcels zoned commercial and planned unit of development. Rapid Valley has large tracts of land, southwest of Box Elder, zoned agricultural.

4.4.3 Pennington County

As shown on **Figure 4-2**, most of the land within Pennington County south of Interstate 90 is zoned agricultural or is unzoned. Land zoned commercial is scattered throughout Pennington County adjacent to transportation routes. Industrial zones are present south of Interstate 90 to the east of the installation. Land at the southwestern corner of Ellsworth AFB, outside of the Box Elder municipal boundaries, is zoned agricultural, residential, industrial, and commercial. Some of these parcels are within the 65 to 69 dBA noise zone and some of the parcels are adjacent to it. In addition, land zoned residential is present south of the 65 to 69 dBA noise zone on Radar Hill Road.

4.4.4 Meade County

Meade County did not have any zoning regulations at the time this study was completed.

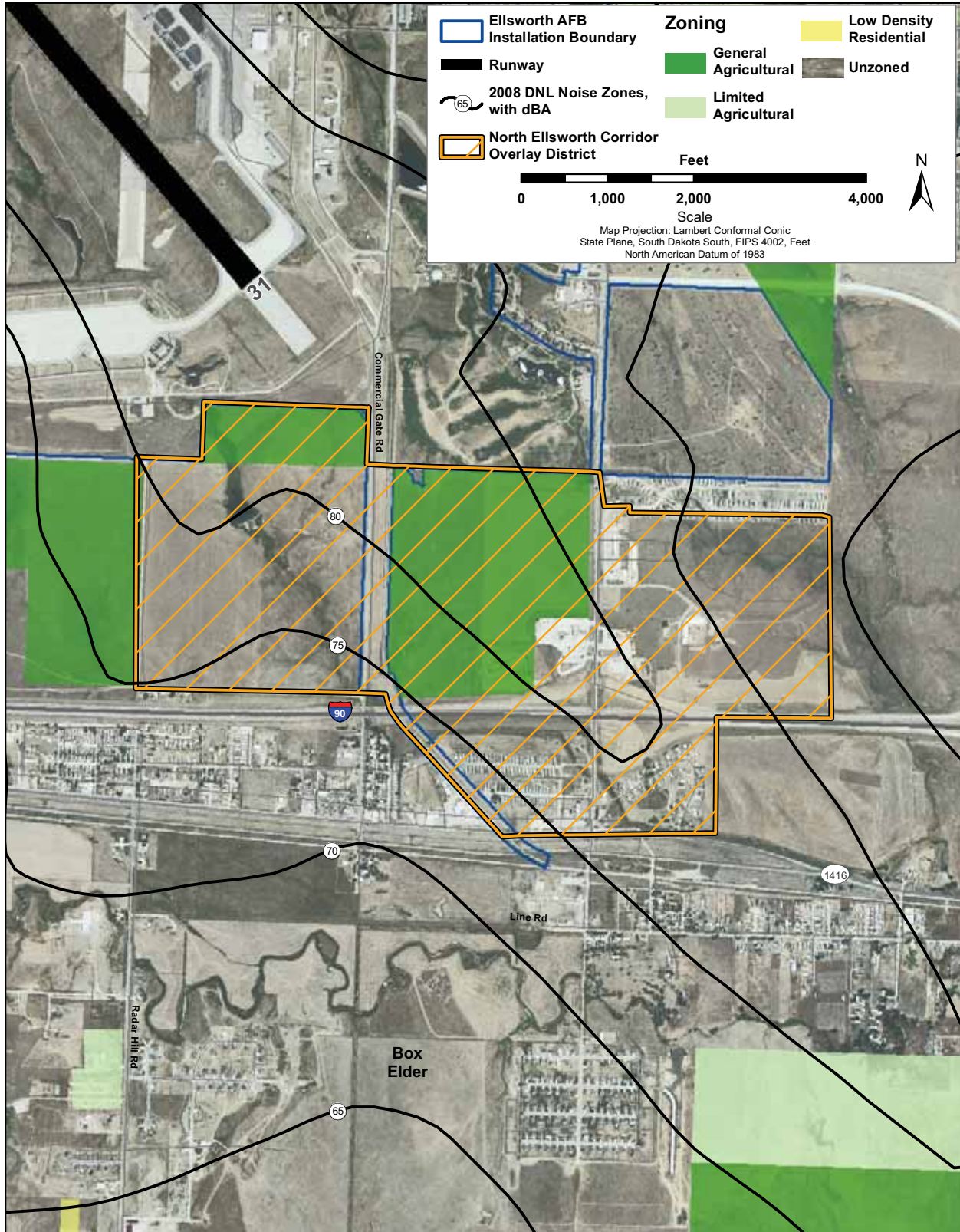
4.5 Regional Zoning Policies

4.5.1 City of Box Elder

The Common Council of the City of Box Elder issued Ordinance #441 for the North Ellsworth Corridor Overlay District on 15 July 2006 (City of Box Elder 2006). The North Ellsworth Corridor is within the 70 to 80+ dBA noise zones and the southern CZ and APZ I (see **Figure 4-3**). This district was created around Ellsworth AFB for the following purposes:

- Minimize the exposure of land uses to aircraft noise
- Minimize public safety risks from potential aircraft accidents
- Protect property values
- Promote sound land use planning and zoning
- Promote public health, safety, and welfare.

In 2006, the City of Box Elder issued the North Ellsworth Corridor Overlay District to minimize risks and noise exposure from aircraft operations at Ellsworth AFB.



Source of North Ellsworth Corridor Overlay District: e²M, Inc 2008.

Figure 4-3. North Ellsworth Corridor Overlay District



Land within the North Ellsworth Corridor Overlay District is currently zoned agricultural or is unzoned. However, the zoning regulations of an overlay district supersede the underlying zoned areas. The North Ellsworth Corridor Overlay District includes regulations on the construction or expansion of new structures, relocation of structures, and the moving or replacement of mobile homes. Proposed development shall comply with the height restrictions in Federal Aviation Regulation Part 77. In addition, there are interior sound attenuation level regulations, population density guidelines, and specific permitted land uses. For specific information on regulations with the North Ellsworth Corridor, refer to the City of Box Elder Ordinance #441.

4.5.2 Rapid City

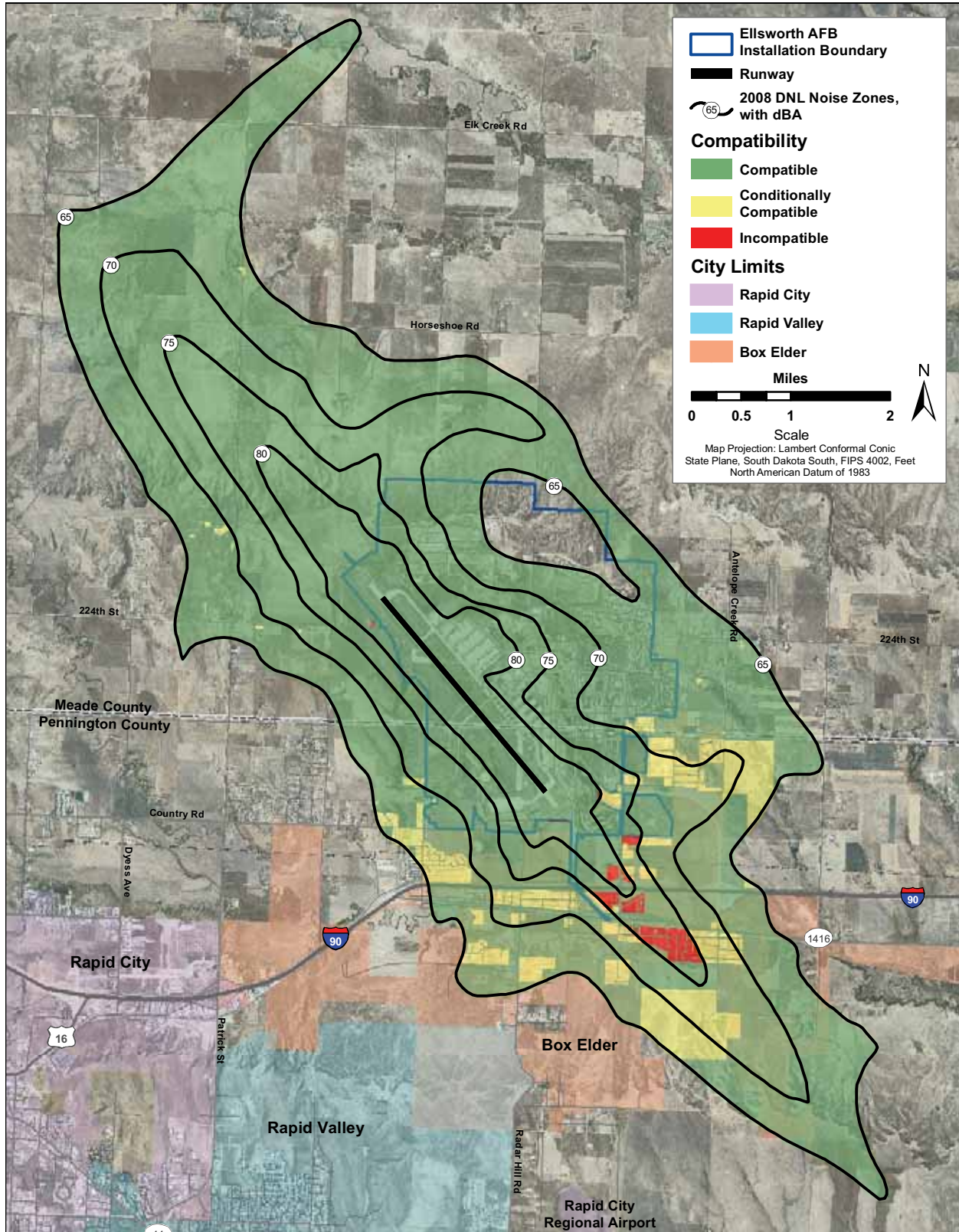
Zoning regulations for Rapid City are provided in the Rapid City Municipal Code (Rapid City 2008). The purpose of these regulations is to promote the “safety, health, morals, convenience, and general welfare” of the public, to encourage compatible land use, to conserve social and economic stability, and to manage population growth and congestion. Although there are large parcels of land that are not zoned, Rapid City has 21 zoning districts including general agriculture, mobile home residential, heavy industrial, and airport zoning. Airport zoning codes are specified for the Rapid City Regional Airport and include regulations for compatible land use, airport encroachment areas, and height regulations.

4.6 Incompatible Land Uses

The USAF established recommended land use guidelines in relation to APZs and noise zones in order to determine if land uses surrounding an installation were recommended in the AICUZ environs. In order to establish land use compatibility, the type of land use is compared to the USAF recommended guidelines in relation to APZs and noise zones (see **Table 3-1**). Land uses are defined as compatible, conditionally compatible, or incompatible. Compatible refers to those land uses and related structures that are recommended within the AICUZ environs without restriction. Incompatible refers to those land uses and related structures that are not recommended within the AICUZ environs and should be prohibited. Conditionally compatible refers to land uses and related structures that are generally recommended within the AICUZ environs, with certain restrictions. Restrictions can include limits on densities of people and structures, requirements that noise level reduction (NLR) measures be incorporated into the design and construction of structures, or the restriction that personnel should wear hearing protection devices. Please see the key and notes for **Table 3-1** for all the limitations on land use compatibility.

4.6.1 Noise Zones

The compatibility status of existing land use in the vicinity of Ellsworth AFB in relation to the 2008 noise zones is shown in **Figure 4-4**. This land use compatibility was developed by taking the land use categories presented in **Figure 4-1**, choosing the respective land use classifications from **Table 3-1**,



Source of Compatibility: eM, Inc 2008.

Figure 4-4. Land Use Compatibility in Relation to 2008 DNL Noise Zones



and applying the recommended land use compatibility. DOD and other Federal agencies, such as HUD and the Federal Housing Administration, use a DNL of 65 dBA as a land use planning threshold. **Table 4-2** summarizes the acreage associated with various land use compatibilities within the noise zones evaluated. Overall, the majority (approximately 93 percent) of the land encompassed by the 2008 noise zones consists of Ellsworth AFB property and land that is considered compatible, approximately 6 percent of the land is considered conditionally compatible, and approximately 1 percent is considered incompatible. The following paragraphs provide a detailed description of land use compatibility for the areas surrounding the installation.

Table 4-2. Land Use Compatibility Status in Relation to 2008 Noise Zones Based on USAF Recommended Land Use Compatibility Guidelines

Noise Zone	USAF Recommended Land Use Compatibility Status	Acres
65–69 dBA	Ellsworth AFB	1,299
	Compatible	8,919
	Conditionally Compatible (residential, public/semi-public)	796
	Incompatible	0
	<i>Subtotal</i>	<i>11,014</i>
70–74 dBA	Ellsworth AFB	1,197
	Compatible	4,079
	Conditionally Compatible (residential, commercial, public/semi-public, recreational)	527
	Incompatible	0
	<i>Subtotal</i>	<i>5,803</i>
75–79 dBA	Ellsworth AFB	828
	Compatible	1,679
	Conditionally Compatible (commercial, public/semi-public)	56
	Incompatible (residential)	135
	<i>Subtotal</i>	<i>2,698</i>
80+ dBA	Ellsworth AFB	1,532
	Compatible	713
	Conditionally Compatible	0
	Incompatible (residential, commercial, public/semi-public)	17
	<i>Subtotal</i>	<i>2,262</i>
Total		21,777

As shown in **Figure 4-4**, the compatibility analysis does not show any incompatible land uses within the 65 to 74 dBA noise zones. However, there are land uses that are considered incompatible in the 75 to 80+ dBA noise zones, which include residential, commercial, and public/semi-public. These



areas are generally south of the installation in the City of Box Elder. The residential land considered incompatible in the 80+ dBA noise zone consists of a 1-acre parcel directly south of the northern CZ. There are two general areas with public/semi-public land use that are considered incompatible in the 80+ dBA noise zone. The public/semi-public parcel in the 80+ dBA noise zone and the southern APZ I contains the Emmanuel Baptist Church. The public/semi-public area, southeast of the runway, contains the South Dakota Air/Space Museum, which abuts the installation boundary. Residential land in the 75 to 79+ dBA noise zone that is considered incompatible consists of mobile homes south of Interstate 90 and north of Old U.S. Highway 1416 as well as mobile homes and single family homes south of Old U.S. Highway 1416.

Land use that is considered conditionally compatible is present in the 65 to 79 dBA noise zones. The majority of this land is present south, southeast, and southwest of the installation in Pennington County. However, there are a few scattered parcels in Meade County that are considered conditionally compatible. Conditionally compatible land in the 65 to 79 dBA noise zones consists of residential, commercial, public/semi-public, and recreational use.

One of the public/semi-public land uses in the 65 to 75 dBA noise zones (that is considered conditionally compatible) contains multiple components of the Douglas School District, which includes Carrousel Pre-School, Francis Case and Badger Clark Elementary Schools, Douglas Middle and High Schools, and multiple school offices. This school area is east of Ellsworth AFB and south of the border that divides Meade and Pennington Counties.

4.6.2 Accident Potential Zones

The same methodology as described in **Section 4.6.1** was applied to land use compatibility within the Ellsworth AFB APZs. APZs are made up of three zones: the CZ, APZ I, and APZ II. Each CZ encompasses an area 3,000 feet wide by 3,000 feet long, APZ I is 3,000 feet wide by 5,000 feet long, and APZ II is 3,000 feet wide by 7,000 feet long (see **Appendix B**).

Table 4-3 summarizes land use compatibility status in relation to the APZs, as shown in **Figure 4-5**. All of the land within the northern CZ and APZs is compatible. In addition, all of the land in the southern CZ is compatible. Approximately 22 percent (223 acres) of the land in the southern APZs is considered conditionally compatible and approximately 4 percent (39 acres) is incompatible. Land that is considered conditionally compatible consists of commercial use in southern APZ I and residential use in APZ II. In southern APZ I, residential and public/semi-public land are considered incompatible uses. In APZ I, residential land consists of mobile homes south of Interstate 90 and north of Old U.S. Highway 1416. The public/semi-public land in APZ I contains the Emmanuel Baptist Church and Harvest Time Free Will Baptist Church. Residential land in APZ II consists of mobile homes and single family homes south of Old U.S. Highway 1416.



Table 4-3. Land Use Compatibility Status in Relation to APZs based on USAF Recommended Land Use Compatibility Guidelines

APZ	USAF Recommended Land Use Compatibility Status	Acres
North End		
CZ	Ellsworth AFB	128
	Compatible	79
	Conditionally Compatible	0
	Incompatible	0
	<i>Subtotal</i>	<i>207</i>
APZ I	Ellsworth AFB	0
	Compatible	345
	Conditionally Compatible	0
	Incompatible	0
	<i>Subtotal</i>	<i>345</i>
APZ II	Ellsworth AFB	0
	Compatible	482
	Conditionally Compatible	0
	Incompatible	0
	<i>Subtotal</i>	<i>482</i>
Total		1,034
South End		
CZ	Ellsworth AFB	154
	Compatible	53
	Conditionally Compatible	0
	Incompatible	0
	<i>Subtotal</i>	<i>207</i>
APZ I	Ellsworth AFB	27
	Compatible	241
	Conditionally Compatible (commercial)	38
	Incompatible (residential, public/semi-public)	39
	<i>Subtotal</i>	<i>345</i>
APZ II	Ellsworth AFB	0
	Compatible	297
	Conditionally Compatible (residential)	185
	Incompatible	0
	<i>Subtotal</i>	<i>482</i>
Total		1,034

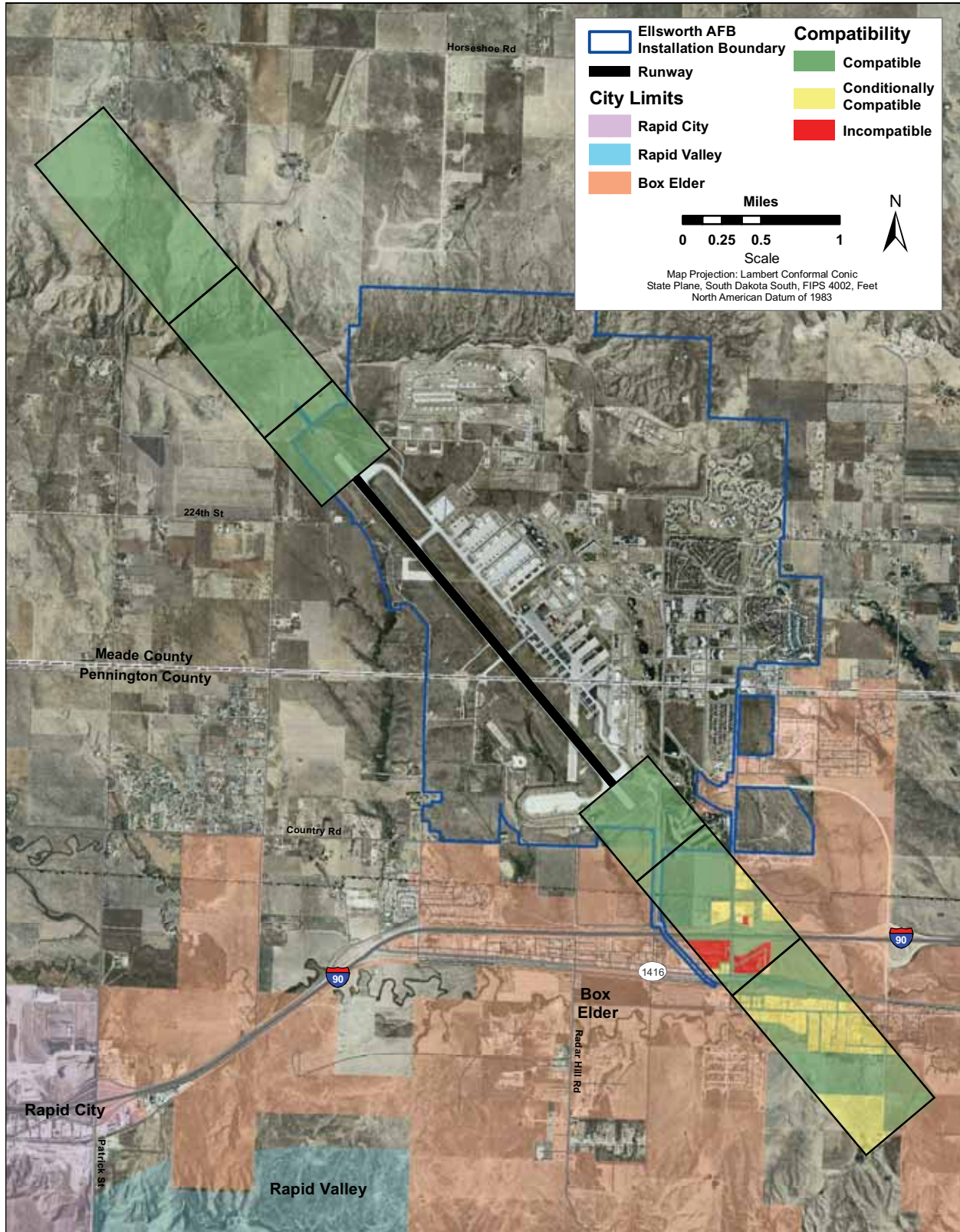


Figure 4-5. Land Use Compatibility in Relation to APZs



4.6.3 Overall Land Use Compatibility within the Noise Zones and APZs

Land that is within the Ellsworth AFB 65 to 80+ dBA noise zones and APZs was evaluated to determine the combined land use compatibility. For example, a single family home would be considered a conditionally compatible use within the 70 to 74 dBA noise zone. Within APZ I, a single family home would be represent an incompatible use. Therefore, if a single family home was within both the 70 to 74 dBA noise zone and APZ I, it would represent an incompatible use. **Figure 4-4** illustrates the land use compatibility for areas within the Ellsworth AFB noise zones and **Figure 4-5** illustrates the land use compatibility for areas within the APZs. All of the parcels that are present within both the noise zones and APZs have the same compatibility or the compatibility is more restrictive in the analysis for the noise zones. The majority of these parcels are in the City of Box Elder.

In southern APZ II, there are residential areas that are also encompassed by the 75 to 79 dBA noise zone. These residences consist of a mix of mobile homes and single family homes, south of Old U.S. Highway 1416. These residences are conditionally compatible in APZ II and incompatible in the 75 to 79 dBA noise zone. Consequently, these residential areas are considered an incompatible use.

In southern APZ I, there are commercial areas that are also encompassed by the 80+ dBA noise zone. These commercial areas are conditionally compatible in APZ I and incompatible in the 80+ dBA noise zone. Consequently, these commercial areas are considered an incompatible use.

4.7 Future Land Use

4.7.1 Pennington County

The *Pennington County Comprehensive Plan* discusses future growth and development constraints in Box Elder, Rapid City, and Pennington County. The Future Land Use portion of the Plan is intended to help Pennington County residents and officials from Rapid City, Box Elder, and Pennington County to visualize the desired future land development pattern in the community (Pennington County 2003b). The future land use plan is intended to be fluid, not a rigid, parcel-specific mandate for how land shall be developed.

Agricultural activities are the single largest land use category in Pennington County, and have a significant impact on Pennington County's overall economy (Pennington County 2003b).

The greatest projected change to current land use in Pennington County would be an increase in residential development on the outskirts of Rapid City. In the Comprehensive Plan, the Pennington County Planning Commission has identified areas suitable for residential development. Residential development is expected to occur in areas zoned Suburban Residential and Planned Unit Development. Currently, there are more than 11,362 acres of property in Pennington County zoned as a Suburban Residential District (Pennington County 2003b); approximately 76 acres of that total are southwest of the installation within the 2008 noise zones. Residential development can also occur in areas zoned Planned Unit Development. Currently no land zoned Planned Unit Development is within



the 2008 noise zones. It is recommended that Pennington County adhere to USAF recommended land use compatibility guidelines when developing these areas.

Commercial land use in Pennington County is present along major transportation routes. Pennington County has two commercial zoning districts, the Highway Service District and General Commercial District. The Comprehensive Plan does not recommend developing or expanding strip commercial areas due to traffic congestion, high accident rates, and premature development into undeveloped areas. In place of strip commercial development, the Comprehensive Plan suggests node development at major intersections, which would allow for preferred cluster development. Future large commercial development is not expected in the unincorporated areas of Pennington County.

The Plan stipulates that industrial land use is important to the overall economy of Pennington County. The Plan suggests that industrial land use should occur where access to appropriate infrastructure, proximity to police and fire departments, and additional space for facility parking and expansion exists. In addition, industrial land use should be separated from other land uses, especially residential uses. Future industrial sites in Pennington County are limited due to site location, lack of amenities, and conflicting land use. The Future Land Use section of the Plan shows a proposed Light Industrial District southwest of Ellsworth AFB, between the installation and Interstate 90. The eastern portion of the Light Industrial District would be within the 65 to 69 dBA noise zone; industrial use is compatible within that noise zone. Additional industrial uses are proposed southeast and northwest of Rapid City, outside of the AICUZ environs.

4.7.2 Meade County

Meade County did not have any future land use plans at the time this study was completed.

4.8 Future Transportation Issues

In addition to future land uses that have the potential to encroach upon AICUZ environs, there are also transportation issues that have the capacity to impact Ellsworth AFB. The *Rapid City Area Transportation Improvement Program (FY 2008–2012)* is a multi-year program of transportation improvements, including highway and transit projects (Rapid City 2007). The Rapid City MPO and the State Department of Transportation cooperate in project selection. The MPO operates under the Transportation Planning Division of the Growth Management Department of Rapid City. The MPO is tasked with planning for future growth through the expansion of the city's transportation network, including the construction and repair of roadways, rehabilitation of public transportation, and bridge repair.

Of the planned transportation improvements scheduled to take place from 2008 to 2012, only one minor project could have a slight effect on traffic patterns surrounding Ellsworth AFB. In 2011, bridge replacement is

Ellsworth AFB is a participant in the transportation planning processes for the Rapid City area, and facilitates communication between the installation and the surrounding jurisdictions.



scheduled on Spruce Street over Box Elder Creek. The work would be approximately 2 miles south of the installation, and would span approximately 0.2 miles.

In addition to the Transportation Improvement Program, the MPO has released guidelines for transportation planning (as outlined in the Rapid City Unified Planning Work Program) that describes annual activities, funding, planning studies, and the goals to be accomplished by the participants of the planning process. Participants include Ellsworth AFB, City of Box Elder, Rapid City Growth Management and Public Works Departments, Pennington County, and Meade County. The participation of Ellsworth AFB in the transportation planning process is necessary to ensure that future transportation plans would not impact Ellsworth AFB's ability to fulfill its mission requirements.

4.9 Incompatible Zoning Uses

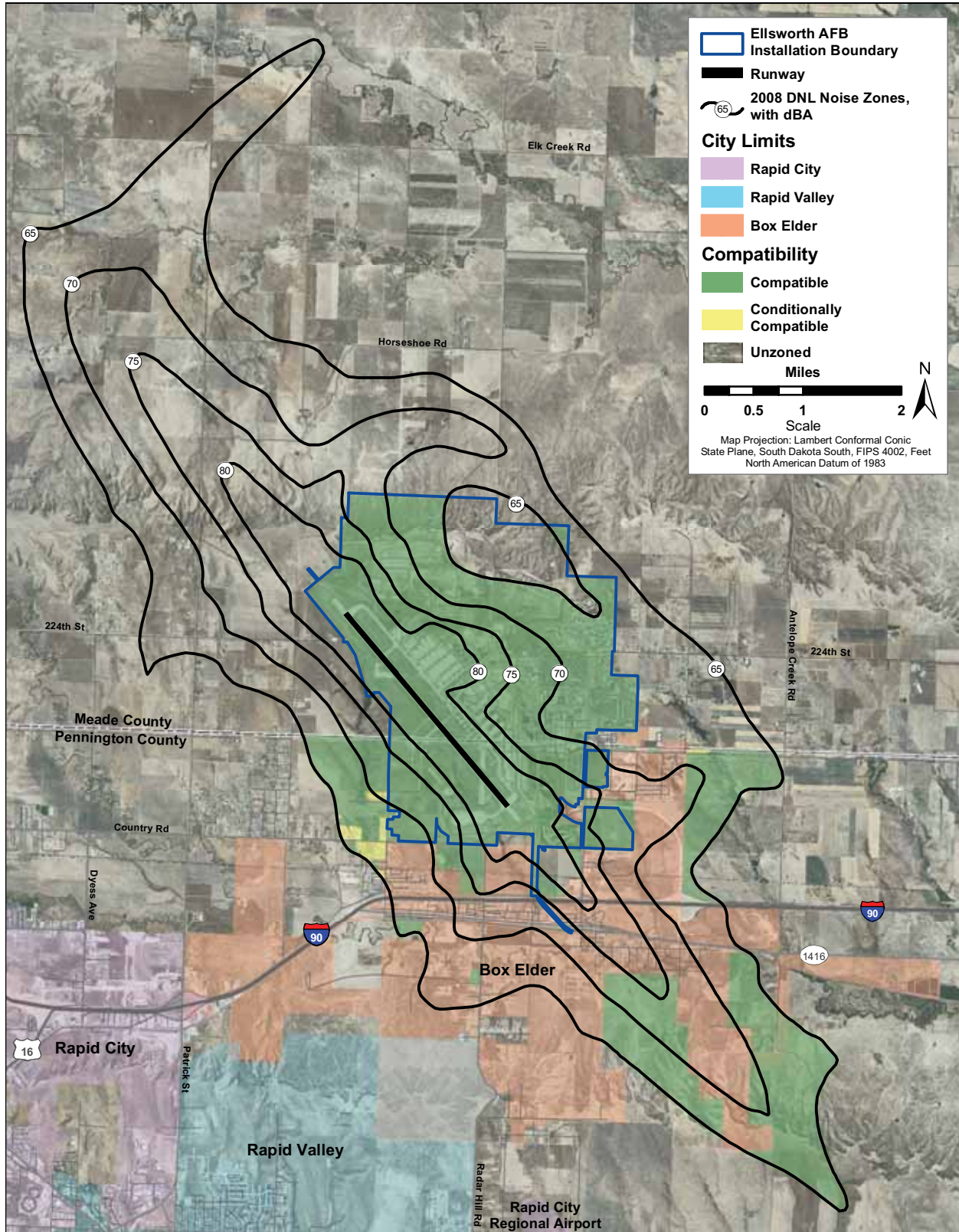
Zoning compatibility with Ellsworth AFB operations should be taken into consideration when the City of Box Elder, Rapid City, Pennington County, and Meade County make planning decisions. Since zoning designation determines the future land use of a parcel, land in the vicinity of Ellsworth AFB should be zoned in accordance with land use guidelines (as shown in **Table 3-1**) within the noise zones, CZs, and APZs.

The majority of the land surrounding Ellsworth AFB is unzoned; therefore, compatibility cannot be determined in these areas. Zoning data were obtained for Pennington County; however, data for the City of Box Elder and Meade County were not available at the time this study was completed. The area surrounding Ellsworth AFB should be zoned to ensure that future development will be compatible with the noise exposure levels and accident potential generated by the installation.

The majority of the land that is zoned in the Ellsworth AFB noise zones and APZs is zoned agricultural. Agricultural zoning is considered a compatible use in multiple noise zones and APZs. However, the land use can be different than the zoning designation. Some of the land that is zoned agricultural in the noise zones and APZs contains scattered residential land uses. See **Section 4.6** for an analysis of incompatible land uses in the Ellsworth AFB noise zones and APZs. Both zoning designations and existing land use should be considered when land use planning decisions are made.

4.9.1 Noise Zones

The compatibility status of existing zoning in the vicinity of Ellsworth AFB in relation to the 2008 noise zones is shown on **Figure 4-6**. This zoning compatibility was developed by taking the zoning categories presented in **Figure 4-2**, choosing the respective land use classifications from **Table 3-1**, and applying the recommended compatibility.



Source of Compatibility: eM, Inc 2008.

Figure 4-6. Zoning Compatibility in Relation to 2008 DNL Noise Zones



As shown in **Figure 4-6**, most of these areas to the south, southeast, and southwest of Ellsworth AFB are zoned agricultural. However, there are some parcels southwest of the installation that are zoned residential and are considered conditionally compatible. These parcels are present in the 65 to 74 dBA noise zones.

4.9.2 Accident Potential Zones

The same methodology as described in **Section 4.9.1** was applied to zoning compatibility within the Ellsworth AFB APZs. Since zoning is only available for Pennington County and not for the City of Box Elder, only a few parcels in the southern APZs could be analyzed for zoning compatibility.

As shown in **Figure 4-7**, the land in the southern APZs that is zoned is compatible with Ellsworth AFB operations. The property is zoned agricultural, which is compatible in APZ I and II. However, there are numerous parcels in the City of Box Elder in the southern CZ, APZ I, and APZ II that are unzoned. As shown on **Figure 4-3**, the North Ellsworth Corridor Overlay District includes property in the City of Box Elder within the southern CZ and the majority of the land within southern APZ I. As discussed in **Section 4.5.1**, the City of Box Elder implemented this overlay district in 2006 to restrict certain types of future developments or modifications to certain types of current land uses in this area. Some of the regulations include restrictions on permitted land uses, construction standards, and height obstructions. The North Ellsworth Corridor Overlay District regulations specify that within the CZ “all uses of land shall be prohibited, except those necessary for the continued operation of military and aircraft and agricultural use limited to grazing only” (City of Box Elder 2006). Therefore, the agricultural zoning present in the southern CZ is considered a compatible use.

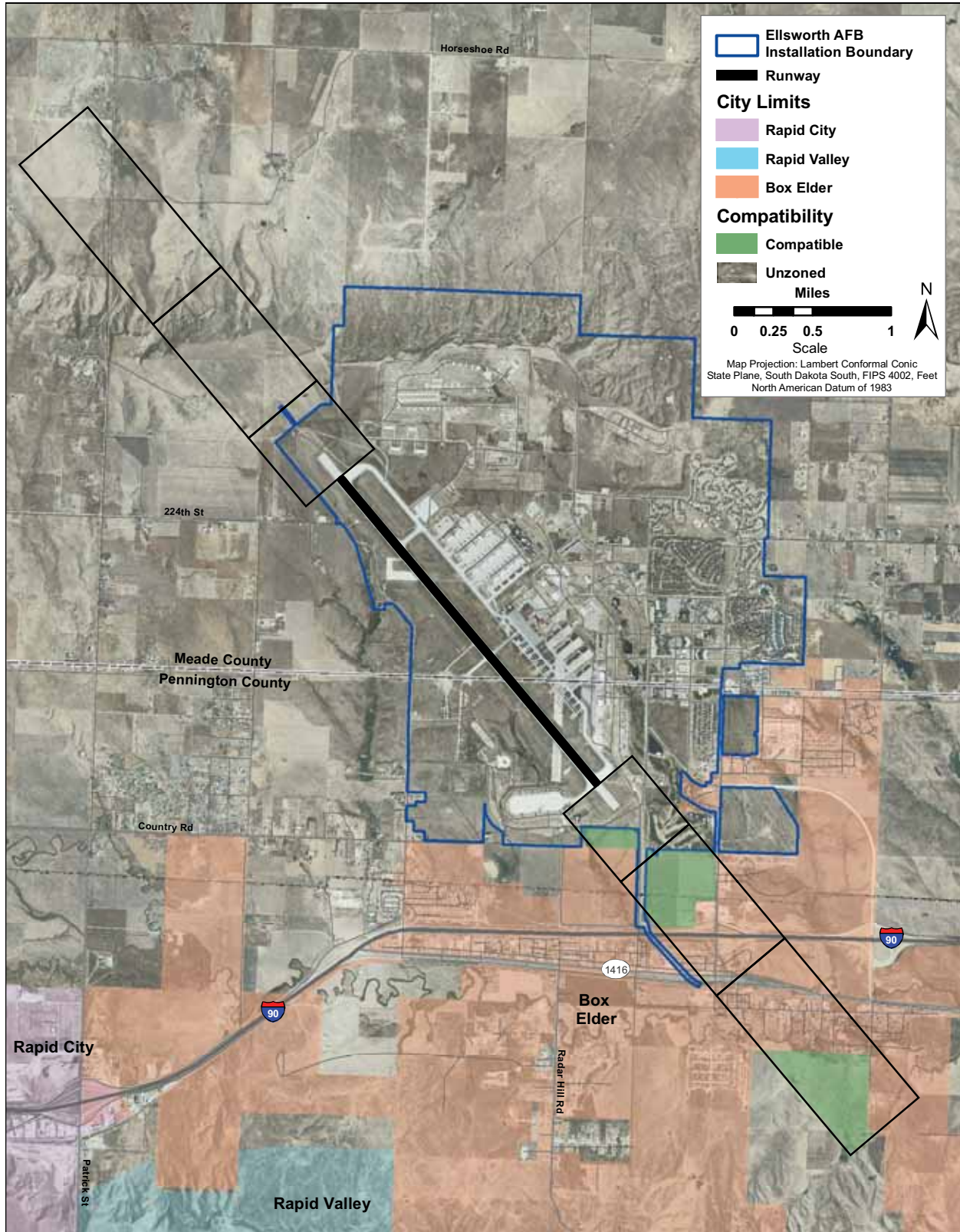
4.9.3 Overall Zoning Compatibility within the Noise Zones and APZs

Land that is zoned within the Ellsworth AFB 65 to 80+ dBA noise zones and APZs was evaluated to determine the combined zoning compatibility. The methodology that was used to determine the combined land use compatibility, discussed in **Section 4.6.3**, was also used to determine the combined zoning compatibility.

Figure 4-6 illustrates the zoning compatibility for land that is zoned within the Ellsworth AFB noise zones and **Figure 4-7** illustrates the zoning compatibility for zoned land within the APZs. All of the land that is zoned within both the noise zones and APZs is zoned for compatible uses with regards to noise exposure levels and accident potential.

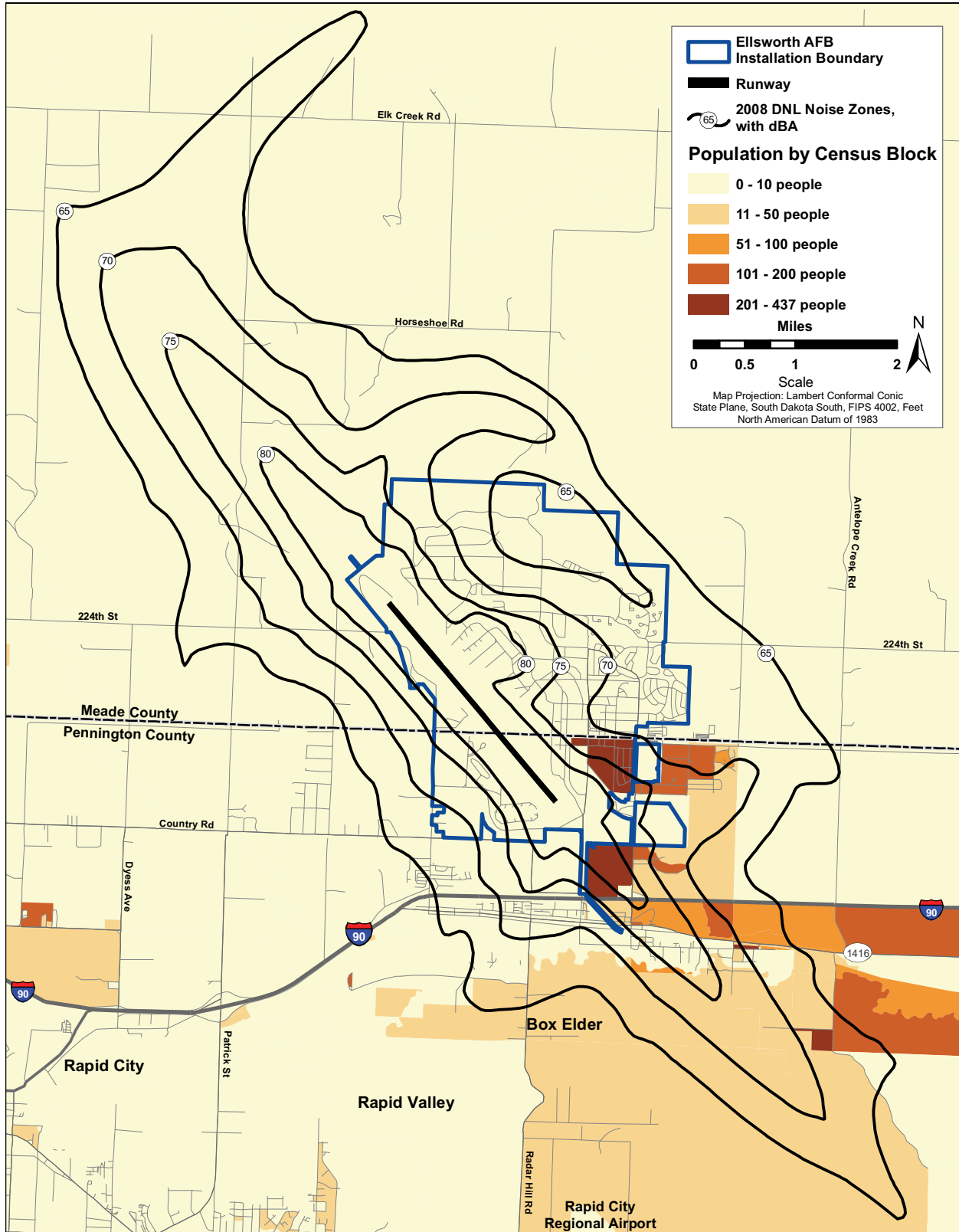
4.10 Population Densities

The number of people potentially affected by aircraft noise in proximity to Ellsworth AFB was estimated using U.S. Census block boundaries. **Figure 4-8** shows the population by census block in relation to the 2008 noise zones.



Source of Compatibility: eM, Inc 2008.

Figure 4-7. Zoning Compatibility in Relation to APZs



Source of Population: 2000 U.S. Census Bureau

Figure 4-8. Census Block Map with 2008 DNL Noise Zones



Table 4-4 shows the 2000 U.S. Census estimated population for each noise zone. The acreage percentage for the census blocks inside of each noise zone was estimated. This percentage was applied to the population of the census block to determine approximately how many people reside within the Ellsworth AFB AICUZ environs. As shown in **Table 4-4**, there are an estimated 3,905 people exposed to noise impacts from aircraft operations at Ellsworth AFB. Of this amount, there are an estimated 1,145 people in the 65 to 69 dBA noise zone, 1,379 in the 70 to 74 dBA noise zone, 1,115 in the 75 to 79 dBA noise zone, and 266 in the 80+ dBA noise zone. The majority (approximately 87 percent) of the population exposed to noise impacts from aircraft operations at Ellsworth AFB are outside the installation boundary in the City of Box Elder and Pennington and Meade counties.

**Table 4-4. Estimated Population Exposed to 2008 Noise Zones
Utilizing 2000 U.S. Census Population Data**

Noise Zone	Population within the Ellsworth AFB Boundary	Population Outside the Ellsworth AFB Boundary	Total
65–69 dBA	13	1,132	1,145
70–74 dBA	280	1,099	1,379
75–79 dBA	199	916	1,115
80+ dBA	5	261	266
Total	497	3,408	3,905

4.11 Planning Considerations

As shown on **Figure 3-1**, the number of acres in the noise zones has the capacity to change based on noise exposure levels from aircraft operations. Should a new mission be established at Ellsworth AFB, such as assigning additional aircraft or changing the model type, the number of acres impacted by noise levels above the specified threshold could increase. This possibility should be fully considered by local jurisdictions before making land use decisions. Zoning and land use regulations should not be based on noise zones alone since the noise levels fluctuate depending on current aircraft operations. Local jurisdictions should explore the idea of creating zoning ordinances dependent on natural boundaries instead of a particular noise zone. Land use and zoning suggestions that could be implemented are as follows:

- The municipalities surrounding the installation should provide timely notification to Ellsworth AFB regarding new development plans within the noise zones or APZs
- Unzoned areas encompassed by the noise zones and APZs for Ellsworth AFB should be zoned to ensure compatible development
- The zoning ordinances for the City of Box Elder and Pennington County should be modified to reflect the compatible land uses outlined in this AICUZ Study



- Meade County should refer to this AICUZ Study when establishing their zoning ordinances in order to ensure compatible development
- Provide for Real Estate disclosures in noise zones and APZs around Ellsworth AFB
- Subdivision regulations should provide for rejection of new subdivisions not compatible with AICUZ land use guidelines and provide controls for continued development in existing subdivisions
- Local municipalities should exercise caution when approving transportation plans, such as the scheduled 2011 bridge replacement on Spruce Street over Box Elder Creek (see **Section 4.8**), to ensure that such plans would not impact Ellsworth AFB's ability to fulfill its mission requirements.



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5. AICUZ STRATEGIES AND RESPONSIBILITIES

The AICUZ Program was developed to describe current air operations and, in some cases, possible future operations scenarios. This AICUZ Study provides the best source of information to ensure land use planning decisions made by the local municipalities are compatible with a future installation presence.

Implementation of the AICUZ Study must be a joint effort between the USAF and adjacent communities. The USAF's role is to minimize the noise impact of Ellsworth AFB operations on local communities. The role of the communities is to ensure the longevity of the installation's mission by incorporating the information presented in this AICUZ Study into local zoning regulations and building codes. The 1994 JLUS is an excellent example of a joint effort between the USAF and adjacent communities (see **Section 4.3.1** for more information on the JLUS). The JLUS program is a key example of how the USAF and local communities can form a partnership to implement the recommendations of this updated AICUZ Study.

5.1 Future Missions

The 2008 noise zones provided in this AICUZ Study describe the noise characteristics of a specific operational environment and can change if aircraft operations increase, decrease, or are modified. DOD recommends that this AICUZ Study be utilized with all other planning data in an effort to make informed land use planning decisions. Therefore, specific land use control decisions should not be based solely on the noise zone boundaries presented in this AICUZ Study. Should a new mission be established that adds a larger number of aircraft or different aircraft types at Ellsworth AFB, this AICUZ Study would likely need to be updated. **Section 3.2.3** offers the community an example of a potential operational increase.

A proactive program that considers "the way ahead" is always more successful than one based on a reactionary approach.

5.2 Land Use Controls

Three types of land use controls have been developed to minimize conflicts between military and civilian airfields and nearby communities: compatible zoning, building code modifications, and aviation easements. Community planning should be the foundation for these controls, and local planners and zoning commissions can employ these controls to protect an installation against further encroachment by incompatible development and future conflicts with aircraft activities. Ellsworth AFB is an important contributor to the adjacent communities' economic well-being and support from local communities is critical to the installation's continued operation.

5.2.1 Compatible Zoning

Proper zoning can facilitate compatible future land use development. Zoning can be used to regulate the intensity of development and ensure that the land uses of a community are properly situated in relation to each other, and zoning is the most commonly used legal device for implementing land use



plans. Community planning should be the foundation of formulating and enforcing zoning codes that are compatible with the installation's mission and activities. Zoning changes can support airport compatibility by directing new growth into compatible areas and thus prevent the future development of noise-sensitive land uses in noise-impacted areas. Noise-impacted areas that currently contain incompatible uses could be rezoned to more compatible categories, such as commercial or industrial.

The City of Box Elder has implemented a zoning ordinance called the North Ellsworth Corridor Overlay District, which creates a District in the southern CZ and the majority of the land in southern APZ I to promote sound land use planning and zoning practices and minimize risks to public safety from potential aircraft accidents (see **Section 4.5.1** for more information on the Overlay District). The Overlay District is an excellent example of a zoning ordinance that was designed to prevent encroachment of incompatible development into areas with high noise exposure levels and accident potential.

Due to the relative impermanence of zoning regulations, continuous monitoring is necessary to preclude the encroachment of incompatible development into undeveloped noise-impacted areas. Zoning that achieves compatibility will be subject to continued pressure for change. Appropriate zoning changes can increase the value of land within noise-affected areas, promote compatibility, and leave land in private ownership on the tax rolls for an economically productive community.

5.2.2 Building Code Modifications

Building codes can ensure that the structural requirements for a safe building are met. Local codes can address the noise levels to which the structures are subjected. The general objective is to achieve a maximum interior noise level of 45 dBA or lower. Codes can include acoustical treatment standards for new or modified noise-sensitive structures and sound-attenuating construction techniques. Building code modifications can also establish sound insulation standards, such as wall insulation values, double-pane windows, and roof insulation.

Local building codes can establish sound insulation standards.

Local jurisdictions are responsible for modifying community building codes or adopting a state building code that includes provisions for soundproofing structures impacted by aircraft noise. Provisions for building code modifications, to include sound insulation from exterior noise sources, require local legislation and enforcement by building inspectors. Additional sound insulation can slightly increase the cost of the construction but provide significant benefits.

Building codes, residential standards, and zoning within the Ellsworth AFB environs should be modified to address AICUZ development concerns with respect to the AICUZ Program and the noise zones presented in this AICUZ Study. The City of Box Elder requires new construction to comply with the 1997 edition of the Uniform Building Code as adopted by the City Council (City of Box Elder 2002). The North Ellsworth Corridor Overlay District



Ordinance #441 states that design and construction of public buildings, residences, and office areas achieve an interior DNL of 45 dBA in the Overlay District (City of Box Elder 2006). Adoption and strict enforcement of these ordinances by local governments can effectively limit incompatible land uses.

The 2005 U.S. Navy *Guidelines for Sound Insulation of Residences Exposed to Aircraft Operations* (U.S. Navy 2005) provides a comprehensive overview of sound insulation techniques for homeowners and builders who are concerned with modifying an existing residence or constructing a new residence that incorporates sound insulation principles. A typical home built with standard design and materials might provide 20 to 30 dBA of NLR from military aircraft noise exposure when the windows and doors are closed, if the home is in good condition. In contrast, an acoustically well-insulated home can provide 30 to 35 dBA of NLR. Providing more than 35 to 40 dBA of NLR is not usually practical for a residence. In either case, the noise levels will be higher inside a house when the windows are open (U.S. Navy 2005). Please see **Appendix E** for more information on these guidelines.

5.2.3 Aviation Easements

As part of the AICUZ Program, the USAF received Congressional authorization for property acquisition in the CZs. Real property interests are acquired by fee or easement giving the installation control over the use of the property. Compatible land use controls for the remaining airfield environs should be accomplished through the community land use planning processes. As discussed in **Section 3.3**, Ellsworth AFB either owns the property or has easements for all of the land within their CZs. In addition, Ellsworth AFB has property easements for the majority of the land within northern APZ I.

Ellsworth AFB has property easements for all of the land within their Clear Zones that are not within the installation boundary.

5.3 USAF Responsibilities

In general, the USAF perceives its AICUZ-related responsibilities as encompassing the areas of flying safety, noise abatement, and providing information to aid local governments implementing their land use planning processes.

Well-maintained aircraft and well-trained aircrews do much to ensure that aircraft accidents are avoided; however, history demonstrates that accidents do occur. In an effort to reduce the exposure of lives and minimize damage to property, overflights of populated areas are avoided whenever possible.

USAF regulations require commanders to periodically review existing air traffic patterns, instrument approaches, minimum weather conditions under which aircraft can use the airfield (e.g., visibility, ceiling), and operating practices, and to evaluate these factors in terms of their potential to affect populated areas and potentially increase surrounding incompatible land uses. In order to satisfy this requirement, all AICUZ studies must include an analysis of flying and flying-related activities designed to reduce and control the effects of such operations on surrounding land areas.



Ellsworth AFB is sensitive to community concerns regarding noise exposure. Flight tracks are normally routed to avoid the heavily populated area southeast of the installation.

The preparation and presentation of this Ellsworth AFB AICUZ Study is one example of the USAF providing information to assist local governments in implementing their planning process. It is recognized that as local communities update their land use plans, the USAF must be ready to provide additional inputs.

It is also recognized that the AICUZ Program will be an ongoing activity even after compatible development plans are adopted and implemented. Installation personnel are prepared to participate in the continuing discussion of zoning and other land use matters as they might affect, or be affected by, Ellsworth AFB. Installation personnel are available to provide information, criteria, and guidelines to state, regional, and local planning bodies; civic associations; and other similar groups.

5.4 Local Community Responsibilities

The residents of the City of Box Elder, Rapid City, and Pennington and Meade counties have a long history of working together with personnel from Ellsworth AFB. Adoption of the following recommendations during the revision of relevant land use planning or zoning regulations will strengthen this relationship, increase the health and safety of the public, and help protect the integrity of the installation's flying mission.

- Community planners from the City of Box Elder, Rapid City, and Pennington and Meade counties should consider the recommendations of this AICUZ Study when they are developing their land use plans and zoning regulations.
- Local governments should implement height and obstruction ordinances that reflect current USAF and 14 CFR Part 77 requirements.
- Enact fair disclosure ordinances to specify disclosure to the public for those AICUZ items that directly relate to aircraft operations at Ellsworth AFB.
- The regulations in the North Ellsworth Corridor Overlay District that can potentially minimize risks and noise exposure levels from aircraft operations at Ellsworth AFB should be expanded to include all of the property in Box Elder that is within the AICUZ environs.
- Local governments should formalize procedures regarding planning and zoning activities that have the potential to be incompatible with aircraft operations at Ellsworth AFB. These procedures could include the creation of a working group representing city planners, county commissioners, and Ellsworth AFB planners to meet at least quarterly to discuss AICUZ concerns and major development proposals that could affect Ellsworth AFB operations.



- Carefully review capital improvement programs to discourage incompatible land use patterns, with particular emphasis on utility extension planning.



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APPENDIX A

AICUZ CONCEPT, PROGRAM, METHODOLOGY, AND POLICIES

APPENDIX A

AICUZ CONCEPT, PROGRAM, METHODOLOGY, AND POLICIES

A.1 Concept

Federal legislation, national sentiment, and other external forces which directly affect the USAF mission have served to greatly increase the USAF's role in environmental and planning issues. Problems of airfield encroachment from incompatible land uses surrounding installations, as well as air and water pollution and socioeconomic impacts, require continued and intensified USAF involvement. The nature of these problems dictates direct USAF participation in comprehensive community and land use planning. Effective, coordinated planning that bridges the gap between the Federal government and the community requires the establishment of good working relationships with local citizens, local planning officials, and state and Federal officials. This planning depends on creating an atmosphere of mutual trust and helpfulness. The Air Installation Compatible Use Zone (AICUZ) concept has been developed in an effort to

- Protect local citizens from the noise exposure and accident potential associated with flying activities
- Prevent degradation of the USAF's capability to achieve its mission by promoting compatible land use planning.

The land use guidelines developed herein are a composite of a number of other land use compatibility studies that have been refined to fit the Ellsworth USAF Base aviation environment.

A.2 Program

Base Commanders establish and maintain active programs to achieve the maximum feasible land use compatibility between air installations and neighboring communities. The program requires that all appropriate governmental bodies and citizens be fully informed whenever AICUZ or other planning matters affecting the installation are under consideration. This includes positive and continuous programs designed to

- Provide information, criteria, and guidelines to Federal, state, regional, and local planning bodies, civic associations, and similar groups.
- Inform such groups of the requirements of the flying activity, noise exposure, aircraft accident potential, and AICUZ plans.
- Describe the noise reduction measures that are being used.
- Ensure that all reasonable, economical, and practical measures are taken to reduce or control the impact of noise-producing activities. These measures include proper location of engine test facilities, provision for sound suppressers where necessary, adjustment of flight tracks, and techniques to minimize the noise impact on populated areas. This must be done without jeopardizing safety or operational effectiveness.

A.3 Methodology

The AICUZ consists of land areas upon which certain land uses might obstruct the airspace or otherwise be hazardous to aircraft operations; and land areas which are exposed to the health, safety, or welfare hazards of aircraft operations. The AICUZ includes

- APZs and CZs based on past USAF aircraft accidents and installation operational data (**Appendix B**)
- Noise Zones produced by the computerized DNL metric (**Appendix C**)
- The area designated by the Federal Aviation Administration and the USAF for purposes of height limitations in the approach and departure zones of the base (**Appendix D**).

The APZs, CZs, and Noise Zones are the basic building blocks for land use planning with AICUZ data. Compatible land uses are specified for these zones, and recommendations on building materials and standards to reduce interior noise levels inside structures are provided in **Appendix E**.

As part of the AICUZ Program, the only real property acquisition for which the USAF has received congressional authorization and the base and Major Commands request appropriation are the areas designated as the CZ. Real property interests are acquired by fee or easement giving the base control over the use of the property. Fee land so acquired may be leased out for agricultural or grazing purposes. Compatible land use controls for the remaining airfield environs should be accomplished through the community land use planning processes.

A.4 AICUZ Land Use Development Policies

The basis for any effective land use control system is the development of, and subsequent adherence to, policies which serve as the standard by which all land use planning and control actions are evaluated. Ellsworth AFB recommends the following policies be considered for incorporation into the comprehensive plans of agencies in the vicinity of the base environs:

Policy 1. To promote the public health, safety, peace, comfort, convenience, and general welfare of the inhabitants of airfield environs, it is necessary to

- Guide, control, and regulate future growth and development
- Promote orderly and appropriate use of land
- Protect the character and stability of existing land uses
- Prevent the destruction or impairment of the airfield and the public investment therein
- Enhance the quality of living in the areas affected
- Protect the general economic welfare by restricting incompatible land use.

Policy 2. In furtherance of Policy 1, it is appropriate to

- Establish guidelines of land use compatibility
- Restrict or prohibit incompatible land use
- Prevent establishment of any land use which would unreasonably endanger aircraft operations and the continued use of the airfield

- Incorporate the AICUZ concept into community land use plans, modifying them when necessary
- Adopt appropriate ordinances to implement airfield environs land use plans.

Policy 3. Within the boundaries of the CZ, certain land uses are inherently incompatible. The following land uses are not in the public interest and must be restricted or prohibited:

- Uses that release into the air any substance, such as steam, dust, or smoke, which would impair visibility or otherwise interfere with the operation of aircraft
- Uses that produce light emissions, either direct or indirect (reflective), which would interfere with pilot vision
- Uses that produce electrical emissions which would interfere with aircraft communication systems or navigation equipment
- Uses that attract birds or waterfowl, such as operation of sanitary landfills, maintenance or feeding stations, or growth of certain vegetation
- Uses that provide for structures within 10 feet of aircraft approach-departure or transitional surfaces.

Policy 4. Certain noise levels of varying duration and frequency create hazards to both physical and mental health. A limited, though definite, danger to life exists in certain areas adjacent to airfields. Where these conditions are sufficiently severe, it is not consistent with public health, safety, and welfare to allow the following land uses:

- Residential
- Retail business
- Office buildings
- Public buildings (schools, churches, etc.)
- Recreation buildings and structures.

Policy 5. Land areas below takeoff and final approach flight paths are exposed to significant danger of aircraft accidents. The density of development and intensity of use must be limited in such areas.

Policy 6. Different land uses have different sensitivities to noise. Standards of land use acceptability should be adopted, based on these noise sensitivities. In addition, a system of Noise Level Reduction guidelines (**Appendix E**) for new construction should be implemented to permit certain uses where they would otherwise be prohibited.

Policy 7. Land use planning and zoning in the airfield environs cannot be based solely on aircraft-generated effects. Allocation of land used within the AICUZ should be further refined by consideration of

- Physiographic factors
- Climate and hydrology
- Vegetation
- Surface geology

- Soil characteristics
- Intrinsic land use potential and constraints
- Existing land use
- Land ownership patterns and values
- Economic and social demands
- Cost and availability of public utilities, transportation, and community facilities
- Other noise sources.

Each runway end at Ellsworth AFB has a 3,000 foot by 3,000 foot CZ and two APZs (**Appendix B**). Accident potential on or adjacent to the runway or within the CZ is so high that the necessary land use restrictions would prohibit reasonable economic use of land. As stated previously, it is USAF policy to request the U.S. Congress to authorize and appropriate funds for the necessary real property interests in this area to prevent incompatible land uses.

APZ I is less critical than the CZ, but still possesses a significant risk factor. This 3,000 foot by 5,000 foot area has land use compatibility guidelines which are sufficiently flexible to allow reasonable economic use of the land, such as industrial/manufacturing, transportation, communication/utilities, wholesale trade, open space, recreation, and agriculture. However, uses that concentrate people in small areas are not acceptable.

APZ II is less critical than APZ I, but still has potential for accidents. APZ II is 3,000 feet wide by 7,000 feet long extending to 15,000 feet from the runway threshold. Acceptable uses include those of APZ I, as well as low-density single family residential, and those personal and business services and commercial/retail trade uses of low-intensity or scale of operation. High-density functions such as multistory buildings, places of assembly (e.g., theaters, churches, schools, restaurants), and high-density office uses are not considered appropriate.

High people densities should be limited to the maximum extent possible. The optimum density recommended for residential usage (where it does not conflict with noise criteria) in APZ II is one dwelling per acre. For most nonresidential usage, buildings should be limited to one story and the lot coverage should not exceed 20 percent.

A.5 Basic Land Use Compatibility

Research on aircraft accident potential, noise, and land use compatibility is ongoing at a number of Federal and other agencies. These studies and all other compatibility guidelines must not be considered inflexible standards. They are the framework within which land use compatibility questions can be addressed and resolved. In each case, full consideration must be given to local conditions such as the following:

- Previous community experience with aircraft accidents and noise
- Local building construction and development practices
- Existing noise environment due to other urban or transportation noise sources
- Time period of aircraft operations and land use activities
- Specific site analysis
- Noise buffers, including topography.

These basic guidelines cannot resolve all land use compatibility questions, but they do offer a reasonable framework within which to work.

A.6 Accident Potential

Land use guidelines for the two APZs are based on a hazard index system which compares the relationship of accident occurrence for five areas:

- On or adjacent to the runway
- Within the CZ
- In APZ I
- In APZ II
- In all other areas within a 10 nautical mile radius of the runway.

Accident potential on or adjacent to the runway or within the CZ is so high that few uses are acceptable. The risk outside APZ I and APZ II, but within the 10 nautical mile radius area, is significant, but is acceptable if sound engineering and planning practices are followed.

Land use guidelines for APZs I and II have been developed. The main objective has been to restrict all people-intensive uses because there is greater risk in these areas. The basic guidelines aim at prevention of uses that

- Have high residential density characteristics
- Have high labor intensity
- Involve aboveground explosive, fire, toxic, corrosive, or other hazardous characteristics
- Promote population concentrations
- Involve utilities and services required for area wide population, such as telephone and gas, where disruption would have an adverse impact
- Concentrate people who are unable to respond to emergency situations, such as children, the elderly, and the handicapped
- Pose hazards to aircraft operations.

There is no question that these guidelines are relative. Ideally, there should be no people-intensive uses in either of these APZs. The free market and private property systems prevent this where there is land development demand. To go beyond these guidelines, however, substantially increases risk by placing more people in areas where there could ultimately be an aircraft accident.

A.7 Noise

Nearly all studies analyzing aircraft noise and residential compatibility recommend no residential uses in land areas associated with a DNL above 75 A-weighted decibels (dBA). Usually, no restrictions are recommended below 65 dBA. Between 65 to 74 dBA, there is currently no consensus or restrictions. These areas might not qualify for Federal mortgage insurance in residential categories according to U.S. Department of Housing and Urban Development (HUD) Regulation 24 Code of Federal Regulations (CFR) Section 51B. In many cases, HUD approval requires noise-attenuation measures, the Regional Administrator's concurrence, and an Environmental Impact Statement. The Department of Veterans

Affairs also has airfield noise and accident restrictions, which apply to their home loan guarantee program. USAF land use recommendations also state that, whenever possible, residential land use should be located on land with a noise level below a DNL of 65 dBA.

Most *industrial/manufacturing* uses are compatible in the airfield environs. Exceptions are uses such as research or scientific activities, which require lower noise levels. Noise-attenuation measures are recommended for portions of buildings devoted to office use, receiving the public, or where there is a requirement for low background noise levels.

Transportation, communications, and utility categories have higher noise level compatibility because they generally are not people-intensive. When people use land for these purposes, the use is generally very short in duration; however, when buildings are required for these uses, additional evaluation is warranted.

The *commercial/retail trade and personal and business services* categories are compatible without restriction up to a DNL of 70 dBA; however, they are generally incompatible above 80 dBA. Between 70 to 80 dBA, noise level reduction measures should be included in the design and construction of buildings.

The nature of most uses in the *public and quasi-public services* category requires a quieter environment, and attempts should be made to locate these uses in land areas below 65 dBA (i.e., a USAF land use recommendation), or else provide adequate noise level reduction.

Although *recreational* use has often been recommended as compatible with high noise levels, recent research has resulted in a more conservative view. Above 75 dBA, noise becomes a factor, which limits the ability to enjoy such uses. Where the requirement to hear is a function of the use (e.g., music shell), compatibility is limited. Buildings associated with golf courses and similar uses should be noise attenuated.

Forestry activities; livestock farming; and uses in the resources production, extraction, and open space categories are compatible almost without restrictions within all noise zones.

APPENDIX B

CLEAR ZONES AND ACCIDENT POTENTIAL ZONES

APPENDIX B

CLEAR ZONES AND ACCIDENT POTENTIAL ZONES

B.1 Guidelines for Accident Potential

Urban areas around airports are exposed to the possibility of aircraft accidents even with well-maintained aircraft and highly trained aircraft crews. Despite stringent maintenance requirements and countless hours of training, past history makes it clear that accidents are going to occur.

When the AICUZ Program began, there were no current comprehensive studies on accident potential. In support of the program, the USAF completed a study of USAF accidents that occurred between 1968 and 1972 within 10 nautical miles of airfields. The study of 369 accidents revealed that 75 percent of aircraft accidents occurred on or adjacent to the runway (1,000 feet to each side of the runway centerline) and in a corridor 3,000 feet wide (1,500 feet on either side of the runway centerline), extending from the runway threshold along the extended runway centerline for a distance of 15,000 feet.

Three zones were established based on crash patterns: The CZ, APZ I, and APZ II. The CZ starts at the end of the runway and extends outward 3,000 feet. It has the highest accident potential of the three zones. The USAF has adopted a policy of acquiring property rights to areas designated as CZs because of the high accident potential. APZ I extends from the CZ an additional 5,000 feet. It includes an area of reduced accident potential. APZ II extends from APZ I an additional 7,000 feet in an area of further reduced accident potential.

The USAF research work in accident potential was the first significant effort in this subject area since 1952 when the President's Airport Commission published *The Airport and Its Neighbors*, better known as the "Doolittle Report." The recommendations of this earlier report were influential in the formulation of the APZ concept.

The risk to people on the ground of being killed or injured by aircraft accidents is small. However, an aircraft accident is a high consequence event and when a crash does occur, the result is often catastrophic. Because of this, the USAF does not attempt to base its safety standards on accident probabilities. Instead the USAF approaches this safety issue from a land use planning perspective.

B.2 Accident Potential Analysis

Military aircraft accidents differ from commercial air carrier and general aviation accidents because of the variety of aircraft used, the type of missions, and the number of training flights. In 1973, the USAF performed an aircraft accident hazard study to identify land near airfields with significant accident potential. Accidents studied occurred within 10 nautical miles of airfields.

The study reviewed 369 major USAF accidents during 1968 – 1972, and found that 61 percent of the accidents related to landing operations and 39 percent related to takeoffs. It also found that 70 percent occurred in daylight, and that fighter and training aircraft accounted for 80 percent of the accidents.

Because the purpose of the study was to identify accident hazards, the study plotted each of the 369 accidents in relation to the airfield. This plotting found that the accidents clustered along the runway and its extended centerline. To further refine this clustering, a tabulation was prepared which described the cumulative frequency of accidents as a function of distance from the runway centerline along the

extended centerline. This analysis was done for widths of 2,000, 3,000, and 4,000 feet. **Table B-1** shows the results of the location analysis.

Table B-1. Location Analysis

Length From Both Ends of Runway (feet)	Width of Runway Extension (feet)		
	2,000	3,000	4,000
Percent of Accidents			
On or adjacent to runway (1,000 feet to each side of runway centerline)	23	23	23
0 to 3,000	35	39	39
3,000 to 8,000	8	8	8
8,000 to 15,000	5	5	7
Cumulative Percent of Accidents			
On or adjacent to runway (1,000 feet to each side of runway centerline)	23	23	23
0 to 3,000	58	62	62
3,000 to 8,000	66	70	70
8,000 to 15,000	71	75	77

Figure B-1 indicates that the cumulative number of accidents rises rapidly from the end of the runway to 3,000 feet, rises more gradually to 8,000 feet, then continues at about the same rate of increase to 15,000 feet, where it levels off rapidly. The location analysis also indicates that the optimum width of the safety zones, designed to include the maximum percentage of accidents in the smallest area, is 3,000 feet (see **Figures B-2** and **B-3**).

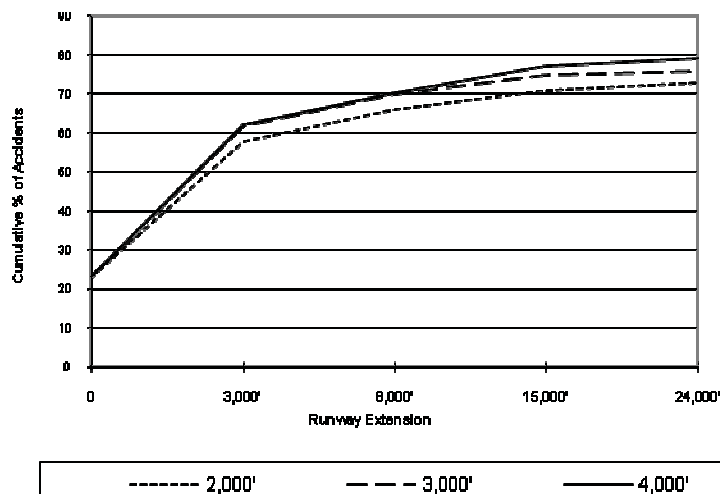


Figure B-1. Distribution of USAF Aircraft Accidents

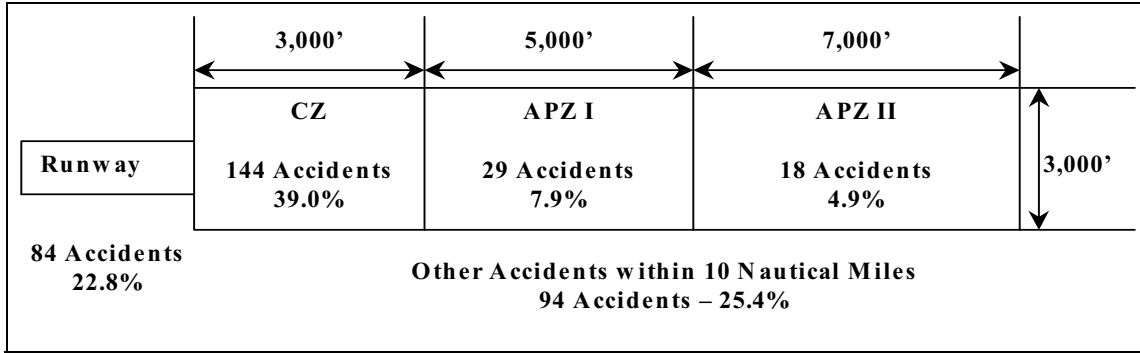


Figure B-2. USAF Accident Data (369 Accidents — 1968–1972)

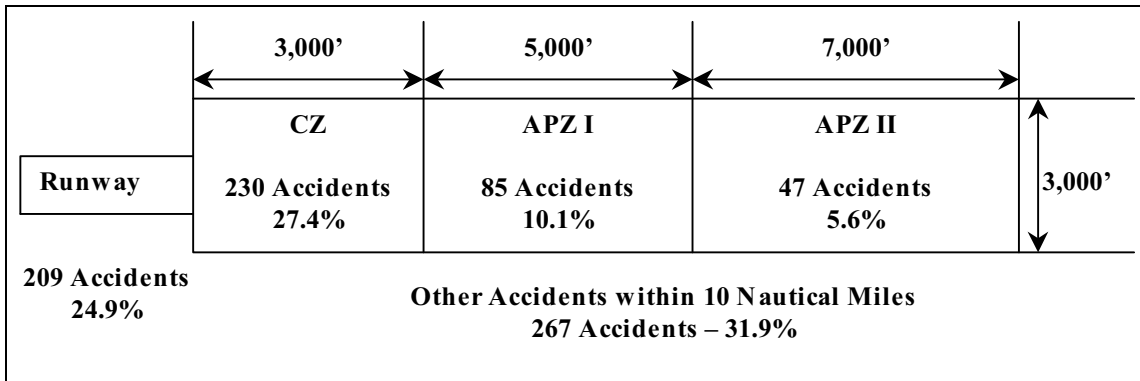


Figure B-3. USAF Accident Data (838 Accidents — 1968–1995)

The original study was updated to include accidents through September 1995. The updated study now includes 838 accidents during the 1968–1995 period. Using the optimum runway extension width of 3,000 feet, the accident statistics of the updated study are shown below.

Using the designated zones and accident data, it is possible to calculate a ratio of percentage of accidents to percentage of area size. These ratios indicate that the CZ, with the smallest area size and the highest number of accidents, has the highest ratio, followed by the runway and adjacent area, APZ I, and APZ II (see **Table B-2**).

B.3 Definable Debris Impact Areas

The USAF also determined which accidents had definable debris impact areas, and in what phase of flight the accident occurred. Overall, 75 percent of the accidents had definable debris impact areas, although they varied in size by type of accident. The USAF used weighted averages of impact areas, for accidents occurring only in the approach and departure phase, to determine the following average impact areas:

The USAF study used weighted averages of impact areas, for accidents occurring only in the approach and departure phase, to determine the following average impact areas:

- Overall Average Impact Area
- Fighter, Trainer, and Miscellaneous Aircraft
- Heavy Bomber and Tanker Aircraft.

Table B-2. Accident to Area Ratio

Ratio of Percentage of Accidents to Percentage of Area (USAF Accident Data 1968 – 1995)						
	Area (acres)¹	Number of Accidents²	Accidents per Acre	% Total Area	% Total Accidents	Ratio: Accidents to Area³
Runway Area ⁴	487	209	1 per 2.3	0.183	24.9	136.0
CZ	413	230	1 per 1.8	0.155	27.4	177.0
APZ I	689	85	1 per 8.1	0.258	10.1	39.0
APZ II	964	47	1 per 20.5	0.362	5.6	16.0
Other	264,053	267	1 per 989.0	99.042	31.9	0.3

Notes:

¹ Area includes land within 10 nautical miles of runway (266,606 acres).

² Total number of accidents is 838 (through 1995).

³ Percent total accidents divided by percent total area.

⁴ Runway dimension is 2,000' x 10,600'.

B.4 Findings

Designation of safety zones around the airfield and restriction of incompatible land uses can reduce the public's exposure to safety hazards.

USAF accident studies have found that aircraft accidents near USAF installations occurred in the following patterns:

- 61% were related to landing operations
- 39% were related to takeoff operations
- 70% occurred in daylight
- 80% were related to fighter and training aircraft operations
- 25% occurred on the runway or within an area extending 1,000 feet out from each side of the runway
- 27% occurred in an area extending from the end of the runway to 3,000 feet along the extended centerline and 3,000 feet wide, centered on the extended centerline
- 15% occurred in an area between 3,000 and 15,000 feet along the extended runway centerline and 3,000 feet wide, centered on the extended centerline.

USAF aircraft accident statistics found that 75% of aircraft accidents resulted in definable impact areas. The size of the impact areas were

- 5.1 acres overall average
- 2.7 acres for fighters and trainers
- 8.7 acres for heavy bombers and tankers.

APPENDIX C

DESCRIPTION OF THE NOISE ENVIRONMENT

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DESCRIPTION OF THE NOISE ENVIRONMENT

C.1 Noise Environment Descriptor

The noise zone methodology used herein is the DNL metric of describing the noise environment. Efforts to provide a national uniform standard for noise assessment have resulted in adoption by the U.S. Environmental Protection Agency of DNL as the standard noise descriptor. The USAF uses the DNL descriptor in assessing the amount of aircraft noise exposure, and as a metric for community response to the various levels of exposure. The DNL values used for planning purposes are 65, 70, 75, and 80 decibels (dB). Land use guidelines are based on the compatibility of various land uses with these noise exposure levels.

It is generally recognized that a noise environment descriptor should consider, in addition to the annoyance of a single event, the effect of repetition of such events and the time of day in which these events occur. DNL begins with a single event descriptor and adds corrections for the number of events and the time of day. Since the primary development concern is residential, nighttime events are considered more annoying than daytime events and are weighted accordingly. DNL values are computed from the single event noise descriptor, plus corrections for number of flights and time of day (**Figure C-1**).

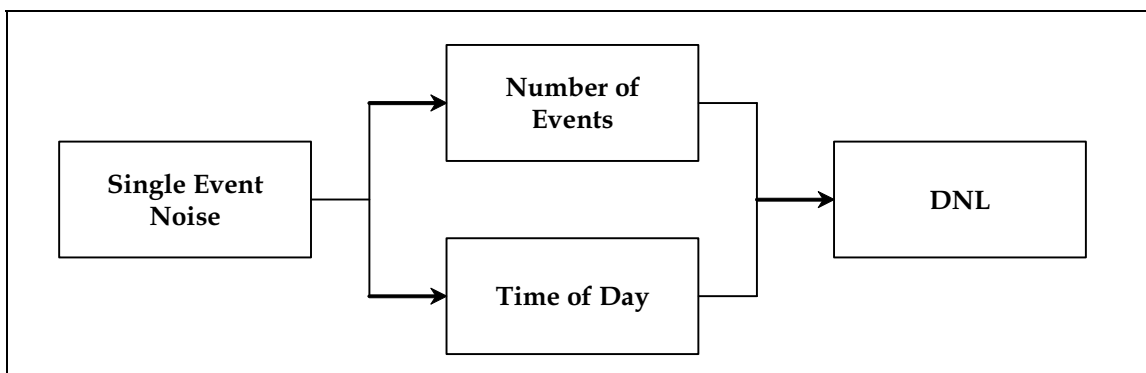


Figure C-1. Day-Night Average A-Weighted Sound Level

As part of the extensive data collection process, detailed information is gathered on the type of aircraft, and the number and time of day of flying operations for each flight track during a typical day. This information is used in conjunction with the single event noise descriptor to produce DNL values. These values are combined on an energy summation basis to provide single DNL values for the mix of aircraft operations at the base. Equal value points are connected to form the contour lines.

C.2 Noise Event Descriptor

The single event noise descriptor used in the DNL system is the Sound Exposure Level (SEL). The SEL measure is an integration of an A-weighted noise level over the period of a single event such, as an aircraft flyover, in dB.

Frequency, magnitude, and duration vary according to aircraft type, engine type, and power setting. Therefore, individual aircraft noise data are collected for various types of aircraft and engines at different

power settings and phases of flight. **Figure C-2** shows the relationship of the single event noise descriptor (SEL) to the source sound energy.

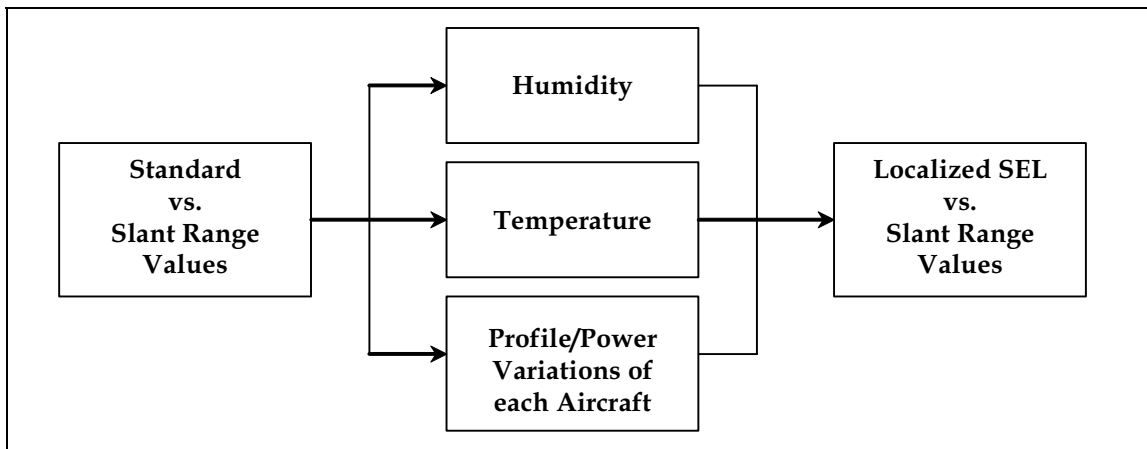


Figure C-2. Sound Exposure Level

SEL versus slant range values are derived from noise measurements made according to a source noise data acquisition plan developed by Bolt, Beranek, and Newman, Inc., in conjunction with and carried out by the USAF's Armstrong Laboratory. These standard day, sea level values form the basis for the individual event noise descriptors at any location and are adjusted to the location by applying appropriate corrections for temperature, humidity, and variations from standard profiles and power settings.

Ground-to-ground sound propagation characteristics are used for altitudes up to 500 feet absolute with linear transition between 500 and 700 feet and air-to-ground propagation characteristics above 700 feet.

In addition to the assessment of aircraft flight operations, the DNL system also incorporates noise resulting from engine and aircraft maintenance checks on the ground. Data concerning the orientation of the noise source, type of aircraft or engine, number of test runs on a typical day, power settings used and their duration, and use of suppression devices are collected for each ground runup or test position. This information is processed and the noise contribution added (on an energy summation basis) to the noise generated by flying operations to produce noise zones reflecting the overall noise environment with respect to aircraft air and ground operations.

C.4 Noise Zone Production

Data describing flight track distances and turns, altitudes, airspeeds, power settings, flight track operational utilization, maintenance locations, ground run-up engine power settings, and number and duration of runs by type of aircraft and engine are assembled by each individual Air Force Base (AFB). The data is screened by the Major Command (MAJCOM) and HQ AFCEE/ECC. Trained personnel process the data for input into a central computer. Flight track maps are generated for verification and approval by the base and MAJCOM. After any required changes have been incorporated, DNL contours are generated by the computer using the supplied data and standard source noise data corrected to local weather conditions. These contours are plotted and prepared for photographic reproduction. A set of these contours is provided in the body of the report.

C.5 Technical Information

Additional technical information on the DNL procedures is available in the following publications:

- *Community Noise Exposure Resulting from Aircraft Operations: Applications Guide for Predictive Procedure.* AMRL-TR-73-105, November, 1974, from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151.
- *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with Adequate Margin of Safety,* US EPA Report 550/9-74-004, March, 1974, from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.
- Adopted Noise Regulations for California Airports, Title 4, Register 70, No. 48-11-28-70, Subchapter 6, Noise Standards.

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APPENDIX D

HEIGHT OBSTRUCTION CRITERIA

APPENDIX D

HEIGHT OBSTRUCTION CRITERIA

D.1 Height Obstruction Criteria

General. This appendix establishes criteria for determining whether an object or structure is an obstruction to air navigation. Obstructions to air navigation are

- Natural objects or man-made structures that protrude above the planes or surfaces as defined in the following paragraphs
- Man-made objects that extend more than 500 feet above the ground at the site of the structure.

Explanation of Terms. The following will apply (see **Figure D-1**):

- *Controlling Elevation.* Whenever surfaces or planes within the obstructions criteria overlap, the controlling (or governing) elevation becomes that of the lowest surface or plane
- *Runway Length.* Ellsworth AFB has one runway, and 13,497 feet of pavement designed and built for sustained aircraft landings and takeoffs
- *Established Airfield Elevation.* The elevation, in feet above mean sea level, for Ellsworth AFB is approximately 3,280 feet
- *Dimensions.* All dimensions are measured horizontally unless otherwise noted.

For a more complete description of airspace and control surfaces for Class A and Class B runways, see Federal Aviation Regulation Part 77, Subpart C, or U.S. Air Force (USAF) Instruction 32-1026.

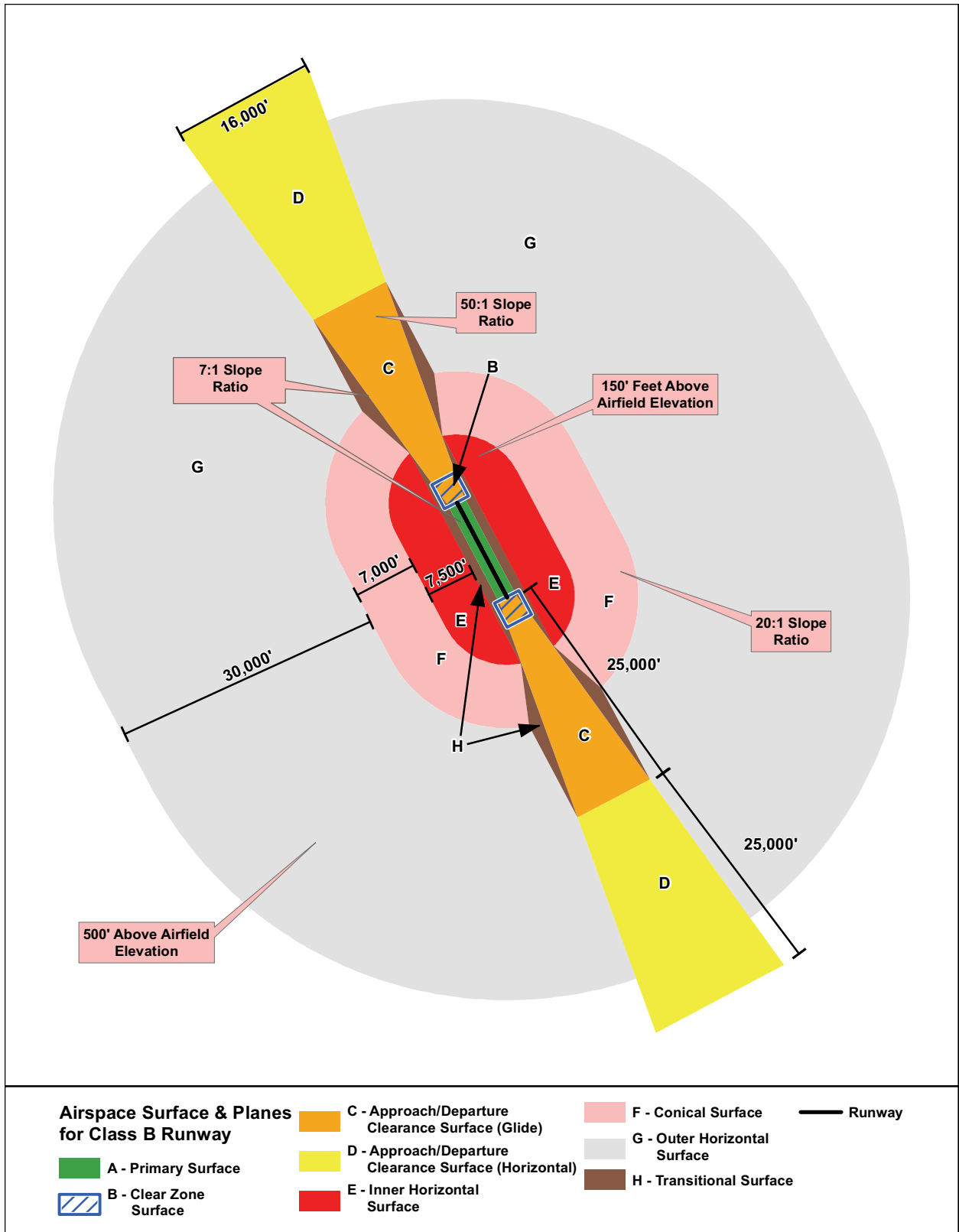
Planes and Surfaces. Definitions are as follows:

Primary Surface

- This surface defines the limits of the obstruction clearance requirements in the immediate vicinity of the landing area
- The primary surface comprises surfaces of the runway, runway shoulders, and lateral safety zones and extends 200 feet beyond the runway end
- The width of the primary surface for a single class "B" runway is 2,000 feet, or 1,000 feet on each side of the runway centerline.

Clear Zone Surface

- This surface defines the limits of the obstruction clearance requirements in the vicinity contiguous to the end of the primary surface
- The clear zone surface is located on the ground or water at each end of the primary surface, with a length of 1,000 feet and the same width as the primary surface.



Source of Airspace & Planes: Federal Aviation Administration Regulation Part 77, Subpart C.

Figure D -1. Airspace Control Surface Plan

Approach-Departure Clearance Surface

- This surface is symmetrical around the runway centerline extended, begins as an inclined plane (glide angle) 200 feet beyond each end of the primary surface of the centerline elevation of the runway end, and extends for 50,000 feet
- The slope of the approach-departure clearance surface is 50:1 along the extended runway (glide angle) centerline until it reaches an elevation of 500 feet above the established airfield elevation
- It then continues horizontally at this elevation to a point 50,000 feet from the start of the glide angle
- The width of this surface at the runway end is 2,000 feet; it flares uniformly, and the width at 50,000 feet is 16,000 feet.

Inner Horizontal Surface

- This surface is a plane, oval in shape at a height of 150 feet above the established airfield elevation
- It is constructed by scribing an arc with a radius of 7,500 feet above the centerline at the end of the runway and interconnecting these arcs with tangents.

Conical Surface

- This is an inclined surface extending outward and upward from the outer periphery of the inner horizontal surface for a horizontal distance of 7,000 feet to a height of 500 feet above the established airfield elevation
- The slope of the conical surface is 20:1.

Outer Horizontal Surface

- This surface is a plane 500 feet above the established airfield elevation
- It extends for a horizontal distance of 30,000 feet from the outer periphery of the conical surface.

Transitional Surfaces

- These surfaces connect the primary surfaces, CZ surfaces, and approach-departure clearance surfaces to the outer horizontal surface, conical surface, other horizontal surface, or other transitional surfaces
- The slope of the transitional surface is 7:1 outward and upward at right angles to the runway centerline
- To determine the elevation for the beginning of the transitional surface slope at any point along the lateral boundary of the primary surface, including the CZ, draw a line from this point to the runway centerline
- This line will be at right angles to the runway axis
- The elevation at the runway centerline is the elevation for the beginning of the 7:1 slope.

The land areas outlined by these criteria should be regulated to prevent uses which might otherwise be hazardous to aircraft operations. The following uses should be restricted or prohibited:

- Uses which release into the air any substance which would impair visibility or otherwise interfere with the operation of aircraft (e.g., steam, dust, or smoke)
- Which used produces light emissions, either direct or indirect (reflective), which would interfere with pilot vision
- Uses which produce electrical emissions which would interfere with aircraft communications systems or navigational equipment
- Uses which would attract birds or waterfowl, including operation of sanitary landfills, maintenance of feeding stations, or the growing of certain vegetation
- Uses that provide for structures within 10 feet of aircraft approach-departure or transitional surfaces.

D.2 Height Restrictions

City/county agencies involved with approvals of permits for construction should require developers to submit calculations which show that projects meet the height restriction criteria of Federal Aviation Administration Part 77 as described, in part, by the information contained in this appendix.

APPENDIX E

**GUIDELINES FOR SOUND INSULATION OF RESIDENCES
EXPOSED TO AIRCRAFT OPERATIONS (APPENDIX D ONLY)**



April 2005

Guidelines for Sound Insulation of Residences Exposed to Aircraft Operations

Prepared for
Department of the Navy
Naval Facilities Engineering Command
Washington Navy Yard
1322 Patterson Avenue, S.W.
Suite 1000
Washington, DC 20374-5065

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Appendix D

Model Building Code

Noise Level Reduction Design Requirements

Appendix D:
Model Building Code
Noise Level Reduction Design Requirements

SECTION 1: PURPOSE

Exterior noise may be isolated and reduced in homes through construction techniques that selectively increase the sound insulating quality of the exterior of occupied structures. The noise level reduction values specified are 20, 25, 30, and 35 dB.

SECTION 2: GENERAL REQUIREMENTS

- A. The Noise Level Reduction (NLR) requirements specified herein may be achieved by any suitable combination of building designs, choices of building materials, and execution of construction details in accordance with established architectural and acoustical principles. The NLR requirements should be applied to all occupied rooms having one or more exterior walls or exterior ceiling. A room without any exterior walls, and which has an occupied space above its entire area, will not be subject to these requirements.
- B. Compliance with the construction standards herein is sufficient to comply with the NLR requirements specified in the various noise zones. These standards are applicable to plans and specifications for any proposed residence. A variety of assumptions were necessary to develop these standards. If the plans and specifications do not indicate compliance with the construction standards herein, the applicant shall provide a written statement from a qualified acoustical consultant certifying that the construction of the building as indicated in the plans and specifications will result in a NLR for appropriate occupied rooms at least as great as the specified NLR requirement.
- C. An “exterior” door or window opens to the exterior or to a partially enclosed space such as a screened-in porch. In this standard whenever the words “doors” or “windows” are used it shall be assumed that the standard provision applies only to exterior doors and exterior windows, unless the word “interior” is specifically used for that provision.
- D. Sound Transmission Class (STC) ratings for windows and doors are valid only if they are determined by laboratory (not field) tests performed by an independent laboratory for the product. A rating estimated for glass alone is not an acceptable substitute for STC tests of windows or doors, except for determining the rating of sidelights and transoms. Likewise, ratings estimated for door leafs alone are not an acceptable substitute for STC ratings of doors. The installed products must have the same composition and overall configuration such as storm panels, glass type (laminated, tempered, or float glass), glass thickness, spacing between panes of insulated glass, door core, gaskets, weatherstripping, door bottom seals, thresholds, etc., and the same overall configuration as the tested assembly. The overall configuration includes the operational type (casement, double hung, fixed, slider, etc.) in the case of windows, and the general size of glazing (1/8-, 1/4-, 1/2-, or full-view) in the case of doors. Issues that do not affect the acoustical performance such as glass

obscuration, internal window muntins, door and window hardware, screens, and applied door moldings can be neglected.

- E. Door sidelights and door and window transoms shall be considered “windows” and shall meet the provisions for windows. For these products it is acceptable to reference the laboratory STC rating of the glass alone. However, for the adjacent windows and doors it is still necessary to reference STC tests for the entire assembly, not just the glass or door leaf.
- F. For this standard it can be assumed that the rating of a prime-and-storm window combination is STC 36 provided the rating of the *storm* window alone is at least STC 29 and the airspace between the prime and storm window is at least 1-3/4” for all sashes.
- G. For this standard it can be assumed that the rating of a prime-and-storm door combination is STC 37 provided the rating of the *storm* door alone is at least STC 30 and the airspace between the prime and storm door is at least 2”.
- H. In order to achieve the STC ratings specified herein special measures are necessary to install doors and windows. These include the use of non-hardening (acoustical) caulk at all hidden surfaces, flexible caulk at all exposed surfaces, and solid continuous blocking to fill all voids over 1/4” around windows and doors.
- I. The phrase “Total Exterior Wall Area” as used in this standard includes the exterior wall area of the room as well as the area of all windows and doors contained within the exterior walls.
- J. The phrase “Roof” as used in this standard shall refer to a ceiling attached to the bottom edge of roof structural members that are at least 14” deep (the depth is the clear distance between the ceiling gypsumboard and the roof deck) for the portion of the structural member over a living space. The use of shallower roof framing is not allowed without a written statement from a qualified acoustical consultant (see section B above). The best acoustical performance is achieved when there are horizontal ceilings, an accessible attic space above, and a sloped roof.
- K. The phrase “Exposed Floor” in this standard shall refer to the floor of a house elevated above the ground without the use of a crawl space. This includes primarily beach houses on pylons.
- L. It is difficult to predict the acoustical performance of open plan spaces. Adjacent habitable spaces that are fully open to each other shall be grouped and treated as one room. When the rooms are only partially open to each other, group them if the partitions separating the rooms are more than 30% open.
- M. The number of exterior walls is a parameter that affects the acoustical performance of the room. If the exterior wall is over 12 feet tall it shall count as two exterior walls. Partial walls count as one exterior wall.

- N. The phrase “wood-framed walls” refers to any walls that do not have brick veneer, concrete blocks, or poured concrete.

SECTION 3: BUILDING REQUIREMENTS FOR A MINIMUM NLR OF 20 dB

A. Exterior Walls

1. The interior surface of exterior walls shall be gypsum board at least 1/2 inch thick, or an alternative material of equal surface mass.
2. For wood-framed walls: Fiberglass, mineral fiber, or cellulose batt or blanket insulation shall be installed continuously and completely throughout the stud cavity. Batts or blankets should be held firmly in place between the studs, with fasteners if necessary, to prevent sagging; however, packing the insulation such that it is compressed may *slightly reduce* its acoustical (and thermal) performance.
3. Insulated concrete form (ICF) or masonry walls, where present, shall contain at least 4” thick normal weight concrete or masonry throughout the surface of the wall.

B. Windows

1. For rooms that have at least one wood-framed exterior wall: Windows shall have a laboratory sound transmission class rating of at least STC 28.
2. For rooms that have all ICF exterior walls: If the exterior windows and doors together comprise 75% or more of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 28.

C. Doors

1. Exterior doors, and interior doors between occupied spaces and attached garages, unfinished attics, and other non-habitable spaces with an exterior wall or ceiling, shall be fully weatherstripped.

D. Roof-Ceiling Assembly

1. Gypsum board ceilings at least 1/2 inch thick shall be provided at top floor. Ceilings at top floor shall be substantially airtight with a minimum number of penetrations.
2. Fiberglass, mineral fiber, or cellulose insulation shall be installed continuously and completely throughout the ceiling joist cavity to a depth of at least 10 inches. Batt or blanket insulation shall be used at sloped ceilings.

3. Roof framing members shall be at least 14" deep for their entire span.
4. Attic access panels shall be constructed of 3/4" thick plywood and shall have continuous neoprene perimeter bulb seals. Pull-down attic stairs shall have moveable or operable covers constructed of 3/4" thick plywood and shall have continuous neoprene perimeter bulb seals.
5. Skylights shall not be provided.

E. Floors, Foundations and Basements

1. For houses elevated on pylons: Use plywood or OSB at least 1/2" thick at the underside of the floor joists with at least 10" thick fiberglass, mineral fiber, or cellulose insulation.
2. If crawl spaces do not have masonry walls, a massive barrier panel must be used as a skirt connecting the bottom of the walls to the ground. 2" thick precast concrete panels are ideal barrier skirts. Alternatively, 2x4 pressure-treated wood studs with 3/4" pressure-treated plywood on each side may be used, as long as the joints between the plywood are covered with batten strips. In flood zones use double-swing plywood flood gates in lieu of vents to the extent allowable by code.

F. Ventilation and Wall Penetrations

1. In-window, through-wall, or through-floor air-conditioning, ventilating, or heating units shall not be used.
2. Through-the-wall/door mailboxes or mail slots shall not be used.
3. A mechanical ventilation system shall be installed that will provide the minimum air circulation and fresh air supply requirements for various uses in occupied rooms, as specified in the North Carolina state building code, without the need to open any windows, doors, or other openings to the exterior.
4. Gravity vent openings in attics shall not exceed the code minimum in number and size.
5. If an attic fan is used for forced ventilation, the attic inlet and discharge openings shall be fitted with sheet metal transfer ducts of at least 20 gauge steel at least 5 feet long with at least one 90° bend.
6. All vent ducts, including those for bathroom exhaust fans and dryers, connecting the interior space to the outdoors shall be rigid metal and contain at least two 90° bends, or one 90° bend and a total length of at least 20 feet (or the maximum length allowed by the dryer manufacturer).
7. Vented domestic range fans shall be not used.

8. Vented wood stoves shall not be used. Where vented fireplaces or vented gas-powered prefabricated units are used provide acoustical chimney top dampers and use tight-fitting 1/4" tempered glass fireplace doors.
9. Vented fuel-burning appliances (e.g., gas dryers, gas fireplaces, oil or gas furnaces, and gas water heaters) shall not be located in habitable spaces (e.g, kitchens, living rooms, bedrooms, etc.). Vent ducts for fuel-burning appliances in non-habitable spaces (e.g., closets and attics) shall have double-wall sheet metal construction.
10. Whole-house fans shall not be provided.
11. All ducts in attics shall be rigid metal.
12. Dryers shall be located in closets or other non-habitable spaces. Dryer ducts shall be rigid metal.

SECTION 4: BUILDING REQUIREMENTS FOR A MINIMUM NLR OF 25 dB

A. Exterior walls

1. The interior surface of exterior walls shall be gypsum board at least 1/2 inch thick, or an alternative material of equal surface mass.
2. For wood-framed walls: Fiberglass, mineral fiber, or cellulose batt or blanket insulation shall be installed continuously and completely throughout the stud cavity. Batts or blankets should be held firmly in place between the studs, with fasteners if necessary, to prevent sagging; however, packing the insulation such that it is compressed may slightly reduce its acoustical (and thermal) performance.
3. Insulated concrete form (ICF) or masonry walls, where present, shall contain at least 4" thick normal weight concrete or masonry throughout the surface of the wall.

B. Windows

1. For rooms with at least one wood-framed wall:
 - a. If there is only one exterior wall:
 - i. If the exterior windows and doors together comprise less than 25% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 26.
 - ii. If the exterior windows and doors together comprise 25-40% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 28.

- iii. If the exterior windows and doors together comprise more than 40% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 30.
 - b. If there are two or more exterior walls:
 - i. If the exterior windows and doors together comprise less than 20% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 28.
 - ii. If the exterior windows and doors together comprise 20-35% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 30.
 - iii. If the exterior windows and doors together comprise more than 35% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 32.
2. For rooms with all ICF walls:
- a. If there is only one exterior wall:
 - i. If the exterior windows and doors together comprise less than 40% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 26.
 - ii. If the exterior windows and doors together comprise 40% or more of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 30.
 - b. If there are two or more exterior walls:
 - i. If the exterior windows and doors together comprise less than 20% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 26.
 - ii. If the exterior windows and doors together comprise 20-30% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 28.
 - iii. If the exterior windows and doors together comprise 30-75% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 30.
 - iv. If the exterior windows and doors together comprise more than 75% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 32.

C. Doors

1. For rooms with at least one wood-framed wall:
 - a. If there is only one exterior wall: If exterior windows and doors together comprise more than 40% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 29.
 - b. If there are more than one exterior wall: If exterior windows and doors together comprise 20% or more of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 29.
2. For rooms with all ICF walls:
 - a. If there is only one exterior wall and the exterior windows and doors together comprise 40% or more of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 29.
 - b. If there are more than one exterior wall and the exterior windows and doors together comprise 30% or more of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 29.
3. Interior doors between occupied spaces and attached garages, unfinished attics, or other non-habitable spaces with an exterior wall or ceiling shall have a laboratory sound transmission class rating of at least STC 23.

D. Roof-Ceiling Assembly

1. Gypsum board ceilings at least 1/2 inch thick shall be provided at top floor. Ceilings at top floor shall be substantially airtight with a minimum number of penetrations. Where recessed lights are used in top-floor ceilings provide a gypsum board enclosure around the lighting fixture and seal the gypsum board joints with caulk or joint compound.
2. Fiberglass, mineral fiber, or cellulose insulation shall be installed continuously and completely throughout the ceiling joist cavity to a depth of at least 10 inches. Batt or blanket insulation shall be used at sloped ceilings.
3. Roof framing members shall be at least 14" deep for their entire span.
4. Attic access panels shall be constructed of 3/4" thick plywood and shall have continuous neoprene perimeter bulb seals. Pull-down attic stairs shall have moveable or operable covers constructed of 3/4" thick plywood and shall have continuous neoprene perimeter bulb seals.

5. Skylights shall not be provided.

E. Floors and Foundations

1. For houses elevated on pylons: Use plywood or OSB at least 1/2" thick at the underside of the floor joists with at least 10" thick fiberglass, mineral fiber, or cellulose insulation.
2. If crawl spaces do not have masonry walls, a massive barrier panel must be used as a skirt connecting the bottom of the walls to the ground. 2" thick precast concrete panels are ideal barrier skirts. Alternatively, 2x4 pressure-treated wood studs with 3/4" pressure-treated plywood on each side may be used, as long as the joints between the plywood are covered with batten strips. In flood zones use double-swing plywood flood gates in lieu of vents to the extent allowable by code.

F. Ventilation and Wall and Roof Penetrations

1. In-window, through-wall, or through-floor air-conditioning, ventilating, or heating units shall not be used.
2. Through-the-wall/door mailboxes or mail slots shall not be used.
3. A mechanical ventilation system shall be installed that will provide the minimum air circulation and fresh air supply requirements for various uses in occupied rooms, as specified in the North Carolina state building code, without the need to open any windows, doors, or other openings to the exterior.
4. Gravity vent openings in attics shall not exceed the code minimum in number and size.
5. If an attic fan is used for forced ventilation, the attic inlet and discharge openings shall be fitted with sheet metal transfer ducts of at least 20 gauge steel at least 5 feet long with at least one 90° bend.
6. All vent ducts, including those for bathroom exhaust fans and dryers, connecting the interior space to the outdoors shall be rigid metal and contain at least two 90° bends, or one 90° bend and a total length of at least 20 feet (or the maximum length allowed by the dryer manufacturer).
7. Vented domestic range fans shall be not used.
8. Vented wood stoves shall not be used. Where vented fireplaces or vented gas-powered prefabricated units are used provide acoustical chimney top dampers and use tight-fitting 1/4" tempered glass fireplace doors.

9. Vented fuel-burning appliances (e.g., gas dryers, gas fireplaces, oil or gas furnaces, and gas water heaters) shall not be located in habitable spaces (e.g., kitchens, living rooms, bedrooms, etc.). Vent ducts for fuel-burning appliances in non-habitable spaces (e.g., closets and attics) shall have double-wall sheet metal construction.
10. Whole-house fans shall not be provided.
11. All ducts in attics shall be rigid metal.
12. Dryers shall be located in closets or other non-habitable spaces. Dryer ducts shall be rigid metal.

SECTION 5: BUILDING REQUIREMENTS FOR A MINIMUM NLR OF 30 dB**A. Exterior Walls**

1. The interior surface of exterior walls shall be gypsum board at least 1/2 inch thick, or an alternative material of equal surface mass.
2. For wood-framed walls:
 - a. Fiberglass, mineral fiber, or cellulose batt or blanket insulation shall be installed continuously and completely throughout the stud cavity. Batts or blankets should be held firmly in place between the studs, with fasteners if necessary, to prevent sagging; however, packing the insulation such that it is compressed may slightly reduce its acoustical (and thermal) performance.
 - b. If there is one only one exterior wall: If exterior windows and doors together comprise 30% or more of the Total Exterior Wall Area, single-leaf resilient channels shall be used between the studs and gypsum board.
 - c. If there are two or more exterior walls single-leaf resilient channels shall be used between the studs and gypsum board.
3. Insulated concrete form (ICF) or masonry walls, where present, shall contain at least 4" thick normal weight concrete or masonry throughout the surface of the wall.

B. Windows

1. For rooms with at least one wood-framed wall:
 - a. If there is only one exterior wall:
 - i. If the exterior windows and doors together comprise less than 20% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 32.
 - ii. If the exterior windows and doors together comprise 20-30% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 34.
 - iii. if the exterior windows and doors together comprise 30-50% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 32.
 - iv. if the exterior windows and doors together comprise more than 50% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 34.

- b. If there are two exterior walls: The windows shall have a laboratory sound transmission class rating of at least STC 34.
 - c. If there are three or more exterior walls:
 - i. If the exterior windows and doors together comprise 70% or less of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 34.
 - ii. If the exterior windows and doors together comprise more than 70% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 36.
2. For rooms with all ICF walls:
- a. If there is only one exterior wall:
 - i. If the exterior windows and doors together comprise less than 20% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 30.
 - ii. If the exterior windows and doors together comprise 20 to 50% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 32.
 - iii. If the exterior windows and doors together comprise more than 50% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 34.
 - b. If there are two exterior walls: The windows shall have a laboratory sound transmission class rating of at least STC 34.
 - c. If there are three or more exterior walls:
 - i. If the exterior windows and doors together comprise 70% or less of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 34.
 - ii. If the exterior windows and doors together comprise more than 70% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 36.

C. Doors

- 1. For rooms with at least one wood-framed wall:
 - a. If there is only one exterior wall:
 - i. If the exterior windows and doors together comprise less than 20% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 31.

- ii. If the exterior windows and doors together comprise 20-30% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 34.
 - iii. If the exterior windows and doors together comprise 30-50% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 31.
 - iv. If the exterior windows and doors together comprise more than 50% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 34.
- b. If there are two exterior walls:
- i. If the exterior windows and doors together comprise less than 20% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 31.
 - ii. If the exterior windows and doors together comprise 20% or more of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 34.
- c. If there are three or more exterior walls:
- i. If the exterior windows and doors together comprise less than 20% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 31.
 - ii. If the exterior windows and doors together comprise 20% or more of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 34.
2. For rooms with all ICF walls:
- a. If there is only one exterior wall:
- i. If the exterior windows and doors together comprise less than 20% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 29.
 - ii. If the exterior windows and doors together comprise 20 to 50% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 31.
 - iii. If the exterior windows and doors together comprise more than 50% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 34.
- b. If there are two exterior walls:
- i. If the exterior windows and doors together comprise less than 20% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 31.
 - ii. If the exterior windows and doors together comprise 20% or more of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 34.

- c. If there are three or more exterior walls:
 - i. If the exterior windows and doors together comprise less than 20% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 31.
 - ii. If the exterior windows and doors together comprise 20% or more of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 34.
3. Interior doors between occupied spaces and attached garages, unfinished attics, or other non-habitable spaces with an exterior wall or ceiling shall have a laboratory sound transmission class rating of at least STC 29.

D. Roof-Ceiling Assembly

1. Ceilings consisting of at least two layers of at least 1/2-inch thick gypsum board shall be provided at top floor. Ceilings at top floor shall be substantially airtight with a minimum number of penetrations. Where recessed lights are used in top-floor ceilings provide a gypsum board enclosure around the lighting fixture and seal the gypsum board joints with caulk or joint compound.
2. Fiberglass, mineral fiber, or cellulose insulation shall be installed continuously and completely throughout the ceiling joist cavity to a depth of at least 10 inches. Batt or blanket insulation shall be used at sloped ceilings.
3. Roof framing members shall be at least 14" deep for their entire span.
4. Attic access panels shall be constructed of 3/4" thick plywood and shall have continuous neoprene perimeter bulb seals. Pull-down attic stairs shall have moveable or operable covers constructed of 3/4" thick plywood and shall have continuous neoprene perimeter bulb seals.
5. Skylights shall not be provided.

E. Floors and Foundations

1. For houses elevated on pylons: Use plywood or OSB at least 1/2" thick at the underside of floor joists that are at least 14" deep with at least 10" thick fiberglass, mineral fiber, or cellulose insulation.
2. If crawl spaces do not have masonry walls, a massive barrier panel must be used as a skirt connecting the bottom of the walls to the ground. 2" thick precast concrete panels are ideal barrier skirts. Alternatively, 2x4 pressure-treated wood studs with 3/4" pressure-treated plywood on each side may be used, as long as the joints between the plywood are covered with batten

strips. Use acoustical louvers for all vents. In flood zones use double-swing plywood flood gates in lieu of vents to the extent allowable by code.

F. Ventilation and Wall and Roof Penetrations

1. In-window, through-wall, or through-floor air-conditioning, ventilating, or heating units shall not be used.
2. Through-the-wall/door mailboxes or mail slots shall not be used.
3. A mechanical ventilation system shall be installed that will provide the minimum air circulation and fresh air supply requirements for various uses in occupied rooms, as specified in the North Carolina state building code, without the need to open any windows, doors, or other openings to the exterior.
4. Gravity vent openings in attics shall not exceed the code minimum in number and size.
5. If an attic fan is used for forced ventilation, the attic inlet and discharge openings shall be fitted with sheet metal transfer ducts of at least 20 gauge steel at least 5 feet long with at least one 90° bend.
6. All vent ducts, including those for bathroom exhaust fans and dryers, connecting the interior space to the outdoors shall be rigid metal and contain at least two 90° bends, or one 90° bend and a total length of at least 20 feet (or the maximum length allowed by the dryer manufacturer).
7. Vented domestic range fans shall be not used.
8. Vented fireplaces, wood stoves, or gas-powered prefabricated units shall not be used.
9. Vented fuel-burning appliances (e.g., gas dryers, gas fireplaces, oil or gas furnaces, and gas water heaters) shall not be located in habitable spaces (e.g, kitchens, living rooms, bedrooms, etc.). Vent ducts for fuel-burning appliances in non-habitable spaces (e.g., closets and attics) shall have double-wall sheet metal construction.
10. Whole-house fans shall not be provided.
11. All ducts in attics shall be rigid metal.
12. Dryers shall be located in closets or other non-habitable spaces. Dryer ducts shall be rigid metal.

SECTION 6: BUILDING REQUIREMENTS FOR A MINIMUM NLR OF 35 dB**A. Exterior Walls**

1. The interior surface of exterior walls shall be gypsum board at least 1/2 inch thick, or an alternative material of equal surface mass.
2. For wood-framed walls:
 - a. Fiberglass, mineral fiber, or cellulose batt or blanket insulation shall be installed continuously and completely throughout the stud cavity. Batts or blankets should be held firmly in place between the studs, with fasteners if necessary, to prevent sagging; however, packing the insulation such that it is compressed may slightly reduce its acoustical (and thermal) performance.
 - b. If there is one only one exterior wall:
 - i. If exterior windows and doors together comprise less than 25% of the Total Exterior Wall Area single-leaf resilient channels shall be used between the studs and gypsum board.
 - ii. If exterior windows and doors together comprise 25% or more of the Total Exterior Wall Area the studs shall be 2x4 studs staggered on 2x6 plates (if the studs need to be 2x6 for structural reasons, use 2x6 studs staggered on 2x8 plates).
 - c. If there are two or more exterior walls:
 - i. If exterior windows and doors together comprise less than 15% of the Total Exterior Wall Area single-leaf resilient channels shall be used between the studs and gypsum board.
 - ii. If exterior windows and doors together comprise 15 to 30% of the Total Exterior Wall Area the studs shall be 2x4 studs staggered on 2x6 plates (if the studs need to be 2x6 for structural reasons, use 2x6 studs staggered on 2x8 plates).
 - iii. If exterior windows and doors together comprise more than 30% of the Total Exterior Wall Area the studs shall be 2x4 studs staggered on 2x6 plates (if the studs need to be 2x6 for structural reasons, use 2x6 studs staggered on 2x8 plates), and two layers of 1/2" gypsum board shall be provided at the interior surface of the room.
3. Insulated concrete form (ICF) or masonry walls, where present, shall contain at least 4" thick normal weight concrete or masonry throughout the surface of the wall.

B. Windows

1. For rooms with at least one wood-framed wall:
 - a. If there is only one exterior wall:
 - i. If the exterior windows and doors together comprise less than 25% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 36.

- ii. If the exterior windows and doors together comprise 25% or more of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 40.
- b. If there are two or more exterior walls:
 - i. If the exterior windows and doors together comprise less than 20% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 38.
 - ii. If the exterior windows and doors together comprise 20% or more of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 42.
- 2. For rooms with all ICF walls:
 - a. If there is only one exterior wall:
 - i. If the exterior windows and doors together comprise less than 15% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 34.
 - ii. If the exterior windows and doors together comprise 15 to 25% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 36.
 - iii. If the exterior windows and doors together comprise 25 to 50% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 38.
 - iv. If the exterior windows and doors together comprise more than 50% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 40.
 - b. If there are two or more exterior walls:
 - i. If the exterior windows and doors together comprise less than 20% of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 40.
 - ii. If the exterior windows and doors together comprise 20% or more of the Total Exterior Wall Area the windows shall have a laboratory sound transmission class rating of at least STC 44.

C. Doors

- 1. For rooms with at least one wood-framed wall:
 - a. If there is only one exterior wall:

- i. If the exterior windows and doors together comprise less than 25% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 34.
 - ii. If the exterior windows and doors together comprise 25% or more of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 40.
 - b. If there are two or more exterior walls:
 - i. If the exterior windows and doors together comprise 30% or less of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 37.
 - ii. If the exterior windows and doors together comprise more than 30% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 40.
2. For rooms with all ICF walls:
 - a. If there is only one exterior wall:
 - i. If the exterior windows and doors together comprise less than 25% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 34.
 - ii. If the exterior windows and doors together comprise 25 to 50% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 37.
 - iii. If the exterior windows and doors together comprise more than 50% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 40.
 - b. If there are two or more exterior walls:
 - i. If the exterior windows and doors together comprise less than 15% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 37.
 - ii. If the exterior windows and doors together comprise 15 to 30% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 40.
 - iii. If the exterior windows and doors together comprise more than 30% of the Total Exterior Wall Area the doors shall have a laboratory sound transmission class rating of at least STC 43.
3. Interior doors between occupied spaces and attached garages, unfinished attics, or other non-habitable spaces with an exterior wall or ceiling shall have a laboratory sound transmission class rating of at least STC 29.

D. Roof-Ceiling Assembly

1. Gypsum board ceilings at least 1/2 inch thick shall be provided at top floor. Single-leaf resilient channels shall be used to hang the gypsum board at top floor. Ceilings at top floor shall be substantially airtight with a minimum number of penetrations. Recessed lights shall not be used in top-floor ceilings.
2. Fiberglass, mineral fiber, or cellulose insulation shall be installed continuously and completely throughout the ceiling joist cavity to a depth of at least 10 inches. Batt or blanket insulation shall be used at sloped ceilings.
3. Roof framing members shall be at least 14" deep for their entire span.
4. Attic access panels shall be constructed of 3/4" thick plywood and shall have continuous neoprene perimeter bulb seals. Pull-down attic stairs shall have moveable or operable covers constructed of 3/4" thick plywood and shall have continuous neoprene perimeter bulb seals.
5. Skylights shall not be provided.

E. Floors and Foundations

1. For houses elevated on pylons: Use plywood or OSB at least 1/2" thick at the underside of floor joists that are at least 14" deep with at least 10" thick fiberglass, mineral fiber, or cellulose insulation.
2. If crawl spaces do not have masonry walls, a massive barrier panel must be used as a skirt connecting the bottom of the walls to the ground. 2" thick precast concrete panels are ideal barrier skirts. Alternatively, 2x4 pressure-treated wood studs with 3/4" pressure-treated plywood on each side may be used, as long as the joints between the plywood are covered with batten strips. Use acoustical louvers for all vents. In flood zones use double-swing plywood flood gates in lieu of vents to the extent allowable by code.

F. Ventilation and Wall and Roof Penetrations

1. In-window, through-wall, or through-floor air-conditioning, ventilating, or heating units shall not be used.
2. Through-the-wall/door mailboxes or mail slots shall not be used.
3. A mechanical ventilation system shall be installed that will provide the minimum air circulation and fresh air supply requirements for various uses in occupied rooms, as specified in the North Carolina state building code, without the need to open any windows, doors, or other openings to the exterior.
4. Gravity vent openings in attics shall not exceed the code minimum in number and size.

5. If an attic fan is used for forced ventilation, the attic inlet and discharge openings shall be fitted with sheet metal transfer ducts of at least 20 gauge steel at least 5 feet long with at least one 90° bend.
6. All vent ducts, including those for bathroom exhaust fans and dryers, connecting the interior space to the outdoors shall be rigid metal and contain at least two 90° bends, or one 90° bend and a total length of at least 20 feet (or the maximum length allowed by the dryer manufacturer).
7. Vented domestic range fans shall be not used.
8. Vented fireplaces, wood stoves, or gas-powered prefabricated units shall not be used.
9. Vented fuel-burning appliances (e.g., gas dryers, gas fireplaces, gas furnaces, and gas water heaters) shall not be located in habitable spaces (e.g, kitchens, living rooms, bedrooms, etc.). Vent ducts for fuel-burning driven appliances in non-habitable spaces (e.g., closets and attics) shall have double-wall sheet metal construction.
10. Whole-house fans shall not be provided.
11. All ducts in attics shall be rigid metal.
12. Dryers shall be located in closets or other non-habitable spaces. Dryer ducts shall be rigid metal.