RANGE AIR INSTALLATIONS COMPATIBLE USE ZONES STUDY FOR THE NAVY DARE COUNTY BOMBING RANGE COMPLEX

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Prepared by

UNITED STATES DEPARTMENT OF THE NAVY
Naval Facilities Engineering Command Mid-Atlantic
Norfolk, Virginia

Prepared for

Fleet Area Control and Surveillance Facility, Virginia Capes

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DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, DC 20350-2000

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From: Director, Shore Readiness Division (N46)
To: Commanding Officer, Fleet Area Control and Surveillance Facility, Virginia Capes

Subj: APPROVAL REQUEST OF THE RANGE AIR INSTALLATIONS COMPATIBLE USE ZONES (RAICUZ) STUDY FOR NAVY DARE RANGE COMPLEX NORTH CAROLINA

Ref: (a) FACSFAC VACAPES ltr 11010 Ser N5/156 of 5 Nov 15 w/encls

1. RAICUZ approved.

2. My point of contact regarding this matter is Karthik Bharat at DSN: 225-5519, COMM: (703) 695-5519, e-mail: karthik.bharat@navy.mil.

E. M. KERN

Copy to:
CNIC (N44)
COMNAVFACENGCOM (AM3)
COMUSFLTFORCOM (N46)
COMNAVAIRFOR (N36)
COMNAVAIRLANT (N3/N4/N7/N8)
COMNAVREG MIDLANT (N4)
FACSFAC VACAPES

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Executive Summary

The purpose of the United States Department of the Navy (Navy) Range Air Installations Compatible Use Zones (RAICUZ) Program is to achieve compatibility between the existing and proposed land uses and airspace in the vicinity of air-to-ground ranges. A RAICUZ Study is a planning document for the Navy to use when working with government entities to adopt programs, policies, and regulations that support the Navy mission and encourage compatible development within the vicinity of military training range facilities. RAICUZ studies analyze community development trends, land use tools, and range installation mission requirements to develop recommendations for compatible land use. Land use considerations facing ranges differ from the common land use and development concerns near air installations.

This RAICUZ Study for the Navy Dare County Bombing Range Complex (NDCBRC, also Range Complex) has been prepared in consideration of expected changes in mission and aircraft and projected operational levels that would likely occur within the next 10- to 15-year planning period.

Dare County Bombing Range

The Dare County Bombing Range (DCBR) is a joint Navy and United States Air Force (Air Force) weapons training range owned by the Air Force. DCBR is split into two distinct range areas, with the Navy operating the northern part of the range (Navy Dare County Bombing Range [Navy Dare]) and the Air Force using the southern part of the range (Air Force Dare County Bombing Range [Air Force Dare]). Additionally, the Navy operates a range called Long Shoal Naval Ordnance Area (LSNOA), also referred to as Stumpy Point, which is located near the center of Pamlico Sound.

The Fleet Area Control and Surveillance Facility Virginia Capes (FACSFAC VACAPES) controls operations for DCBR. The remote location of DCBR facilitates a safe and realistic training environment, providing an ideal training area for strike warfare, including air-to-ground bombing and gunnery exercises against realistic targets. The Air Force (managed by Seymour Johnson Air Force Base [AFB]) owns DCBR, which is located completely within the boundaries of the Alligator River National Wildlife Refuge (ARNWR).

The primary users of DCBR are the F/A-18 squadrons from Naval Air Station (NAS) Oceana, MH-60S squadrons from Naval Station Norfolk, and F-15E aircraft crews from Seymour Johnson AFB. DCBR is also used by Air National Guard, the United States Coast Guard (USCG), the United States Army (Army), the United States Marine Corps (Marine Corps), and the Joint Naval Special Warfare Development Group.

Navy Dare County Bombing Range Complex

Navy Dare and LSNOA are known collectively as the Range Complex. Navy Dare includes approximately 23,000 acres and consists of 22 existing and proposed targets. Navy Dare permits a wide range of inert ordnance, including fixed-wing strafing, light and heavyweight training bombs, and precision-guided munitions. Rotary-wing and tilt-rotor aircraft are capable of conducting strafing, door gunnery, and tail gunnery training at Navy Dare.

The LSNOA is a water-based range and serves as an air-to-ground training location. LSNOA supports overwater training and serves as an important overflow target area when the Navy Dare is experiencing heavy usage. The LSNOA range consisted of a single, active, semi-submerged target located between Long Shoal Point and the Outer Banks. Authorized munitions at the LSNOA include lightweight and inert munitions, paraflares, and night photoflashes.

While significant increases in usage at the Range Complex are not anticipated, guidance provided by Navy personnel indicate that the Range Complex may experience a slight increase in utilization over the next few years because of expanded training opportunities. These opportunities include the

addition of precision guided munitions, increased rotary-wing and tilt-rotor gunnery, an expansion of operations on new and future targets, and increased sorties resulting from troop withdrawals abroad.

Noise Analysis

Noise contours provide an installation, local community planning organizations, and the public with maps of the modeled noise-related impacts from aircraft operations and aerial gunnery events. Noise contours, when overlaid with local land uses, can help identify areas of compatible/incompatible land uses, and plan for future development around a range.

The noise contours and Range Compatibility Zones (RCZs) presented in this 2015 RAICUZ Study are based on projected operations at DCBR. The main sources of noise at the DCBR are from aircraft flight operations and aerial gunnery events. This RAICUZ Study analyzed the noise generated from aircraft operations at the range and within special use airspace (SUA), as well as the noise generated from aerial gunnery operations.

Range Safety Analysis

In order to maintain the viability of the Range Complex for air-to-ground training while ensuring the safety of participating and non-participating personnel in the vicinity, a range safety analysis has been conducted to identify areas of potential concern near the Range Complex. This RAICUZ Study provides the results of weapon danger zone (WDZ) modeling for all air-to-ground operations at the Range Complex and the locations of RCZs. WDZs define the areas of potential safety hazard based on containment of ordnance, fragments, ricochets, and debris, but they do not define the risk associated with aircraft operations. This RAICUZ Study also presents the results of a risk analysis that examined the likelihood of impacts to specific areas of critical concern (ACC) with a risk greater than 1:1,000,000.

RCZs translate aviation and ordnance delivery safety concerns into compatible land use recommendations for use in RAICUZ studies. Each RCZ has

specific recommended restrictions related to the land uses that are planned within the confines of the zone. There are three RCZs related to air-to-ground ranges:

- RCZ-I is comprised of the sum of all WDZs for a particular range and represents the area of greatest safety hazards. This RCZ includes the ground and airspace for the lateral and vertical containment of projectiles, fragments, and debris from aviation ordnance.
- RCZ-II is comprised of the "area of armed overflight." This RCZ is less restrictive than RCZ-I, but more restrictive than RCZ-III.
- RCZ-III is comprised of the area below the aircraft maneuvering airspace. This maneuvering airspace allows for access to/from the range, tactical maneuvering, and non-participating aircraft separation.

Land Use Compatibility

The Navy has developed recommended guidelines for compatible development and land use within a range's noise zones and RCZs. These land use guidelines are provided in the RAICUZ Instruction (Office of the Chief of Naval Operations Instruction [OPNAVINST] 3550.1A). The land use compatibility analysis provided in this RAICUZ Study is based on the assessment of existing land uses and proposed development near the DCBR. Population growth projections prepared by the North Carolina Office of State Budget and Management and local government land use plans and zoning regulations were evaluated to determine how local and regional development patterns could impact future operations at the range.

The goal of the Navy RAICUZ Program can most effectively be accomplished by the active participation of all interested parties, including the Navy, state, regional, and local governments, private citizens, developers, real estate professionals, and others. Seymour Johnson AFB and FACSFAC VACAPES are responsible for informing and educating community decision makers about the RAICUZ Program; however, local governments should continue to actively inform, and request input from, Seymour Johnson AFB regarding land use decisions that could impact the readiness sustainment of the DCBR.

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Acronyms and Abbreviations

ACC	Area of Critical Concern
AFB	Air Force Base
AFI	Air Force Instruction
Air Force	United States Air Force
Air Force Dare	Air Force Dare County Bombing Range
Army	United States Army
ARNWR	Alligator River National Wildlife Refuge
CAMA	Coastal Area Management Act
CDNL	C-Weighted Day-Night Average Sound Level
CO	Commanding Officer
COMUSFLTFORCOMINST	Commander United States Fleet Forces Command Instruction
CPLO	Community Plans and Liaison Officer
CRC	Coastal Resources Commission
dB	Decibels
dBA	A-Weighted Decibel
dBPk	Peak Sound Pressure Level
DCBR	Dare County Bombing Range
DNL	Day-Night Average Sound Level
DOD	United States Department of Defense
FAA	Federal Aviation Administration
FACSFAC	Fleet Area Control and Surveillance Facility
FACSFACVACAPESINST	Fleet Area Control and Surveillance Facility, Virginia Capes Instruction
FW	Fighter Wing
FY	Fiscal Year
GIS	Geographic Information System
HSCWL	Helicopter Sea Combat Wing Atlantic
HUD	United States Department of Housing and Urban Development
JDAM	Joint Direct Attack Munition
JLUS	Joint Land Use Study
kW	Kilowatt
LCdn	C-Weighted Day-Night Average Sound Level
L_{dnmr}	Average Monthly Onset Rate Adjusted DNL
LGTR	Laser-Guided Training Round

LSNOA	Long Shoal Naval Ordnance Area
LUP	Land Use Plan
Marine Corps	United States Marine Corps
MLT	Moving Land Target
MOA	Military Operations Area
MTRs	Military Training Routes
NAS	Naval Air Station
Navy	United States Department of the Navy
Navy Dare	Navy Dare County Bombing Range
NC-12	North Carolina State Highway 12
NCDOT	North Carolina Department of Transportation
NCMAC	North Carolina Military Affairs Commission
NCWRC	North Carolina Wildlife Resources Commission
NDCBRC	Navy Dare County Bombing Range Complex
nm	Nautical Mile
OPNAVINST	Office of the Chief of Naval Operations Instruction
RAICUZ	Range Air Installations Compatible Use Zones
Range Complex	Navy Dare County Bombing Range Complex
RCZ	Range Compatibility Zone
REPI	Readiness and Environmental Protection Integration
RSZ	Range Safety Zone (obsolete methodology)
SDZ	Surface Danger Zone
SFWL	Strike Fighter Wing Atlantic
Stumpy Point	Long Shoal Naval Ordnance Area
SUA	Special Use Airspace
USACE	United Sates Army Corps of Engineers
USCG	United States Coast Guard
USFF	United States Fleet Forces
VACAPES	Virginia Capes
WDZ	Weapon Danger Zone

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Introduction

The United States Department of the Navy (Navy) initiated the Range Air Installations Compatible Use Zones (RAICUZ) Program to achieve compatibility between existing and proposed land use and airspace in the vicinity of Navy ranges. The goal of this program is to protect public health, safety, and welfare, and to prevent encroachment from degrading the operational capabilities of air-to-ground ranges.

The RAICUZ Program recommends that noise contours, range compatibility zones (RCZs), height and obstruction requirements, and associated land use recommendations be incorporated into local community planning to reduce impacts on the community and ensure operational capabilities of the range. Cooperation between ranges and neighboring communities serves to increase public awareness of the importance of air-to-ground ranges and the need to address mission requirements and associated noise and risk factors. As the communities that surround an air-to-ground range grow and develop, the Navy has the responsibility to communicate and collaborate with local governments regarding land use planning.

The Dare County Bombing Range (DCBR) is comprised of two separate training areas:

- Navy Dare County Bombing Range (Navy Dare), located in the northern half of DCBR; and
- Air Force Dare County Bombing Range (Air Force Dare), located in the southern half of DCBR.

Navy Dare and the Long Shoal Naval Ordnance Area (LSNOA), also referred to as "Stumpy Point," are collectively known as the "Navy Dare County Bombing Range Complex" (NDCBRC) and also referred to as the "Range Complex" for the purposes of this RAICUZ Study. This Range Complex RAICUZ Study represents the first RAICUZ Study to combine Navy Dare and the LSNOA into one document.

This RAICUZ Study has been prepared for Fleet Area Control and Surveillance Facility Virginia Capes (FACSFAC VACAPES). The 2014 noise contours and RCZs presented in this RAICUZ Study are based on projected operations. This RAICUZ Study has been prepared in consideration of expected changes in mission, aircraft, and projected operational levels that would likely occur within the next 10- to 15-year planning period.

This 2015 RAICUZ Study includes the chapters listed below:

- **Chapter 1**: Provides background information on the RAICUZ Program, RAICUZ methodology, and changes that require a RAICUZ update;
- **Chapter 2**: Describes the location and history of the Range Complex, range operations, range users, and operational areas;
- **Chapter 3**: Outlines the methodology for determining noise contours and discusses measures the Navy has implemented to mitigate any community noise concerns;
- **Chapter 4**: Discusses range safety issues, weapon danger zones (WDZs), the development of RCZs, and areas of critical concern (ACCs);
- **Chapter 5**: Evaluates the compatibility of both current and proposed surrounding land uses with range operations; and
- **Chapter 6**: Provides recommendations for promoting land use compatibility consistent with the goals of the RAICUZ Program.

1.1 RAICUZ Program

OPNAVINST 3550.1A currently governs the Navy's RAICUZ Program.

The Office of the Chief of Naval Operations Instruction (OPNAVINST) 3550.1A governs the Navy's RAICUZ Program. The primary objectives of the RAICUZ Program are as follows:

- Inform the public about the RAICUZ Program and seek cooperative efforts to reduce potential safety and noise impacts in the vicinity of the air-to-ground ranges;
- Establish working relationships between the installation and appropriate local, regional, and state community councils, commissions, Native American tribes, and planning and zoning departments in order to communicate proposed actions that could affect public health, safety, and welfare, as well as operational and training capabilities and compatible land use recommendations;
- Promote compatible land use near air-to-ground ranges;
- Protect Navy investments by safeguarding the current and potential operational capabilities of those ranges; and
- Prevent public exposure to hazards and noise associated with air-to-ground ranges.

1.2 Purpose, Scope, and Authority

The purpose of the RAICUZ Program is to achieve compatibility between the air-to-ground ranges, existing and proposed land use, and airspace in the vicinity of the range installation.

The purpose of the RAICUZ Program is to achieve compatibility between the air-to-ground ranges, existing and proposed land uses, and airspace in the vicinity of the range installation. RAICUZ studies analyze community development trends, land use tools, and range installation mission requirements to develop compatible land use recommendations. RAICUZ recommendations are based on how the impacts of noise and safety concerns may affect local economic viability.

The scope of this RAICUZ Study includes an analysis of current and future range utilization, special use airspace (SUA), Military Training Routes (MTRs), aircraft noise, aerial gunnery noise, and RCZs. This RAICUZ Study also provides an analysis of existing and projected land use compatibility within the noise zones and RCZs and recommendations for compatible development.

The authority for the establishment and implementation of the RAICUZ Program and the guidance on range operations and procedures for Navy Dare and Air Force Dare are derived from:

The RAICUZ Study is a planning document that shows the modeled effects of aircraft noise, ordnance noise, and weapons danger zone footprints to assess the compatibility of range operations and surrounding land uses.

- OPNAVINST 3550.1A, Range Air Installations Compatible Use Zones Program, January 28, 2008;
- Air Force Instruction 13-212, Range Planning and Operations, January 6, 2010;
- Air Force Instruction 13-212 Addendum A, Seymour Johnson Air Force Base Addendum A, Dare County Bombing Range Instruction, October 27, 2010;
- Fleet Area Control and Surveillance Facility, Virginia Capes Instruction (FACSFACVACAPESINST) 3710.1A, Navy Dare and Stumpy Point User's Manuals, December 17, 2010; and
- Commander United States Fleet Forces Command Instruction (COMUSFLTFORCOMINST) 3550.1, Weapon Danger Zone Approval for Air-to-Ground Training Ranges, January 7, 2013.

1.3 RAICUZ Methodology

A RAICUZ Study is a planning document that shows the modeled effects of aircraft noise, ordnance (aerial gunnery and impact) noise, and weapons safety footprints to assess the compatibility of range operations and surrounding land uses.

The nature of flight operations at a bombing range differs significantly from those at an air station. Range flight operations, such as aerial weapons deliveries, air-to-ground gunnery (strafing), and high-speed low-altitude

maneuvers, are maneuvers not usually performed at or near an airport. These maneuvers require additional safety precautions and generate slightly different noise profiles than flight training at an airfield. Also, firing and/or detonation of live ordnance at some ranges produce impulse (blast) noises not associated with air station operations. (Note. Operations at DCBR and LSNOA do not include the use of live ordnance.)

In support of this RAICUZ Study, the Navy completed a noise study for DCBR and LSNOA. Noise levels were analyzed using a computer model of typical range operations that provides site-specific operational data, including the type and frequency of aircraft using the range, the flight tracks, and the time of operations. Chapter 3 discusses aircraft noise contour development, methods, and results.

The Navy can provide recommendations on land use however; local leaders must take the necessary actions to preserve land use compatibility near the range complex.

To assess safety hazards associated with air-to-ground munitions delivery and incompatible land uses surrounding the Range Complex, WDZs were developed using the Multi-Service WDZ Tool (version 10.0.0.4.5). WDZs define the areas of potential safety hazard based on containment of ordnance, weapons malfunctions, fragments, ricochets, and debris, but they do not define the risk associated with aircraft operations. The WDZ Tool incorporates a weapons database, a digitized range database, and an impact probability distribution function. Chapter 4 provides further discussion on WDZ footprints, methods, and applications for the Range Complex..

1.4 Responsibility of Compatible Land Use

Range Commanders are encouraged to collaborate and partner with their neighboring communities and local governments to promote compatible land use planning. The Navy can provide recommendations or advise community decision makers; however, ultimately, local leaders must take the necessary actions to preserve land use compatibility near the Range Complex. Cooperative action by stakeholders is essential to prevent land use incompatibility. Table 1-1 identifies some responsibilities assigned to various community stakeholders.

Table 1-1 Responsibility for Compatible Land Use Development

Stakeholders	Responsibility
Private Citizens	▪ Learn about the importance of the RAICUZ Program using publically available information. ▪ Identify RAICUZ considerations in property transactions. ▪ Understand RAICUZ effects before buying, renting, leasing, or developing property.
Real Estate Professionals	▪ Inform potential buyers and lessees of RAICUZ information on affected properties and facilitate understanding of this information. ▪ When working with builder/developers, ensure an understanding and evaluation of the RAICUZ Program.
Builders/Developers	▪ Develop properties in a manner that appropriately protects the health, safety, and welfare of the civilian population by constructing facilities that are compatible with aircraft operations (e.g., sound attenuation features, densities, and occupations).
Local Government	▪ Consider incorporation of RAICUZ guidelines into a comprehensive development plan and zoning ordinance. ▪ Consider regulating height and obstruction concerns through local ordinance. ▪ Consider regulating acoustical treatment in new construction. ▪ Require fair disclosure in real estate for buyers, renters, lessees, and developers.
Navy	▪ Examine air mission for operation changes that could reduce impacts. ▪ Conduct noise and safety studies. ▪ Develop RAICUZ maps. ▪ Examine local land uses and growth trends. ▪ Make land use recommendations. ▪ Release a RAICUZ Study in accordance with OPNAVIST 3550.1A. ▪ Work with local governments and private citizens. ▪ Monitor operations and noise complaints. ▪ Update RAICUZ studies, as required.

1.5 Previous RAICUZ Efforts, Joint Land Use Study, and Related Studies

DCBR was one of the first ranges to have a RAICUZ Study completed. Since the start of the program in 1998, numerous studies and reports have been published related to the activities at Navy Dare and LSNOA, including a RAICUZ for Stumpy Point, a Noise Study for DCBR, a RAICUZ for Navy Dare, two Encroachment Action Plans, and a Range Complex Management Plan. This RAICUZ combines two previously separate RAICUZ documents into a single source document (Navy Dare and Stumpy Point). This RAICUZ Study will be used in concert with the United States Air Force's (Air Force's) planning documents and ongoing Seymour Johnson Air Force Base (AFB) Joint Land Use Study, which includes DCBR and associated SUA, MTRs, military operations areas (MOAs) and surrounding communities. The DOD initiated the Joint Land Use Study Program as part of the Congressional authorization to help better understand and incorporate the RAICUZ technical data into local planning programs. It is under management of the State of North Carolina and funded by the DOD Office of Economic Adjustment. The Joint Land Use Study provides recommendations regarding land development.

PREVIOUS RAICUZ EFFORTS

2003 First Official Stumpy Point RAICUZ; CNIC approved Aug 04

2006 Noise Study for DCBR (Wyle 2006)

2007 Weapons Impact Analysis, using Safe-Range. (NAVFAC Atlantic 2007)

2007 First official RAICUZ for Dare County Bombing Range; OPNAV approved 29 April 2008.

2014 Joint Land Use Study for Seymour Johnson AFB, Dare County Bombing Range, and associated MOAs and MTRs (ongoing, Dec 2014)

1.6 Changes that Require a RAICUZ Update

A RAICUZ Study should be updated when a range has a significant change in aircraft operations, types of aircraft operating at the range, flight paths or procedures, new types of ordnance, target location, or methods of ordnance delivery that could affect the weapons impact footprint/composite WDZs or RCZs, as described in Chapter 4.

Updated RAICUZ for both Navy Dare and LSONA were desired for multiple reasons, to include new modeling software, new aircraft (MV-22), and new munitions for Navy Dare (already in use at Air Force Dare). Specifically, the improvements to the accuracy of WDZ modeling software, an increase in the use of 20mm ammunition at Navy Dare, modeling for the MV-22B at LSNOA, and the addition of Joint Direct Attack Munitions (JDAM) to Navy Dare required a revision to Navy Dare and LSNOA documents.

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Dare County Bombing Range Complex

2.1 Location and History

DCBR is located in northeastern North Carolina approximately 70 nautical miles (nm) south of Naval Air Station (NAS) Oceana and approximately 76 miles east of Seymour Johnson AFB (Figure 2-1). DCBR spans approximately 46,000 acres within the Alligator River National Wildlife Refuge (ARNWR). Navy Dare is approximately 23,000 acres.

The Impact Area at Navy Dare known as the "Keyhole"

DCBR was constructed in 1965 on land first leased from WV Pulp and Paper, and then later leased from First Colony Farms in 1973. In 1978, the Air Force obtained exclusive federal jurisdiction over the entire property (Navy 2004).

DCBR is split in two distinct range areas: Navy Dare and Air Force Dare (Figure 2-1). The Navy operates the northern part of this range under an Inter-Service Support Agreement with the Air Force. The Air Force uses the southern part of DCBR. Through a Use Agreement with the State of North Carolina, dated January 29, 1959, FACSFAC VACAPES maintains control over the range. The Use Agreement does not contain an expiration or termination date (Navy 2009b).

Figure 2-1
Regional Location Map

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013

LSNOA is located near the center of Pamlico Sound, 7 miles southeast of Long Shoal Peninsula, in Dare County, North Carolina (Figure 2-1). LSNOA is approximately 15 nm southeast of Navy Dare and may be used concurrently with Navy and Air Force Dare (Navy 2010c). The original target at LSNOA consisted of a scuttled landing ship hull. Over the past 50 years, LSNOA has been refurbished and upgraded numerous times; however, operations were suspended in 1997 because of target deterioration from extensive use. Later, in 2003, the Navy refurbished LSNOA to accommodate increased demand at Navy Dare. Within two weeks of renewed operations, Hurricane Isabel damaged the target in September of 2003. The target remained idle and non-operational until it was rebuilt in 2012. The Commanding Officer (CO) of FACSFAC VACAPES noted the target has degraded because of use and its exposure to salt water (Blake 2014b). A summer 2014 storm sank the target silhouette in the Pamlico Sound. During development of the RAICUZ, FACSFAC VACAPES and United States Fleet Forces (USFF) have been working on a solution.

2.2 Mission

FACSFAC VACAPES controls operations for DCBR. FACSFAC VACAPES's mission is "to support homeland defense and advance the combat readiness of U.S. Atlantic Fleet and Joint Forces by providing control, surveillance, management, sustainment, and ready access to assigned airspace, operating areas, training ranges and resources."

The Navy Dare range provides a realistic strike warfare training environment that includes air-to-ground bombing and gunnery exercises. LSNOA supports overwater training and serves as an important overflow target area when Navy Dare is experiencing heavy flight volume.

In support of this overarching mission, DCBR provides the necessary training environment to ensure operational readiness for the Navy, Air Force, United States Marine Corps (Marine Corps), and various other military branch services (Navy 2010a). The remote location of DCBR facilitates a safe and realistic training environment, but also remains readily accessible from multiple

military installations in the region. As such, DCBR helps prepare combat-capable naval forces that are ready to deploy worldwide (Navy 2009b).

2.3 Airspace

2.3.1 Special Use Airspace

SUA is the designation of airspace in which specific activities must be confined or where limitations may be imposed on aircraft operations that are not part of those activities. The SUA dimensions are defined so that military activities can operate and have boundaries that limit access by non-participating aircraft. Relevant local SUA used by aircraft operating at DCBR are as follows (Figure 2-2):

- **Military Operating Areas:** Airspace with defined vertical and lateral limits to segregate certain non-hazardous military activities from instrument flight rules traffic and to identify visual flight rules traffic where military activities are conducted. DCBR includes the Phelps A/B/C MOAs, the Pamlico A and B MOAs, and the Stumpy Pointy MOA.
- **Restricted Airspace:** Restrictions on aircraft flight due to hazards often make these airspace areas invisible to aircraft (e.g., artillery firing, aerial gunnery, and guided missiles). Restricted areas are established to separate operations that are hazardous to non-participating aircraft. DCBR includes Restricted Areas R-5314A/B/C/D/E/F//H/J. The Air Force range users have exclusive use of R-5314A/B/C, while the Navy range users have exclusive use of R-5314D/E/F. R-5314H and R-5314J are concurrent-use airspace, and caution should be exercised when using this airspace (Air Force 2010; Navy 2010d).

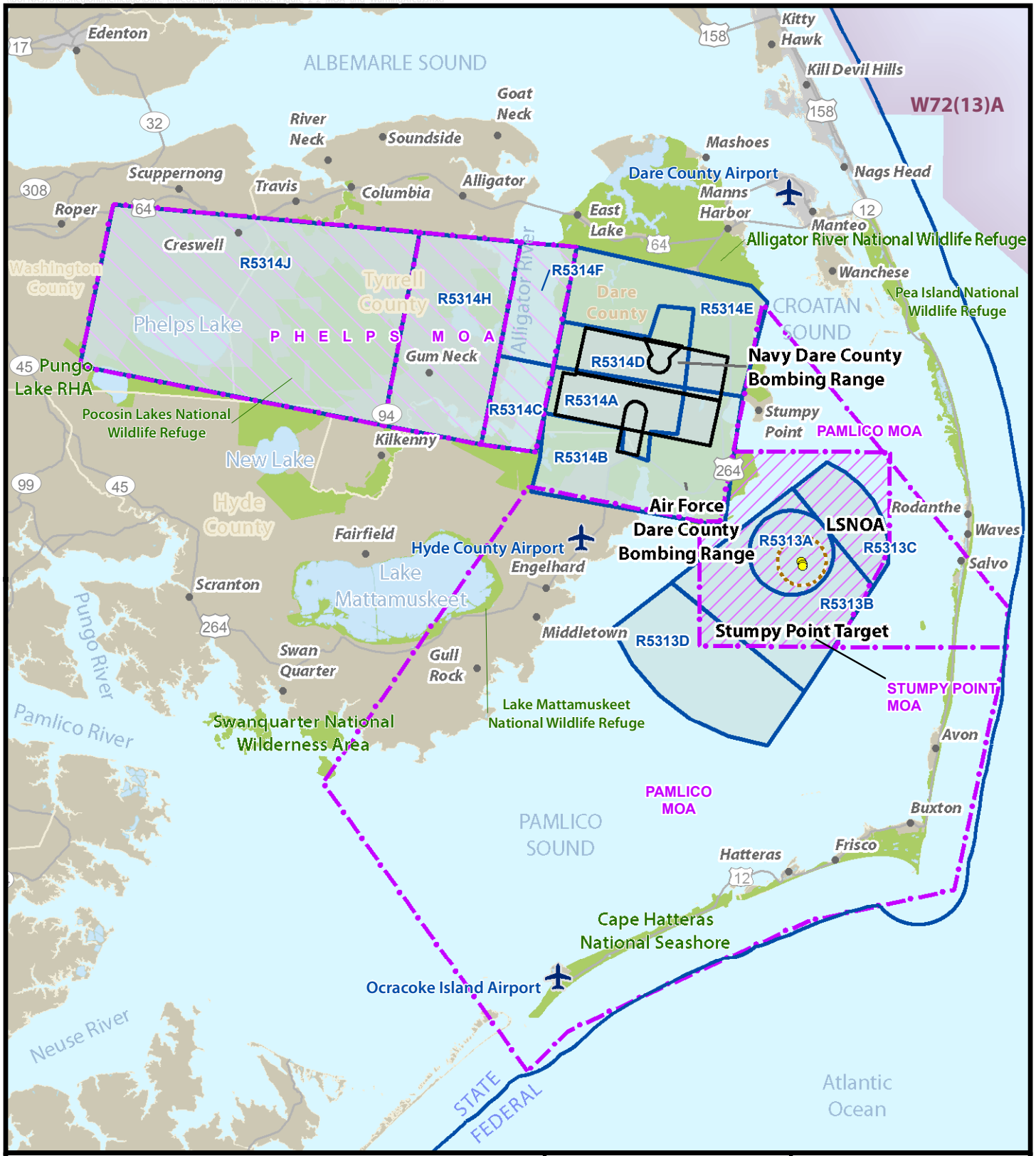


Figure 2-2
Special Use Airspace

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013

2.3.2 Military Training Routes

MTRs are flight corridors used to practice low-altitude, high-speed, terrain-following training missions. MTRs are established below 10,000 feet above mean sea level for operations at speeds in excess of 250 knots. Each segment of an MTR is allocated a floor altitude (at the earth's surface or any Federal Aviation Administration [FAA] designated altitude above the surface) and a ceiling altitude with lateral boundaries. Lateral boundaries are shown in nautical miles to the left and right of the centerline. Aircraft may freely maneuver within the lateral and vertical confines of the MTR segment or block. See Figure 2-3 for MTRs near DCBR and LSNOA.

2.3.3 Local General Aviation

Hyde County Airport and Dare County Regional Airport are two airports near the DCBR and LSNOA ranges that may have a potential compatibility concern. Hyde County Airport is located approximately 6 miles south of DCBR, approximately 1.5 miles from Restricted Area (R) R-5314B, and underneath the Pamlico A and B MOAs (see Figure 2-2). Dare County Regional Airport is located approximately 9 miles north of DCBR.

Ocracoke Island Airport is located approximately 42 miles southeast of DCBR and is not likely to contribute to compatibility concerns.

2.3.3.1 Hyde County Airport

Hyde County Airport is relatively small with no fueling facilities and no locally based planes. When civilian aircraft are operating out of Hyde County Airport, close coordination must occur with Air Force Dare to ensure safety of aircraft operating in the area and in the special use airspace.

Based on the number of operations at Hyde County Airport and the potential for increased frequency of civilian operations, a potential compatibility concern may exist. Recommend continued coordination between personnel at Air Force Dare and Hyde County Airport.

Figure 2-3
Military Training Routes

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013

2.3.3.2 Dare County Regional Airport

Dare County Regional Airport is a full-service airport, servicing more than 15,000 flights annually (Skyvector 2014). The airport's non-controlled airspace (common traffic advisory frequency [CTAF]) shares a border with Restricted Area R-5314E, overlapping along the northeastern border of the restricted area. (see Figure 2-2). When civilian aircraft are operating out of Dare County Regional Airport, close coordination must occur with Navy Dare to ensure safety of aircraft operating in the area and in the special use airspace. Based on the number of operations at Dare County Airport and the practice instrument approaches into the airport during visual conditions, a potential compatibility concern may exist. Recommend continued coordination between personnel from Navy Dare and Dare County Regional Airport.

2.3.3.3 Ocracoke Island Airport

Ocracoke Island Airport, located within the Cape Hatteras National Seashore, is a relatively small airport with one runway that serves approximately 117 aircraft operations per week. The proximity of VR-701, an MTR, is about 5 miles to the northeast and is a transit corridor from the Atlantic Ocean to DCBR (see Figure 2-3). The National Park Service owns the airport, and the North Carolina Department of Transportation (NCDOT) operates the facility. Based on the distance from DCBR and the number of operations at the Ocracoke Island Airport, this facility is not likely to contribute to compatibility concerns.

2.4 Range Users

The primary users of DCBR are the F/A-18 squadrons from NAS Oceana, H-60S and MH-53E from Naval Station Norfolk (approximately 15 miles northwest of NAS Oceana), and F-15E aircraft crews from Seymour Johnson AFB. DCBR is also used by the Air National Guard (multiple states), the United States Coast Guard (USCG), the United States Army (Army), the Marine Corps, the United States government and government contractors, and the Joint Naval Special Warfare Development Group. DCBR supports training for installations located in District of Columbia, North Carolina, South Carolina, Florida, and Virginia. These installations include Marine Corps Air Station Cherry Point, Marine Corps Air Station New River, NAS Oceana, NAS Norfolk,

NAS Mayport, Shaw AFB, Pope AFB, and the Virginia Air National Guard Richmond International Airport. Aircraft carrier groups operating in the Atlantic Ocean may also use DCBR and LSNOA (see Table 2-1).

Table 2-1 Typical Squadron Users at the Dare County Bombing Range Complex

Unit	Home Base	Type of Aircraft
Navy Range Users		
VFA-11, 15, 31, 32, 34, 37, 81, 83, 87, 103, 105, 106, 131, 136, 143, 211, and 213	NAS Oceana	F/A-18 A-D, F/A-18 E/F
HSC-2, 5, 7, 9, 11, 26, and 28	Naval Station Norfolk	MH-60S
HM-14 and 15	Naval Station Norfolk	MH-53E
VMM-162	MCAS New River	MV-22B
HMH-366,	MCAS Cherry Point	CH-53E
HMH-461 and 464,	MCAS New River	CH-53E
HMLA-167, 269	MCAS New River	UH-1Y, AH-1W, AH-1Z
Air Force Range Users		
335th, 336th FS	Seymour Johnson AFB	F-15E
55th, 77th, 79th FS	Shaw AFB	F-16C/D
121st FS	Joint Base Andrews	F-16C/D

The primary fixed-wing aircraft at DCBR include the Navy and Air Force F/A-18 A-D/E/F, F-16 A/B/C/D, and F-15E. There are numerous rotary-wing aircraft at DCBR, with the three primary rotary-wing aircraft being the Navy MH-60 R/S, MV-22B, and MH-53E. A summary of each type of aircraft that routinely uses DCBR and LSNOA follows a brief description of range users.

2.4.1 Navy Range Users

2.4.1.1 Strike Fighter Wing Atlantic

The Strike Fighter Wing Atlantic (SFWL) is based at NAS Oceana in Virginia Beach, Virginia, and is comprised of 18 squadrons. The SFWL is charged with training and equipping strike fighter squadrons in order to meet combatant and fleet commander requirements. The SFWL maintains

administrative and operational control of one Fleet Replacement Squadron (VFA-106) and 17 operational "fleet" F/A-18 squadrons (Navy 2009c).

VFA-106 is the East Coast Fleet Replacement Squadron and is charged with the training of F/A-18 Hornet Replacement Aircrew to support Fleet commitments. Navy and Marine Corps Aircrew trainees take part in a nine-month training course that teaches the basics of air-to-air and air-to-ground missions before being assigned to a fleet Hornet squadron. Training events conducted at Navy Dare allow aviators from VFA-106 to fulfill their training requirements and mission (Navy 2009d).


F/A-18 "Hornet"

F/A-18 A-D "Hornet"

The F/A-18 A-D Hornet is a twin-engine, mid-wing, multi-mission, tactical aircraft. The Hornet is designed to attack targets both airborne and on the surface.

F/A-18 E/F "Super Hornet"

Built on the F/A-18 Hornet's original design, the Super Hornet is an attack aircraft and fighter based on the selected use of external equipment and advanced networking capabilities to accomplish specific missions.

2.4.1.2 Helicopter Sea Combat Wing Atlantic


F/A-18 E/F "Super Hornet"

Helicopter Sea Combat Wing Atlantic (HSCWL) is based out of Naval Station Norfolk, with squadrons operating over 110 aircraft and employing over 5,400 personnel. HSCWL includes one Fleet Replacement Squadron, 11 operational squadrons, the Helicopter Sea Combat Weapons School Atlantic, Airborne Mine Countermeasures Weapons System Training School, and Aircraft Intermediate Maintenance Department, Corpus Christi, Texas (Navy 2010b).

Helicopter Sea Combat Squadron 2 (HSC-2) is the Navy's East Coast Fleet Replacement Squadron for the MH-60S Knight Hawk. HSC-2 trains pilots and aircrew members to fly the MH-60S and, along with the operational helicopter squadrons, uses DCBR and LSNOA to fulfill training requirements.

MH-60 R/S "Seahawk"


MH-60 R/S "Seahawk"

The MH-60 R/S Seahawk is a four-bladed, twin-engine, medium-lift utility helicopter designed for various missions. The MH-60R focuses on Anti-Submarine Warfare, Anti-Surface Warfare, Surveillance, Communications Relay, Combat Search and Rescue, Naval Gunfire Support, and Logistics Support (Navy 2012a). MH-60S missions include Anti-Surface Warfare, Combat Support, Humanitarian Disaster Relief, Combat Search and Rescue, and Aero Medical Evacuation.

Helicopter Mine Countermeasures Squadron 14 (HM-14) provides ready for training aircraft to Airborne Mine Countermeasures Weapons System Training School. HM-14 operates MH-53E Sea Dragon aircraft and includes active duty and full time support reserve personnel (Navy 2009a). A second Helicopter Mine Counter Measures Squadron, HM-15, in addition to HM-14, conducts training at DCBR.

MH-53E "Sea Dragon"


MH-53E "Sea Dragon"

The MH-53E Sea Dragon is a heavy lift passenger and cargo helicopter for ships at sea. The Sea Dragon is equipped with the capability to tow numerous types of minesweeping gear as well as side-mounted 7.62mm and tail-mounted .50cal weapons.

2.4.1.3 2nd Marine Aircraft Wing

The 2nd Marine Aircraft Wing (2nd MAW) is the major east coast aviation unit of the Marine Corps. 2nd MAW is made up of six subordinate wings, 44 squadrons, and over 15,000 personnel based at Cherry Point, New River, and Beaufort, South Carolina. Aircraft used by 2nd MAW include the MV-22B, MH-53E, UH-1N/Y, AH-1W, and AH-1Z. The 2nd MAW's mission is to conduct air operations in support of the Marine Forces as well as take part in the execution of Navy functions, as directed by the Fleet Commander (Marine Corps 2014). The newest 2nd MAW squadron that uses DCBR and LSNOA ranges is the Marine Corps tilt-rotor squadron, Marine Medium Tilt-rotor Squadron 162 (VMM-162), which is part of Marine Aircraft Group 26. VMM-162 is based out of the MCAS New River, NC. The VMM-162 mission is to provide assault support of combat troops, supplies, and equipment. In 2006,

VMM-162 began transitioning to the operation of MV-22B Osprey, thereby becoming the second operational Osprey squadron in the Marine Corps (Marine Corps 2013).


MV-22B "Osprey"

MV-22B "Osprey"

The MV-22B Osprey is a tilt-rotor Vertical/Short Takeoff and Landing aircraft designed to accomplish the medium-lift missions. The Osprey can operate as a helicopter or a turboprop aircraft, and offers twice the speed, six times the range, and three times the payload of the CH-46 aircraft it replaced.


CH-53E "Super Stallion"

CH-53E "Super Stallion"

The CH-53E Super Stallion is a heavy lift cargo helicopter used by the Marine Corps. The Super Stallion's mission is the transportation of heavy equipment and supplies for amphibious assault.


UH-1N/Y "Huey"

UH-1N/Y "Huey/Super Huey"

In 2016, the UH-1N Huey will be completely phased out in favor of the newer UH-1Y. The Marine Corps primarily uses this aircraft. The Super Huey features four ballistics tolerant blades and rotor systems, as well as upgraded engines, transmissions, and payload capabilities. The UH-1Y also provides increased load carrying ability, greater range and survivability, a smaller logistical footprint, and easier maintenance.


AH-1W "Super Cobra"

AH-1W "Super Cobra"

The AH-1W Super Cobra is an upgraded version of the world's first attack helicopter, the AH-1 Cobra. Starting in 2006, the AH-1Z Viper began replacing the Super Cobra as part of a remanufacturing program, with the last Super Cobra being retired in 2020. The Super Cobra provides close air support, armed escort, and armed reconnaissance for the Marine Corps.


AH-1Z "Viper"

AH-1Z "Viper"

The AH-1Z Viper is the latest generation attack helicopter and provides rotary-wing close air support, anti-armor, armed escort, armed/visual reconnaissance, and fire support coordination capabilities under day/night and adverse weather conditions for the Marine Corps.

2.4.2 Air Force Range Users

2.4.2.1 4th Fighter Wing

The 4th Fighter Wing (4th FW) is the host wing of Seymour Johnson AFB, North Carolina, and the host unit for DCBR (Air Force 2010). The 4th FW was the first operational F-15E Strike Eagle Wing in the Air Force and is assigned over 6,400 military members, including roughly 600 civilians and 96 F-15E Strike Eagles. The 4th FW consists of four units, including the 4th Operations Group, the 4th Maintenance Group, the 4th Mission Support Group, and the 4th Medical Group. The 4th Operations Group consists of two operational F-15E squadrons, the 335th FS and the 336th FS. Additionally, the 333rd FS and 334th FS are formal training units that prepare the next generation of F-15E pilots and Weapons System Officers for operational employment. The 307 FS is a Reserve Squadron of the 414th Fighter Group that supplements the instructor cadre of the 333rd FS and 334th FS (Air Force 2014).


F-15E "Strike Eagle"

F-15E "Strike Eagle"

The F-15E Strike Eagle is a dual-role fighter designed to perform air-to-air and air-to-ground missions. An array of avionics and electronics systems gives the F-15E the capability to fight at low altitude, day or night, and in all weather.

2.4.2.2 20th Fighter Wing

The 20th Fighter Wing (20th FW), the host wing of Shaw AFB, South Carolina, consists of four units, including the 20th Operations Group, the 20th Maintenance Group, the 20th Mission Support Group, and the 20th Medical Group. The 20th Operations Group consists of three Air Force Fighter Squadrons, including the 55th Fighter Squadron, the 77th Fighter Squadron, and the 79th Fighter Squadron. These Fighter Squadrons maintain mission ready, multi-role capability to mobilize, deploy, and tactically employ forces worldwide in support of national objectives (Air Force 2013b).

2.4.2.3 113th Wing

The 113th Wing is operated by the District of Columbia Air National Guard and is based at Joint Base Andrews, Maryland. The 113th Wing provides air sovereignty forces to defend the nation's capital, and provides fighter, airlift, and support forces. The 113th Wing is made up of the 113th Mission Support Group, the 113th Medical Group, the 113th Maintenance Group, the 113th Operations Group, and 201st Airlift Squadron. The 121st Fighter Squadron (121st FS) operates the F-16C/D Fighting Falcon. The 121st FS also conducts training to ensure mission readiness (Air National Guard 2013).


F-16 C/D "Fighting Falcon"

F-16C/D "Fighting Falcon"

The F-16C/D Fighting Falcon is a single-engine, multi-role jet fighter aircraft with superior maneuverability and sophisticated tracking and weapon systems for the interception and attack of other aircraft.

2.5 Range Training

The entire DCBR is owned and maintained by the Air Force. Ultimately the Air Force controls use of DCBR; however, FACSFAC VACAPES is responsible for the day-to-day operational control of Navy Dare. FACSFAC VACAPES is also responsible for use and scheduling of DCBR special use airspace.

2.5.1 Hours of Operation

According to FACSFACVACAPESINST 3710.1A, normal hours of operation on the NDBRC are Monday through Thursday from 8:00 a.m. to 12:00 a.m. (midnight), and Friday from 8:00 a.m. to 4:00 p.m. The normal hours of operation for Air Force Dare are Monday through Thursday from 8:00 a.m. to 10:00 p.m., and Friday from 8:00 a.m. to 6:00 p.m., Air Force Dare has limited weekend hours of operations, which are between 9:00 a.m. to 4:00 p.m., except on Saturdays that occur during a federal holiday weekend. However, bombing range operating hours vary weekly based on the 4th FW flying schedule and mission requirements (Air Force 2010). On weekends, the public has access to the NDBRC unless the operations tempo requires or specifies otherwise.

2.5.2 Navy Dare County Bombing Range

2.5.2.1 Navy Dare County Bombing Range Description

Navy Dare is a range that includes about 23,000 acres and consists of 15 current and seven proposed targets (Figure 2-4). The range houses several administrative, command and control, and maintenance facilities. The main (central) tower accommodates administrative offices and Weapons Impact Scoring System control. The flanking (east) tower is used for score spotting. Additional facilities include a helicopter pad near the intersection of Navy Shell Road and Center Road, and the Main Gate communications building. There are three targets that are designed to allow pilots to take advantage of targeting tightly packed targets in a given area. These targets are designated as Military Operations in Urban Terrain training areas. Table 2-2 provides a brief description of each target.

Navy Dare is primarily used by Navy F/A-18 aircraft originating from NAS Oceana and Navy helicopters from Naval Station Norfolk. To a lesser extent, Air Force, Marine Corps, and Air and Army National Guard units also use Navy Dare. DCBR permits a wide range of inert ordnance, from fixed-wing strafing to light- and heavyweight training bombs, as well as precision-guided munitions. Rotary-wing and tilt-rotor aircraft are capable of conducting strafing, door gunnery, and tail gunnery training at Navy Dare (Blake 2014b).

2.5.2.2 Navy Dare County Bombing Range Operations

The Navy is the primary user of Navy Dare and is accountable for over 90% of sorties flown between Fiscal Year (FY) 2011 and FY2013. On average, 38 different Navy squadrons use Navy Dare each year, each of which may participate in anywhere from one sortie up to roughly 1,500 sorties at the range annually (Table 2-3). Marine Corps air assets from MCAS Cherry Point and MCAS New River also use Navy Dare. Air Force aircraft also use Navy Dare when Air Force Dare is unavailable. Other users of Navy Dare include the Air National Guard (multiple states), the USCG, and the Army. In 2013, the largest percentage of sorties were flown by F/A-18 Hornets from VFA-106 (1,256 sorties flown in 2013), VFA-213 (570 sorties flown in 2013), and VFA-211 (432 sorties flown in 2013).

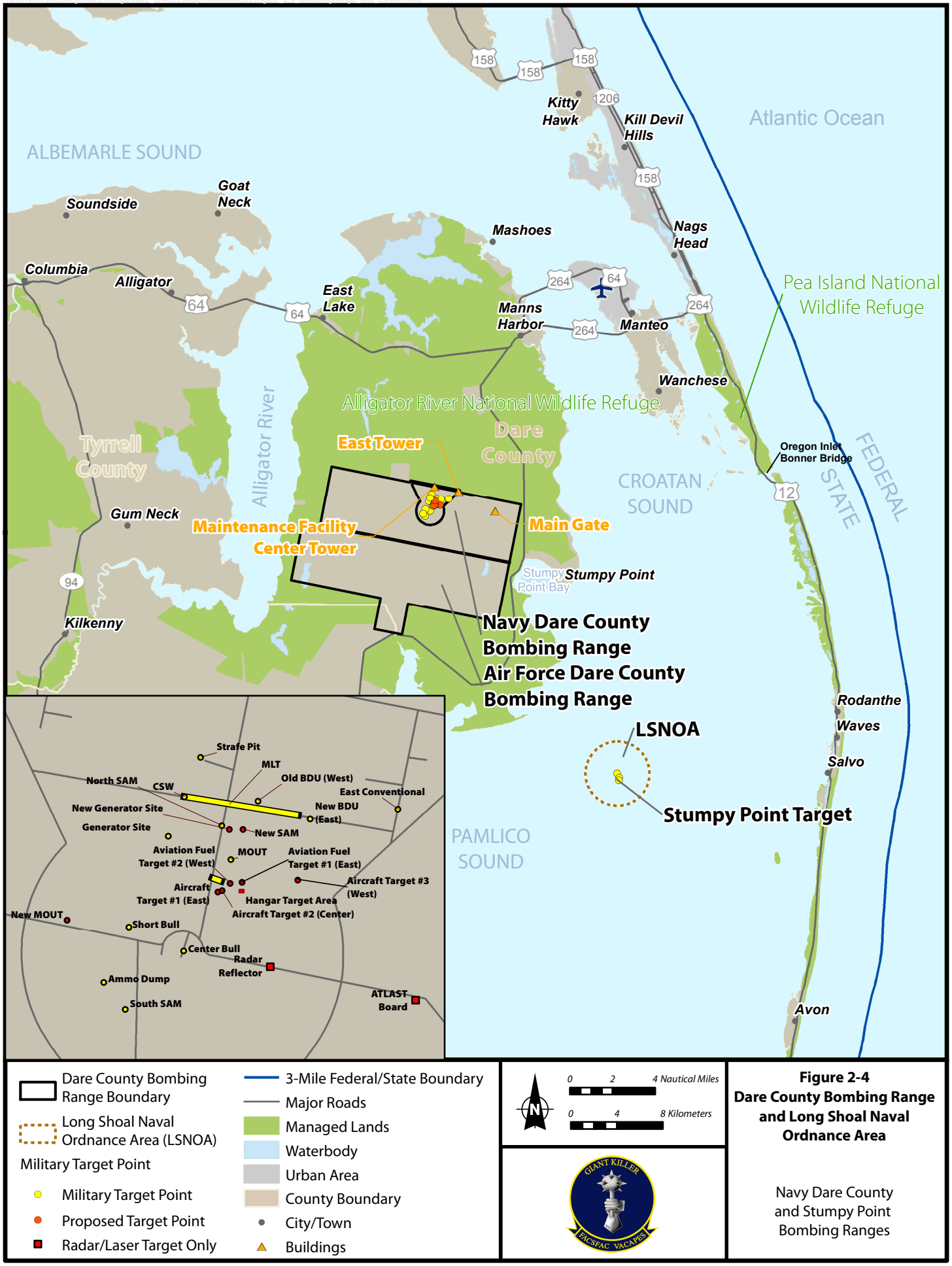


Figure 2-4
Dare County Bombing Range and Long Shoal Naval Ordnance Area

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013

Table 2-2 Target Inventory at Navy Dare and LSNOA

Target	Description
Navy East Conventional Target	▪ Rocket-glide bombing targets ▪ Can be illuminated by a 50’ circle of white lights
Center Bull Target	▪ Large, circular special weapons target ▪ Composed of white steel cans in 500’ diameter circle and outer 1,000’ diameter circle with 10’ height ▪ Bombing and laser munitions permitted ▪ Strafing
Short Bull Target	▪ Bombing and laser munitions permitted ▪ Strafing
Bomb Dummy Unit (BDU) Targets (East and West)	▪ Cylindrical, 14’ long, 8’ wide, painted orange with silver stripes ▪ Bombing and laser munitions permitted
Strafing Target	▪ Has acoustical scoring system for fixed-wing and rotary-wing aircraft
Surface-to-Air Missile (SAM) Site Target (North, South, and New)	▪ Simulates a surface-to-air missile site
Moving Land Target (MLT)	▪ Vehicle mounted laser receiver ▪ Section of road which can be traversed east and west ▪ Uses remote controlled vehicle ▪ Only laser designated munitions approved (as of Aug 2014)
Aviation Fuel Targets (East and West)	▪ Designed to look like fuel tankers found at an aviation facility
Stumpy Point Targets (1-3)	▪ Semi-submerge target. Note: FFVC, CNAL, and USFF are working on a replacement target. ▪ Light inert, 2.75” rockets, 7.62mm, .50-cal, laser-guided training round (LGTR) munitions approved
Military Operations in Urban Terrain Area	▪ Training areas (current and proposed) and proposed hangar targets ▪ Designed to allow pilots to take advantage of targeting tightly packed targets in a given area
Hangar Target Area	▪ Designed to look like an active aviation facility ▪ Runway Target is considered a linear target ▪ Only light inert munitions approved
Crew-Served Weapons (Convoy)	▪ Light inert, 2.75” rockets, 7.62mm, and .50-cal used.
Strafe Pit	▪ Light inert, 2.75” rockets, 7.62mm, and .50-cal used.
Ammo Dump	▪ Bombing and laser munitions permitted ▪ Cylindrical, 14’ long, 8’ wide, painted orange with silver stripes
Runway	▪ Bombing and laser munitions permitted

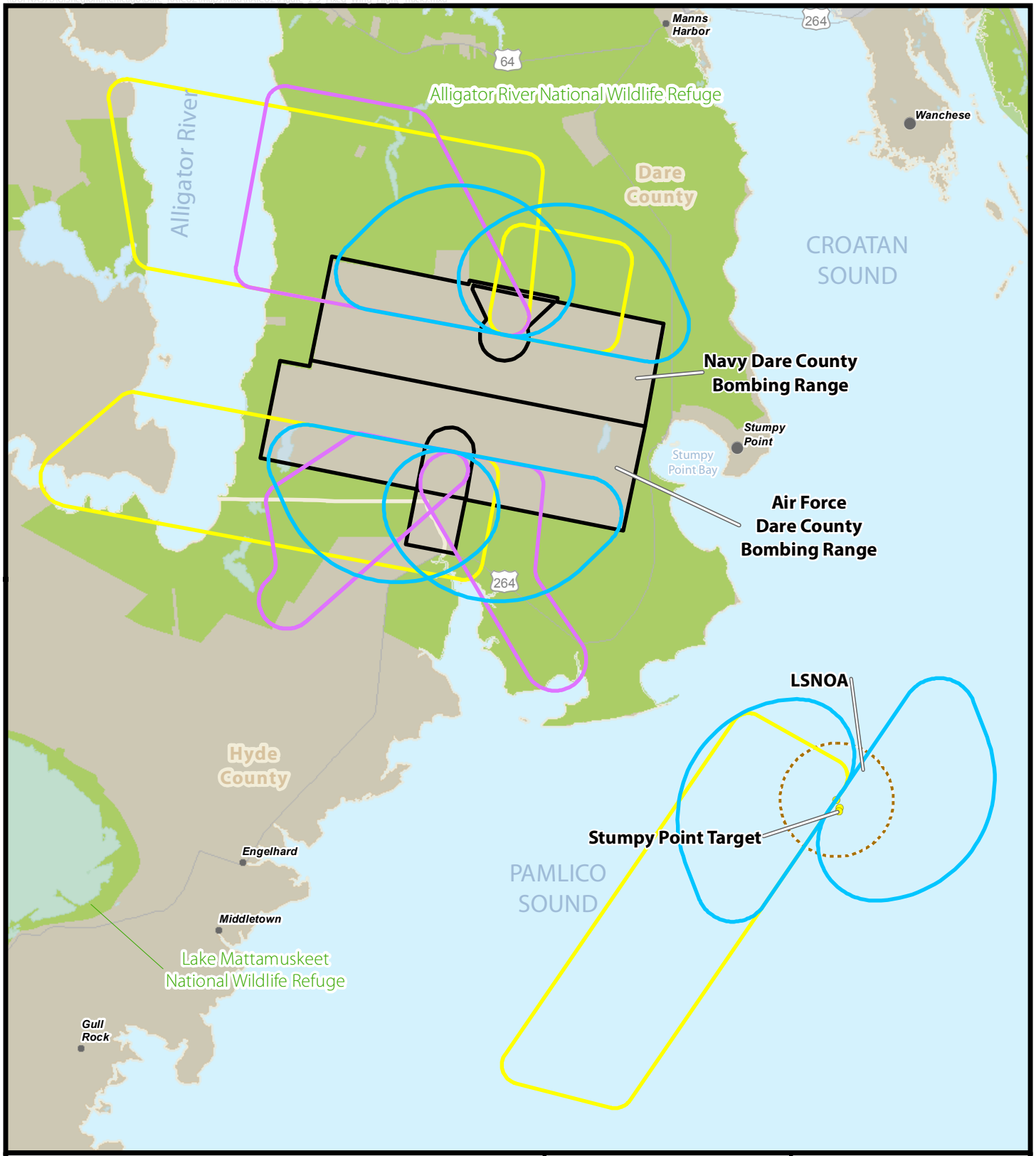
Table 2-3 Navy Dare Users and Annual Sorties

	Year			Average Number of Squadrons Annually	Average Number of Sorties Annually
	2011	2012	2013		
U.S. Navy	44	32	39	38.3	6,746
U.S. Air Force	7	6	5	6.0	193
U.S. Marine Corps	6	11	5	7.3	122
U.S. Army	2	2	1	1.7	
U.S. Coast Guard	1	2	1	1.3	
Army National Guard	2	3	1	2.0	
Other military (not specified)	0	1	0	0.3	
Foreign Military	1	0	0	0.3	
Air National Guard	2	1	2	1.7	142

Source: Navy 2013a

Air-to-ground operations conducted at DCBR include Conventional bombing, Circle the Wagons, Pop-Up attacks, Strafe/Gunnery patterns, Captive Air Training Missile Exercises, and Tactical Attack runs (BRRC 2013). Figures 2-5 and 2-6 displays a representative sample of the various types of flight tracks used for noise modeling at DCBR and LSNOA. During Conventional pattern, also called a box pattern, the aircraft typically begins from a level flight and has a level or diving release of the weapon. A Circle the Wagons pattern is similar to a conventional pattern except after weapons release the aircraft turns at a constant rate turn to acquire a down-wind leg and the same turn rate to reacquire a final approach leg for weapons release. The Pop-Up pattern consists of a low altitude run-in towards the target on a heading oblique to the planned delivery heading, then pulling up, or "popping," in an oblique climb, and then pulling back down to the predetermined dive angle and delivery heading at the target for manual release. There are multiple variants of the Pop-Up pattern depending on aircraft and release method; typically, aircraft change altitude and angle of bank multiple times during each pattern.

Strafing (aerial gunnery) deliveries use both diving and level deliveries based on aircraft type; strafing is typically done is the most efficient pattern (a variation of the circle the wagons).



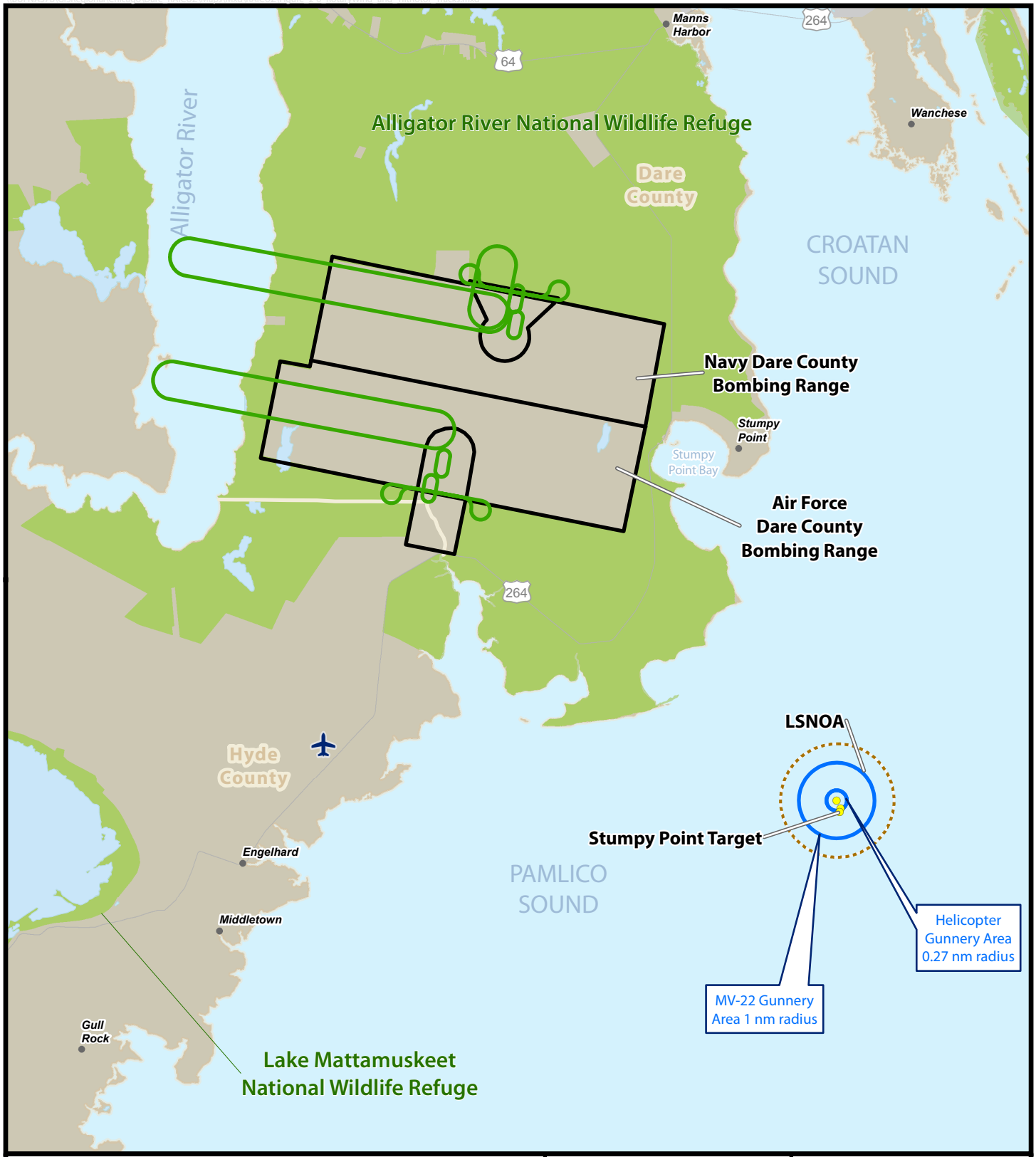
Dare County Bombing Range Boundary
Long Shoal Naval Ordnance Area (LSNOA)
Stumpy Point Target
City/Town
Managed Lands
County Boundary
Circle the Wagon Flight Track
Conventional (Box) Flight Track
Pop-up Flight Track

0 1 2 Nautical Miles
0 2 4 Kilometers

Figure 2-5
Fixed Wing Flight Tracks

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013



Dare County Bombing Range Boundary
Long Shoal Naval Ordnance Area (LSNOA)
Stumpy Point Target
City/Town
Flight Track
Managed Lands
County Boundary
Area Mission Boundary

0 1 2 Nautical Miles
0 2 4 Kilometers

Figure 2-6
Rotary-Wing and Tilt-Rotor Flight Tracks and Areas

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013

MH-60S/F/H helicopter sorties flown by Navy squadrons comprise the next significant number of sorties flown at Navy Dare. A smaller number of MH-53 sorties were flown by Navy squadrons HM-14 and HM-15 from 2011 to 2013. In 2013, five Marine Corps squadrons utilizing MV-22B aircraft as well as Air Force F-15s and F-16s also used Navy Dare, as the Air Force may use Navy Dare when Air Force Dare is unavailable (Navy 2013a).

2.5.3 Air Force Dare County Bombing Range

2.5.3.1 Air Force Dare County Bombing Range Description

Air Force Dare is a three-tower, Class-A range. The range contains a nuclear target, a conventional target, heavyweight targets, a strafe pit, laser targets, two military operations in urban terrain target arrays, and multiple tactical targets. The tactical targets include specialized active infrared targets. The conventional and nuclear targets are equipped with lights for night deliveries (Air Force 2010).

2.5.3.2 Air Force Dare County Bombing Range Operations

Air Force Dare is the primary training range for the 4th FW from Seymour Johnson AFB. Navy and Marine Corps aircraft also schedule and use Air Force Dare when Navy Dare is unavailable. Air-to-ground operations conducted at Air Force Dare include Conventional bombing, Circle the Wagons, Pop-Up, Strafe/Gunnery patterns, and Tactical Attack runs (BRRC 2013). Figures 2-5 and 2-6 displays the various types of flight tracks used for noise modeling at Air Force Dare.

2.5.4 Long Shoal Naval Ordnance Area

2.5.4.1 Long Shoal Naval Ordnance Area Description

The LSNOA is an instrumented water-based range and serves as an air-to-ground training location. The LSNOA range consists of a single, active, semi-submerged target located between Long Shoal Point and the Outer Banks (see Figure 2-2). The target is contained within and surrounded by the footprint of the airspace of Restricted Area R 5313A/B/C/D. The Stumpy Point MOA and Pamlico A and B MOAs further surround the restricted airspace.

2.5.4.2 Long Shoal Naval Ordnance Area Operations

Military users at the LSNOA are similar to those at Navy Dare. The Navy is the primary user of LSNOA and, on average, 25 naval squadrons have used the range for an average of 901 sorties annually since its reopening in 2012 (Table 2-4). Similar to Navy Dare, the greatest numbers of sorties have been conducted by Navy F-18 aircraft. Additional range users include the Army, USCG, Marine Corps, Air National Guard, and Air Force squadrons.

Table 2-4 LSNOA (Stumpy Point) Users and Annual Sorties

	Year		Average Number of Squadrons Annually	Average Number of Sorties Annually
	2012	2013		
U.S. Navy	24	27	25.5	901
U.S. Air Force	1	2	1.5	2
U.S. Marine Corps	5	4	4.5	14
U.S. Army	0	1	0.5	
U.S. Coast Guard	0	1	0.5	
Air National Guard	0	1	1.0	0

Source: Navy 2013a
Note: Squadron data only accounts for the lead aircraft in a "flight" of multiple aircraft. The number of squadrons participating may be higher than recorded due to software limitations.

Authorized munitions at the LSNOA include inert lightweight and heavyweight, paraflares, and night photoflashes. Only lightweight, inert ordnance is authorized for aircraft deploying air-to-ground weapons at this range; fixed-wing strafing is prohibited (Navy 2010c). Current plans include adding the ability to conduct live-fire training using small caliber crew-served weapons mounted on small patrol vessels (Blake 2014b).

Figure 2-4 shows the locations of the most recent targets. FACSFAC VACAPES, COMNAVAIRLANT, and USFF are working on a replacement target for LSNOA. Operations conducted at LSNOA include Conventional bombing, Strafe/Gunnery patterns (no ordnance released), and Tactical Attack runs. Figures 2-5 and 2-6, described in Section 2.5.3, display the various types of flight tracks used for noise modeling at LSNOA.

LSNOA is primarily used by Navy F/A-18 aircraft originating from NAS Oceana and by Navy helicopters originating from Naval Station Norfolk. To a lesser extent, Marine Corps MV-22 aircraft also use LSNOA.

2.6 Projected Operations

Future range operations at the Range Complex will likely remain at a consistent level over the next five years (BRRC 2013). Overall usage at Navy Dare has increased by 2% between 2011 and 2013 (Table 2-5) and increased 3% between 2008 and 2013. Unlike the consistent level of utilization at Navy Dare, operations at LSNOA decreased by 25% between 2012 and 2013 (Table 2-6); however, anticipated increases related to expanding training opportunities may make up for the decrease in usage reported at LSNOA between 2012 and 2013.

Table 2-5 Number of Sorties Flown per Aircraft Type at Navy Dare

Year	F-15	F-16	F/A-18	MH-60	MH-53	MV-22	AH-1, OH-58	T-34, Cessna	E-2, E-3, C-130	Civilian Contract Fixed Wing Aircraft	Total
2011	141	66	6,363	339	-	-	31	70	3	209	7,222
2012*	211	141	6,340	211	70	70	20	125	1	178	7,367
2013	214	54	6,355	539	10	10	15	76	-	96	7,369
Percent Change from 2011 to 2013	52%	18%	-0.1%	59%	-	-	-52%	9%	-100%	-54%	2%

Sources: (BRRC 2013; Navy 2013a)
Note:*2012 usage data was reported in the 2013 Noise Study all other data is from FACSFAC VACAPES usage data (Navy 2013a).

Table 2-6 Number of Sorties flown per Aircraft at LSNOA (Stumpy Point)

Year	F-15	F/A-18	MH-60	MH-53	MV-22	UH-1	T-34	Civilian Contract Fixed Wing Aircraft	Total
2012*	2	804	150	32	35	3	9	7	1,042
2013	3	594	156	0	5	-	4	18	780
Percent Change from 2012 to 2013	50%	-26%	4%	-	-86%	-100%	-56%	157%	-25%

Sources: (BRRC 2013; Navy 2013a)
Note:*2012 usage data was reported in the 2013 Noise Study all other data is from FACSFAC VACAPES usage data (Navy 2013a).

2.6.1 Crew-Served Weapons

The Navy anticipates an overall increase in the use of crew-served weapons including those using 5.56mm, 7.62mm, and .50-caliber ammunition (BRRC 2013). However, because of alternative training areas, including surrounding ranges, open water, and the Fort Pickett Army National Guard Maneuver Training Center in Blackstone, Virginia, there may be little change in utilization at Navy Dare unless the number of squadrons located in the area changes. The Navy plans to use LSNOA to conduct surface-to-surface weapons training with short-range training ammunition from riverine patrol craft. The use of short-range training ammunition will allow the firing of weapons up to .50 caliber with smaller surface danger zones (SDZs) than standard small caliber ammunition (Blake 2014a).

2.6.2 Joint Direct Attack Munition

The Navy intends to begin using JDAMs for training purposes at Navy Dare in the next five years. While this will lead to increased operations at Navy Dare, this may result in a shift of the use of JDAMs away from Air Force Dare, resulting in no net increase in JDAM missions at DCBR.

2.6.3 Laser-Guided Training Round

There is a potential for increased use of Laser-Guided Training Round (LGTR) mission at Navy Dare. However, with only two years of utilization rates from 2012 and 2013, it is possible that there will be no net increase resulting from the LGTR mission at Navy Dare (BRRC 2013; Blake 2014a).

2.6.4 Target Expansion

The Navy is planning for three new targets at DCBR, including an area target and two linear targets. Two linear targets were also modeled for Navy Dare: the Moving Land Target (MLT) Roadway and the runway. The MLT Roadway is a future target that will consist of a remote-controlled target that can traverse east and west along the current 3,500-foot road. Currently, the only use of this target is laser designation. To prevent destruction of the MLT, a “tow sled” may be developed that would travel behind the MLT for the use of crew-

served weapons targeting. The second linear target is the runway located just south of the current military operations in urban terrain facility.

2.6.5 Joint Strike Fighter F-35

The Navy began transitioning to the F-35 in 2015, and it is expected to make up a strong majority of the Navy and Marine Corps tactical airpower over the next 10 to 15 years, which could result in increased operations by this aircraft at DCBR (BRRC 2013). The F-35 generates noise comparable to F-18E/Fs and is louder than F-16s, which may result in changes to future noise footprints.

2.6.6 MV-22Bs

As troops return from Afghanistan, there is an anticipated slight increase in utilization of the Range Complex by MV-22Bs. It should be noted, however, that despite the decreasing mission in Afghanistan and the likely increases in the usage of Stumpy Point, utilization of Navy Dare may remain relatively static (Blake 2014a).

While significant increases in usage at the Range Complex are not anticipated, guidance provided by Navy personnel show that the Range Complex may experience a slight increase in utilization over the next few years because of expanded training opportunities (Blake 2014a). Those opportunities include an increase in the use of precision-guided munitions, increased rotary-wing and tilt-rotor aerial gunnery, an expansion of operations on new and future targets, and increased sorties resulting from troop withdrawals abroad.

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3

Noise Analysis

Understanding the impact of aircraft noise is a critical factor in the planning of future land use near air facilities and ranges. How a military range manages noise can play a significant role in shaping the range's relationship with the community. The community response to noise is a particular concern near training ranges and under the SUA because of the noise exposure characteristics commonly associated with low-altitude high-speed aircraft operations, muzzle blast, and the detonation of ordnance (only inert at ordnance authorized at the Range Complex). The Navy has defined noise zones for the surrounding areas of each air-to-ground target range using the guidance provided in the Navy's RAICUZ Instruction (OPNAVINST 3550.1A). These noise zones provide the community with a tool to plan for compatible development near ranges.

3.1 What is Sound/Noise?

Sound is vibrations in the air that can be generated by a multitude of sources. When sound is considered unwanted or invasive to a listener, it becomes noise. Some sources of noise include roadway traffic, recreational activities, construction activities, and aircraft operations. Appendix A provides further discussion of noise and its effects on people and the environment.

3.1.1 Range Noise Sources and Noise Modeling

The main sources of noise at DCBR and LSNOA are flight operations, aerial gunnery (strafing) and, to a lesser extent, inert ordnance. Generally, the number of operations fluctuates from year to year, and small fluctuations in the annual number of operations or ordnance will not have a significant effect on community noise exposure. Computer models develop noise contours based on information about these operations, including:

- Aircraft flight profile (power settings, speeds, and altitudes);
- Environmental data (temperature and humidity);
- Number of operations per day/year;
- Terrain and surface type;
- Time of operation (day and night); and
- Type of operation.

3.1.2 Aircraft Noise

The noise environment at DCBR and LSNOA is dominated by aircraft flight operations and aerial gunnery events. In this RAICUZ Study, the Navy analyzed the noise generated from aircraft operations at the range and within the SUAs (e.g., restricted areas, MOAs, and MTRs), as well as the noise generated from aerial gunnery operations. Aircraft noise generated in SUAs is different from noise associated with an airfield. To account for the sporadic nature of SUA activities, the number of average daily operations is determined from the number of flying days in the calendar month, with the highest number of operations in the airspace of interest.

The noise exposure from aircraft at DCBR and LSNOA is calculated using the day-night average sound level (DNL) metric expressed in decibels (dB), which is used to define the level of noise exposure on a community. The DNL has a 10-dB penalty (10 times the day noise level for nighttime operations) to account for generally lower background sound levels and greater community sensitivity to noise during the nighttime hours. Nighttime is defined as the period from 10:00 p.m. to 7:00 a.m. The DNL is shown as a noise contour that connects points of equal value.

NOISEMAP, a DOD-approved noise-modeling program, calculates DNL noise contours resulting from aircraft operations using such variables as power settings, aircraft model and type, maximum sound levels, duration, and flight profiles. The noise contours generally are concentrated over the target area due to the combination of aircraft and aerial gunnery events. The noise contours

generated from the modeling program show where aircraft noise occurs at the range and in the SUA, and at what sound level.

Decibel A-weighting, expressed as dBA, is applied to instrument-measured sound levels to account for the relative "loudness" perceived by the human ear, as the ear is less sensitive to low audio frequencies. The noise contours in this RAICUZ Study are provided in increments of five dBA (60, 65, 70, >75 DNL).

For airspace operations, DNL is adjusted for the onset rate of aircraft noise on a listener on the ground and designated as the average monthly onset rate adjusted DNL (L_{dnmr}). L_{dnmr} is the primary noise metric used in this RAICUZ Study to define and analyze the aircraft noise exposure of DCBR and LSNOA. The DNL metrics can be adjusted to account for the "surprise" effect of the onset of aircraft noise events on humans. The contours generally follow the flight paths of aircraft in the SUA. The noise contours generated from the modeling program show where aircraft noise occurs around DCBR and LSNOA and at what sound level.

Noise contours provide the range, local community planning organizations, and the public with maps of the modeled noise-related impacts of aircraft operations. Noise contours, when overlaid with local land uses, can help identify areas of incompatible land uses and plans for future development around a range. Calculated noise contours do not represent exact measurements. Noise levels inside a contour may be similar to those outside a contour line. When the contour lines are close, the change in noise level is more drastic. When the contour lines are far apart, the change in noise level is gradual.

3.1.3 Airborne Weaponry Noise

Airborne weaponry noise describes the total noise created during aerial gunnery operations (strafing) at DCBR and LSNOA. This noise is impulsive in nature, with sudden bursts of noise from the firing of airborne guns, such as the F/A-18C/D's M61A1 Vulcan 20mm weapon. For impulsive noise, C-weighted sound levels (CDNL) are used. "C-weighted" denotes an adjustment to the frequency content of a noise event to represent human response to louder noise

levels. Compared to A-weighting, C-weighting enhances the lower frequency content. Strafing noise has two components: ballistic waves (sonic booms) from the bullets, and muzzle blast from the gun firing. The ballistic waves from the bullets only occur forward of the firing point, while muzzle blast can be heard in all directions. The DNL metric is used to characterize strafing noise, but C-weighted sound levels are used to account for the lower frequency content and higher levels of strafing.

In addition to CDNL, peak sound pressures can be used to assess the potential for complaints. The peak sound pressure level (dBPk) is the highest instantaneous, un-weighted sound level over any given period time. It is used to quantify impulsive, short duration events, such as a large-caliber weapon firing or a sonic boom. The primary drivers of the maximum peak levels are the sonic booms from the supersonic delivery of the bullets and the muzzle blast. Peak levels above 115dBpk remain well within the range boundary and, thus, there is a low risk of complaints from the surrounding population.

3.2 RAICUZ Noise Contours

Noise contour maps provide the Navy, local community planning organizations, and the public with modeled noise-related impacts of range operations. Noise contours, when overlaid with local land uses, can help identify areas of incompatible land uses and plans for future compatible development around a range.

The level of noise exposure is related to variables including aircraft type, engine power setting, altitude, flight track, temperature, relative humidity, frequency, and time of operations. Small fluctuations in the annual number of operations or ordnance will not have a significant effect on community noise exposure. Noise sources at the Range Complex are mainly from aircraft flight and strafing events. These events were modeled against the two most commonly used metrics, DNL and dBPk. See Figures 3-1, 3-2, and 3-3 for 2014 noise contours at DCBR and LSNOA.

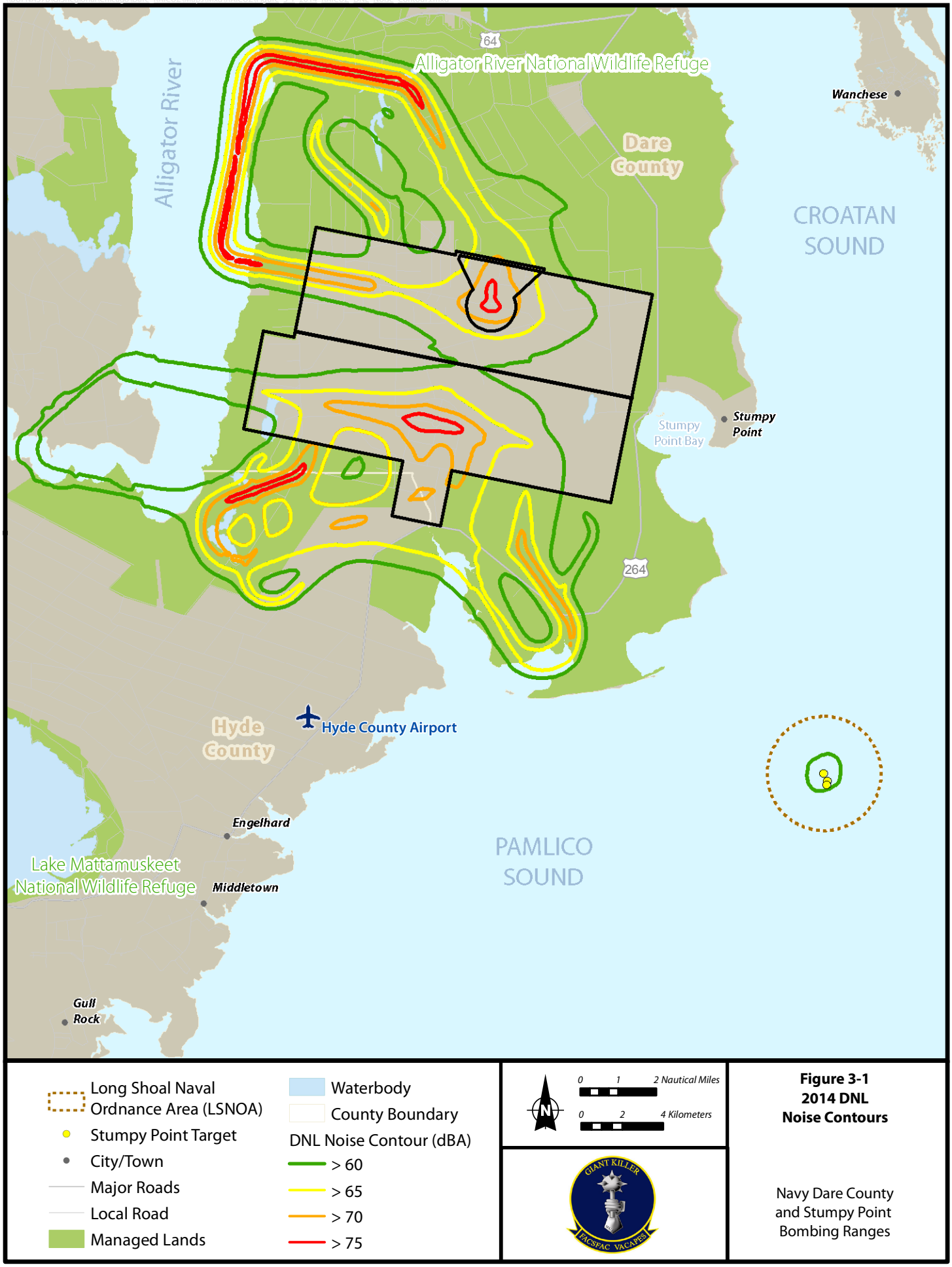
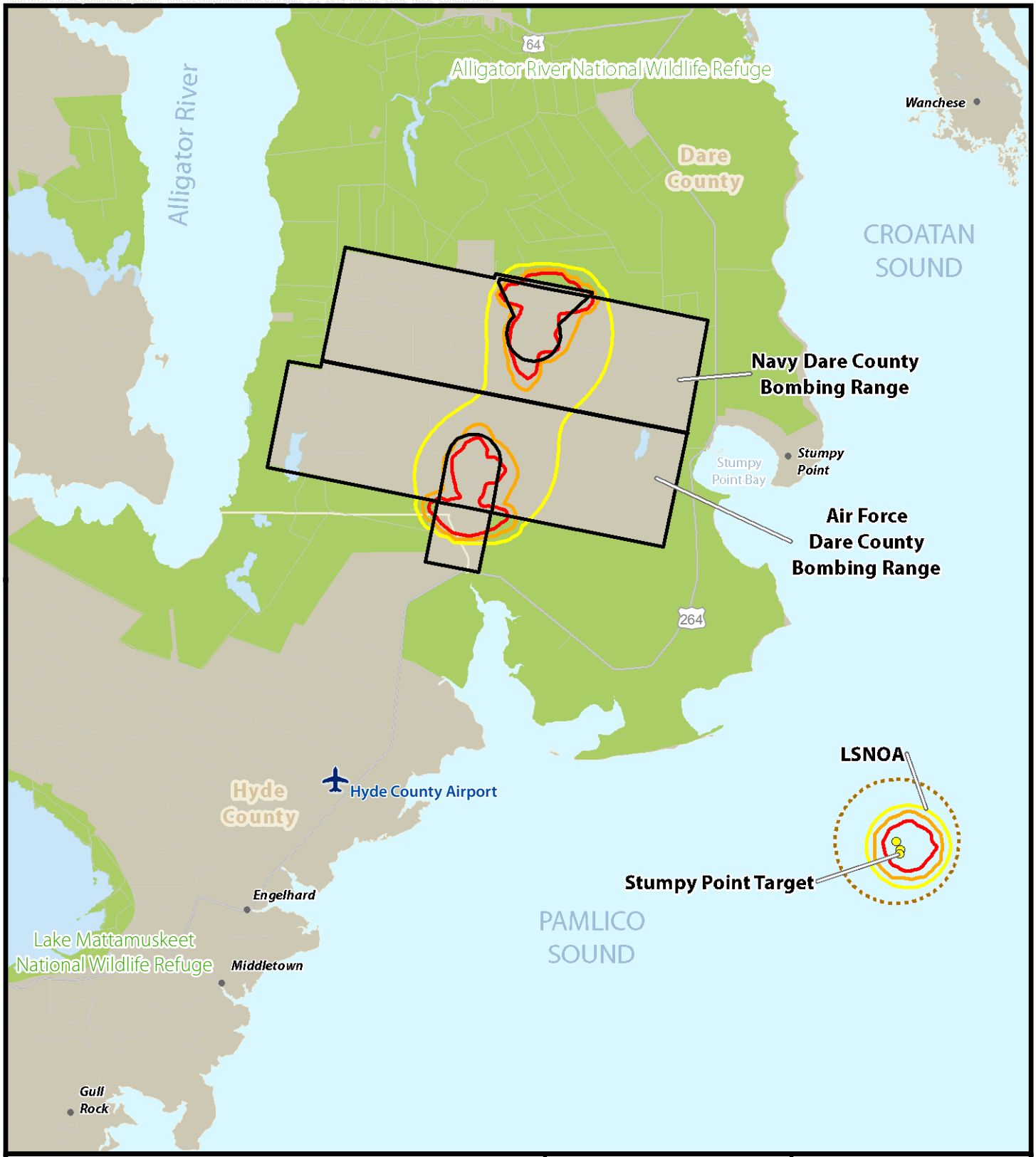


Figure 3-1
2014 DNL
Noise Contours

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013; BRRC 2014



Dare County Bombing Range Boundary
Long Shoal Naval Ordnance Area (LSNOA)
Stumpy Point Target
City/Town
Major Roads
Local Road

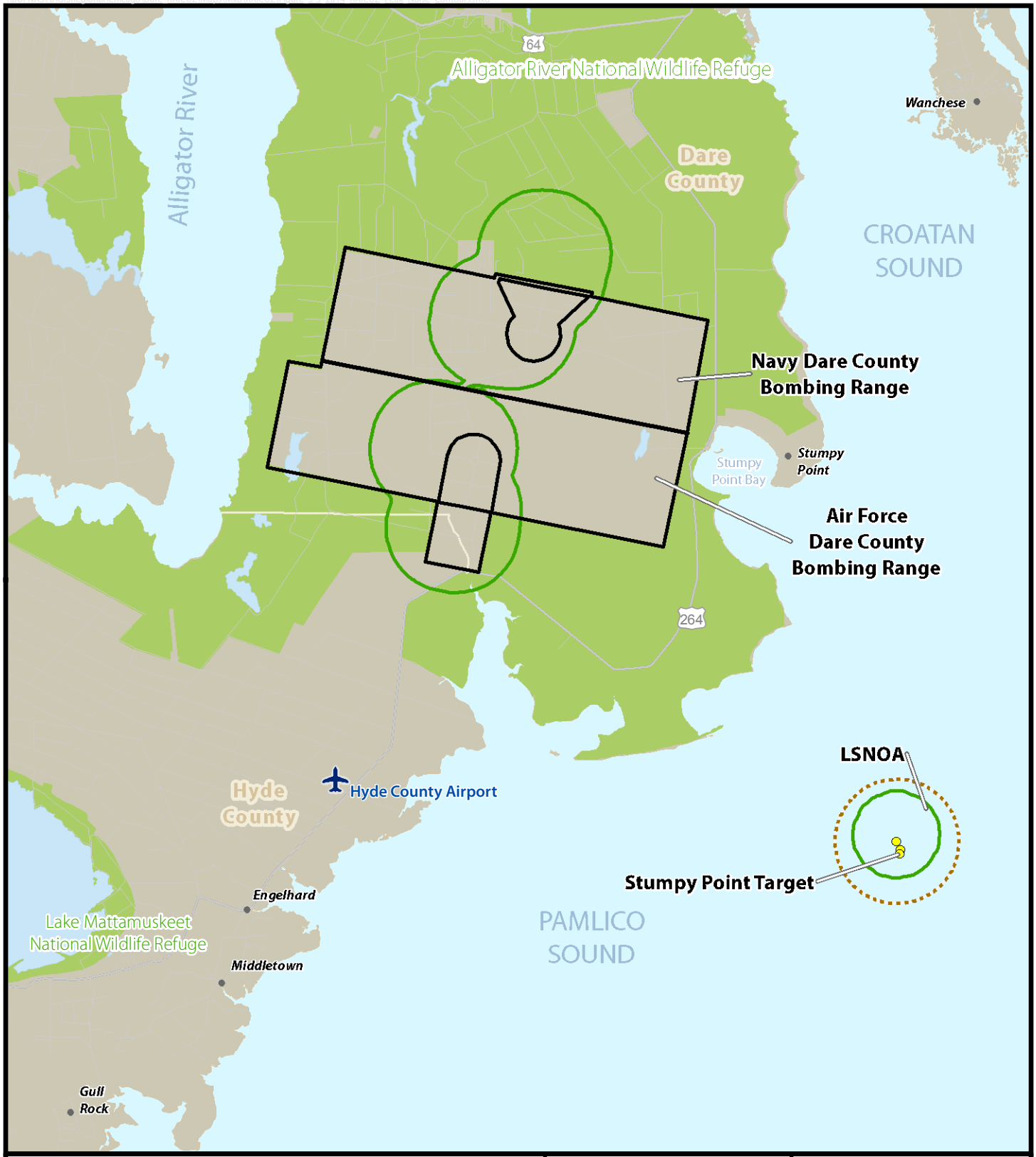
Managed Lands
Waterbody
County Boundary
CDNL Noise Contour (dBC)
> 57
> 62
> 67

0 1 2 Nautical Miles
0 2 4 Kilometers

Figure 3-2
2014 CDNL Noise Contours

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013



Dare County Bombing Range Boundary
Long Shoal Naval Ordnance Area (LSNOA)
Stumpy Point Military Target
City/Town
Major Roads
Local Road
Managed Lands
Waterbody
County Boundary
Peak Noise Contour (dbPK)
> 115

0 1 2 Nautical Miles
0 2 4 Kilometers

Figure 3-3
2014 RAICUZ Peak Noise Contours, Air Gunnery Operations

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013; BRRC 2014

3.2.1 Navy Dare County Bombing Range 2014 Noise Contours

The 2014 noise contours at Navy Dare primarily align with the Pop-Up attack/bombing patterns. Noise levels at Navy Dare are concentrated over the target area and along the northwestern extent of the F/A-18 A-D and F/A-18 E/F Pop-Up bombing flight tracks (Figures 3-1, 3-2, and 3-3). These are the areas along the flight track where the flight profile conducted is at its lowest altitude. Noise exposure from aircraft operations extends beyond the boundary of the range to the north and west over the ARNWR and over the east side of the Alligator River:

- The extension of the 60-dB DNL noise contour over the target area is attributed to Circle the Wagons bombing patterns; and
- The F-18 flight profiles have a greater noise impact than the other aircraft due to the dominant number of operations.

3.2.2 Air Force Dare County Bombing Range 2014 Noise Contours

The 2014 noise contours at Air Force Dare primarily align with the Pop-Up and conventional (racetrack) bombing patterns. These are the areas along the flight track where the flight profile conducted is at its lowest altitude. Noise exposure from aircraft operations extends beyond the boundary of the range to the west and south over the ARNWR and parts of Hyde and Tyrrell counties.

3.2.3 Long Shoal Naval Ordnance Area 2014 Noise Contours

For LSNOA, the operational tempo is only sufficient to generate a 60 dBA DNL contour that is centered on the target location with a diameter of approximately 1 nm within Pamlico Sound; hence, the aircraft noise is contained well within the range (Figures 3-1, 3-2, and 3-3).

3.2.4 Navy Dare County Bombing Range 2007 RAICUZ Noise Contours

The 2007 RAICUZ noise analysis was adapted from the Noise Study for Dare County Range, North Carolina, January 2006, developed by Wyle

Laboratories. DNL levels were calculated for each aircraft type based on the number of operations, existing run-in headings, and flight tracks for Navy and Air Force aircraft using the MR_NMAP 2.2 software using 2003 data. CDNL contours between 60 and 70 dB, excluding areas under ingress/egress routes, are shown on Figure 3-4. In the 2007 RAICUZ, noise exposure from aircraft operations extends beyond the boundary of the range to the north, south, east, and west, and over the west of the Alligator River:

- The 65-dB DNL noise contour extends south of Air Force Dare and west of the Alligator River; and
- The 75-dB DNL noise contour is concentrated over the Alligator River.

The F-18 flight profiles have a greater noise impact than the other aircraft due to the dominant number of operations for Navy Dare, and the F-15E flight profiles have a greater impact for Air Force Dare.

3.2.5 Comparison of 2007 and 2014 Noise Contours

The 2014 noise contours have changed in size and location from the 2007 RAICUZ noise contours (see Figures 3-1 and 3-4). The 2007 RAICUZ did not contain a complete study of the methodology; however, information was sufficient to determine the sources and the flight patterns and types of operations that generated the contours as described above in Section 3.2.4. Differences between the 2007 and 2014 noise contours show that changes are due, in part, to aircraft operations, aircraft types, and the locations of holding patterns, run-in headings, and improved modeling techniques.

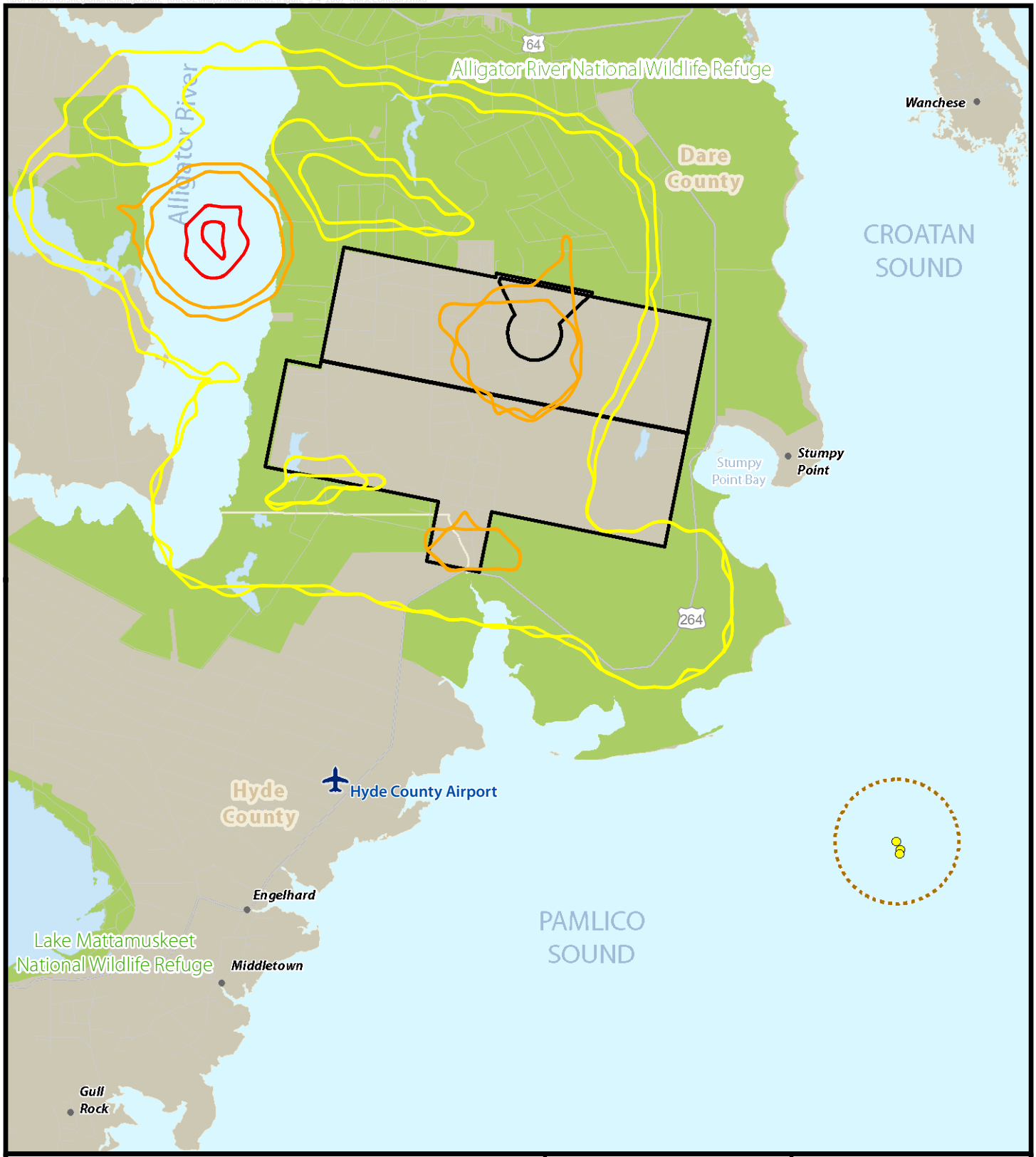


Figure 3-4
2007 RAICUZ DNL Noise Contours

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013; BRRC 2014

The 2014 noise contours have decreased in overall size using the 65-dBA DNL contours as a metric. Specifically, the 2014 contours at Navy Dare primarily align with the Pop-Up flight tracks over the ARNWR and a significantly reduced noise profile over the western edge of the Alligator River and the Alligator River Game Lands compared to the 2007 contours (see Figures 3-1, 3-4, and 5-2). The 75-dBA DNL noise contour under the 2007 RAICUZ is contained primarily over the Alligator River and over the installation. The 2014 75-dBA DNL noise contour also is contained primarily over the ARNWR, the installation, and the Alligator River to the north and west of the installation. Overall, the changes to the 75-dBA DNL contour are over sparsely populated areas. Section 5.6 discusses the land use recommendations for the 2014 noise contours.

3.3 How Weather Affects Noise

Weather, as well as atmospheric, geographic, and local influences, has an effect on aircraft noise at DCBR and LSNOA. Variations in temperature, relative humidity, wind, foliage extent, and even cloud cover, in addition to other conditions, such as foliage extent, can significantly affect the perception of aircraft noise on the ground. These effects can be simplified to those that affect the propagation of sound. It is important to note that the propagation of sound at DCBR and LSNOA includes both aircraft noise and the percussive sounds of weaponry (muzzle blast).

Sound waves travel through air, similar to waves through water. Sound travels faster through cold air than warm air. This makes aircraft seem louder on cold days than those with warmer temperatures. Temperature inversion (i.e., where a warm air mass sits on top of a cold air mass similar to a lid) amplifies this affect by trapping and reflecting sound horizontally over the earth's surface rather than vertically out into space (National Research Council 2008). Adding to this, humidity and cloud cover can further amplify sound waves by acting similarly to a backstop at a band shell and reflecting sound back down towards the ground.

Another factor that plays a role in sound perception on the ground is wind speed. Wind helps to propagate sound in a particular direction, thereby amplifying it in one direction (Jandakot Airport 2014). Figure 3-5 shows this effect. Locally, the extent of foliage on mixed hardwoods, loblolly pine, and plants near DCBR can also affect the perception of sound on the ground. During spring and summer, when groves of trees have a full covering of leaves, they are able to act as another insulating layer from noise (FAA 1978). Sound absorption in the atmosphere and by foliage mostly effects the perception of sound on the ground without affecting the decibel level produced by the aircraft. Conversely, sound is relatively unobstructed over surfaces that are not porous, such as water or hard packed ground.

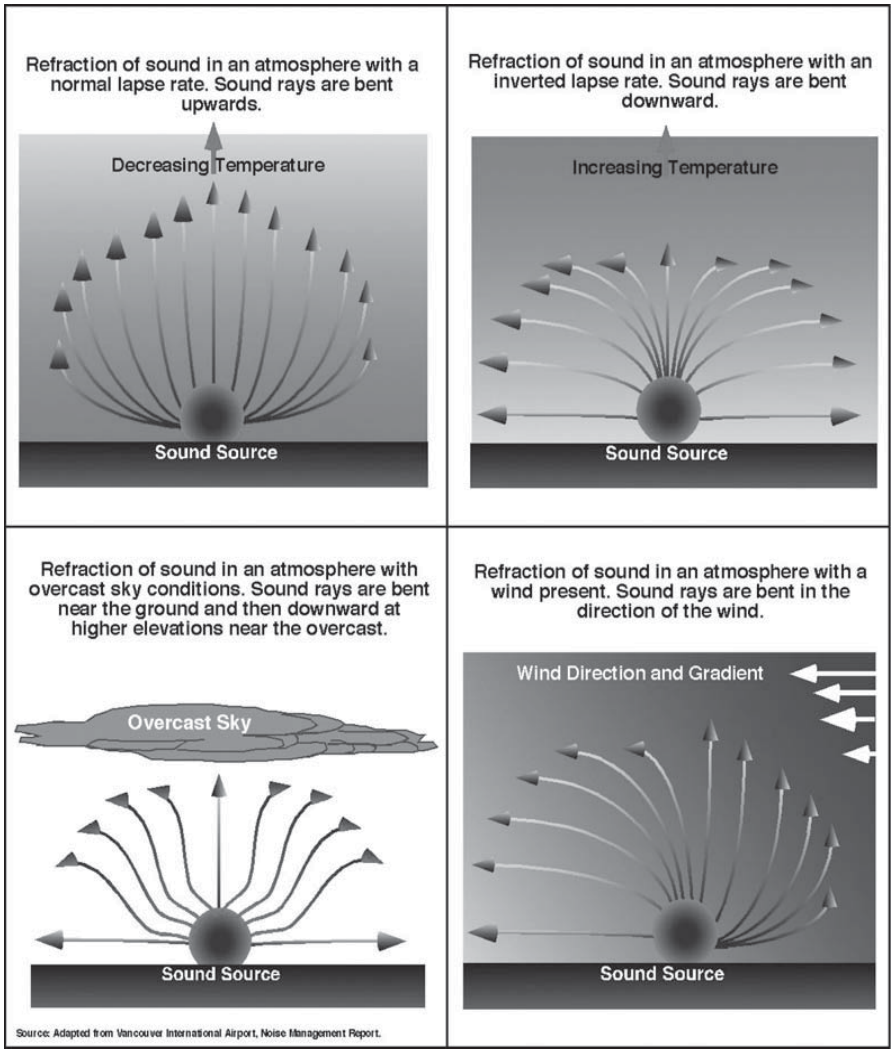


Figure 3-5 Weather Effects on Sound Propagation

Weather, atmospheric, geographic, and local influences also affect the function and efficiency of the aircraft engines. Geographic influences at DCBR At higher relative humidity, aircraft engines will need to be at a higher power setting to produce the same amount of thrust needed to climb at the same rate. This means that an aircraft engine will produce higher decibel sounds at lower altitudes for longer periods in order to achieve the same altitude (Shillito and Harp 1950). As such, the factors described above and their influence on noise produced by aircraft and aerial gunnery events at DCBR are considered when evaluating potential noise impacts.

3.4 Noise Abatement and Complaints

Noise Complaint hotline for operations at DCBR

910-722-1045

To mitigate noise complaints and provide citizens with a prompt response, FACSFAC VACAPES and Seymour Johnson AFB have a formalized noise and airspace complaint program. Citizens who wish to register a complaint can call the dedicated hotline to voice their concerns. This information is recorded on the Noise/Airspace Complaint Form to document the date and time of the incident, as well as the nature of the complaint and identification of the complainant. Complaints are then passed on to the Air Force and Navy Range Managers and the CO of FACSFAC VACAPES. By assessing noise complaints, the Navy can identify noise sensitive areas, determine which operational activities are responsible for the noise complaints, and ultimately help abate future noise complaints. See Figure 3-6 for the locations of noise sensitive areas (called “Avoidance Areas”) (Navy 2010c).

3.4.1 Noise Abatement Procedures

The Navy had restricted approaches and established general avoidance areas to reduce noise impacts due to range operations. Noise has never been a major issue at DCBR and LSNOA due to the range’s remote location. To reduce noise impacts, the Navy has implemented general avoidance areas. Current noise abatement procedures for Navy use of the range are found in FACSFACVACAPESINST 3710.1A, Navy Dare Operations Manual. The range is also used by the Air Force, and Air Force noise abatement instructions are found in Air Force Instruction 13-212 Addendum A (Navy 2010d).

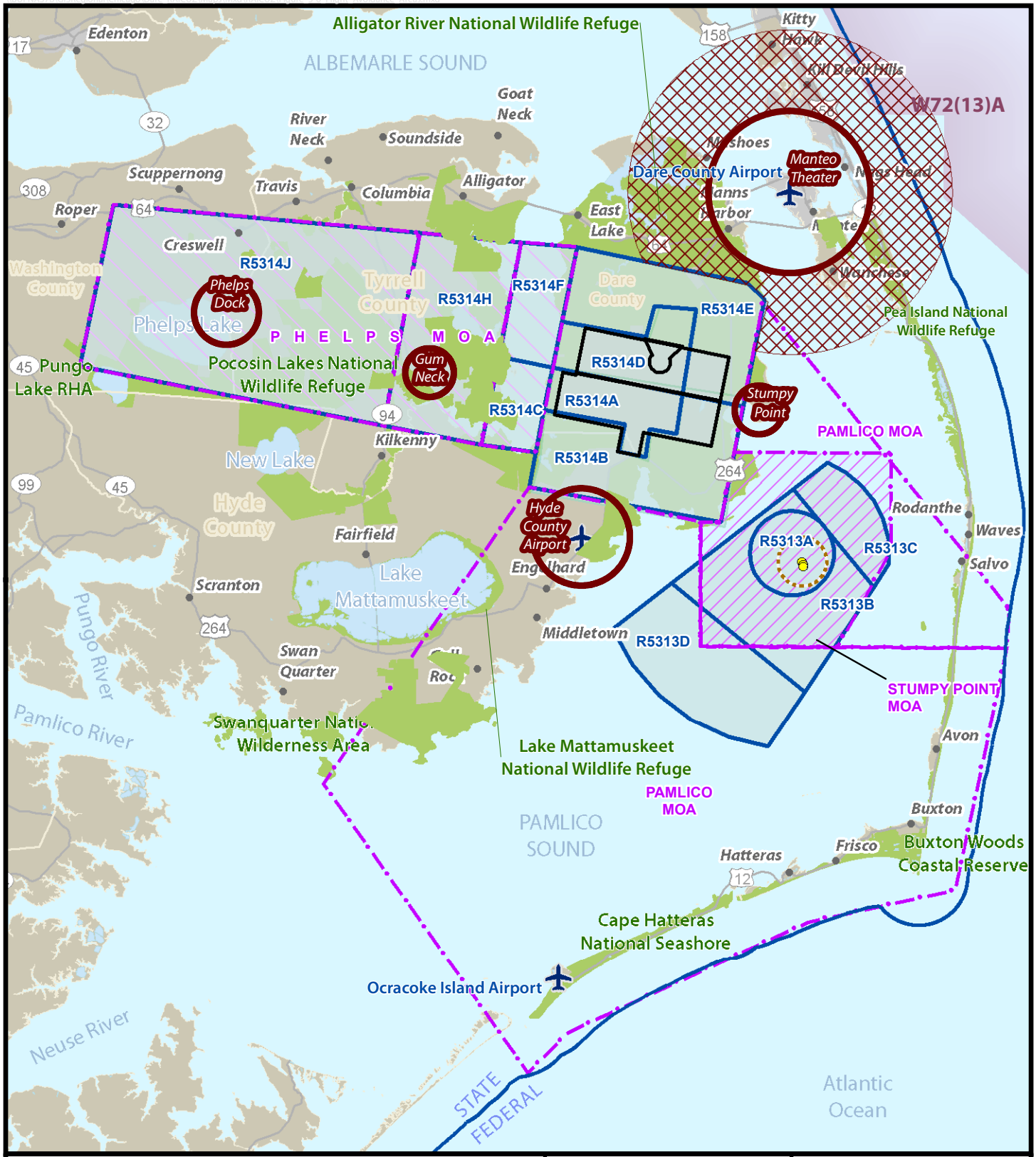


Figure 3-6
Avoidance Areas

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013

4 Range Safety Analysis

Personnel safety is paramount to the Navy near DCBR. In order to maintain the viability of Navy Dare for air-to-ground training while ensuring the safety of participating and non-participating personnel in the vicinity, a range safety analysis has been conducted to identify areas of potential concern near the Range Complex. This chapter contains three primary components. First, WDZ/SDZ development is discussed; second, it explains RCZ development for RCZ-I, RCZ-II, and RCZ-III; and third, it presents the selection and results of a probability analysis that examined the likelihood of impacts to specific ACC.

4.1 Weapon Danger Zone and Surface Danger Zone Development

To analyze potential incompatibilities between aircraft operations and land use surrounding Navy Dare and LSNOA, WDZs were developed using the Multi-Service Range Mangers Toolkit WDZ Tool (version 10.0.0.4.5). WDZs define the areas of potential safety hazards based on containment of ordnance, weapons failures, fragments, ricochets, and debris. Strafing operations and door gunnery were modeled to 99.999% containment, and bombs and rockets were modeled to 99.99% containment (both to the 95% confidence factor) in accordance with COMUSFLTFORCOMINST 3550.1. SDZs define the areas of potential safety hazards based on containment of ordnance, ricochets, and debris from non-aircraft fired munitions over water.

Individual WDZs are constructed on air-to-ground targets. Since a RAICUZ Study is a forward-looking planning document, it is important not only to capture the current range configuration but also to determine the locations and types of targets planned for the future.

For Navy Dare, 515 WDZs were modeled. At LSNOA, 51 WDZs were modeled to one target. Three SDZs were also modeled for small caliber crew-served weapons from riverine patrol craft. SDZs were modeled using the Multi-Service Range Managers Tool Kit SDZ Tool (version 10.0.0.4.3) for operations at LSNOA.

4.2 Range Compatibility Zone Development

This section of the RAICUZ Study identifies the three RCZs that are applicable to both Navy Dare and LSNOA: RCZ-I, RCZ-II, and RCZ-III. RCZs translate aviation safety and ordnance delivery safety concerns into recommended compatible land use zones. RCZ-I was developed quantitatively through WDZ Tool and SDZ Tool modeling. This RCZ is the sum of individual WDZs for Navy Dare and individual WDZs and SDZs for LSNOA. Because there is not a single quantitative method to identify the area of armed overflight or maneuvering airspace, RCZ-II and RCZ-III required a qualitative approach. Review of local standard operating procedures, data collection interviews, and local airspace structure were used to identify RCZ-II and RCZ-III.

RCZ-I is the composite WDZ generated by combining all individual WDZs associated with air-to-ground weapons delivery.

At Navy Dare and Stumpy Point, RCZ-I is comprised of two components (one for each target range).

4.2.1 Range Compatibility Zone I

RCZ-I is defined in OPNAVINST 3550.1A as the composite footprint based on each of the individual WDZs associated with air-to-ground weapons delivery. RCZ-I represents the entire weapons impact area (including potential ricochets, dust, and debris). In terms of land use, RCZ-I is the most restrictive. RCZ-I was developed for Navy Dare and LSNOA by combining the individual WDZs associated with each range into a single composite WDZ that shows all live-fire operations. Since Navy Dare and LSNOA are separated by about 10 miles, the composite WDZs for the two ranges do not overlap. Therefore, there are two RCZ-I components (one for each range), as shown on Figures 4-1 and 4-2.

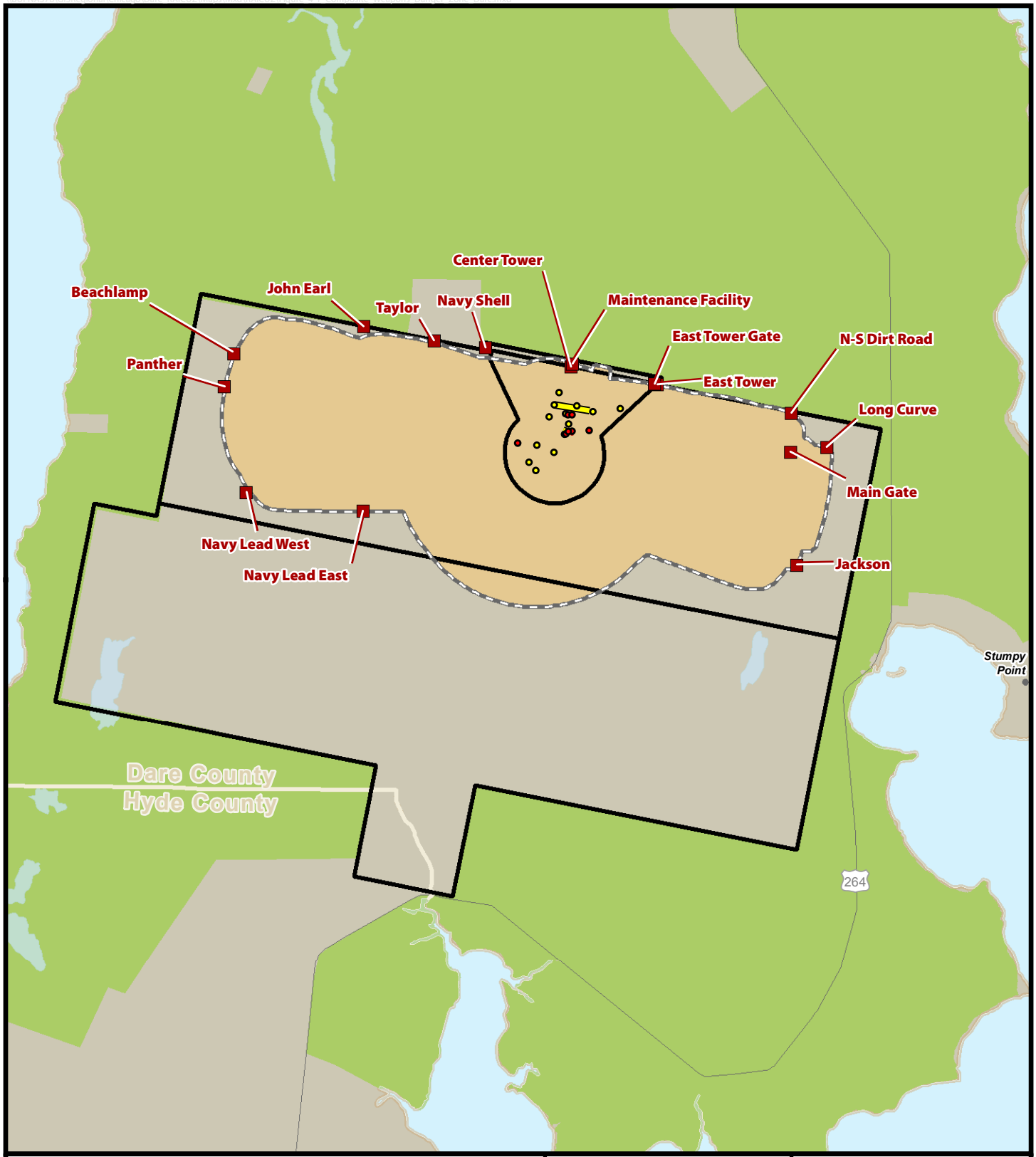
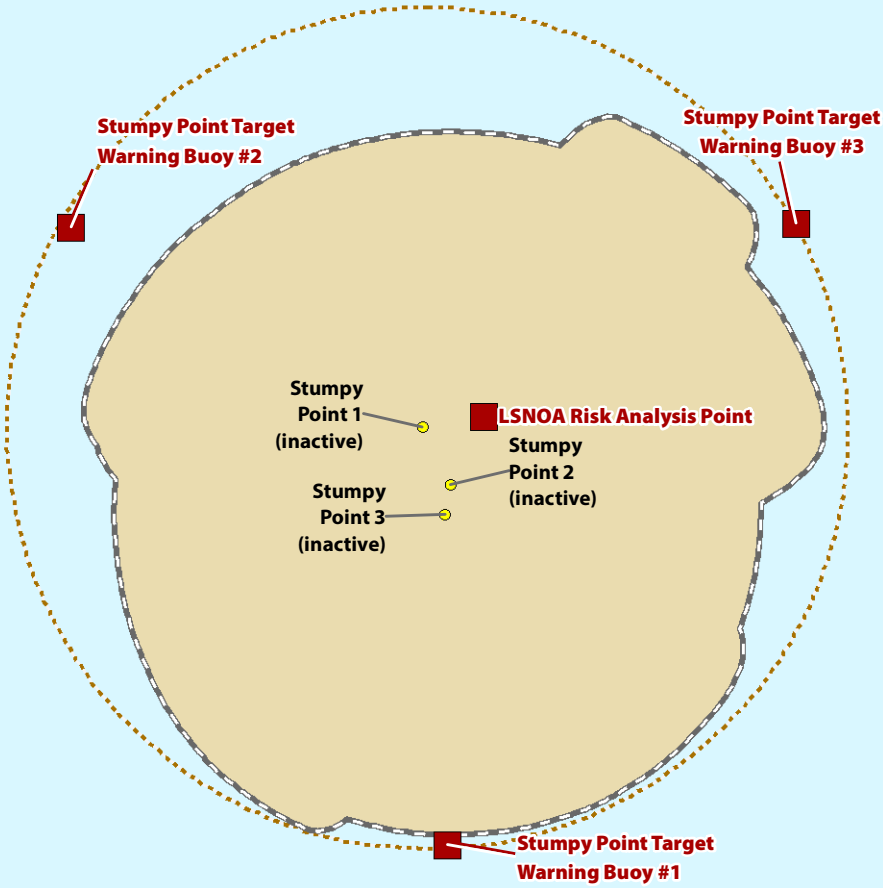


Figure 4-1
Composite Weapons Danger Zone and Areas of Critical Concern

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013



Long Shoal Naval Ordnance Area (LSNOA)

WDZ Composite Footprint

RCZ-I

Military Target Point

ACC Site

N

0 0.25 Nautical Miles

0 0.25 0.5 Kilometers

Figure 4-2
Composite Weapons Danger Zone and ACC Long Shoal Naval Ordnance Area

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013

RCZ-I is not contained within the range boundaries on Navy controlled property; however, this RCZ is contained within the federal property of the ARNWR and will require the Navy (USFF) to obtain agreement with the Air Force and U.S. Fish and Wildlife Service (see Figure 4-1). With public safety in mind, weapons release parameters were adjusted to reduce the composite WDZ footprint while still providing effective training.

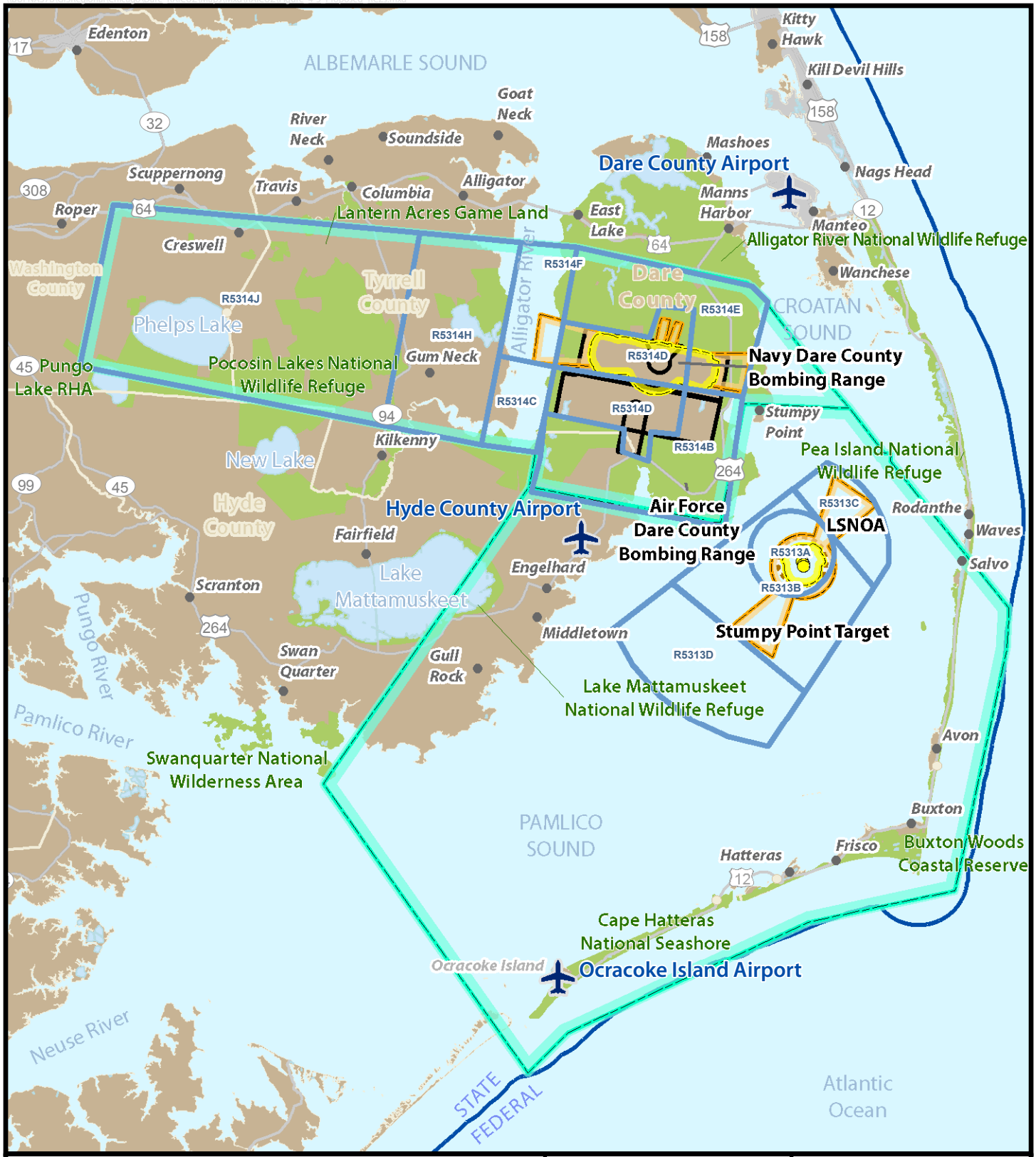
4.2.2 Range Compatibility Zone II

RCZ-II describes the area where aircraft may be in the "armed" position and is, therefore, an area with a higher potential for the inadvertent release of ordnance. To define this area for Navy Dare and LSNOA, interviews were conducted with range personnel as well as with pilots who conduct training at these ranges. As with RCZ-I, the distance between the two ranges requires the identification of two separate areas for RCZ-II for each location (Figure 4-3).

At Navy Dare, the arming of Navy fixed-wing aircraft typically occurs anywhere within a 3-nm arc around the center of the impact area. However, arming could technically occur anywhere in Restricted Area R-5314 A/B/D/E. De-arming occurs after the bombing run is complete and the pilot begins to pull up out of the dive.

Navy rotary-wing aircraft arming typically occurs within a 1-nm arc around the center of the impact area. De-arming occurs after completion of the strafing run, door gunnery, and tail gunnery, and typically within 1 nm of the target.

At LSNOA, the arming of all aircraft occurs within Restricted Area R-5313 A/C, and typically occurs within a 3-nm arc around the center of the target.



Dare County Bombing Range Boundary
Long Shoal Naval Ordnance Area (LSNOA)
Stumpy Point Target
City/Town
Urban Area
County Boundary
3-Mile Federal/State Boundary
Major Roads
Managed Lands
Waterbody
Restricted Area
Range Compatibility Zone
RCZ-I
RCZ-II
RCZ-III

0 2.5 5 Nautical Miles
0 5 10 Kilometers

Figure 4-3
2015 Range Compatibility Zones

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013

4.2.3 Range Compatibility Zone III

RCZ-III defines the area used by participating aircraft for maneuvering onto and away from the target. Interviews with FACSFAC VACAPES and range control personnel and pilots described an area for maneuvering that can extend beyond the boundary of Restricted Areas R-5314 A/B/D/E and R-5313 A/B/C/D, but remains inside of the Phelps, Pamlico, and Stumpy Point MOAs. R-5313 B/C/D/, however, is limited to 20 hours per month. In particular, fixed-wing maneuvering at Navy Dare can extend up to 9 nm from the center of the range out over the Alligator River during pop-up bombing pattern operations. At LSNOA, maneuvering airspace is used for holding to allow vessel traffic to clear from the nautical SDZ. Figure 4-3 shows the proposed boundaries for RCZ-III, as well as boundaries for RCZ-I and RCZ-II.

While the WDZs do not quantify risks, a WDZ Tool risk analysis can provide a quantified assessment for potential weapon impacts at selected ACCs.

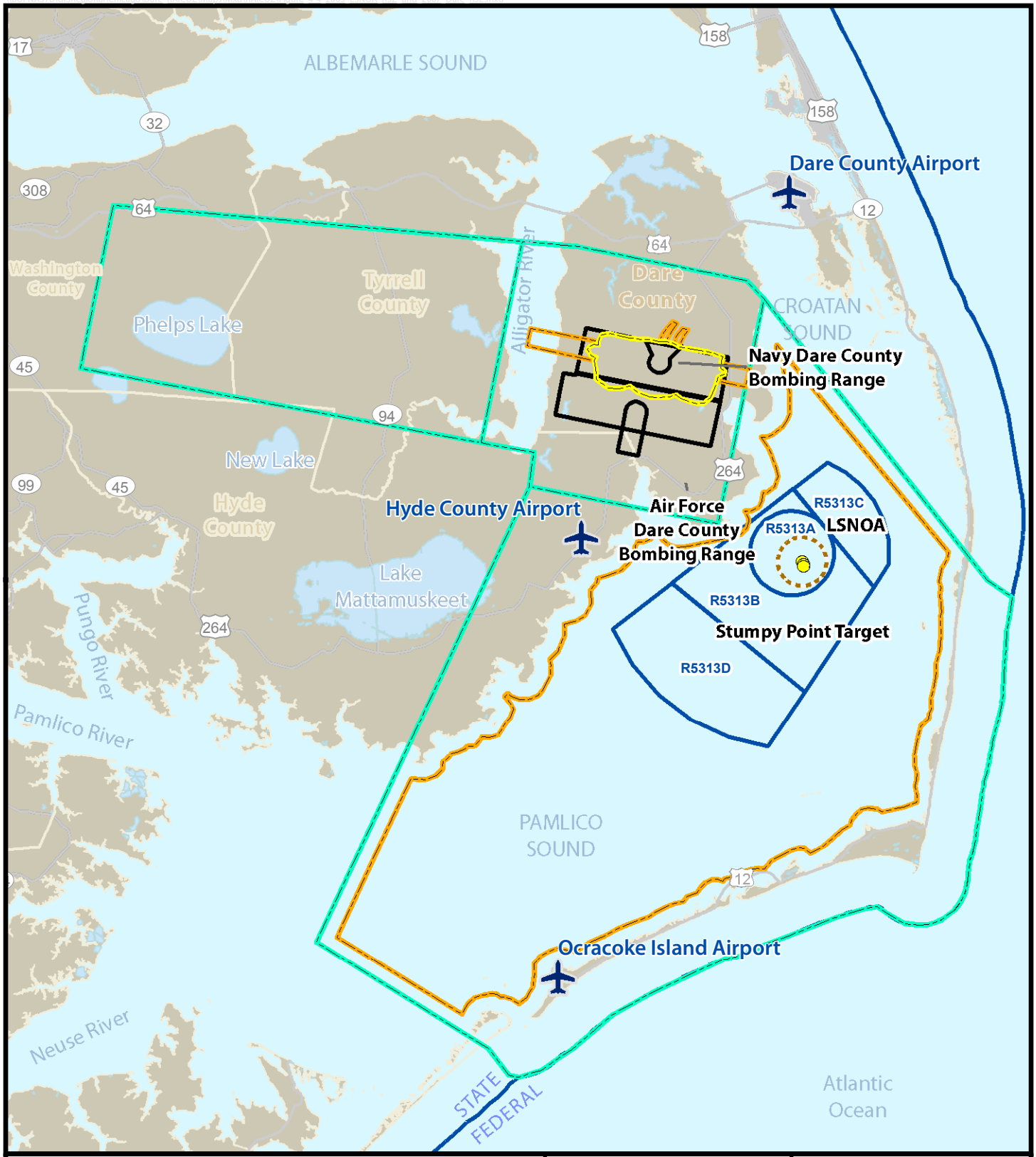
4.2.4 Range Safety Zones

Range Safety Zones (RSZs) are the predecessor of RCZs. A brief discussion of the RSZs follows to understand the differences between RCZs and RSZs. Figure 4-4 provides an example of 2003 and 2007 RSZs previously approved for distribution.

- RSZ-A is defined as the required surface impact target areas, which are areas of extreme hazard and subject to possible impact from dropped munitions. Unlike RCZ-I, RSZ-A does not account for ricochets, dirt, and debris.

- RSZ-B includes designated areas subject to significant overflight conditions where jet aircraft are operating in an armed mode (area of armed overflight). The definitions for RSZ-B and RCZ-II are similar.

RSZ-C is intended to provide an adequate area of protected airspace in which military training exercises can be safely conducted without interference from general aviation traffic. The definitions for RSZ-C and RCZ-III are similar; however, RCZ-III is the area for participating aircraft to use when maneuvering onto and away from a target.



Dare County Bombing Range Boundary
Long Shoal Naval Ordnance Area (LSNOA)
Stumpy Point Target
Urban Area
County Boundary
3-Mile Federal/State Boundary
Major Roads
Waterbody
Restricted Area
Range Safety Zone
RSZ A
RSZ B
RSZ C

0 2.5 5 Nautical Miles
0 5 10 Kilometers

Figure 4-4
2003 LSNOA Range Safety Zones and 2007 Dare County Bombing Range Safety Zones

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013; The Onyx Group, 2007; The Onyx Group, 2003

4.2.5 Comparison of 2003/2007 RSZs and 2015 RCZs

The 2015 RAICUZ RCZ-I and the 2003/2007 RSZ-A were developed using the Multi-Service WDZ Tool, version 10.0.0.4.5, and the Safe Range 2.2 modeling software, respectively. A comparison between the 2003 Stumpy Point/2007 Dare County RSZs and the 2015 RAICUZ RCZs show that changes are due, in part, to the improvements in modeling software, changes to aircraft types, munition changes, and a detailed analysis of mission requirements.

After interviews and an exhaustive evaluation of the area needed to support the Range Complex, RCZ-I at Navy Dare decreased by 3,954 acres and LSNOA increased to 4,385 acres which resulted in a total increase of 441 acres compared to 2003/2007 RSZ-A (see Figures 4-3 and 4-4). RCZ-II was reduced by approximately 562,000 acres, compared to 2003/2007 RSZ-B. As compared to the 2003/2007 RSZ-C for LSNOA, RCZ-III was reduced by approximately 240,000 acres by limiting RCZ-III to the extent of the Pamlico MOA.

4.3 Risk Analysis

The WDZ Tool has the capability to conduct a risk analysis for operations at both ranges to quantify the risk of a weapon's impact at various locations in, or very near, RCZ-I. While the individual and composite WDZs alert the observer to a potential risk, these WDZs do not quantify the risk. The risk analysis, on the other hand, provides a quantified assessment for potential weapon impacts at any selected location. Risk calculations include both initial weapon impacts, any ricochet impacts that may occur, and dust/debris that may be generated. For the purposes of this RAICUZ Study, risk is generally considered negligible when the WDZ Tool shows an impact probability of less than 1:1,000,000 (one in 1 million) at an ACC.

Risk is presented in a ratio format (i.e., 1:10,000 means that the probability of an impact at the applicable ACC is one in 10,000).

4.3.1 Navy Dare County Bombing Range, Area of Critical Concern Risk Analysis

The Navy evaluated 15 ACCs for risk associated with the WDZs developed for current and future operations at Navy Dare. The Navy selected the ACCs after reviewing potential areas of concern, such as staffed facilities, range access points, and equipment locations. These ACCs, presented in Table 4-1, are

range facilities that are necessary for safety, operations, and maintenance at the range and road intersections both on and off range.

Table 4-1 Navy Dare Areas of Critical Concern

ACC	Surface Area (sq. ft.)	Description
Center Tower	144	Range buildings located along the northern boundary
East Tower	126	Structures located along the northern boundary of the impact area
Maintenance Facility	654	Maintenance facility located 500 feet north of center tower
Main Gate	10	Primary access point to the range
Beachlamp	100	Road and WDZ
John Earl	100	Road intersection
Taylor	110	Road and WDZ boundary
Navy Shell	100	Old West Tower
East Tower Gate	100	Road intersection (off range)
Dirt Road	100	Road intersection and range boundary
Long Curve	110	Road intersection and WDZ boundary (northeast corner)
Jackson	100	Road and WDZ boundary
Navy Lead East	100	Road and WDZ boundary
Navy Lead West	100	Road and WDZ boundary
Panther	100	Road and WDZ boundary

Table 4-2 presents a list of WDZs at Navy Dare, in association with specific ACCs, with a calculated risk of impact greater than 1:1,000,000. The Navy Dare range risk analysis shows that the chance of a weapon or fragment striking one of the 15 ACCs varies from approximately zero to a high risk of a 2.12:100,000. The greatest risk is to the Main Gate due to its location under WDZs on the range. Also at risk is the Center Tower and the Maintenance Facility, primarily due to 20mm strafing operations. As Table 4-2 shows, the only ACCs with a risk of impact greater than 1:1,000,000 are the Main Gate and the Maintenance Facility..

Table 4-2 Areas of Critical Concern at Navy Dare Exceeding 1:1,000,000 Probability of a Weapon Impact

ACC	WDZ Name	Risk Measurement
Main Gate	111-1	2.12: 100,000
Main Gate	111-2	2.12: 100,000
Maintenance Facility	201-2	1.91: 100,000
Main Gate	111-3	1.34: 100,000

4.3.2 Long Shoal Naval Ordnance Area, Area of Critical Concern Risk Analysis

The Stumpy Point target was modeled with a 360-degree moving field of fire toward the target. Four ACCs were evaluated for risk associated with the WDZs developed for operations at LSNOA. These ACCs, presented in Table 4-3, are target warning buoys and points to evaluate risk to shipping traffic. (Note: ACCs are relevant only to WDZs. There is not a similar risk-based function associated with the SDZ Tool.)

Table 4-3 Areas of Critical Concern at Long Shoal Naval Ordnance Area

ACC	Surface Area (sq. ft.)	Description
LSNOA Risk Analysis Point	100	0.75 nautical mile away from target
Stumpy Point Target Warning Buoy #1	100	Stumpy Point Target Warning Light – Buoy
Stumpy Point Target Warning Buoy #2	100	Stumpy Point Target Warning Light – Buoy
Stumpy Point Target Warning Buoy #3	100	Stumpy Point Target Warning Light – Buoy

Table 4-4 provides a list of WDZ names at LSNOA, in association with specific ACCs, with a calculated risk of impact greater than 1:1,000,000. The LSNOA Range risk analysis shows that the chance of a weapon or fragment striking one of the designated ACCs ranges from about zero risk to a high risk of 1.92:100,000. As Table 4-4 shows, only LSNOA Risk Analysis Point has a risk of impact greater than 1:1,000,000, and demonstrates the area near the Stumpy Point target has the highest risk of impact.

Table 4-4 Areas of Critical Concern at Long Shoal Naval Ordnance Area Exceeding 1:1,000,000 Probability of a Weapon Impact

ACC	WDZ Name	Risk Measurement
LSNOA Risk Analysis Point	Stumpy Pt-1	1.92: 100,000
LSNOA Risk Analysis Point	Stumpy Pt-2	1.18: 100,000

4.3.3 Navy Dare County Bombing Range Complex Risk Analysis

The Range Complex risk analysis shows that the chance of a weapon or fragment striking one of the designated ACCs varies from approximately zero to a high risk of 2.12:100,000 (Main Gate at Navy Dare) for ACCs near the boundaries of Navy Dare and all of LSNOA (see Table 4-5).

Table 4-5 Areas of Critical Concern at the Range Complex Exceeding 1:1,000,000 Probability of a Weapon Impact

ACC	WDZ Name	Risk Measurement
Main Gate	111-1	2.12: 100,000
Main Gate	111-2	2.12: 100,000
LSNOA Risk Analysis Point	Stumpy Pt-1	1.92: 100,000
Maintenance Facility	201-2	1.91: 100,000
LSNOA Risk Analysis Point	Stumpy Pt-2	1.18: 100,000
Main Gate	111-3	1.34: 100,000

5 Land Use Compatibility Analysis

This land use compatibility analysis is based on the assessment of existing land uses and proposed development near the Range Complex. Population growth projections prepared by the North Carolina Office of State Budget and Management and local government land use plans and zoning regulations were evaluated to determine how local and regional development patterns could affect future operations at the range. Local governments are encouraged to adopt programs, policies, and regulations that support the Navy mission and promote compatible land use in noise and safety zones, where appropriate and practical.

5.1 Land Use Compatibility Guidelines and Classifications

The Navy has developed guidelines for compatible development and land use within a range's noise zones and RCZs. These land use guidelines are provided in RAICUZ Instruction (OPNAVINST 3550.1A). Table 5-1 provides a list of common land use classifications and their compatibility recommendations within RAICUZ noise zones and RCZs. Land use classifications in this table are generalized and do not represent the local communities' land use designations. When the current and future land uses in the vicinity are evaluated on these guidelines, recommended compatible and incompatible land uses can be identified. Appendix B provides the complete index of the Navy's land use compatibility recommendations. Appendix C provides a list of land use definitions used in this RAICUZ.

Table 5-1 Land Use Classification and Compatibility Guidelines

Land Use	Compatibility with RAICUZ Noise Zones (DNL)						Compatibility with RAICUZ RCZs		
	Noise Zone 1 (1)		Noise Zone 2 (1)		Noise Zone 3 (1)				
	<55	55-65	65-70	70-75	75-80	>85	RCZ-I	RCZ-II	RCZ-III
Single-Family Residential									(4)
Multi-Family Residential and Hotels									
Public Assembly Areas and Auditoriums									
Schools and Hospitals			(2)	(2)					
Manufacturing/Industrial									(3)
Outdoor Parks and Recreation Areas								(3)	(3)
Business Services				(2)	(2)				(3)
Agriculture, Forestry, and Mining									(3)

Source: Adapted from OPNAVINST 3550.1A
Notes: This generalized land use table provides an overview of recommended land use. Specific land use compatibility guidelines are provided in OPNAVINST 3550.1A.
(1) Noise contours are measured in dBA L_{dnmr}.
(2) Land use and related structures generally compatible; however, measures to achieve recommended noise level reduction should be incorporated into design and construction of the structures.
(3) Incompatible for areas within 500 feet of low altitude over flight.
(4) Maximum density of one to two dwellings per acre.
Key:

= Compatible

= Incompatible

5.1.1 Land Use Compatibility Guidelines for Noise

For land use planning purposes, the area exposed to noise from aircraft operations is divided into three noise zones:

- Noise Zone 1 (DNL < 65 dB) is an area of minimal impact;
- Noise Zone 2 (DNL/ 65–75 dB) is an area of moderate impact where some land use controls are needed;

- Noise Zone 3 (DNL > 75 dB) is the most severely impacted area and the area for which the greatest degree of compatible land use control is recommended.

Areas of concern outside of the noise zones (e.g., areas under ingress and egress routes to and from training ranges) may be defined where noise levels are not considered objectionable (DNL <65 dB) but where compatible land use planning is recommended.

The Navy's RAICUZ land use guidelines recommend noise-sensitive land uses (e.g., houses, churches) will be placed outside high-noise zones (Noise Zones 2 and 3). Land use restrictions are not typically recommended for areas within noise zones below 65 dB; however, in rural areas with low ambient noise levels, some restrictions may be appropriate. Chapter 3 provides detailed information regarding noise zones.

5.1.2 Land Use Compatibility Guidelines for RCZs

For land use planning purposes, the Navy has defined three RCZs for varying levels of safety hazard due to a potential weapons impact:

- RCZ-I defines the land area of the greatest potential safety hazard and designates the minimum range surface area needed to contain all ordnance delivered at air-to-ground ranges;
- RCZ-II defines the land below the area of armed aircraft over-flight; and
- RCZ-III is the land area under SUA used by aircraft for tactical maneuvering.

Navy guidance states that no land uses are considered compatible within RCZ-I due to the inherent dangers associated with ordnance and in consideration of public safety. Many land uses are also considered incompatible with RCZ-II or may be considered compatible with certain restrictions in place. RCZ-III is the least restrictive zone of the three RCZs in terms of land use compatibility recommendations. Chapter 4 provides detailed information regarding RCZs.

5.2 Planning Authorities

Local governments manage land use and future growth through zoning regulations, land use plans, subdivision regulations, and building codes. These planning tools define standards to restrict or permit land uses, density, and development. Elected city or county legislators enact zoning laws and appoint agencies/boards to review proposed development and administer zoning regulation provisions.

The DCBR is located within the unincorporated areas of the mainland of Dare County. LSNOA is located in the Pamlico Sound within the jurisdiction of Dare County. The composite RAICUZ footprint extends to the Outer Banks of North Carolina and into portions of Hyde, Tyrrell, and Washington counties.

The regulatory authority of local governments is granted by the state and limited to the extent of their geographical jurisdictional boundaries. In North Carolina, the adoption and enforcement of land use regulations, including zoning ordinances, and comprehensive planning are within the authority of the local municipality or county. Planning and zoning jurisdictions within the composite RAICUZ footprint of DCBR and LSNOA include Dare, Hyde, Tyrrell, and Washington counties.

5.2.1 County Board of Commissioners

The County Board of Commissioners is the governing body of the Dare County. Zoning laws are adopted and amended by the County Board of Commissioners. The Planning Board is an advisory board to the County Board of Commissioners, is responsible for reviewing development proposals, and proposed zoning amendments to ensure consistency with the county's Comprehensive Plan. The County Board of Commissioners holds public hearings to seek comment from interested parties on proposed amendments, and then the Board of Commissioners will approve, deny, or approve a modified amendment. The Zoning Board of Adjustment hears and grants zoning appeals, special use permits, and variance requests.

5.2.2 North Carolina Coastal Area Management Act

The North Carolina Coastal Area Management Act (CAMA) of 1974 established a cooperative program between the State of North Carolina and local governments to regulate development within the coastal counties. The CAMA requires both permitting measures and state and local planning standards to ensure an appropriate balance of use of North Carolina's coastal resources. The

State of North Carolina is responsible for identifying coastal areas of concern, establishing planning standards, and providing oversight and review of local land use plans. The State created the Coastal Resources Commission (CRC) after the adoption of the CAMA to prepare and adopt statewide policies and standards to guide coastal development and use of land and water within the coastal areas. The CRC also identifies and designates CAMA Areas of Environmental Concern.

Under the North Carolina CAMA, coastal counties are required to prepare local land use plans to guide future development and growth. The CRC certifies county CAMA Land Use Plans (LUPs). Counties that do not develop their own local LUP must adopt the State-developed CAMA LUP. Dare, Hyde, and Tyrrell counties have adopted CAMA LUPs. The Dare County CAMA LUP applies to the county's unincorporated areas. The County Board of Commissioners adopted the LUP in December 2010, and the North Carolina CRC certified the LUP in February 2011. Each incorporated municipality in Dare County (Duck, Southern Shore, Kitty Hawk, Kill Devil Hills, Nags Head, and Manteo) has adopted their own LUP for their respective jurisdiction. The County Board of Commissioners adopted the Hyde County CAMA LUP in January 2008, and the North Carolina CRC certified the Hyde County CAMA LUP in March 2008. The Tyrrell County CAMA LUP was adopted by the County Board of Commissioners in December 2009 and the Town of Columbia in February 2010, and was certified by the North Carolina CRC in 2010. Washington County's CAMA LUP was adopted in 1976 and has not been updated.

5.2.3 North Carolina Department of Environment and Natural Resources, Division of Coastal Management

The North Carolina Department of Environment and Natural Resources, Division of Coastal Management implements CRC policies and issues CAMA permits. Pursuant to the North Carolina CAMA, proposed developments in designated CAMA Areas of Environmental Concern must submit permit applications to the Division of Coastal Management for review. In turn, the Division of Coastal Management must ensure consistency with federal regulations and with the guidelines and land use designations in local LUPs. The

County CAMA LUP is used to determine if proposed developments under permit review are consistent with the county's goals for future and environmental protection.

5.3 Regional Population Estimates and Projections

From 1960 to 2008, the Atlantic coastline population (measured by coastline counties) increased by almost 15 million people (Census Bureau 2010a). This region had the largest population gain from 1990 to 2008 of any coastal region in the United States. Most of this coastline growth occurred in metropolitan areas (Census Bureau 2010a). Population growth in coastal areas can be attributed to the aesthetic and economic value of coastal areas, including transportation and accessibility, commerce opportunities, employment, and recreational activities. Because of these attractions, visitors frequently cause substantial population surges during tourist seasons.

Dare, Hyde, Tyrrell, and Washington counties are largely rural in character, with scattered populations and town centers less than 10,000 persons. Significant land area within these counties is dedicated to conservation, which may attribute to the counties' lack of major urban areas and significant population growth. Population estimates and projections for Dare, Hyde, Tyrrell, and Washington counties are discussed later in this section and are summarized in Table 5-2. According to the North Carolina Office of State Budget and Management, populations for Dare and Hyde counties are projected to increase through 2030, and populations in Washington and Tyrrell counties are projected to decline. Figure 5-1 shows the size of the four counties' populations relative to each other and their projected change from 2010 to 2030.

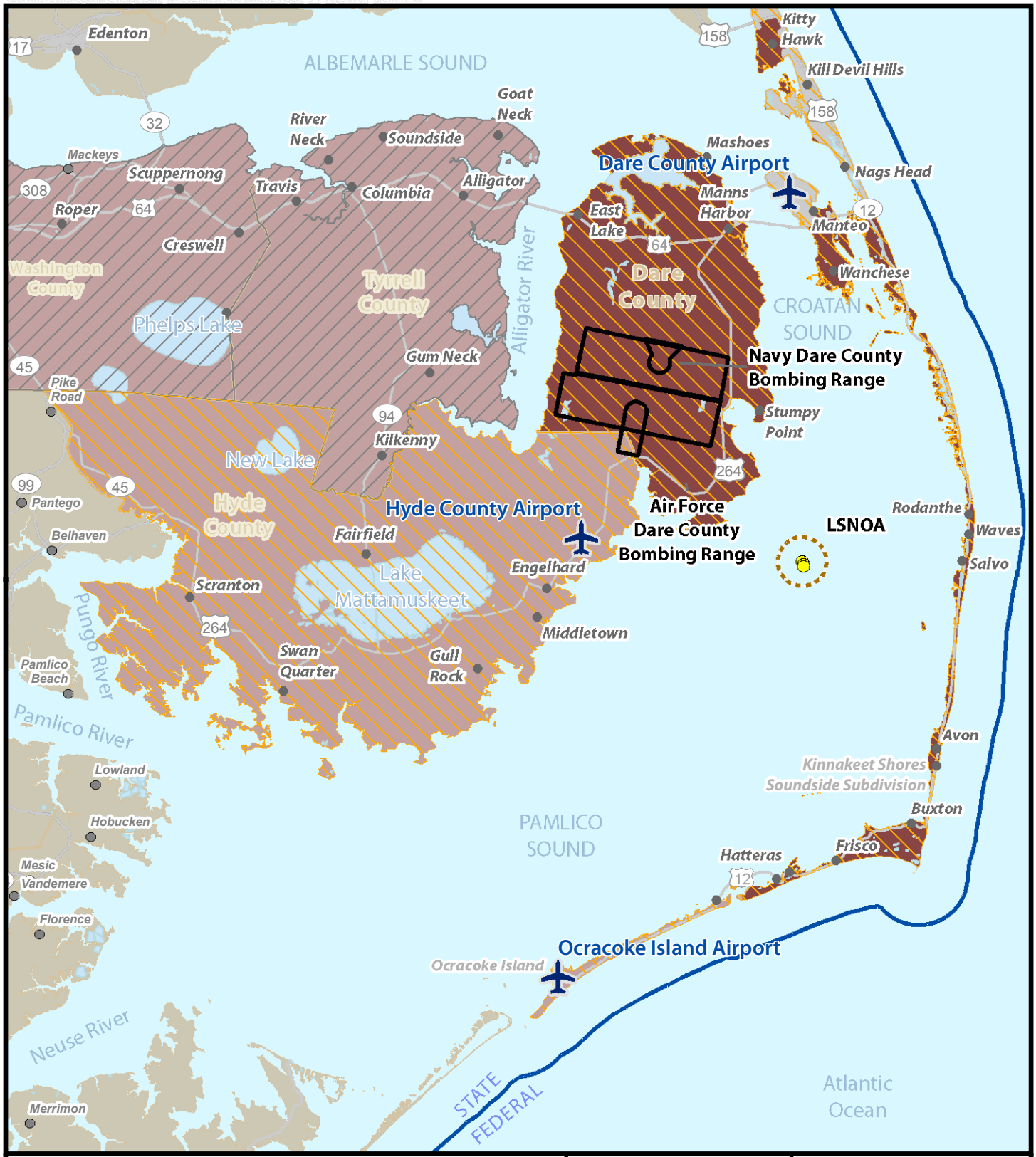


Figure 5-1
Population and Growth in Dare, Hyde, Tyrrell, and Washington Counties

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013

Table 5-2 Regional Population Estimates and Projections

County	2000[1]	2010[1]	2020[2]	2030[2]	% Change 2000-2010	%Change 2010-2030
Dare County	29,967	33,920	39,822	45,976	13.2%	35.5%
Hyde County	5,826	5,810	5,971	6,245	-.03%	7.5%
Tyrrell County	4,149	4,407	3,992	3,771	6.2%	-14.4%
Washington County	13,723	13,228	12,476	11,854	-3.6%	-10.4%
Totals	53,665	57,365	62,261	67,846	6.4%	18.3%

Sources:
(1) Census Bureau Population Estimates 1990, 2000, and 2010
(2) North Carolina Office of State Budget and Management 2013

5.3.1 Dare County

Dare County is the most heavily populated of the four counties within the RAICUZ footprint, with a population density of approximately 88.5 persons per square mile (Census Bureau 2010b). The estimated population is 33,920 persons, including over 15,000 households and 33,686 total housing units (Census Bureau 2010b). During the tourist season (June to August), the average daily population is estimated to increase to approximately 225,000 to 300,000 (Dare County 2014a). The county's population increased about 13% from 2000 to 2010 (Table 5-2), and the majority of the permanent population growth has been in the incorporated areas on the Outer Banks (Dare County 2009). Dare County's permanent population is projected to grow 35.5% between 2010 and 2030, to 45,967 residents (North Carolina Office of State Budget and Management 2013). This projected growth is expected to continue within the Outer Banks. (Note: Figure 5-1 depicts total growth of each county and only a small percentage of the population resides on the peninsula near DCBR.)

5.3.2 Hyde County

The estimated population for Hyde County is 5,810 persons, including 1,982 households and 3,345 housing units (Census Bureau 2010c). The population density of Hyde County is 9.5 persons per square mile (Census Bureau 2010c). The largest populated area is Ocracoke Island, on the Outer Banks, with 948 persons (Census Bureau 2010d). Swan Quarter (county seat) is

the second largest populated area in Hyde County, and Ocracoke Island account for the majority of the county's population.

During Ocracoke Island's peak season (May through October), the seasonal population average is approximately 6,000 people (Holland Consulting Planners, Inc. 2008). Season population estimates include day visitors and may vary depending on weather and economic conditions. Seasonal population increases are also notable on Hyde County's mainland during the winter peak season for hunting, fishing, and bird watching (October to February). The mainland population increases by about 6,000 seasonal visitors during the peak season (Holland Consulting Planners, Inc. 2008).

Overall, the county's highest population average occurs during weekends in July and August. The county's population slightly decreased from 2000 to 2010 (Table 5-2); however, Hyde County's permanent population is projected to grow about 7.5% between 2010 and 2030, to a total 6,245 residents (North Carolina Office of State Budget and Management 2013).

5.3.3 Tyrrell County

Tyrrell County is the least populous county in North Carolina. The estimated population for Tyrrell County is 4,407, including 1,666 households and 2,061 housing units (Census Bureau 2010e). The county has a population density of about 11.3 persons per square mile (Census Bureau 2010e). The county's population increased about 6.2% from 2000 to 2010 (Table 5-2); however, the county's overall population is estimated to decline about 14% from 2010 to 2030 (North Carolina Office of State Budget and Management 2013). Tyrrell County consists of low-lying, poorly drained land, including swamp forests and wetlands, which have limited development and growth.

Seasonal population fluctuation in Tyrrell County is less significant than in other North Carolina coastal counties; in fact, the county's percentage of owner-occupied housing is significantly higher than the state average (Holland Consulting Planners, Inc. 2009).

5.3.4 Washington County

The estimated population for Washington County is 13,228, including 5,096 households and 6,458 housing units (Census Bureau 2010d). The county has a population density of about 38 persons per square mile (Census Bureau 2010d). The county's population decreased by about 3.6% from 2000 to 2010 (Table 5-2), and is projected to continue to decrease from 2010 to 2030 by 10.4% (North Carolina Office of State Budget and Management 2013).

5.4 Existing Land Uses

Land uses surrounding DCBR are designated as residential (single-family, multi-family, and rural residential), mixed use, commercial, industrial, public use/institutional, agricultural, recreation/park, utility, and undeveloped/vacant. Existing land uses were assessed using Geographic Information System (GIS) land use and parcel data provided by Dare and Washington counties. GIS land use data was not readily available for Hyde and Tyrrell Counties; therefore, existing land uses and residences were digitized based on aerial photographs and 2012 National Agricultural Imagery Program data. Additional land use analysis was derived from the counties' comprehensive land use plans, as available. Areas designated as rural residential land use are individual single-family homes and do not represent residential communities or neighborhoods. Other identified developed areas (based on aerial imagery) were designated as "mixed use" to represent a mix of residential, commercial, and public facilities, when parcel and land use data were not available.

5.4.1 Dare County Existing Land Uses

Dare County includes about 383 square miles (Census Bureau 2010b), with the mainland and a 110-mile-long stretch of the Outer Banks. Dare County's mainland is primarily undeveloped, with large tracts of land on the mainland dedicated to conservation and limited buildable areas. About 80% of the county is federally owned and unable to be developed for residential and commercial uses (Dare County 2009). Developed areas of the county are largely concentrated on the Outer Banks. The county's six incorporated municipalities (Duck, Southern Shore, Kitty Hawk, Kill Devil Hills, Nags Head, and Manteo [county

seat]) are all located within the Outer Banks. No incorporated municipalities within the county are located within the RAICUZ footprint.

The County's planning jurisdiction extends to the unincorporated areas of the Outer Banks and the mainland villages of Manns Harbor, Mashoes, East Lake, and Stumpy Point. Manns Harbor, Mashoes, and East Lake are located north of the Range Complex, and are not within the boundaries of the RAICUZ footprint. Stumpy Point is located south of the Navy Dare range and falls within the RAICUZ footprint. Unincorporated areas along the Outer Banks include Roanoke Island (Wanchese and unincorporated area of Manteo), Colington, Martin's Point, Rodanthe, Waves, Salvo, Avon, Buxton, Frisco, and Hatteras.

Stumpy Point is mostly undeveloped with a majority of the property owned by permanent residents. Located on Pamlico Sound, commercial fishing activities have a significant economic impact on the village. Stumpy Point is isolated from other parts of the county and has not experienced increased development activities from seasonal uses. Due to poor soil conditions and low elevations, development is limited. A wastewater treatment plant was recently completed in Stumpy Point but is not expected to contribute to additional development in the village. The wastewater treatment plant replaced failing septic systems in the village with the intent to handle current demand rather than accommodate additional development (Creef 2013; Dare County 2009).

Salvo[1] is located east of the Range Complex across Pamlico Sound along North Carolina State Highway 12 (NC-12). This village is comprised of a mix of residential and commercial development, including visitor-oriented businesses and seasonal residences. The Cape Hatteras National Seashore extends south of Salvo. Salvo is zoned as Special District (S-1), which is "a minimal zoning district that allows all uses but establishes dimensional standards for development" (Dare County 2014b). The County expects residential development for seasonal visitors to continue along the oceanfront and near shore areas as well as some multi-family development; however, flood zones, coastal

1 The villages of Rodanthe and Waves are just north of Salvo, but outside of the RAICUZ footprint. These areas are developed, and their land uses are similar to Salvo.

erosion, and poorly drained soils may limit development. Coastal wetlands along the estuarine shoreline are protected from development.

Avon village is located further south along NC-12 and to the southeast of the Range Complex. This area is fairly developed with a mix of residential use, mobile homes, and commercial development (Dare County 2009). Much of the development supports seasonal populations and visitor businesses. Vacant parcels within the Kinnakeet Shores Soundside Subdivision, a multi-phase development, will increase residential land use. Local zoning regulations allow for limited areas of multi-family residential use. Commercial development will likely continue along NC-12. Coastal wetlands run along the estuarine shoreline and are protected from development.

Buxton and Frisco are located approximately 6 to 12 miles south of Avon along NC-12. These areas are a mix of single-family residential, commercial, and industrial uses. Public facilities in the areas include churches and schools. A few hotels are located at the northern end of Buxton. The majority of the area consists of maritime forest (Buxton Woods). The Buxton Woods maritime forest is zoned as a Special Environmental District (SED-1), which "establishes special standards for land clearing and vegetation removal intended to protect the vegetative canopy of the Buxton Woods forest" (Dare County 2014b). Frisco, zoned as Special District (S-1), lacks use-specific zoning, which may lead to increased development in the future, compared to other areas of the Outer Banks with more restrictive zoning regulations.

Hatteras village is the southernmost part of the Outer Banks within Dare County. The village is comprised of a mix of residential, commercial, and public land uses. Commercial development continues to grow along NC-12 and around the Hatteras–Ocracoke ferry landing. Large seasonal residences are located along the oceanfront, and residential development will continue within platted subdivisions. Local zoning regulations allow for multi-family residential use and hotels, but no specific development plans have been proposed. Coastal wetlands along the estuarine shoreline are protected from development.

5.4.2 Hyde County Existing Land Uses

Hyde County includes about 612 square miles of land (Census Bureau 2010c). Hyde County is largely undeveloped and rural. Approximately 38% of the county is forest/open space land, which includes national wildlife refuges and game lands, and approximately 40% is unbuildable land that is designated as coastal wetlands and national seashore areas (Holland Consulting Planners, Inc. 2008). The county does not have any incorporated areas. Developed communities within the RAICUZ footprint include Engelhard, Middletown, Gull Rock, and Ocracoke Island.

Engelhard is located approximately 10 miles south of DCBR. According to the county's LUP, about 82% of the community is vacant/undeveloped land (Holland Consulting Planners, Inc. 2008). Aerial photographs show that this could include agricultural land. Other significant land uses within the community include residential, commercial, and public/institutional development.

Ocracoke Island is located across Pamlico Sound and about 35 miles south of the Range Complex. About 87% of the entire island is protected National Seashore lands. The community of Ocracoke Island represents the most densely developed area of the county and the only developed area within Hyde County located along the Outer Banks. Development within Ocracoke Island consists primarily of residential land use (51%) with a mix of commercial and public use facilities, including schools and churches. The Ocracoke Island Airport is located along the southern boundary of the community. The community does not have zoning to control development.

5.4.3 Tyrrell County Existing Land Uses

Tyrrell County includes about 389 square miles of land (Census Bureau 2010e). Tyrrell County is mainly forest land (55.4%) and agricultural land (30.4%) (Holland Consulting Planners, Inc. 2009). The town of Columbia, which is located in the northern part of the county along U.S. Route 64 and outside of the RAICUZ footprint, is the only urban area in the county. Other rural communities include Gum Neck, Kilkenny, Goat Neck, Travis, Alligator, Sound Side, and River Neck. Gum Neck is located within the RAICUZ footprint. Aerial photographs show that county land uses within the RAICUZ footprint are mostly

undeveloped or agricultural lands with scattered rural residential areas to the north and pockets of commercial uses in support of farming. A few local churches are also located within the RAICUZ footprint.

5.4.4 Washington County Existing Land Uses

Washington County includes about 343 square miles of land (Census Bureau 2010d). The county seat of Washington County is Plymouth, North Carolina. Washington County is largely rural and agricultural land. The Town of Creswell, which is located in the northeast corner of the county just south of U.S. Route 64, is the county's only developed community within the RAICUZ footprint. The Poquoson Lake National Wildlife Refuge is located within the southeast corner of the county. Pettigrew State Park, which is comprised of about 5,000 acres of land next to Lake Phelps, is also located within the southeast corner of the county and within the RAICUZ footprint.

5.4.5 Other Land Use Activities

5.4.5.1 Hunting

Hunting is a popular recreational activity in the national wildlife refuges and federal game lands around DCBR, including ARNWR, which surrounds the Range Complex. Deer is the most popular game for hunters (see Figure 5-2). About half of the refuge is open to deer hunting, with deer season generally running from September through December. Waterfowl hunting is permitted in the ARNWR, but primarily occurs on the sounds and rivers surrounding the refuge (USFWS 2013).

Hunting is allowed on certain leased areas of DCBR. The North Carolina Wildlife Resources Commission (NCWRC) manages the Dare Game Land lease. Access to DCBR during these hunts is subject to the authority of CO DCBR. Most access roads are gated, and gates are closed when it is not safe for hunters to be on range property, including during nighttime hours and when the range is in use (NCWRC, n.d.; Montgomery 2013). The Air Force permits black bear hunting on Dare Game Land eight days out of the year during the fall and winter months when the Air Force opens sections of the property for the hunters.

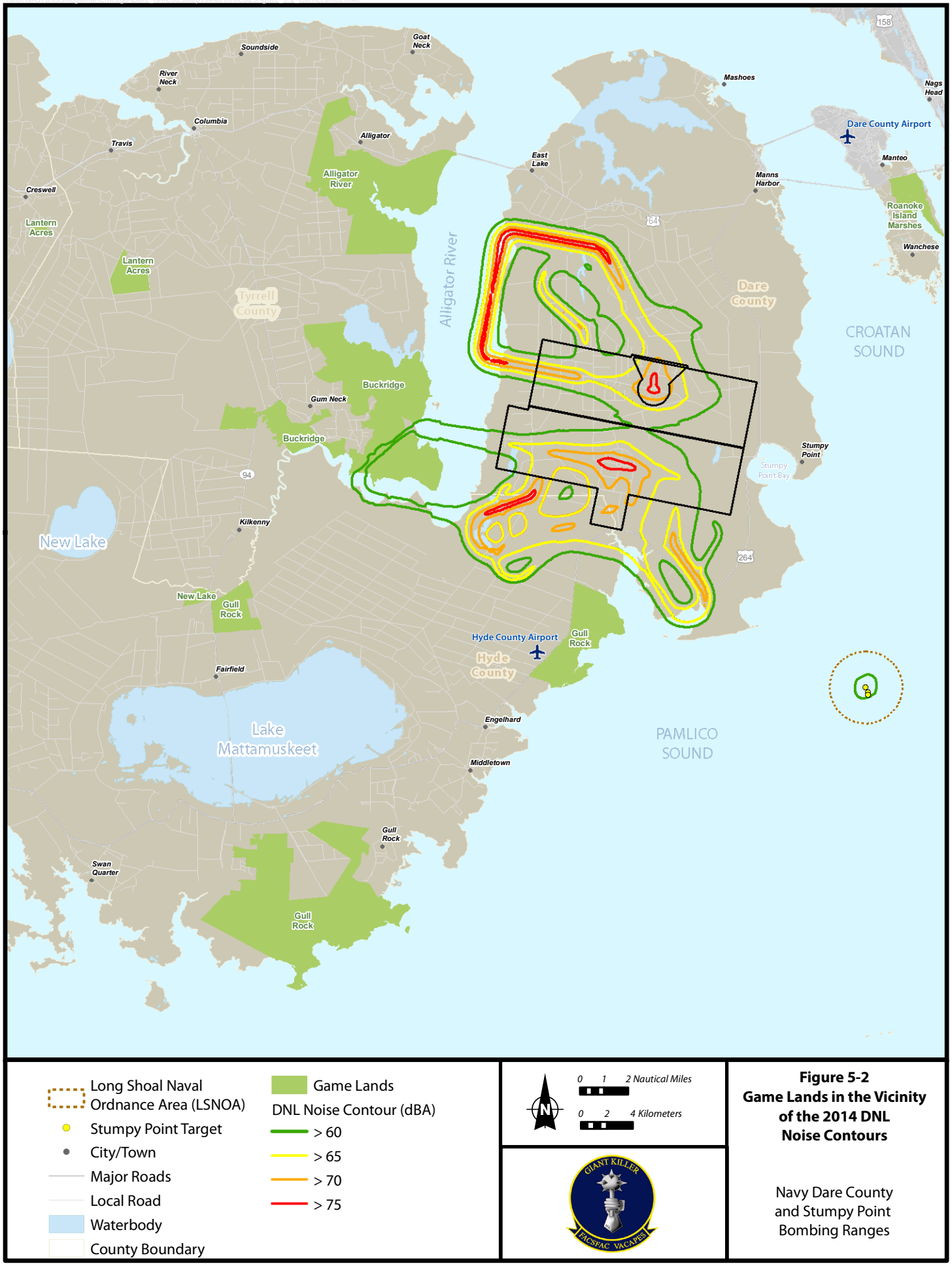


Figure 5-2
Game Lands in the Vicinity of the 2014 DNL Noise Contours

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013; BRRC 2014

In addition to the Dare Game Land lease, several other NCWRC-managed game lands are located near the Range Complex. Hunting on these game lands is subject to NCWRC Game Land regulations and is limited from three to six days of the week; for Roanoke Island Marshes Game Land, hunting is only allowed by permit. (See Figure 5-2 for location of game lands surrounding DCBR.)

5.4.5.2 Commercial and Recreational Fishing

Significant commercial fishing occurs in Pamlico Sound, including in the waters around the LSNOA, as well as off the coasts of Dare and Hyde counties in the Atlantic Ocean. Wanchese, in southern Roanoke Island, is a historical fishing community and home to the North Carolina Seafood Industrial Park where commercial vessels and seafood dealers from the region gather and distribute a substantial share of the regional catch. The town of Stumpy Point in Dare County also supports commercial fishing and related industries.

Recreational fishing occurs in Pamlico Sound, but primarily occurs off the coasts of Dare and Hyde counties in the Atlantic Ocean. Several shipwrecks and other features have become known fishing spots, and the Stumpy Point target, itself, also serves as a fishing spot. Offshore fishing is popular along the entire North Carolina coast, particularly among residents and visitors to the Outer Banks. Charter fishing trips leave from almost all the towns along the Outer Banks, including the towns of Roanoke Island, Hatteras Island, and Ocracoke Island.

5.5 Future Land Uses and Proposed Development

Sections 5.5.1 through 5.5.4 discuss future land uses based on the counties' land use plans and discussions with county officials. Section 5.7 discusses other proposed developments and future activities that may raise compatibility concerns, such as wind energy development.

5.5.1 Dare County Future Land Use

Dare County is largely publicly owned, which significantly limits development potential. The majority of the mainland is within the ARNWR and is protected from urban development. Outside of the ARNWR boundaries, no large development projects are proposed within the unincorporated areas of mainland Dare County (Creef 2013). The County anticipates the majority of growth will occur along the Outer Bank villages. Future development will likely follow existing growth patterns. Both permanent and seasonal populations will continue to grow, and future land uses within the unincorporated areas of Dare County will be primarily residential with limited commercial development. The County intends to direct growth towards smaller scale residential mixed-use areas to maintain the character of the community and prevent rapid urban growth.

The NCDOT is proposing to widen U.S. Route 64 from Columbia in Tyrrell County to its intersection with U.S. Route 264 in Dare County west of Mann's Harbor. Highway improvements may lead to increased commercial and residential development within the towns and villages along the corridor; however, development potential is limited by existing soil conditions. The United States Army Corps of Engineers and NCDOT are currently preparing an Environmental Impact Statement for the proposed project, and NCDOT is prepared to acquire property for the highway widening within Tyrrell County by FY2016 and within Dare County by FY2019.

The NCDOT is also proposing to replace the Herbert C. Bonner Bridge, which extends over the Oregon Inlet and provides the only highway access between Hatteras Island and the mainland. Replacement of the Herbert C. Bonner Bridge is the highest transportation priority for Dare County, and the replacement project has been added to the NCDOT State Transportation Improvement Program. Design and construction of the new bridge has been funded, and construction was scheduled to begin in 2013; however, the project is on hold due to pending lawsuits (NCDOT, n.d.).

5.5.2 Hyde County Future Land Use

Future development within the unincorporated areas of Hyde County is also guided by the county's CAMA LUP. Future land uses will be consistent with

the existing rural character of the county and preservation of natural resources. No large-scale commercial or residential development plans are proposed in Hyde County. The County does not expect an increase in industrial or business development that would affect growth.

The County anticipates that the majority of residential and commercial growth will occur within the village area of Ocracoke Island. To accommodate growth, multi-family housing developments are likely to increase on Ocracoke Island as property values increase. Except for Ocracoke Island, Hyde County will not promote high-density development due to the lack of adequate sewer capacity. Future residential development will be limited to areas where the county can provide utility services and infrastructure. Residential development may increase in existing communities, such as Engelhard and Swan Quarter, which have better access to services and facilities. Commercial development is likely to occur in the existing village areas of Engelhard, Fairfield, Swan Quarter, Scranton, Ponzer, and Ocracoke and not in the county's rural areas.

5.5.3 Tyrrell County Future Land Use

Future development in Tyrrell County and the town of Columbia is guided by the county's CAMA LUP. Future land uses will likely be consistent with the existing rural character of the county. Future growth within Tyrrell County is expected to primarily occur in the town of Columbia and areas within unincorporated Tyrell County that have centralized wastewater and water utility services. In 2013, the town of Columbia expanded their wastewater treatment plant operating capacity to accommodate increased residential development within the town limits and its extra-territorial jurisdiction.

Large tracts of land east of Columbia, within the town limits, have been subdivided for residential development. At full build-out, these tracts of land could accommodate over 600 houses (United States Army Corps of Engineers and NCDOT 2012). Additionally, planning initiatives for infill development and redevelopment of vacant properties within the town of Columbia may also encourage future commercial and industrial land uses.

5.5.4 Washington County Future Land Use

Limited information was available for future development in Washington County. The County has not updated their CAMA LUP since 1976. No known large-scale commercial, industrial, or residential development plans are proposed in Washington County that would significantly affect future growth within the RAICUZ footprint.

5.6 Land Use Compatibility Assessment

The RCZs and land use compatibility recommendation were developed with public safety in mind. The land use compatibility assessment compared the Navy's land use recommendation for each of the noise zones and RCZs for DCBR and LSNOA with existing land uses. The 2014 noise contours and RCZs were overlaid on land use data, and/or aerial photographs. Figure 5-3, presented at the conclusion of Section 5.6, shows the existing land uses within the Navy Dare and LSNOA RAICUZ composite footprint. Figures 5-3 and 5-4, also presented at the conclusion of this section, show the existing land uses within the noise contours and RCZs, respectively. Table 5-3 summarizes the acreage of existing land uses within the noise zones and RCZs.

5.6.1 Compatibility of Existing Land Use with 2014 Noise Contours

Existing land uses within Navy Dare and LSNOA RAICUZ noise zones primarily consist of undeveloped land, military property, and water, which are considered compatible with the Navy's land use guidelines. Under Noise Zone 2, 99.96% of land use is compatible. Existing land use that is considered incompatible is limited to 4 acres of single-family residential land are located within the 65 to 75 ADNL noise exposure area northwest of Navy Dare (see Figure 5-4, inset 2 for location). The Navy's land use guidelines identified no other incompatible land uses within the 2014 noise contours.

Noise exposure from aircraft operations (ADNL noise contours) extends beyond the boundary of the range to the north, south, and west over the ARNWR (classified as undeveloped land use). The C-Weighted Day-Night Average Sound Level (CNDL) noise contours from air gunnery operations are largely contained

Table 5-3 Existing Land Uses within the Noise Zones and RCZs

Land Use	RAICUZ Noise Zone (acres)			RCZs (acres)		
	Noise Zone 1	Noise Zone 2	Noise Zone 3			
	<65 dBA	65-75 dBA	>75 dBA	RCZ-I	RCZ-II	RCZ-III
Agricultural	88	24	0	0	0	94,624
Commercial	0	0	0	0	0	1,869
Mixed Use	0	0	0	0	0	789
Multi-Family Residential	0	0	0	0	0	77
Single-Family Residential	0	4	0	0	0	10,530
Rural Residential	0	0	0	0	0	2,790
Public Use/Institutional	0	0	0	0	0	1,232
Industrial	0	0	0	0	0	36
Recreational	0	0	0	0	0	720
Military Property	14,626	14,971	591	16,735	2,280	26,779
Utilities and Roadways	556	482	17	0	145	5,152
Undeveloped (Federally Managed Lands). See Note 1.	23,373	37,177	927	10	7,007	320,641
Undeveloped	13	145	0	0	0	58
Water	6,505	10,005	469	4,386	22,702	831,529
Agricultural	0	0	0	0	0	94,624
Commercial	0	0	0	0	0	1,869
Mixed Use	0	0	0	0	0	789
Multi-Family Residential	0	0	0	0	0	77
Single-Family Residential	0	0	0	0	0	10,530
Rural Residential	0	0	0	0	0	2,790
Public Use/Institutional	0	0	0	0	0	1,232
Industrial	0	0	0	0	0	36
Recreational	0	0	0	0	0	720
Military Property	8,271	6,489	0	16,735	2,280	26,779
Utilities and Roadways	5	3	0	0	145	5,152
Undeveloped (Federally Managed Lands)	385	385	429	10	7,007	281,767
Undeveloped	0	0	0	0	0	58
Water	874	1,783	0	4,386	22,702	831,529

Note 1: Managed Lands are natural and recreation areas, which are owned or managed by North Carolina Department of Environment and Natural Resources.

within the military property boundary but also extend over the ARNWR to the north of Navy Dare and to the south of Air Force Dare. Higher noise exposure levels are generally concentrated around the target area. Noise exposure levels at the LSNOA are concentrated over the target location. No land is located within the noise contour around the LSNOA.

5.6.2 Compatibility of Existing Land Use with 2015 RAICUZ RCZs

Existing land use within the Range Complex RAICUZ RCZs consists primarily of undeveloped land, agricultural, and water, which are considered compatible with range operations. The RCZ-I land area is largely contained within the boundaries of the Range Complex. About 14 acres of RCZ-I extend over the ARNWR to the north of the range boundary (see Figure 5-5). About 7,007 acres of RCZ-II extend over the ARNWR to the north, east, and west of the range boundary. No residences, commercial businesses, public assembly facilities, or public use areas are currently located within RCZ-I or RCZ-II.

Most of the non-military land within RCZ-III (376,391 acres) consists of undeveloped, federally managed land[2] and agricultural land, which are considered compatible land uses. While the majority of land in RCZ-III is used for developments or activities considered compatible with military operations, some types of residential, public/institutional, and mixed land uses in the RCZ are considered incompatible according to Navy guidance. About 1,232 acres of public/institutional uses, 789 acres of mixed use areas, and 13,397 acres of residential uses (including rural residential, single-family residential, and multi-family residential) are located within RCZ-III. Public/institutional land uses and mixed-use areas generally are considered incompatible in RCZ-III if they are "people-intensive" or gather a large number of people together in one location.

Residential development within RCZ-III is primarily located along the Outer Banks and in Washington County. Rural and low-density, single-family residential development (one to two dwellings per acre) within RCZ-III is

[2] Managed lands are natural and recreation areas, which are owned or managed by the North Carolina Department of Environment and Natural Resources.

considered compatible with the Navy's land use guidelines. Single-family development makes up the majority of residential development in RCZ-III and covers 10,530 acres in the RCZ.

Navy guidance recommends that multi-family housing be developed outside of RCZ-III, similar to other people-intensive land uses such as public assembly facilities, schools, and hospitals. However, Navy guidance takes into consideration that other social, environmental, and economic factors may determine the location of housing in a community. Multi-family housing has been developed over a small area, 77 acres, within RCZ-III on the Outer Banks.

5.7 Compatibility Concerns

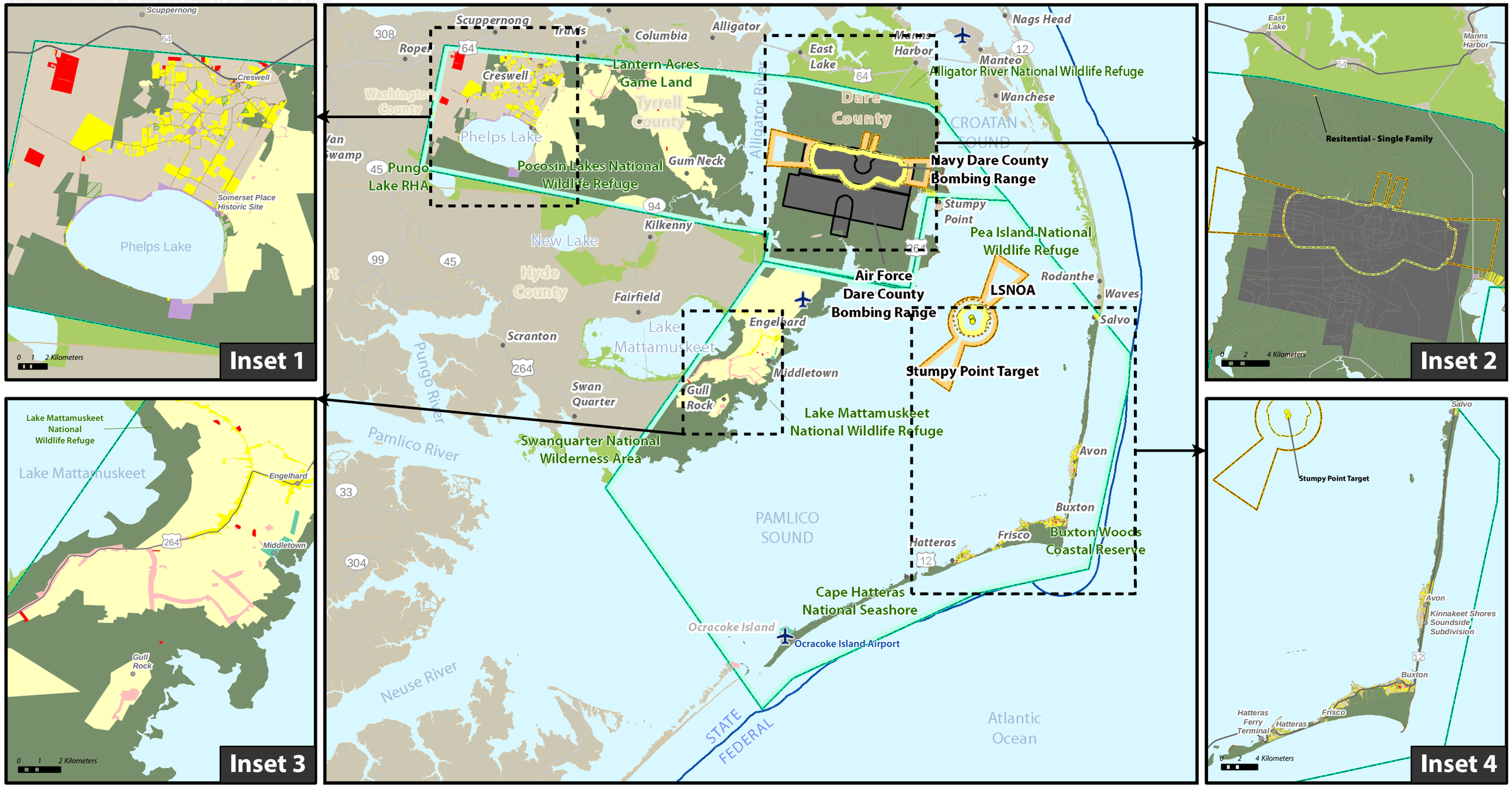
5.7.1 Compatibility Concerns to Range Operations

5.7.1.1 Commercial and Recreational Fishing

Commercial fishing is the primary compatibility concern to operations at LSNOA, primarily due to scheduling conflicts. Two of the economic hubs for commercial fishing in the sound, Stumpy Point and Wanchese, are located near LSNOA. National Oceanic and Atmospheric Administration charts show SDZs around the target range and specify that the range area is closed to persons and navigation, except for military personnel and military vessels. As a mitigation measure, the Navy provides advanced notice of scheduled at-sea hazardous training events to the USCG for the release of weekly Notices to Mariners. The USCG routinely patrols the target range and clears the area of unauthorized vessels.

5.7.1.2 Public Safety

Munitions and, specifically, fragments of munitions can be found throughout the entirety of DCBR because of operations that have taken place at the range since 1965. The Pains Bay fire in 2011 exposed munitions across large areas of the eastern part of the range. Exposed and unexposed munitions present safety risks for recreational users at the Range Complex and within areas of ARNWR north and east of the range, as well as for operators at the Range Complex.



Dare County Bombing Range Boundary

Long Shoal Naval Ordnance Area (LSNOA)

Stumpy Point Target

City/Town

3-Mile Federal/ State Boundary

Major Roads

Managed Lands

County Boundary

Range Compatibility Zone

RCZ-I

RCZ-II

RCZ-III

Existing Land Use

Agriculture

Commercial / Business Service

Developed Area/Mixed Use

Industrial

Military Land

Public Use / Institutional

Recreation/Parks and Open Space

Residential - Multi Family

Residential - Single Family

Rural Residential

Transportation/Roadways

Utility

Vacant/Undeveloped (Federally Managed Lands)

Vacant/Undeveloped (Unmanaged Lands)

Water

0 2.5 5 Nautical Miles

0 5 10 Kilometers

Figure 5-3
Existing Land Use within 2015 RAICUZ RCZs

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013

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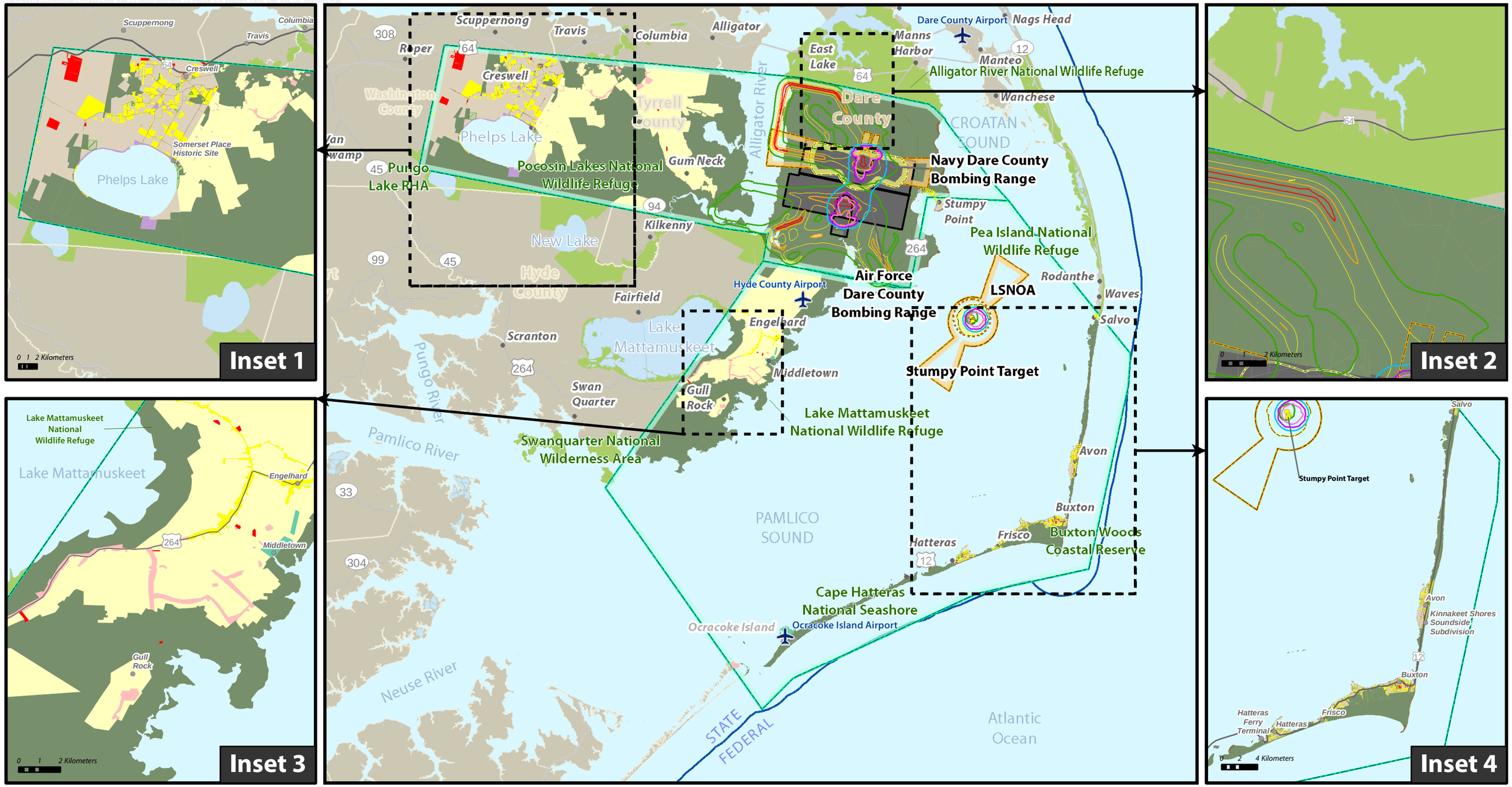

Figure 5-4
Existing Land Use within the 2015 Composite RAICUZ Footprint

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013

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In accordance with the Navy's Operational Range Clearance Policy (OPNAVINST 3571.4), the Navy regularly removes and disposes of exposed munitions from Navy Dare. However, munitions at Navy Dare often land in a surrounding wetland area and are not visible; therefore, these munitions are not removed and disposed. The remaining munitions can increase hazards when fires or weather events, such as hurricanes or coastal storms, expose or move the munitions.

5.8.1.1 Range Trespassing

Unauthorized range access by civilians creates risks to public safety at the Range Complex. The ARNWR surrounds the Range Complex and provides hunting and recreation opportunities to local residents and visitors. Hunters and anglers are known to access range property outside of the leased game lands to hunt and fish, and hunters have been observed crossing over closed gates onto restricted property to retrieve hunting dogs. Gates block Road access to Navy Dare property during operating hours, but gates may be open during non-operating hours for public access to authorized recreational areas on the range. The gates have not entirely controlled trespassing, and the Jackson Road gate is forcibly breached more frequently than other gates (Montgomery 2013). Range trespassers are also subject to high level of risk during range operations, creating potential liability for the Navy.

In addition to hunting, the ARNWR supports recreational activities including hiking, kayaking, fishing, and wildlife observation. ARNWR receives about 45,000 visitors annually (USFWS 2014), and the number of annual visitors to ARNWR has increased since opening the visitor center in 2012, especially during summer months (Lanier 2013). Occasionally, recreational users and visitors trespass onto the Range Complex property from the ARNWR. Trespassing onto the Range Complex property or into WDZs can interfere with range operations or may expose trespassers to hazards from munitions. Air-dropped munitions that embed into target and buffer areas and have not been completely recovered by the Navy represent a potential explosive hazard when disturbed (Montgomery 2013). Resource Conservation and Recovery Act and United States Environmental Protection Agency regulations state that munitions

on a range are an intended use and may remain on a range until a range owner/operator recovers them.

To address the significant public safety risks from trespassing into areas where active training is occurring or areas with material potentially posing an explosive hazard, the Air Force is considering restricting recreational use on DCBR due to safety concerns. Prohibiting recreational access to the range would cause controversy with local hunters and the public.

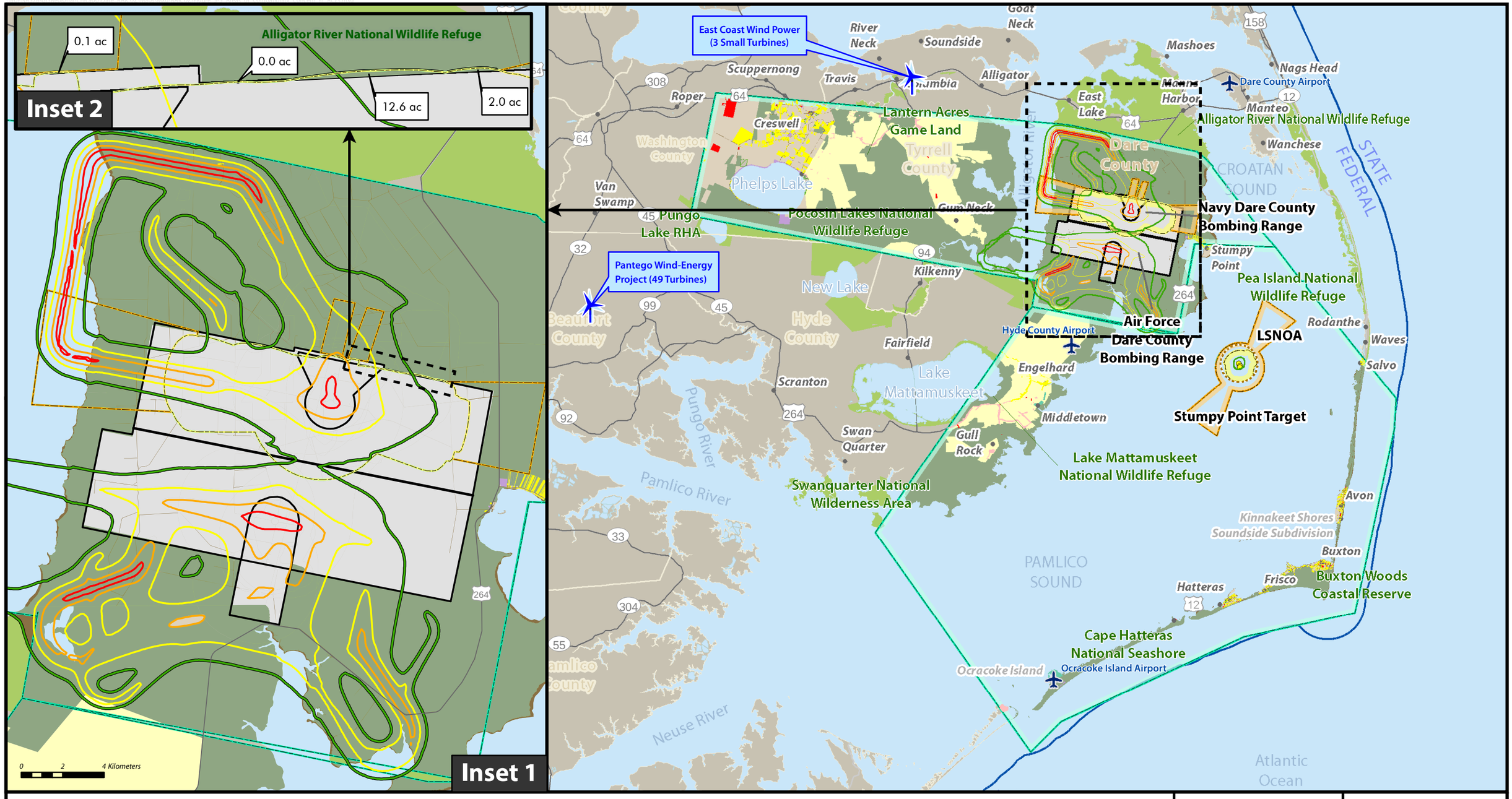
5.8.1.2 Wind Energy Development

Utility-scale wind turbines near ranges and in the direct flight path of low-level training routes may create avoidance areas, restrict training operations, reduce the quality of training, and compromise pilot safety by creating tall obstructions in the airspace or near low-level flight tracks. Wind development in the area of DCBR has the ability to affect range operations. Factors contributing to radar inference include the radar cross-section of a wind turbine, the number of turbines and their configuration, and Doppler shift.

Within the RAICUZ footprint, only three small (less than 2.5-kilowatt turbines, each 42 feet tall) wind turbines have been installed on a commercial property east of Columbia in Tyrell County (Appalachian State University 2014, 2015). These turbines are not considered to have adverse impacts on Navy flight operations at the Range Complex because of their limited height above ground level. One utility-scale wind energy facility is currently operating in eastern North Carolina. The Pantego Wind Energy Project, developed by Invenergy Wind Development, LLC, in Northern Beaufort County, has 49 wind turbines generating 80 megawatts of energy on private land.

5.8.1.3 Aircraft Operations in the Vicinity of DCBR and LSNOA

As stated in Section 2.3.3, there are two airports near DCBR and LSNOA that may have an effect on operations. Hyde County Airport is located about 6 miles south of DCBR and about 1.5 miles from Restricted Area R-5314B, and underneath the Pamlico B MOA.



Source: ESRI 2011; Navy EIMS 2013

Figure 5-5
Areas of Compatibility Concern in Dare, Hyde, Tyrell and Washington Countiest

Navy Dare County and Stumpy Point Bombing Ranges

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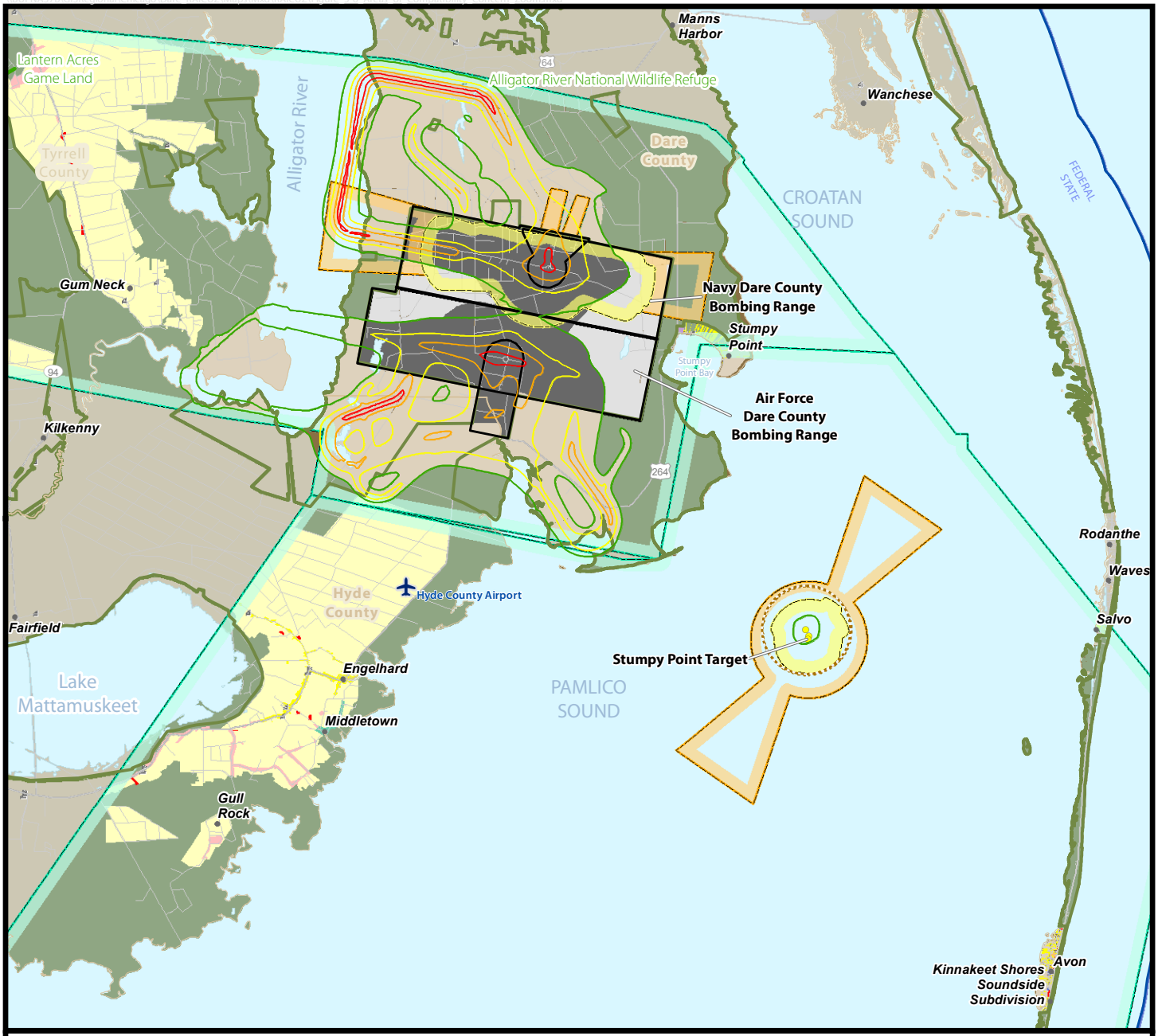

Existing Land Use
- Agriculture
- Commercial / Business Service
- Developed Area/Mixed Use
- Industrial
- Military Land
- Public Use / Institutional
- Recreation/Parks and Open Space
- Residential - Multi Family
- Residential - Single Family
- Rural Residential
- Transportation/Roadways
- Utility
- Vacant/Undeveloped (Federally Managed Lands)
- Vacant/Undeveloped (Unmanaged Lands)
- Water

2014 Composite RAICUZ Footprint

Range Compatibility Zone
- RCZ-I
- RCZ-II
- RCZ-III

DNL Noise Contour (dBA)
- > 60
- > 65
- > 70
- > 75

- Dare County Bombing Range Boundary
- Long Shoal Naval Ordnance Area (LSNOA)
- Stumpy Point Military Target
- City/Town
- Church
- School
- 3-Mile Federal/State Boundary
- Major Roads
- Managed Lands
- County Boundary
- Airport

0 1 2 Nautical Miles

0 2 4 Kilometers

Figure 5-6
Areas of Compatibility Concern within RCZ I and RCZ II

Navy Dare County and Stumpy Point Bombing Ranges

Source: ESRI 2011; Navy EIMS 2013

Dare County Regional Airport is located about 9 miles north of DCBR. The airport's tower-controlled airspace shares a border with Restricted Area R-5314E, overlapping along the northeastern border of the restricted area. During instrument conditions, instrument flight rules flight paths bring aircraft in close proximity to this restricted area (Blake 2014b). Adding to congestion in the airspace, both airports have limited ingress and egress options available due to Restricted Areas R-5314, R-5313A/B/C/D, Phelps MOAs A, B, C, and D, Pamlico A and B MOAs, and the Stumpy Point MOA.

Federal Aviation Administration (FAA) Order JO 7400.8W limits the use of the Stumpy Point target at LSNOA to 20 hours per month for aircraft in Restricted Area R-5313 (B-D) (FAA 2014). FACSFAC VACAPES schedulers must track and adhere to this regulation. The primary fixed-wing user of the range for the Navy is VFA-106. Additional primary users of LSNOA include Marine Corps and Air Force aircraft.

5.8.1.4 Urban Development

Navy Dare is sparsely populated and undeveloped, with a large National Wildlife Refuge that surrounds the complex. Property around the impact areas is federally preserved land with little possibility of development. However, noise generated from aircraft operations and air gunnery events has resulted in a few noise complaints from surrounding communities, particularly along the coast. In response to noise complaints and to prevent conflict with tourism, the Navy has implemented flight avoidance areas over the entire coastline from Virginia to North Carolina, as well as Roanoke Island, Somerset Place on the northeastern shore of Phelps Lake, the town of Gum Neck, and the Hyde County airport (E & E 2012; BRRC 2013).

The compatibility of future development should be considered during the planning and permitting process to avoid compatibility concerns between urban development and military operations. The Navy has developed guidelines for compatible development and land use within a range's noise zones and RCZs. These land use guidelines are provided in RAICUZ Instruction (OPNAVINST 3550.1A [Appendix B]) of this RAICUZ Study. To protect public health, safety, welfare, and military operational capabilities, communities should evaluate future

land uses against these guidelines to identify recommended incompatible land uses in the RCZs and noise zones. These guidelines may also be used to identify compatible land uses, allowing for a balance between economically beneficial urban development and military operational capabilities.

5.8.1.5 Controlled Burns

Smoke from wildfires presents challenges to Navy pilots because it reduces visibility and can ultimately damage targets or require that training be cancelled. Therefore, to reduce potential wildfires on or next to DCBR, the Air Force has a contract with the North Carolina Service Park Service to perform prescribed burns on both Navy Dare and Air Force Dare. Burns are scheduled on regular intervals.

5.8.1.6 Bird/Animal Aircraft Strike Hazards

Wildlife represents a significant hazard to flight operations. Birds, in particular, are drawn to different habitat types found in the range environment including hedges, grass, brush, forest, and water.

DCBR is located within a major migratory bird path and is part of the Alligator River Lowlands Important Bird Area (IBA). Because of this, Bird/Animal Aircraft Strike Hazard (BASH) occurrences are a safety concern at the range. The primary BASH concerns at DCBR are during low-level flights over the target and when aircraft use low-level training routes.

5.8.2 Compatibility Concerns to the Public

5.8.2.1 Access to Hunting and Recreational Resources

The land around Navy Dare impact areas is owned by the military, and there is no public access to any impact areas. However, land around the impact areas is used for hunting and fishing activities. Hunting and fishing within and around DCBR and ARNWR have occurred for many generations. The Navy remains sensitive to the use of these lands for hunting and actions that may reduce access to traditional hunting and fishing grounds.

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6

Land Use Tools and Recommendations

The goal of the RAICUZ Program—to protect the public health, safety, and welfare of those living near air-to-ground training ranges while preserving the operational capabilities of military air-to-ground ranges—can most effectively be accomplished by the active participation of interested parties, including the Navy, state, regional and local governments, private citizens, developers, real estate professionals, and others. This chapter provides tools, alternative techniques, and recommendations for FACSFAC VACAPES and Navy Dare personnel, local governments and agencies, and private citizens for use in exploring, modifying, combining, and implementing policies, plans, and regulations necessary to help ensure the goal of the RAICUZ Program is met.

6.1 Federal/Navy Tools and Recommendations

As discussed in Section 1.1, pursuant to OPNAVINST 3550.1A, the Range Air Installation Commander is committed to and shall:

- Implement a RAICUZ Program for the Navy Dare and LSNOA;
- Work with state and local planning officials to implement the objectives of the RAICUZ Study;
- Provide assistance in developing RAICUZ information, including operational data needed to update the RAICUZ Study;
- Work with local decision makers in the surrounding communities to evaluate and justify the retention of land or interest in land required for operational performance; and,

- Notify the chain-of-command in the RAICUZ Program office when local conditions merit update or review of the RAICUZ Study.

As a result of this RAICUZ Study, it is recommended that the Navy:

- Communicate the results of the RAICUZ Study with planning commissions for each county;
- Coordinate/engage with ARNWR with regards to about 14 acres of spillage;
- Engage with planners in Columbia County about development and impact concerns; and
- Engage with wind developers and monitor wind development.

Additionally, various federal agency programs can support the local governments' ongoing efforts to control land use and development near DCBR.

6.1.1 Federal/Navy Land Use Compatibility Tools

Fundamentals of the RAICUZ Study can be incorporated into the environmental review process for federal projects.

6.1.1.1 Environmental Review

This RAICUZ Study meets the requirements of federal noise laws. The National Environmental Policy Act mandates full disclosure of the environmental effects resulting from proposed federal actions, approvals, or funding. Federal agencies, including the Navy, are required to consider the environmental impacts of any federal project that could significantly impact the environment by conducting a comprehensive environmental review Impacts of the action are generally documented in an Environmental Impact Statement or Environmental Assessment. The environmental review process is a viable means for incorporating the fundamentals of this RAICUZ Study in the planning review process of a project. Applicable guidance supporting environmental review follows.

6.1.1.2 Executive Order 12372, Intergovernmental Review of Federal Programs (July 1982)

Executive Order 12372 allows state governments, in consultation with local governments, to establish review periods and processes for federal projects.

In accordance with the Intergovernmental Cooperation Act of 1968, the United States Office of Management and Budget requires federal agencies to coordinate and communicate with state, regional, and local officials in the early planning stages of any federal aid development projects. The Intergovernmental Review Program provides an early entry point into the process for the Navy to introduce RAICUZ concepts and discuss RAICUZ issues.

6.1.1.3 Housing and Urban Development Circular 1390.2: Noise Abatement and Control

In 1971, the United States Department of Housing and Urban Development (HUD) established noise standards and polices for approving HUD-assisted housing projects in high noise areas and noise attenuation measures under HUD Circular 1390.2: Noise Abatement and Control. The approval of mortgage loans from the Federal Housing Administration or the Veterans Administration is subject to the standards and polices of the HUD noise regulations. The HUD regulations allow for new housing construction assisted or supported by HUD within a noise area of 65 DNL or less. Construction within a 65 to 75 DNL noise area is subject to appropriate sound attenuation measures, and construction within an area exceeding a 75 DNL noise level is not acceptable. As noted in Chapter 3, noise levels at Navy Dare are concentrated over the target area (Figures 3-1, 3-2, 3-3, 5-5, and 5-6). Noise exposure from aircraft operations extends beyond the boundary of the range to the north and west over the ARNWR, over the east side of Alligator River and south of Air Force Dare. These levels are 65 DNL or less and do not restrict construction near the ARNWR area.

Encroachment partnering is a cooperative, multi-party, real estate-based program use to mitigate the impacts of off-base land uses that are potentially incompatible with military operations. It implies that the DOD and its partner(s) are both willing and able to contribute to the cost and effort of acquiring land interests.

6.1.1.4 DOD Encroachment Partnering Program

Title 10, United States Code Section 2684a authorizes the Secretary of Defense or the Secretary of a military department to enter into agreements with an eligible entity or entities to address the use or development of real property in the vicinity of, or ecologically related to, a military air-to-ground range or military airspace, to limit encroachment or use of the property that would be incompatible with the mission of the range or place other constraints on military training, testing, and operations. Eligible entities include a state, a political subdivision of a state, and a private entity that has as its principal organizational

purpose or goal the conservation, restoration, or preservation of land and natural resources, or a similar purpose or goal. The DOD Readiness and Environmental Protection Integration (REPI) Program is a tool for ensuring the sustainability of our military's training, testing, and operational capabilities through cooperative land use planning and integrated land protection around installations and ranges. REPI partnerships are only one example of the suite of DOD tools that have evolved to prevent and avoid restrictions on military operations. REPI partnerships benefit DOD installations and the surrounding communities within which they are located by contributing to the maintenance of open space, protecting against mission relocations that can affect local economies, and protecting against the need for reactive spending associated with new range construction when restrictions constrain the regular use of testing, training, and operating lands.

Encroachment partnering agreements provide for an eligible entity to acquire fee simple title in land for limiting encroachment on the mission of a military range and/or to preserve habitat off the range to relieve current or anticipated environmental restrictions that might interfere with military operations or training at the range. The DOD can share the real estate acquisition costs for projects that support the purchase of fee or conservation or other restrictive easement for such property. The eligible entity negotiates and acquires the real estate interest for encroachment partnering projects with a voluntary seller. The eligible entity must transfer the agreed-on restrictive easement interest to the United States of America at the request of the Secretary.

If the readiness sustainment of a military range is threatened from incompatible development, and the local community cannot resolve the threat, the Navy can obtain the land through purchase, voluntary agreement, or condemnation.

6.1.1.5 Dare County Bombing Range Advisory Council

The Dare County Bombing Range Advisory Council is run by the 4th Fighter Wing out of Seymour Johnson AFB. The council consists of state and local government officials, Seymour Johnson AFB personnel, Air Force and Navy representatives, U.S. Fish and Wildlife Service staff, and local citizens. The council meets quarterly to advise the Dare County Commissioners and 4th Fighter Wing in matters concerning the range and to provide a direct communication link between the Dare County Commissioners, the public, and the military. Overall, this direct communication fosters a long-standing cooperative relationship among

the military, Dare County citizens, and the state and federal agencies that have a direct interest in DCBR.

6.1.1.6 Land Acquisition

The Navy may seek to acquire interest in properties (acquisition) to protect its mission and prevent or manage incompatible land use in the vicinity of an air-to-ground range. When possible, the Navy seeks to acquire property through negotiation and voluntary agreements with landowners. The Navy partners with the Air Force to acquire properties around DCBR as they become available, in order to maintain compatible land use near the range.

6.1.1.7 Adjustment of Operational Procedures

The Navy, in very limited situations, can adjust operational procedures to reduce aircraft and ordnance noise exposure (noise abatement) and potential mishaps. Only after careful consideration of all options should changes in operational procedures be made. No changes that compromise Navy training at Range Complex should be instituted by Navy Dare.

Adjustments to operational procedures can be made only after careful consideration of all options and only if the changes do not compromise the range's mission.

6.1.1.8 DOD Siting Clearinghouse

The Secretary of Defense established the DOD Siting Clearinghouse in 2010 to address compatibility concerns between military missions and energy development proposals. Proposed wind farm sites are processed through the FAA's Obstruction Evaluation/Airport Airspace Analysis, and the FAA provides notification to the DOD for input.

The FAA's Obstruction Evaluation/Airport Airspace Analysis website outlines filing procedures and notification requirements prior to construction or alterations that may impact air navigation. The website provides access to application forms (Form 7460-1, Notice of Proposed Construction or Alteration), notification criteria, proposed cases, and determination of Notice of Presumed Hazard cases. The website also includes a DOD Preliminary Screening Tool that allows developers to map long-range and weather radars, MTRs, and SUAs relative to the proposed location of their development to preview potential areas of impact to military operations. Military installations can also use this site to monitor local notices of proposed developments that may obstruct flight courses.

Through the clearinghouse process, the DOD and the Navy will formally review all tall structures, including renewable energy and wind energy projects, filed with the FAA for potential adverse impacts to operations. Only the Secretary of Defense or his/her deputy can officially object to a project after a full consideration of potential mitigation.

6.1.2 Federal/Navy Action Recommendations

6.1.2.1 Engage in the Local Planning Process

Seymour Johnson AFB, which controls DCBR, and FACSFAC VACAPES, which is the Navy command responsible for day-to-day operations at DCBR, should maintain routine communication with the Dare, Hyde, Tyrrell, and Washington county governments. Routine communication will help these parties stay informed of local land use plans and regulations and to ensure the Navy's input is offered in the early stages of any long-range planning initiatives, especially in terms of wind energy development near the range. This area of the state has high potential for wind energy development and the Navy command should stay in contact with local governments to address the Navy's concerns.

A designated representative from Seymour Johnson AFB and from FACSFAC VACAPES, in addition to Navy and Air Force range managers, should attend public hearings and provide comments on actions that affect RAICUZ planning, including land use studies, capital improvement plans, and other land development regulation updates/amendments. The joint Navy and Air Force team should advise counties of future operations and offer guidance on identifying areas of potential incompatibilities.

In addition to ongoing community involvement, the designated representative and range managers could attend County Board of Commissioners meetings. Attendance and participation will keep the Navy engaged in the local planning process and provide a forum for comments as they affect RAICUZ planning. During local planning meetings, the Navy can also address current and future range activities, noise complaints (both the process for filing and resolving complaints), and other relevant topics related to the interaction between range users and the surrounding communities.

6.1.2.2 Community Outreach Activities

Outreach and information sharing helps in educating the community about the Navy's mission and helps build alliances with the community and regional decision makers to ensure continuation of mission-essential operations.

Additionally, Seymour Johnson AFB and FACSFAC VACAPES should provide community decision makers with the information necessary to make informed decisions regarding the impacts of their actions on mission readiness. Through outreach efforts, the Navy can educate the public on the importance of Navy Dare's training operations and the ability of the Range Complex to support military activities to sustain a combat-ready Navy.

6.1.2.3 Presentation of the RAICUZ Study and Educational Materials

To encourage community interaction and to facilitate a better understanding of the Navy's scope of operations, Seymour Johnson AFB and FASFAC VACAPES could develop a package of RAICUZ outreach materials, including community presentations and educational brochures, on training activities and the Navy's mission. Specifically, it is recommended that the Navy create brochures for a civilian audience, including the recreational and commercial fishing community, hunting organizations, local governments, the ARNWR, and real estate brokers, with appropriate verbiage and maps to explain the basic elements of the RAICUZ Program, and how incompatible development within the RAICUZ footprint can impact range operations and the public. The brochures should detail the significance of RCZs and noise zones to inform both Navy pilots and civilians. Brochures should be created for Navy Dare and LSNOA.

The Navy could prepare a presentation outlining elements of the RAICUZ Program for community decision makers, including the County Board of Commissioners, Economic Development Councils, Board of Realtors, and local civic organizations. The RAICUZ Program presentation could also discuss how land uses and local policies (e.g., infrastructure siting, schools, rezoning) can influence Navy operations.

Seymour Johnson AFB and FACSFAC VACAPES should post the 2015 RAICUZ Study and related educational materials on their public website. Presentation and distribution materials, including RAICUZ poster boards, maps of the range, and fact sheets, should also be posted to the FACSFAC VACAPES website(s) and used for community outreach activities.

6.1.2.4 Real Estate Disclosures

Seymour Johnson AFB and FACSFAC VACAPES should provide local real estate agencies with RAICUZ-related materials and maps showing MTRs, MOAs, RAICUZ boundaries, and WDZs. Seymour Johnson AFB and a FACSFAC VACAPES representative should meet with the local Board of Realtors to discuss the importance of real estate disclosure when buying or selling property within or near the RAICUZ footprint.

6.1.2.5 Noise Complaint Monitoring and Response Program

NAS Oceana and Seymour Johnson AFB have a formalized noise and airspace complaint program. Seymour Johnson AFB provides a dedicated noise complaint hotline for citizens who want to register a complaint. Information provided by each caller is recorded on a Community Concerns form to document the date and time of the incident, the nature of the complaint, and contact information of the caller. If a complaint originates from areas around the DCBR, Seymour Johnson AFB forwards the record of the complaint to the Air Force's Range Manager for response. If the complaint is referring to a Navy aircraft operation, the range manager will provide the record of the complaint to the Range Complex manager. The Navy has also implemented various flight avoidance areas, including the entire oceanfront from Virginia to North Carolina to prevent conflict with tourism and reduce noise complaints.

Seymour Johnson AFB should continue to record and assess noise complaints. Assessing noise complaints identifies noise-sensitive areas, determines which operational activities are responsible for the noise complaints, and ultimately helps abate future noise complaints. Through the noise complaint program, Seymour Johnson AFB and NAS Oceana personnel can evaluate flight procedures to reduce noise impacts on the surrounding communities. Controlled Burns

Seymour Johnson AFB and FACSFAC VACAPES should continue their coordination with the North Carolina Forest Service in regards to controlled burns. Controlled burns help to reduce the chances of wildfires, which can hinder pilots from fulfilling mission requirements

6.2 State/Regional Tools and Recommendations

North Carolina regulations and programs that provide land use controls and manage growth around the DCBR can be used to direct development within the RAICUZ footprint. Also, regional planning agencies can help control incompatible growth by aiding and influencing local governments in the development of policies, plans, and regulations necessary for the physical and economic expansion of the region.

6.2.1 State/ Regional Level Tools

6.2.1.1 North Carolina Military Affairs Commission

The North Carolina Military Affairs Commission (NCMAC) is a 50-member commission established within the Office of the Governor in 2013. The North Carolina Department of Commerce is responsible for the organizational, budgetary, and administrative purposes of the NCMAC. The vision of the NCMAC is to make North Carolina the most military-friendly state in the country. The NCMAC protects the missions and existing installations within North Carolina by advising state and local officials, including the Governor, on ways to protect the military community's infrastructure, training ranges, and low-level routes from encroachment challenges. The NCMAC works to expand defense related economic development by supporting economic opportunities that focus on the military (North Carolina Department of Commerce 2014).

6.2.1.2 North Carolina Commanders Council

The North Carolina Commanders Council was established in 2009, as a group comprised of installation commanders from major military bases and agencies in North Carolina, including Seymour Johnson AFB. The NC Commanders Council "provides a forum for installation commanders to

communicate, collaborate, and coordinate actions and/or support from the state and regional organizations on actions and issues affecting military training and operational readiness in North Carolina" (North Carolina Department of Commerce 2009).

6.2.1.3 North Carolina Planning and Regulation of Development

In accordance with Sections 153A-323(b) and 160A-364 of the North Carolina General Statutes, counties and surrounding cities are required to provide written notice to the commander of a military base of any proposed changes to zoning or land uses within 5 miles of the perimeter boundary of a military base at least ten days prior to the public hearing date. If the base CO provides comments or analysis on the proposed ordinance or amendment, the local governing body must consider these comments before making a final determination.

6.2.1.4 North Carolina Military Lands Protection Act of 2013

The North Carolina Military Lands Protection Act of 2013 amends Chapter 143 of the General Statutes by adding Article 9G, requiring people proposing to construct a tall building or structure (more than 200 feet tall) within 5 miles of a major military installation to notify any potentially affected installation before a letter of endorsement is obtained from the state Building Code Council. The Building Code Council will solicit written comments from the CO of a potentially affected major military installation. Wind energy facilities and new, temporary, cellular and television towers erected following a natural disaster are exempt from this requirement but are covered under other sections of Chapter 143. The DCBR is included under the act as a facility under the oversight of Seymour Johnson AFB.

6.2.1.5 Permitting Program for the Siting and Operation of Wind Energy Facilities

The North Carolina state government has strengthened state oversight of proposed onshore wind development. In 2013, the North Carolina General Assembly amended Chapter 143 of the General Statutes by adding Article 21C (Session Law 2013-51, Act to Establish a Permitting Program for the Siting and Operation of Wind Energy Facilities), which requires people proposing to construct, operate, or expand a wind energy facility to obtain a permit from the

North Carolina Department of Environment and Natural Resources. Applicants for a permit must conduct a preliminary evaluation of the site or sites for the proposed facility or facility expansion to determine, in part, if the proposed wind energy facility or facility expansion would pose a serious risk to military operations.

6.2.2 State/Regional Level Recommendations

Seymour Johnson AFB and FACSFAC VACAPES should work with the NCMAC and the North Carolina Commanders Council to propose statewide regulations that prohibit the development of structures that may interfere with the use of military training routes or compromise the mission and operations at DCBR. Seymour Johnson AFB and FACSFAC VACAPES should provide these agencies with information regarding air operations and flight courses.

6.3 Local Government Tools and Recommendations

Local governments have the authority to implement regulations and programs to control development and direct growth to ensure land use activity is compatible with range operations. Local governments should recognize their responsibility in providing land use control in those areas encumbered by the RAICUZ footprint by incorporating RAICUZ information into their planning policies and regulations.

Zoning is the legal tool to implement a municipality's land use plan. Zoning regulates land use, density, and height of structures, and can prohibit the creation of other hazards.

6.3.1 Local Government Tools

6.3.1.1 Local Government Comprehensive Plans

Comprehensive plans can be adopted in North Carolina to guide future development and growth, establish long-range planning policies, and ultimately provide the framework for zoning and land use regulations. Comprehensive plans are decision-making tools to evaluate proposed development and/or land use activities in context with the community's long range-planning policies. While comprehensive plans provide guidance for future land uses and development, these plans do not constitute zoning regulations or establish zoning district boundaries. Components of a comprehensive plan may include future land use,

annexation, transportation, infrastructure, conservation, recreation and open space, and capital improvements. Comprehensive plans can also influence the capital budget and funding of capital improvement plans. Coastal counties in North Carolina, including Dare, Hyde, Tyrrell, and Washington Counties, are required to prepare CAMA LUPs to control growth and encourage efficient development that preserves the county's cultural and natural resources. CAMA LUPs are approved and certified by the State Coastal Resources Commission and act as the local comprehensive plan for the county.

6.3.1.2 Zoning

While comprehensive planning allows municipalities and counties to consider the impacts of current and future development, zoning is the legal tool to implement a municipality's land use plan. Zoning regulates land use, density, and height of structures, and can prohibit the creation of other hazards, including smoke, radio interference, and glare. In North Carolina, zoning authority is carried out through the county or municipality, depending on where the property is located. Through zoning regulations, cities/counties are authorized to create zoning districts that permit or prohibit property use, construction standards, and development density.

With transfer of development rights, property around a range that is incompatible with noise contours and RCZs can be transferred for property that is more favorable to that type of development.

6.3.1.3 Wind Energy Ordinances

Dare, Hyde, Tyrrell, and Washington counties have adopted ordinances to regulate the construction and operation of wind energy facilities. Each county's ordinance differs in the restrictions they place on the locations of wind turbines and their requirements for DOD and other federal agency approval. Dare County's ordinance is the most protective of Navy operating capabilities at DCBR, and includes an option for the county planning director to require DOD release/approval of a proposed wind energy research site. Dare and Washington counties are the only counties that specify zoning district restrictions for wind turbines. The ordinances also vary in regulating the maximum height of wind turbines and requiring completion of an environmental assessment for large- or utility-scale wind projects.

6.3.1.4 Capital Improvements Program Projects

Capital improvement program projects, such as extension of potable water lines or transmission lines, road paving and/or improvements, right-of-way acquisition, and school construction/renovation, can encourage new development to under-served areas. Dare County's 2015-2019 Capital Improvements Plan outlines specific projects that can be used to direct future growth patterns and ensure that the areas near military ranges are developed in accordance with the RAICUZ Program's recommended land use guidelines (Dare County 2014b). Local governments can coordinate capital improvement projects to avoid extending infrastructure into or near high noise zones or RCZs.

6.3.1.5 Purchase of Development Rights

Local governments (or a land trust) can also establish purchase of development rights programs to manage growth and preserve open space. A local government or agency provides landowners compensation for not developing their land—essentially buying the development rights—and then obtains a legal easement (conservation easement) that further restricts development on the property. The landowner maintains ownership of the property and can use the land under conditions specified in the terms of the easement (e.g., farming, timber production, or hunting). The local government may consider purchase of development rights for agricultural land within the RAICUZ footprint.

Real estate disclosures should provide information to prospective clients regarding aviation noise and RCZs so they can make informed decisions, thereby reducing frustration and criticism of an installation's mission.

6.3.1.6 Building Codes

Building codes, which are enforced through local ordinances, are standards applied to the construction, modification, and/or use of buildings. Local building codes may be modified to ensure consistency with the noise attenuation recommendations of the RAICUZ Program through construction permits. By using proper sound insulation construction techniques and materials, impacts from aircraft noise can be reduced and interference of regular indoor activities can be reduced. Although building codes will not prevent incompatible development, they can help reduce impacts.

6.3.1.7 Real Estate Disclosures

Real estate disclosures allow prospective buyers, lessees, or renters of property in the vicinity of military operations areas to make informed decisions

regarding the purchase or lease of property. Disclosure of noise and safety zones is a crucial tool in protecting and notifying the community about expected impacts of aviation noise and locations of RCZs, thereby reducing frustration and criticism by those who were not adequately informed prior to purchase of properties within affected areas.

6.3.1.8 Land Acquisition Programs

To avoid land use incompatibilities near ranges, land can be acquired through voluntary real estate transactions.

Local governments can establish land acquisition programs to support the RAICUZ Program. Land acquisition programs are designed to eliminate land use incompatibilities through voluntary transactions in the real estate market and local development process. Land acquisition strategies can support goals of preventing urban growth near military ranges, while protecting the environment, maintaining agricultural lands, and conserving open spaces. Local governments can partner with the Navy to identify areas of conservation interest and determining protection priorities around air-to-ground ranges.

6.3.2 Local Government Recommendations

6.3.2.1 Communication

Seymour Johnson AFB and FACSFAC VACAPES are responsible for informing and educating community decision makers about the RAICUZ Program; however, local governments should continue to actively inform and request input from Seymour Johnson AFB and FACSFAC VACAPES regarding land use decisions that could impact the readiness sustainment of the Range Complex. It is recommended that local government websites include information about the RAICUZ Program and provide a link to the Seymour Johnson AFB and FACSFAC VACAPES websites for information regarding range operations.

Capital improvement projects should be evaluated for impacts on the RAICUZ Program.

Local governments are recommended to coordinate with Seymour Johnson AFB and FACSFAC VACAPES on aircraft operations at Dare County Regional Airport and Hyde County Airport and work to ensure the safety of all parties.

6.3.2.2 Land Use Plans and Regulations

In accordance with the North Carolina Coastal Area Management Act, Dare County has a Land Use Plan (LUP) that local planning agencies use as

guidance for development patterns and other land use issues that are important to Dare County (Dare County 2009). Local governments should, to the extent possible, adhere to the land use recommendations in the RAICUZ Instructions to mitigate noise impacts, range safety, height obstructions, and incompatible development within the RAICUZ footprint.

6.3.2.3 Capital Improvement Plans

As discussed in Section 6.3.1.4, Dare County has a Capital Improvement Plan that outlines projects for FY2015 through FY2019. Capital improvement projects in proximity to the DCBR should be evaluated and reviewed for potential direct and indirect impacts that such improvements may have on the ability to implement a successful RAICUZ Program.

6.3.2.4 Building Codes

Local governments should continue to monitor and/or amend their building codes to require noise attenuation techniques for new construction within the RAICUZ footprint. Additional insulation and soundproofing should be included in the local building standards for new single- and multi-family residential construction within the footprint.

Citizens can choose not to invest in property located within a high-noise zone or RCZ.

6.3.2.5 Real Estate Disclosures

Dare, Hyde, Tyrrell, and Washington counties may consider establishing a real estate disclosure area around the DCBR to require property owners and real estate professionals to provide written disclosure to prospective purchasers, renters, or lessees when a property is located within an RCZ or high noise zone.

6.4 Private Citizens/Real Estate Professionals/Businesses Tools and Recommendations

Local citizens and businesses should recognize their responsibility in adhering to and complying with land use controls in those areas encumbered by the 2015 RAICUZ footprint. The sections below provide actions, procedures, and recommendations that private groups can use or consider to help control development within the 2015 RAICUZ footprint.

6.4.1 Private Sector Tools

6.4.1.1 Business Development and Construction Loans to Private Contractors

Lending institutions can limit financing for real estate purchases or construction incompatible with the RAICUZ Program by restricting or prohibiting mortgages and/or other types of loans. The state and/or local government could designate restricted areas around the DCBR.

6.4.1.2 Real Estate Professionals

Real estate professionals have the ability to ensure prospective buyers or lessees are fully aware of what it means to be within a high noise zone and/or RCZ. Real estate professionals have the ability and should be required to show prospective buyers and lessees the property at a time when noise exposure is expected to be at its worst.

6.4.2 Private Sector Recommendations

6.4.2.1 Real Estate Professionals Cooperation

Real estate agents should provide full disclosure of noise exposure and RCZs to prospective clients and acknowledge the RAICUZ Program on their websites.

Real estate professionals should continue to ensure that prospective buyers or lessees have all available information concerning the noise environment and range compatibly zones surrounding an air-to-ground range prior to purchasing or leasing property near the range. They should provide written disclosure to prospective purchasers, renters, or lessees when a property is located within an RCZ or high noise zone. Real estate professionals should also show properties at a time when noise exposure is expected to be at its worst in order to provide full awareness of the potential magnitude of noise exposures.

6.4.2.2 Private Citizens

It is recommended that citizens of the local communities surrounding the DCBR become informed about the RAICUZ Program and learn about the program's goals and objectives, its value in protecting the health, safety, and welfare of the population, the limits of the program, and the positive community aspects of a successful RAICUZ Program.

Citizens considering purchasing, renting, or leasing properties near the DCBR should ask local real estate professionals and lending institutions representatives if the property is within an RCZ and/or noise zone.

Citizens should also provide sufficient and accurate information when registering a noise complaint with the range. Range personnel needs sufficient and accurate information to assess the potential causes resulting in the complaint and to assess any practical remedies for reducing future complaints.

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Appendix A

Discussion of Noise and Its Effects on the Environment

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Discussion of Noise and its Effects on the Environment

March 2012

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Prepared for:
Ecology and Environment, Inc.

Authors:
Wyle Staff

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1 Basics of Sound

Noise is unwanted sound. Sound is all around us; sound becomes noise when it interferes with normal activities, such as sleep or conversation.

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air, and are sensed by the human ear. Whether that sound is interpreted as pleasant (e.g., music) or unpleasant (e.g., jackhammers) depends largely on the listener's current activity, past experience, and attitude toward the source of that sound.

The measurement and human perception of sound involves three basic physical characteristics: intensity, frequency, and duration. First, intensity is a measure of the acoustic energy of the sound vibrations and is expressed in terms of sound pressure. The greater the sound pressure, the more energy carried by the sound and the louder the perception of that sound. The second important physical characteristic of sound is frequency, which is the number of times per second the air vibrates or oscillates. Low-frequency sounds are characterized as rumbles or roars, while high-frequency sounds are typified by sirens or screeches. The third important characteristic of sound is duration or the length of time the sound can be detected.

The loudest sounds that can be detected comfortably by the human ear have intensities that are a trillion times higher than those of sounds that can barely be detected. Because of this vast range, using a linear scale to represent the intensity of sound becomes very unwieldy. As a result, a logarithmic unit known as the decibel (abbreviated dB) is used to represent the intensity of a sound. Such a representation is called a sound level. A sound level of 0 dB is approximately the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level of approximately 60 dB; sound levels above 120 dB begin to be felt inside the human ear as discomfort. Sound levels between 130 to 140 dB are felt as pain (Berglund and Lindvall 1995).

Because of the logarithmic nature of the decibel unit, sound levels cannot be arithmetically added or subtracted and are somewhat cumbersome to handle mathematically. However, some simple rules are useful in dealing with sound levels. First, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. For example:

60 dB + 60 dB = 63 dB, and

80 dB + 80 dB = 83 dB.

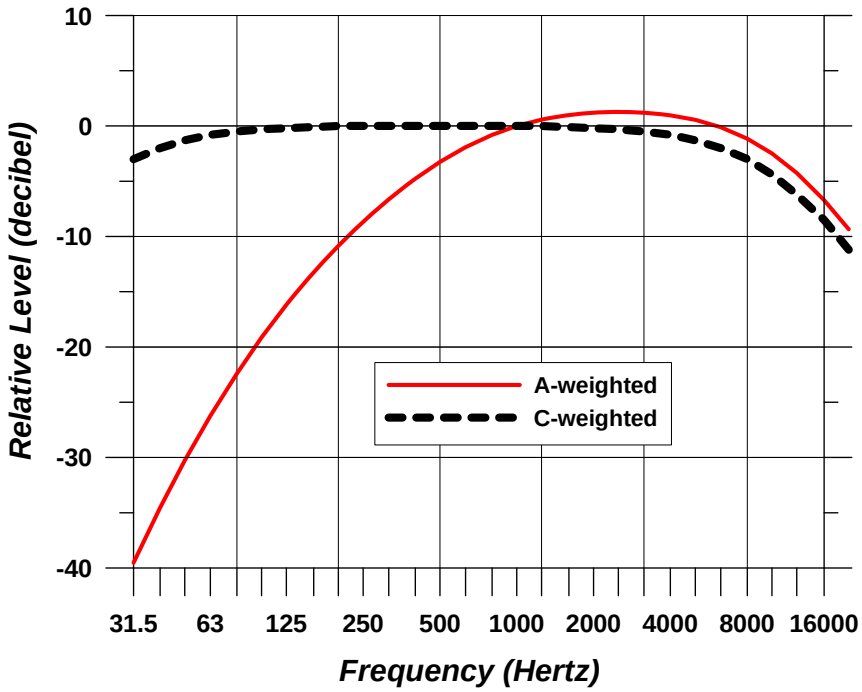
Second, the total sound level produced by two sounds of different levels is usually only slightly more than the higher of the two. For example:

60.0 dB + 70.0 dB = 70.4 dB.

Because the addition of sound levels is different than that of ordinary numbers, such addition is often referred to as "decibel addition" or "energy addition." The latter term arises from the fact that what we are really doing when we add decibel values is first converting each decibel value to its corresponding acoustic energy, then adding the energies using the normal rules of addition, and finally converting the total energy back to its decibel equivalent.

The minimum change in the sound level of individual events that an average human ear can detect is about 3 dB. On average, a person perceives a change in sound level of about 10 dB as a doubling (or halving) of the sound's loudness, and this relation holds true for loud and quiet sounds. A decrease in sound level of 10 dB actually represents a 90 percent decrease in sound intensity but only a 50 percent decrease in perceived loudness because of the nonlinear response of the human ear (similar to most human senses).

Sound frequency is measured in terms of cycles per second (cps), or hertz (Hz), which is the standard unit for cps. The normal human ear can detect sounds that range in frequency from about 20 Hz to about 15,000 Hz. All sounds in this wide range of frequencies, however, are not heard equally by the human ear, which is most sensitive to frequencies in the 1,000 to 4,000 Hz range. Weighting curves have been developed to correspond to the sensitivity and perception of different types of sound. A-weighting and C-weighting are the two most common weightings. A-weighting accounts for frequency dependence by adjusting the very high and very low frequencies (below approximately 500 Hz and above approximately 10,000 Hz) to approximate the human ear's lower sensitivities to those frequencies. C-weighting is nearly flat throughout the range of audible frequencies, hardly de-emphasizing the low frequency sound while approximating the human ear's sensitivity to higher intensity sounds. The two curves shown in Figure A-1 are also the most adequate to quantify environmental noises.



Source: ANSI S1.4A -1985 "Specification of Sound Level Meters"

Figure A-1. Frequency Response Characteristics of A- and C-Weighting Networks

1.1 A-weighted Sound Level

Sound levels that are measured using A-weighting, called A-weighted sound levels, are often denoted by the unit dBA or dB(A) rather than dB. When the use of A-weighting is understood, the adjective "A-weighted" is often omitted and the measurements are expressed as dB. In this report (as in most environmental impact documents), dB units refer to A-weighted sound levels.

Noise potentially becomes an issue when its intensity exceeds the ambient or background sound pressures. Ambient background noise in metropolitan, urbanized areas typically varies from 60 to 70 dB and can be as high as 80 dB or greater; quiet suburban neighborhoods experience ambient noise levels of approximately 45-50 dB (U.S. Environmental Protection Agency (EPA) 1978).

Figure A-2 is a chart of A-weighted sound levels from typical sounds. Some noise sources (air conditioner, vacuum cleaner) are continuous sounds which levels are constant for some time. Some (automobile, heavy truck) are the maximum sound during a vehicle pass-by. Some (urban daytime, urban nighttime) are averages over extended periods. A variety of noise metrics have been developed to describe noise over different time periods, as discussed below.

Aircraft noise consists of two major types of sound events: aircraft takeoffs and landings, and engine maintenance operations. The former can be described as intermittent sounds and the latter as continuous. Noise levels from flight operations exceeding background noise typically occur beneath main approach and departure corridors, in local air traffic patterns around the airfield, and in areas immediately adjacent to parking ramps and aircraft staging areas. As aircraft in flight gain altitude, their noise contribution drops to lower levels, often becoming indistinguishable from the background.

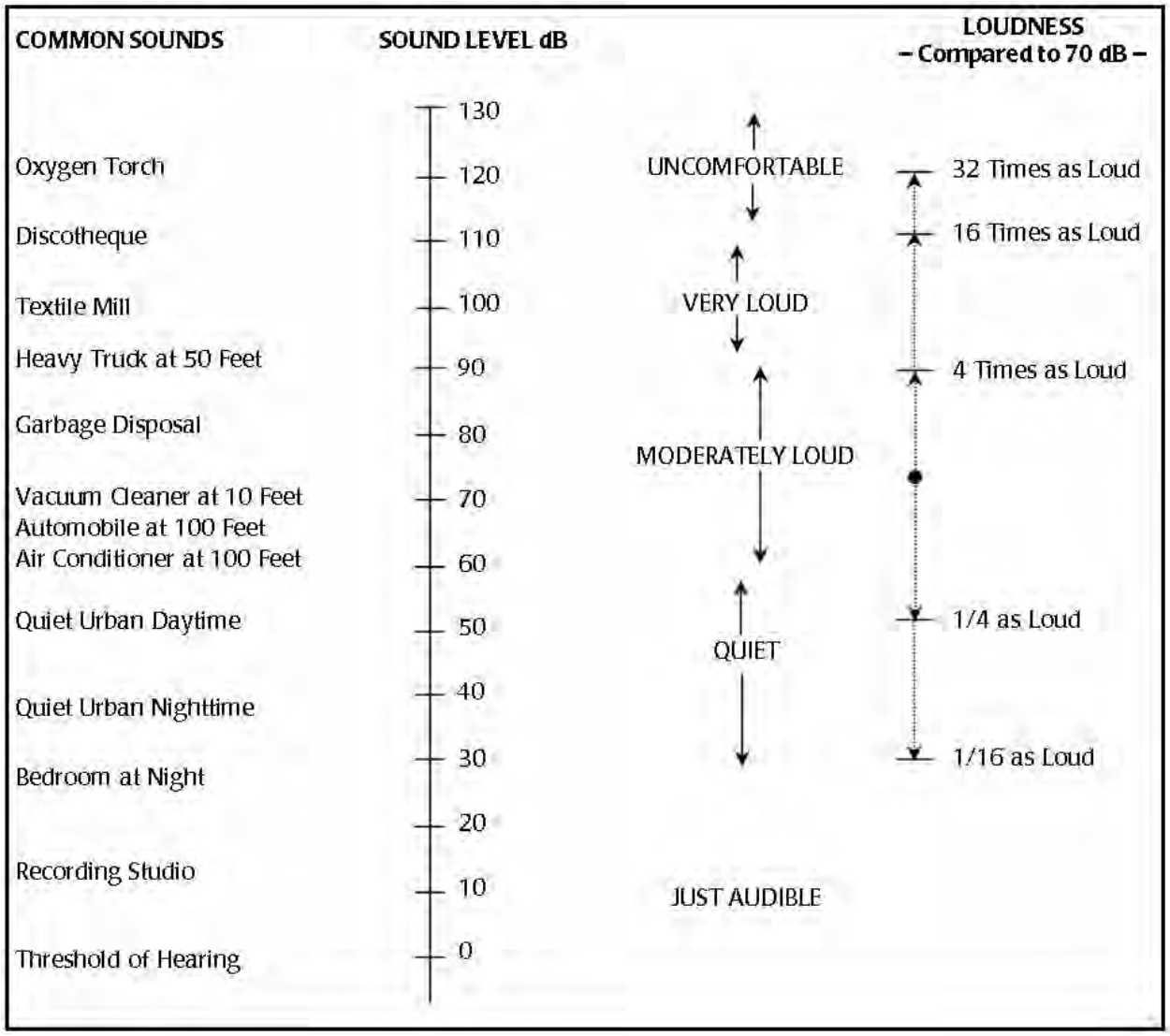
C-weighted Sound Level

Sound levels measured using a C-weighting are most appropriately called C-weighted sound levels (and denoted dBC). C-weighting is nearly flat throughout the audible frequency range, hardly de-emphasizing the low frequency. This weighting scale is generally used to describe impulsive sounds. Sounds that are characterized as impulsive generally contain low frequencies. Impulsive sounds may induce secondary effects, such as shaking of a structure, rattling of windows, inducing vibrations. These secondary effects can cause additional annoyance and complaints.

The following definitions in the American National Standard Institute (ANSI) Report S12.9, Part 4 provide general concepts helpful in understanding impulsive sounds (ANSI 1996).

Impulsive Sound: Sound characterized by brief excursions of sound pressure (acoustic impulses) that significantly exceeds the ambient environmental sound pressure. The duration of a single impulsive sound is usually less than one second (ANSI 1996).

Highly Impulsive Sound: Sound from one of the following enumerated categories of sound sources: small-arms gunfire, metal hammering, wood hammering, drop hammering, pile driving, drop forging, pneumatic hammering, pavement breaking, metal impacts during rail-yard shunting operation, and riveting.



SOURCE: Handbook of Noise Control, *C.M. Harris, Editor McGraw-Hill Book Co., 1979, and FICAN 1997*

Figure A-2. Typical A-weighted Sound Levels of Common Sounds

High-energy Impulsive Sound: Sound from one of the following enumerated categories of sound sources: quarry and mining explosions, sonic booms, demolition and industrial processes that use high explosives, military ordnance (e.g., armor, artillery and mortar fire, and bombs), explosive ignition of rockets and missiles, explosive industrial circuit breakers, and any other explosive source where the equivalent mass of dynamite exceeds 25 grams.

2 Noise Metrics

In general, a metric is a statistic for measuring or quantifying. A noise metric quantifies the noise environment. There are three families of noise metrics described herein – one for single noise events such as an aircraft flyby, one for cumulative noise events such as a day's worth of aircraft activity and one which quantifies the events or time relative to single noise events.

Within the single noise event family, metrics described below include Peak Sound Pressure Level, Maximum Sound Level and Sound Exposure Level. Within the cumulative noise events family, metrics described below include Equivalent Sound Level, Day-Night Average Sound Level and several others. Within the events/time family, metrics described below include Number of Events Above a Threshold Level and Time Above a Specified Level.

2.1 Maximum Sound Level (L_{max})

The highest A-weighted integrated sound level measured during a single event in which the sound level changes value with time (e.g., an aircraft overflight) is called the maximum A-weighted sound level or Maximum Sound Level.

During an aircraft overflight, the noise level starts at the ambient or background noise level, rises to the maximum level as the aircraft flies closest to the observer, and returns to the background level as the aircraft recedes into the distance. The L_{max} indicates the maximum sound level occurring for a fraction of a second. For aircraft noise, the "fraction of a second" over which the maximum level is defined is generally one-eighth of a second, and is denoted as "fast" response (ANSI 1988). Slowly varying or steady sounds are generally measured over a period of one second, denoted "slow" response. The L_{max} is important in judging the interference caused by a noise event with conversation, TV or radio listening, sleep, or other common activities. Although it provides some measure of the intrusiveness of the event, it does not completely describe the total event, because it does not include the period of time that the sound is heard.

2.2 Peak Sound Pressure Level (L_{pk})

The Peak Sound Pressure Level, is the highest instantaneous level obtained by a sound level measurement device. The L_{pk} is typically measured using a 20 microseconds or faster sampling rate, and is typically based on unweighted or linear response of the meter.

2.3 Sound Exposure Level (SEL)

Sound Exposure Level is a composite metric that represents both the intensity of a sound and its duration. Individual time-varying noise events (e.g., aircraft overflights) have two main characteristics: a sound level that changes throughout the event and a period of time during which the event is heard. SEL provides a measure of the net impact of the entire acoustic event, but it does not directly represent the sound level heard at any given time. During an aircraft flyover, SEL would include both the L_{max} and the lower noise levels produced during onset and recess periods of the overflight.

SEL is a logarithmic measure of the total acoustic energy transmitted to the listener during the event. Mathematically, it represents the sound level of a constant sound that would, in one second, generate the same acoustic energy as the actual time-varying noise event. For sound from aircraft overflights, which typically lasts more than one second, the SEL is usually greater than the L_{max} because an individual overflight takes seconds and the L_{max} occurs instantaneously. SEL represents the best metric to compare noise levels from overflights.

2.4 Equivalent Sound Level (L_{eq})

A cumulative noise metric useful in describing noise is the Equivalent Sound Level. L_{eq} is the continuous sound level that would be present if all of the variations in sound level occurring over a specified time period were smoothed out as to contain the same total sound energy.

Just as SEL has proven to be a good measure of the noise impact of a single event, L_{eq} has been established to be a good measure of the impact of a series of events during a given time period. Also, while L_{eq} is defined as an average, it is effectively a sum over that time period and is, thus, a measure of the cumulative impact of noise. For example, the sum of all noise-generating events during the period of 7 a.m. to 4 p.m. could provide the relative impact of noise generating events for a school day.

2.5 Day-Night Average Sound Level (DNL or L_{dn}) and Community Noise Equivalent Level (CNEL)

Day-Night Average Sound Level and Community Noise Equivalent Level are composite metrics that account for all noise events in a 24-hour period. In order to account for increased human sensitivity to noise at night, a 10 dB penalty is applied to nighttime events (10:00 p.m. to 7:00 a.m. time period). A variant of the DNL, the CNEL includes a 5 dB penalty on noise during the 7:00 a.m. to 10:00 p.m. time period, and a 10 dB penalty on noise during the 10:00 p.m. to 7:00 a.m. time period. The notations DNL and L_{dn} are both used for Day-Night Average Sound Level and are equivalent.

Like L_{eq}, DNL and CNEL without their penalties are average quantities, mathematically representing the continuous A-weighted or C-weighted sound level that would be present if all of the variations in sound level that occur over a 24-hour period were smoothed out so as to contain the same total sound energy. These composite single-measure time-average metrics account for the SELs, L_{max}, the duration of the events (sorties or operations), and the number of events that occur over a 24-hour period but do not provide specific information on the number of noise events or the individual sound levels that occur during the 24-hour day. Like SEL, neither DNL nor CNEL represent the sound level heard at any particular time, but quantifies the total sound energy received. While it is normalized as an average, it represents all of the sound energy, and is therefore a cumulative measure.

The nighttime penalties in both DNL and CNEL account for the added intrusiveness of sounds that occur during normal sleeping hours, both because of the increased sensitivity to noise during those hours and because ambient sound levels during nighttime are typically about 10 dB lower than during daytime hours. The evening penalty in CNEL accounts for the added intrusiveness of sounds during that period.

The inclusion of daytime, evening and nighttime periods in the computation of the DNL and CNEL reflects their basic 24-hour definition. They can, however, be applied over periods of multiple days. For application to civil airports, where operations are consistent from day to day, DNL and CNEL are usually applied as an annual average.

The logarithmic nature of the decibel unit causes the noise levels of the loudest events to control the 24-hour average. A DNL of 65 dB could result from a very few noisy events or a large number of quieter events.

As a simple example of this characteristic, consider a case in which only one aircraft overflight occurs during the daytime over a 24-hour period, creating a sound level of 100 dB for 30 seconds. During the remaining 23 hours, 59 minutes, and 30 seconds of the day, the ambient sound level is 50 dB. The DNL for this 24-hour period is 65.9 dB. Assume, as a second example that 10 such 30-second overflights occur during daytime hours during the next 24-hour period, with the same ambient sound level of 50 dB during the remaining 23 hours and 55 minutes of the day. The DNL for this 24-hour period is 75.5 dB. Clearly, 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 those events.

Daily average sound levels are typically used for the evaluation of community noise effects (i.e., long-term annoyance), and particularly aircraft noise effects. In general, scientific studies and social surveys have found a high correlation between the percentages of groups of people highly annoyed and the level of average noise exposure measured in DNL (EPA 1978 and Schultz 1978).

2.6 Onset-Rate Adjusted Monthly Day-Night Average Sound Level (L_{dnmr}) and Onset-Rate Adjusted Monthly Community Noise Equivalent Level ($CNEL_{mr}$)

Military aircraft utilizing Special Use Airspace (SUA) such as Military Training Routes (MTRs), Military Operating Areas (MOAs) and Restricted Areas/Ranges generate a noise environment that is somewhat different from that associated with airfield operations. As opposed to patterned or continuous noise environments associated with airfields, flight activity in SUAs is highly sporadic and often seasonal ranging from ten per hour to less than one per week. Individual military overflight events also differ from typical community noise events in that noise from a low-altitude, high-airspeed flyover can have a rather sudden onset, exhibiting a rate of increase in sound level (onset rate) of up to 150 dB per second.

To represent these differences, the conventional SEL metric is adjusted to account for the "surprise" effect of the sudden onset of aircraft noise events on humans with an adjustment ranging up to 11 dB above the normal SEL (Stusnick, et al. 1992). Onset rates between 15 to 150 dB per second require an adjustment of 0 to 11 dB, while onset rates below 15 dB per second require no adjustment. The adjusted SEL is designated as the onset-rate adjusted sound exposure level (SEL_r).

Because of the sporadic characteristic of SUA activity and so as not to dilute the resultant noise exposure, the month with the most operations or sorties from a yearly tabulation for the given SUA is examined -- the so-called busiest month. The cumulative exposure to noise in these areas is computed by DNL over the busy month, but using SEL_r instead of SEL. This monthly average is denoted L_{dnmr}. If onset rate adjusted DNL is computed over a period other than a month, it would be designated L_{dnr} and the period must be specified. In the state of California, a variant of the L_{dnmr} includes a penalty for evening operations (7 p.m. to 10 p.m) and is denoted $CNEL_{mr}$.

2.7 Number-of-Events Above (NA) a Threshold Level (L)

The Number-of-events Above metric (NA) provides the total number of noise events that exceed the selected noise level threshold during a specified period of time. Combined with the selected threshold level (L), the NA metric is symbolized as NAL. The threshold L can be defined in terms of either the SEL or L_{max} metric, and it is important that this selection is reflected in the nomenclature. When labeling a contour line or point of interest (POI) on a map the NAL will be followed by the number of events in parentheses for that line or POI. For example, the noise environment at a location where 10 events exceed an SEL of 90 dB, over a given period of time, would be represented by the nomenclature NA90SEL(10). Similarly, for L_{max} it would be $NA90L_{max}(10)$. The period of time can be an average 24-hour day, daytime, nighttime, school day, or any other time period appropriate to the nature and application of the analysis.

NA can be portrayed for single or multiple locations, or by means of noise contours on a map similar to the common DNL contours. A threshold level is selected that best meets the need for that situation. An L_{max} threshold is normally selected to analyze speech interference, whereas an SEL threshold is normally selected for analysis of sleep disturbance.

The NA metric is the only supplemental metric that has been developed that combines single-event noise levels with the number of aircraft operations. In essence, it answers the question of how many aircraft (or range of aircraft) fly over a given location or area at or above a selected threshold noise level.

2.8 Time Above (TA) a Specified Level (L)

The Time Above (TA) metric is a measure of the total time that the A-weighted aircraft noise level is at or above a defined sound level threshold. Combined with the selected threshold level (L), the TA metric is symbolized as TAL. TA is not a sound level, but rather a time expressed in minutes. TA values can be calculated over a full 24-hour annual average day, the 15-hour daytime and 9-hour nighttime periods, a school day, or any other time period of interest, provided there is operational data to define the time period of interest.

TA has application for describing the noise environment in schools, particularly when comparing the classroom or other noise sensitive environments for different operational scenarios. TA can be portrayed by means of noise contours on a map similar to the common DNL contours.

The TA metric is a useful descriptor of the noise impact of an individual event or for many events occurring over a certain time period. When computed for a full day, the TA can be compared alongside the DNL in order to determine the sound levels and total duration of events that contribute to the DNL. TA analysis is usually conducted along with NA analysis so the results show not only how many events occur above the selected threshold(s), but also the total duration of those events above those levels for the selected time period.

3 Noise Effects

This noise effects section includes discussions of annoyance, speech interference and sleep disturbance, and the effects of noise on hearing, health, performance, learning, animals, property values, terrain and archaeological sites.

3.1 Annoyance

The primary effect of aircraft noise on exposed communities is one of long-term annoyance, defined by the Environmental Protection Agency (EPA) as any negative subjective reaction on the part of an individual or group. The scientific community has adopted the use of long-term annoyance as a primary indicator of community response because it attempts to account for all negative aspects of effects from noise, e.g., increased annoyance due to being awakened the previous night by aircraft and interference with everyday conversation.

Numerous laboratory studies and field surveys have been conducted to measure annoyance and to account for a number of variables, many of which are dependent on a person's individual circumstances and preferences. Laboratory studies of individual response to noise have helped isolate a number of the factors contributing to annoyance, such as the intensity level and spectral characteristics of the noise, duration, the presence of impulses, pitch, information content, and the degree of interference with activity. Social surveys of community response to noise have allowed the development of general dose-response relationships that can be used to estimate the proportion of people who will be highly annoyed by a given noise level. The results of these studies have formed the basis for criteria established to define areas of compatible land use.

A wide variety of responses have been used to determine intrusiveness of noise and disturbances of speech, sleep, audio/video entertainment, and outdoor living; but the most useful metric for assessing peoples' responses to noise is the percentage of the population expected to be "highly annoyed." The concept of "percent highly annoyed" has provided the most consistent response of a community to a particular noise environment. In his synthesis of several different social surveys that employed different response scales, Schultz (1978) defined "highly annoyed" respondents as those respondents whose self-described annoyance fell within the upper 28 percent of the response scale where the scale was numerical or un-named. For surveys where the response scale was named, Schultz counted those who claimed to be highly annoyed, combining the responses of "very annoyed" and "extremely annoyed." Schultz's definition of "percent highly annoyed" (%HA) became the basis for the Federal policy on environmental noise. Daily average sound levels are typically used for the evaluation of community noise effects, such as long-term annoyance.

In general, scientific studies and social surveys have found a correlation between the percentages of groups of people highly annoyed and the level of average noise exposure. Thus, the results are expressed as the average %HA at various exposure levels measured in DNL. The classic analysis is Schultz's original 1978 study, whose results are shown in Figure A-3. This figure is commonly referred to as the Schultz curve. It represents the synthesis of a large number of social surveys (161 data points in all), that relates the long-term community response to various types of noise sources, measured using the DNL metric.

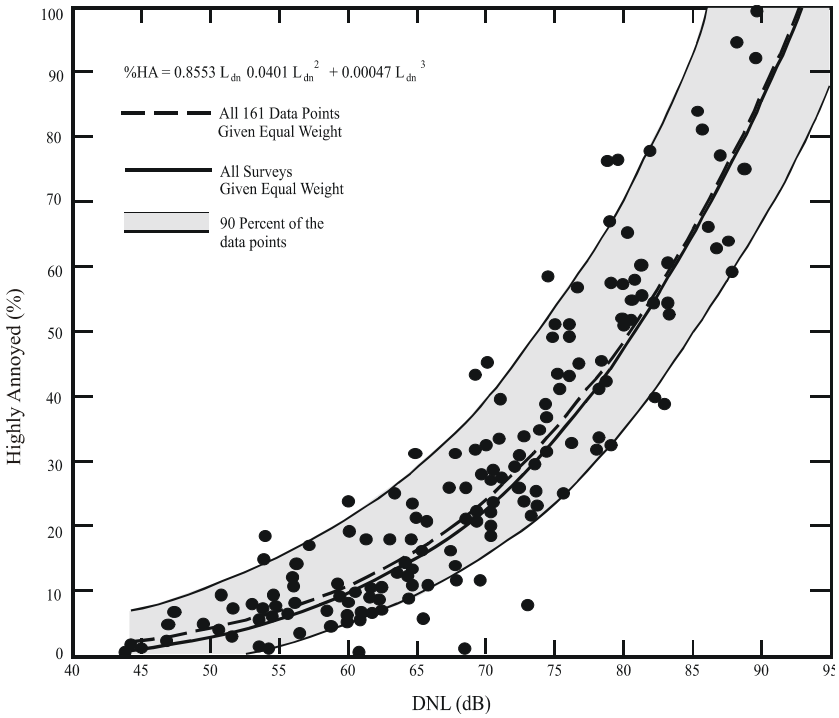
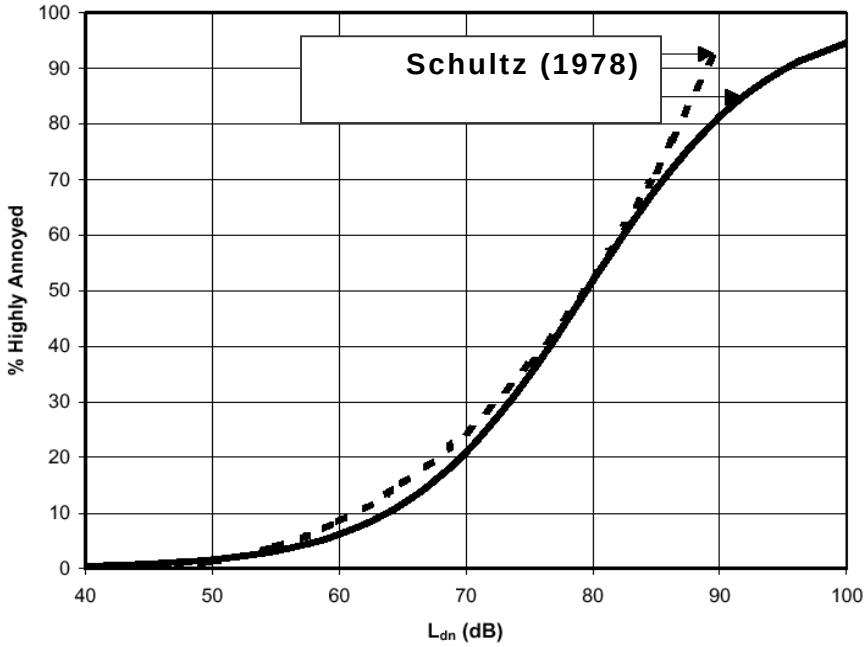


Figure A-3. Community Surveys of Noise Annoyance

An updated study of the original Schultz data based on the analysis of 400 data points collected through 1989 essentially reaffirmed this relationship. Figure A-4 shows an updated form of the curve fit in comparison with the original Schultz curve (Finegold 1994). The updated fit, which does not differ substantially from the original, is the preferred form in the U.S. The relationship between %HA and DNL is:

$$\%HA = 100/[1+ \exp(11.13 - 0.141L_{dn})]$$



SOURCE:(Schultz, 1978) and Current (Finegold, et al. 1994) Curve Fits

Figure A-4. Response of Communities to Noise; Comparison of Original

In general, correlation coefficients of 0.85 to 0.95 are found between the percentages of groups of people highly annoyed and the level of average noise exposure. However, the correlation coefficients for the annoyance of individuals are relatively low, on the order of 0.5 or less. This is not surprising, considering the varying personal factors that influence the manner in which individuals react to noise.

A number of non-acoustic factors have been identified that may influence the annoyance response of an individual. Newman and Beattie (1985) divided these factors into emotional and physical variables.

Emotional Variables:

- Feelings about the necessity or preventability of the noise;
- Judgment of the importance and value of the activity that is producing the noise;
- Activity at the time an individual hears the noise;
- Attitude about the environment;
- General sensitivity to noise;
- Belief about the effect of noise on health; and
- Feeling of fear associated with the noise.
- Physical Variables:
- Type of neighborhood;
- Time of day;

- Season;
- Predictability of noise;
- Control over the noise source; and
- Length of time an individual is exposed to a noise.

The low correlation coefficients for individuals' reactions reflect the large amount of scatter among the data drawn from the various surveys and point to the substantial uncertainty associated with the equation representing the relationship between %HA and DNL. Based on the results of surveys it has been observed that noise exposure can explain less than 50 percent of the observed variance in annoyance, indicating that non-acoustical factors play a major role. As a result, it is not possible to accurately predict individual annoyance in any specific community based on the aircraft noise exposure. Nevertheless, changes in %HA can be useful in giving the decision maker more information about the relative effects that different alternatives may have on the community.

The original Schultz curve and the subsequent updates do not separate out the annoyance from aircraft noise and other transportation noise sources. This was an important element, in that it allowed Schultz to obtain some consensus among the various social surveys from the 1960s and 1970s that were synthesized in the analysis. In essence, the Schultz curve assumes that the effects of long-term annoyance on the general population are the same, regardless of whether the noise source is road, rail, or aircraft. In the years after the classical Schultz analysis, additional social surveys have been conducted to better understand the annoyance effects of various transportation sources.

Miedema & Vos (1998) present synthesis curves for the relationship between DNL and percentage "Annoyed" and percentage "Highly Annoyed" for three transportation noise sources. Separate, non-identical curves were found for aircraft, road traffic, and railway noise. Table A-1 illustrates that, for a DNL of 65 dB, the percent of the people forecasted to be Highly Annoyed is 28 percent for air traffic, 18 percent for road traffic, and 11 percent for railroad traffic. For an outdoor DNL of 55 dB, the percent highly annoyed would be close to 12 percent if the noise is generated by aircraft operations, but only 7 percent and 4 percent, respectively, if the noise is generated by road or rail traffic. Comparing the levels on the Miedema & Vos curve to those on the updated Schultz curve indicates that the percentage of people highly annoyed by aircraft noise may be higher than previously thought when the noise is solely generated by aircraft activity.

Table A-1. Percent Highly Annoyed for Different Transportation Noise Sources

DNL (dB)	Percent Hightly Annoyed (% HA)			
	Miedema and Vos			Schultz Combined
	Air	Road	Rail	
55	12	7	4	3
60	19	12	7	6
65	28	18	11	12
70	37	29	16	22
75	48	40	22	36

Source: Miedema & Vos 1998

As noted by the World Health Organization (WHO), even though aircraft noise seems to produce a stronger annoyance response than road traffic, caution should be exercised when interpreting synthesized data from different studies (WHO 2000). The WHO noted that five major parameters should be randomly distributed for the analyses to be valid: personal, demographic, and lifestyle factors, as well as the duration of noise exposure and the population experience with noise.

The FICON found that the updated Schultz curve remains the best available source of empirical dosage effect information to predict community response to transportation noise without any segregation by transportation source (FICON 1992); a position held by the FICAN in 1997 (FICAN 1997). However, FICON also recommended further research to investigate the differences in perceptions of aircraft noise, ground transportation noise (highways and railroads), and general background noise.

3.2 Speech Interference

Speech interference associated with aircraft noise is a primary cause of annoyance for communities. The disruption of routine activities such as radio or television listening, telephone use, or family conversation gives rise to frustration and irritation. The quality of speech communication is particularly important in classrooms and offices. In industrial settings it can cause fatigue and vocal strain in those who attempt to communicate over the noise.

The disruption of speech in the classroom is a primary concern, due to the potential for adverse effects on children's learning ability. There are two aspects to speech comprehension:

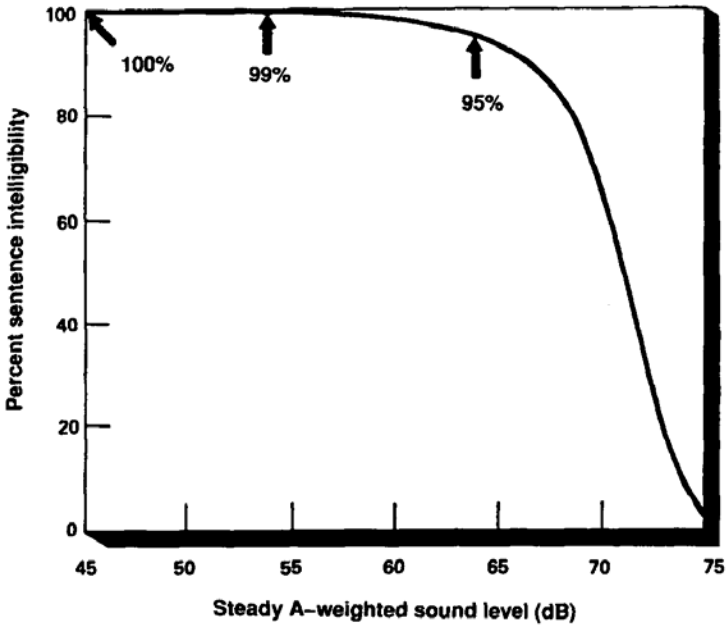
1. *Word Intelligibility* - the percent of words transmitted and received. This might be important for students in the lower grades who are learning the English language, and particularly for students who have English as a Second Language.
2. S*entence Intelligibility* – the percent of sentences transmitted and understood. This might be important for high-school students and adults who are familiar with the language, and who do not necessarily have to understand each word in order to understand sentences.

For teachers to be clearly understood by their students, it is important that regular voice communication is clear and uninterrupted. Not only does the background sound level have to be low enough for the teacher to be clearly heard, but intermittent outdoor noise events also need to be minimized. It is therefore important to evaluate the steady background level, the level of voice communication, and the single-event level due to aircraft overflights that might interfere with speech.

Several research studies have been conducted and guideline documents been developed resulting in a fairly consistent set of noise level criteria for speech interference. This section provides an overview of the results of these studies.

U.S. Federal Criteria for Interior Noise

In 1974, the EPA identified a goal of an indoor 24-hour average sound level $L_{eq(24)}$ of 45 dB to minimize speech interference based on the intelligibility of sentences in the presence of a steady background noise (EPA 1974). Intelligibility pertains to the percentage of speech units correctly understood out of those transmitted, and specifies the type of speech material used, i.e. sentences or words. The curve displayed in Figure A-5 shows the effect of steady indoor background sound levels on sentence intelligibility. For an average adult with normal hearing and fluency in the language, steady background sound levels indoors of less than 45 dB L_{eq} are expected to allow 100 percent intelligibility of sentences.



Source: EPA 1974

Figure A-5. Speech Intelligibility Curve

The curve shows 99 percent sentence intelligibility for background levels at a L_{eq} of 54 dB, and less than 10 percent intelligibility for background levels above a L_{eq} of 73 dB. Note that the curve is especially sensitive to changes in sound level between 65 dB and 75 dB - an increase of 1 dB in background sound level from 70 dB to 71 dB results in a 14 percent decrease in sentence intelligibility, whereas a 1 dB increase in background sound level from 60 dB to 61 dB results in less than 1 percent decrease in sentence intelligibility.

Classroom Criteria

For listeners with normal hearing and fluency in the language, complete sentence intelligibility can be achieved when the signal-to-noise ratio (i.e., the difference between the speech level and the level of the interfering noise) is in the range 15-18 dB (Lazarus 1990).

Both the ANSI and the American Speech-Language-Hearing Association (ASHLA) recommend at least a 15 dB signal-to-noise ratio in classrooms, to ensure that children with hearing impairments and language disabilities are able to enjoy high speech intelligibility (ANSI 2002; ASHLA 1995). As such, provided that the average adult male or female voice registers a minimum of 50 dB L_{max} in the rear of the classroom, the ANSI standard requires that the continuous background noise level indoors must not exceed a L_{eq} of 35 dB (assumed to apply for the duration of school hours).

The WHO reported for a speaker-to-listener distance of about 1 meter, empirical observations have shown that speech in relaxed conversations is 100 percent intelligible in background noise levels of about 35 dB, and speech can be fairly well understood in the presence of background levels of 45 dB. The WHO recommends a guideline value of 35 dB L_{eq} for continuous background levels in classrooms during school hours (WHO 2000).

Bradley suggests that in smaller rooms, where speech levels in the rear of the classroom are approximately 50 dB L_{max}, steady-state noise levels above 35 dB L_{eq} may interfere with the intelligibility of speech (Bradley 1993).

For the purposes of determining eligibility for noise insulation funding, the Federal Aviation Administration (FAA) guidelines state that the design objective for a classroom environment is 45 dB L_{eq} resulting from aircraft operations during normal school hours (FAA 1985).

However, most aircraft noise is not continuous and consists of individual events where the sound level exceeds the background level for a limited time period as the aircraft flies over. Since speech interference in the presence of aircraft noise is essentially determined by the magnitude and frequency of individual aircraft flyover events, a time-averaged metric alone, such as L_{eq}, is not necessarily appropriate when evaluating the overall effects. In addition to the background level criteria described above, single-event criteria, which account for those sporadic intermittent outdoor noisy events, are also essential to specifying speech interference criteria.

In 1984, a report to the Port Authority of New York and New Jersey recommended utilizing the Speech Interference Level (SIL) metric for classroom noise criteria (Sharp and Plotkin 1984). This metric is based on the maximum sound levels in the frequency range (approximately 500 Hz to 2,000 Hz) that directly affects speech communication. The study identified an SIL (the average of the sound levels in the 500, 1000, and 2000 Hz octave-bands) of 45 dB as the desirable goal, which was estimated to provide 90 percent word intelligibility for the short time periods during aircraft over-flights. Although early classroom level criteria were defined in terms of SIL, the use and measurement of L_{max} as the primary metric has since become more popular. Both metrics take into consideration the L_{max} associated with intermittent noise events and can be related to existing background levels when determining speech interference percentages. An SIL of 45 dB is approximately equivalent to an A-weighted L_{max} of 50 dB for aircraft noise (Wesler 1986).

In 1998, a report also concluded that if an aircraft noise event's indoor L_{max} reached the speech level of 50 dB, 90 percent of the words would be understood by students seated throughout the classroom (Lind, Pearsons, and Fidell 1998). Since intermittent aircraft noise does not appreciably disrupt classroom communication at lower levels and other times, the authors also adopted an indoor L_{max} of 50 dB as the maximum single-event level permissible in classrooms. Note that this limit was set based on students with normal hearing and no special needs; at-risk students may be adversely affected at lower sound levels.

Bradley recommends SEL as a better indicator of indoor estimated speech interference in the presence of aircraft overflights (Bradley 1985). For acceptable speech communication using normal vocal efforts, Bradley suggests that the indoor SEL be no greater than 64 dB. He assumes a 26 dB outdoor-to-indoor noise reduction that equates to 90 dB SEL outdoors. Aircraft events producing outdoor SEL values greater than 90 dB would result in disruption to indoor speech communication. Bradley's work indicates that, for speakers talking with a casual vocal effort, 95 percent intelligibility would be achieved when indoor SEL values did not exceed 60 dB, which translates approximately to an L_{max} of 50 dB.

In the presence of intermittent noise events, ANSI states that the criteria for allowable background noise level can be relaxed since speech is impaired only for the short time when the aircraft noise is close to its maximum value. Consequently, they recommend when the background noise level of the noisiest hour is dominated by aircraft noise, the indoor criteria (35 dB L_{eq} for continuous background noise) can be increased by 5 dB to an Leq of 40 dB, as long as the noise level does not exceed 40 dB for more than 10 percent of the noisiest hour. (ANSI 2002).

The WHO does not recommend a specific indoor L_{max} criterion for single-event noise, but does place a guideline value at L_{eq} of 35 dB for overall background noise in the classroom. However, WHO does report that "for communication distances beyond a few meters, speech interference starts at sound pressure levels below 50 dB for octave bands centered on the main speech frequencies at 500 Hz, 1kHz, and 2 kHz." (WHO 2000). One can infer this can be approximated by an L_{max} value of 50 dB.

The United Kingdom Department for Education and Skills (UKDFES) established in its classroom acoustics guide a 30-minute time-averaged metric [$L_{eq(30min)}$] for background levels and $L_{A1,30}$ min for intermittent noises, at thresholds of 30-35 dB and 55 dB, respectively. $L_{A1,30}$ min represents the A-weighted sound level that is exceeded one percent of the time (in this case, during a 30 minute teaching session) and is generally equivalent to the L_{max} metric (UKDFES 2003).

Summary

As the previous section demonstrates, research indicates that it is not only important to consider the continuous background levels using time-averaged metrics, but also the intermittent events, using single-event metrics such as L_{max}. Table A-2 provides a summary of the noise level criteria recommended in the scientific literature.

Table A-2. Indoor Noise Level Criteria Based on Speech Intelligibility

Source	Metric/Level (dB)	Effects and Notes
U.S. FAA (1985)	L_{eq}(during school hours) = 45 dB	Federal assistance criteria for school sound insulation; supplemental single-event criteria may be used
Lind et al. (1998), Sharp and Plotkin (1984), Wesler (1986)	L_{max} = 50 dB / SIL 45	Single event level permissible in the classroom
WHO (1999)	L_{eq} = 35 dB L_{max} = 50 dB	Assumes average speech level of 50 dB and recommends signal to noise ratio of 15 dB
U.S. ANSI (2002)	L_{eq} = 40 dB, Based on Room Volume	Acceptable background level for continuous noise/ relaxed criteria for intermittent noise in the classroom
U.K. DFES (2003)	$L_{eq(30min)}$ = 30-35 dB L_{max} = 55 dB	Minimum acceptable in classroom and most other learning environs

When considering intermittent noise caused by aircraft overflights, a review of the relevant scientific literature and international guidelines indicates that an appropriate criteria is a limit on indoor background noise levels of 35 to 40 dB L_{eq} and a limit on single events of 50 dB L_{max}.

3.3 Sleep Disturbance

The disturbance of sleep is a major concern for communities exposed to nighttime aircraft noise. There have been numerous research studies that have attempted to quantify the complex effects of noise on sleep. This section provides an overview of the major noise-induced sleep disturbance studies that have been conducted, with particular emphasis placed on those studies that have influenced U.S. federal noise policy. The studies have been separated into two groups:

1. Initial studies performed in the 1960s and 1970s, where the research was focused on laboratory sleep observations.
2. Later studies performed in the 1990s up to the present, where the research was focused on field observations, and correlations to laboratory research were sought.

Initial Studies

The relationship between noise levels and sleep disturbance is complex and not fully understood. The disturbance depends not only on the depth of sleep, but also on the previous exposure to aircraft noise, familiarity with the surroundings, the physiological and psychological condition of the recipient, and a host of other situational factors. The most readily measurable effect of noise on sleep is the number of arousals or awakenings, and so the body of scientific literature has focused on predicting the percentage of the population that will be awakened at various noise levels. Fundamentally, regardless of the tools used to measure the degree of sleep disturbance (awakenings, arousals, etc.), these studies have grouped the data points into bins to predict the percentage of the population likely to be disturbed at various sound level thresholds.

FICON produced a guidance document that provided an overview of the most pertinent sleep disturbance research that had been conducted throughout the 1970s (FICON 1992). Literature reviews and meta-analysis conducted between 1978 and 1989 made use of the existing datasets that indicated the effects of nighttime noise on various sleep-state changes and awakenings (Lukas 1978; Griefahn 1978; Peasons et. al. 1989). FICON noted that various indoor A-weighted sound levels – ranging from 25 to 50 dB were observed to be thresholds below which significant sleep effects were not expected. Due to the large variability in the data, FICON did not endorse the reliability of the results.

However, FICON did recommend the use of an interim dose-response curve—awaiting future research—which predicted the percent of the exposed population expected to be awakened as a function of the exposure to single event noise levels expressed in terms of SEL. This curve was based on the research conducted for the U.S. Air Force (Finegold 1994). The dataset included most of the research performed up to that point, and predicted that ten percent of the population would be awakened when exposed to an interior SEL of approximately 58 dB. The data utilized to derive this relationship were primarily the results of controlled laboratory studies.

Recent Sleep Disturbance Research – Field and Laboratory Studies

It was noted in the early sleep disturbance research that the controlled laboratory studies did not account for many factors that are important to sleep behavior, such as habituation to the environment and previous exposure to noise and awakenings from sources other than aircraft noise. In the early 1990s, field studies were conducted to validate the earlier laboratory work. The most significant finding from these studies was that an estimated 80 to 90 percent of sleep disturbances were not related to individual outdoor noise events, but were instead the result of indoor noise sources and other non-noise-related factors. The results showed that there was less of an effect of noise on sleep in real-life conditions than had been previously reported from laboratory studies.

FICAN

The interim FICON dose-response curve that was recommended for use in 1992 was based on the most pertinent sleep disturbance research that was conducted through the 1970s, primarily in laboratory settings. After that time, considerable field research was conducted to evaluate the sleep effects in peoples' normal, home environment. Laboratory sleep studies tend to show higher values of sleep disturbance than field studies because people who sleep in their own homes are habituated to their environment and, therefore, do not wake up as easily (FICAN 1997).

Based on the new information, FICAN updated its recommended dose-response curve in 1997, depicted as the lower curve in Figure A-6. This figure is based on the results of three field studies (Ollerhead 1992; Fidell et. al. 1994; Fidell et al. 1995a and 1995b), along with the datasets from six previous field studies.

The new relationship represents the higher end, or upper envelope, of the latest field data. It should be interpreted as predicting the "maximum percent of the exposed population expected to be behaviorally awakened" or the "maximum percent awakened" for a given residential population. According to this relationship, a maximum of 3 percent of people would be awakened at an indoor SEL of 58 dB, compared to 10 percent using the 1992 curve. An indoor SEL of 58 dB is equivalent to outdoor SEL's of 73 and 83 dB respectively assuming 15 and 25 dB noise level reduction from outdoor to indoor with windows open and closed, respectively.

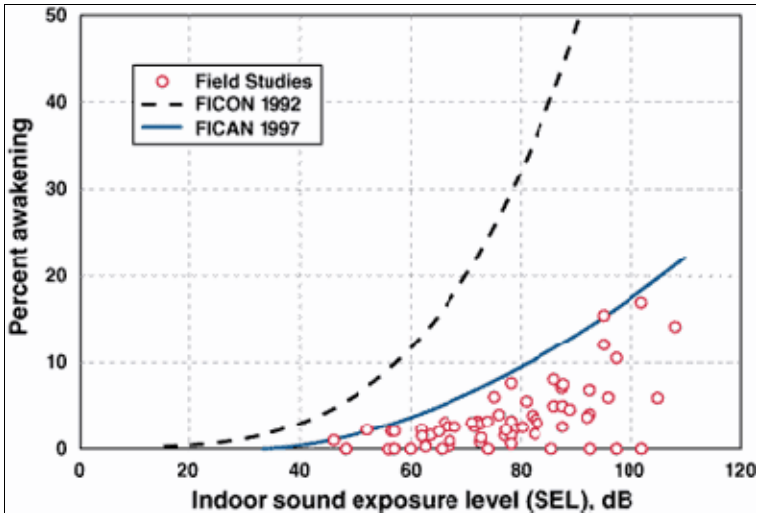


Figure A-6. FICAN's 1997 Recommended Sleep Disturbance Dose-Response Relationship

The FICAN 1997 curve is represented by the following equation:

$$\text{Percent Awakenings} = 0.0087 \times [\text{SEL} - 30]^{1.79}$$

Note the relatively low percentage of awakenings to fairly high noise levels. People think they are awakened by a noise event, but usually the reason for awakening is otherwise. For example, the 1992 UK CAA study found the average person was awakened about 18 times per night for reasons other than exposure to an aircraft noise – some of these awakenings are due to the biological rhythms of sleep and some to other reasons that were not correlated with specific aircraft events.

Number of Events and Awakenings

In recent years, there have been studies and one proposal that attempted to determine the effect of multiple aircraft events on the number of awakenings. The German Aerospace Center (DLR) conducted an extensive study focused on the effects of nighttime aircraft noise on sleep and other related human performance factors (Basner 2004). The DLR study was one of the largest studies to examine the link between aircraft noise and sleep disturbance and involved both laboratory and in-home field research phases. The DLR investigators developed a dose-effect curve that predicts the number of aircraft events at various values of L_{max} expected to produce one additional awakening over the course of a night. The dose-effect curve was based on the relationships found in the field studies.

In July 2008 ANSI and the Acoustical Society of America (ASA) published a method to estimate the percent of the exposed population that might be awakened by multiple aircraft noise events based on statistical assumptions about the probability of awakening (or not awakening) (ANSI 2008). This method relies on probability theory rather than direct field research/experimental data to account for multiple events.

Figure A-7 depicts the awakenings data that form the basis and equations of ANSI S12.9-2008. The curve labeled 'Eq. (B1)' is the relationship between noise and awakening endorsed by FICAN in 1997. The ANSI recommended curve labeled 'Eq. (1)' quantifies the probability of awakening for a population of sleepers who are exposed to an outdoor noise event as a function of the associated indoor SEL in the bedroom. This curve was derived from studies of behavioral awakenings associated with noise events in "steady state" situations where the population has been exposed to the noise long enough to be habituated. The data points in Figure A-7 come from these studies. Unlike the FICAN curve, the ANSI 2008 curve represents the average of the field research data points.

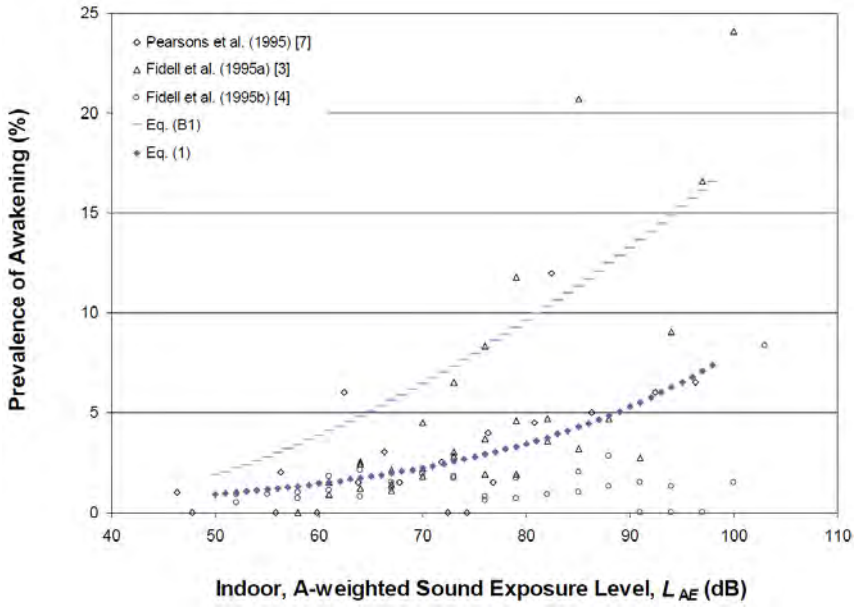


Figure A-7. Plot of Sleep Awakening Data versus Indoor SEL

In December 2008, FICAN recommended the use of this new estimation procedure for future analyses of behavioral awakenings from aircraft noise. In that statement, FICAN also recognized that additional sleep disturbance research is underway by various research organizations, and results of that work may result in additional changes to FICAN's position. Until that time, FICAN recommends the use of ANSI S12.9-2008.

3.4 Noise-Induced Hearing Impairment

Residents in surrounding communities express concerns regarding the effects of aircraft noise on hearing. This section provides a brief overview of hearing loss caused by noise exposure. The goal is to provide a sense of perspective as to how aircraft noise (as experienced on the ground) compares to other activities that are often linked with hearing loss.

Hearing Threshold Shifts

Hearing loss is generally interpreted as a decrease in the ear's sensitivity or acuity to perceive sound; i.e. a shift in the hearing threshold to a higher level. This change can either be a Temporary Threshold Shift (TTS), or a Permanent Threshold Shift (PTS) (Berger 1995).

TTS can result from exposure to loud noise over a given amount of time, yet the hearing loss is not necessarily permanent. An example of TTS might be a person attending a loud music concert. After the concert is over, the person may experience a threshold shift that may last several hours, depending upon the level and duration of exposure. While experiencing TTS, the person becomes less sensitive to low-level sounds, particularly at certain frequencies in the speech range (typically near 4,000 Hz). Normal hearing ability eventually returns, as long as the person has enough time to recover within a relatively quiet environment.

PTS usually results from repeated exposure to high noise levels, where the ears are not given adequate time to recover from the strain and fatigue of exposure. A common example of PTS is the result of working in a loud environment such as a factory. It is important to note that a temporary shift (TTS) can eventually become permanent (PTS) over time with continuous exposure to high noise levels. Thus, even if the ear is given time to recover from TTS, repeated occurrence of TTS may eventually lead to permanent hearing loss. The point at which a Temporary Threshold Shift results in a Permanent Threshold Shift is difficult to identify and varies with a person's sensitivity.

Criteria for Permanent Hearing Loss

Considerable data on hearing loss have been collected and analyzed by the scientific/medical community. It has been well established that continuous exposure to high noise levels will damage human hearing (EPA 1978). The Occupational Safety and Health Administration (OSHA) regulation of 1971 standardizes the limits on workplace noise exposure for protection from hearing loss as an average level of 90 dB over an 8-hour work period or 85 dB over a 16-hour period (the average level is based on a 5 dB decrease per doubling of exposure time) (US Department of Labor 1970). Even the most protective criterion (no measurable hearing loss for the most sensitive portion of the population at the ear's most sensitive frequency, 4,000 Hz, after a 40-year exposure) is an average sound level of 70 dB over a 24-hour period.

The US EPA established 75 dB for an 8-hour exposure and 70 dB for a 24-hour exposure as the average noise level standard requisite to protect 96 percent of the population from greater than a 5 dB PTS (EPA 1978). The National Academy of Sciences Committee on Hearing, Bioacoustics, and Biomechanics identified 75 dB as the minimum level at which hearing loss may occur (CHABA 1977). Finally, the WHO has concluded that environmental and leisure-time noise below an L_{eq24} value of 70 dB "will not cause hearing loss in the large majority of the population, even after a lifetime of exposure" (WHO 2000).

Hearing Loss and Aircraft Noise

The 1982 EPA Guidelines report specifically addresses the criteria and procedures for assessing the noise-induced hearing loss in terms of the Noise-Induced Permanent Threshold Shift (NIPTS), a quantity that defines the permanent change in hearing level, or threshold, caused by exposure to noise (EPA, 1982). Numerically, the NIPTS is the change in threshold averaged over the frequencies 0.5, 1, 2, and 4 kHz that can be expected from daily exposure to noise over a normal working lifetime of 40 years, with the exposure beginning at an age of 20 years. A grand average of the NIPTS over time (40 years) and hearing sensitivity (10 to 90 percentiles of the exposed population) is termed the Average NIPTS or Ave NIPTS for short. The Average Noise Induced Permanent Threshold Shift (Ave. NIPTS) that can be expected for noise exposure as measured by the DNL metric is given in Table A-3.

Table A-3. Ave. NIPTS and 10th Percentile NIPTS as a Function of DNL

DNL	Ave. NIPTS dB*	10th Percentile NIPTS dB*
75-76	1.0	4.0
76-77	1.0	4.5
77-78	1.6	5.0
78-79	2.0	5.5
79-80	2.5	6.0
80-81	3.0	7.0
81-82	3.5	8.0
82-83	4.0	9.0
83-84	4.5	10.0
84-85	5.5	11.0

* Rounded to the nearest 0.5 dB

For example, for a noise exposure of 80 dB DNL, the expected lifetime average value of NIPTS is 2.5 dB, or 6.0 dB for the 10th percentile. Characterizing the noise exposure in terms of DNL will usually overestimate the assessment of hearing loss risk as DNL includes a 10 dB weighting factor for aircraft operations occurring between 10 p.m. and 7 a.m. If, however, flight operations between the hours of 10 p.m. and 7 a.m. account for 5 percent or less of the total 24-hour operations, the overestimation is on the order of 1.5 dB.

From a civilian airport perspective, the scientific community has concluded that there is little likelihood that the resulting noise exposure from aircraft noise could result in either a temporary or permanent hearing loss. Studies on community hearing loss from exposure to aircraft flyovers near airports showed that there is no danger, under normal circumstances, of hearing loss due to aircraft noise (Newman and Beattie 1985). The EPA criterion (L_{eq24} = 70 dBA) can be exceeded in some areas located near airports, but that is only the case outdoors. Inside a building, where people are more likely to spend most of their time, the average noise level will be much less than 70 dBA (Eldred and von Gierke 1993). Eldred and von Gierke also report that "several studies in the U.S., Japan, and the U.K. have confirmed the predictions that the possibility for permanent hearing loss in communities, even under the most intense commercial take-off and landing patterns, is remote."

With regard to military airbases, as individual aircraft noise levels are increasing with the introduction of new aircraft, a 2009 DoD policy directive requires that hearing loss risk be estimated for the at risk population, defined as the population exposed to DNL greater than or equal to 80 dB and higher (DoD 2009). Specifically, DoD components are directed to "*use the 80 Day-Night A-Weighted (DNL) noise contour to identify populations at the most risk of potential hearing loss*". This does not preclude populations outside the 80 DNL contour, i.e. at lower exposure levels, from being at some degree of risk of hearing loss. However, the analysis should be restricted to populations within this contour area, including residents of on-base housing. The exposure of workers inside the base boundary area should be considered occupational and evaluated using the appropriate DoD component regulations for occupational noise exposure.

With regard to military airspace activity, studies have shown conflicting results. A 1995 laboratory study measured changes in human hearing from noise representative of low-flying aircraft on MTRs (Nixon, et al. 1993). The potential effects of aircraft flying along MTRs is of particular concern because of maximum overflight noise levels can exceed 115 dB, with rapid increases in noise levels exceeding 30 dB per second. In this study, participants were first subjected to four overflight noise exposures at A-weighted levels of 115 dB to 130 dB. Fifty percent of the subjects showed no change in hearing levels, 25 percent had a temporary 5 dB *increase* in sensitivity (the people could hear a 5 dB wider range of sound than before exposure), and 25 percent had a temporary 5 dB decrease in sensitivity (the people could hear a 5 dB narrower range of sound than before exposure). In the next phase, participants were subjected to a single overflight at a maximum level of 130 dB for eight successive exposures, separated by 90 seconds or until a temporary shift in hearing was observed. The temporary hearing threshold shifts showed an *increase* in sensitivity of up to 10 dB.

In another study of 115 test subjects between 18 and 50 years old in 1999, temporary threshold shifts were measured after laboratory exposure to military low-altitude flight noise (Ising, et al. 1999). According to the authors, the results indicate that repeated exposure to military low-altitude flight noise with L_{max} greater than 114 dB, especially if the noise level increases rapidly, may have the potential to cause noise induced hearing loss in humans.

Summary

Aviation and typical community noise levels near airports are not comparable to the occupational or recreational noise exposures associated with hearing loss. Studies of aircraft noise levels associated with civilian airport activity have not definitively correlated permanent hearing impairment with aircraft activity. It is unlikely that airport neighbors will remain outside their homes 24 hours per day, so there is little likelihood of hearing loss below an average sound level of 75 dB DNL. Near military airbases, average noise levels above 75 dB may occur, and while new DoD policy dictates that NIPTS be evaluated, no research results to date have definitively related permanent hearing impairment to aviation noise.

3.5 Nonauditory Health Effects

Studies have been conducted to determine whether correlations exist between noise exposure and cardiovascular problems, birth weight, and mortality rates. The nonauditory effect of noise on humans is not as easily substantiated as the effect on hearing. The results of studies conducted in the United States, primarily concentrating on cardiovascular response to noise, have been contradictory (Cantrell 1974). Cantrell concluded that the results of human and animal experiments show that average or intrusive noise can act as a stress-provoking stimulus. Prolonged stress is known to be a contributor to a number of health disorders. Kryter and Poza (1980) state, "It is more likely that noise-related general ill-health effects are due to the psychological annoyance from the noise interfering with normal everyday behavior, than it is from the noise eliciting, because of its intensity, reflexive response in the autonomic or other physiological systems of the body." Psychological stresses may cause a physiological stress reaction that could result in impaired health.

The National Institute for Occupational Safety and Health and EPA commissioned CHABA in 1981 to study whether established noise standards are adequate to protect against health disorders other than hearing defects. CHABA's conclusion was that:

Evidence from available research reports is suggestive, but it does not provide definitive answers to the question of health effects, other than to the auditory system, of long-term exposure to noise. It seems prudent, therefore, in the absence of adequate knowledge as to whether or not noise can produce effects upon health other than damage to auditory system, either directly or mediated through stress, that insofar as feasible, an attempt should be made to obtain more critical evidence.

Since the CHABA report, there have been more recent studies that suggest that noise exposure may cause hypertension and other stress-related effects in adults. Near an airport in Stockholm, Sweden, the prevalence of hypertension was reportedly greater among nearby residents who were exposed to energy averaged noise levels exceeding 55 dB and maximum noise levels exceeding 72 dB, particularly older subjects and those not reporting impaired hearing ability (Rosenlund, et al. 2001). A study of elderly volunteers who were exposed to simulated military low-altitude flight noise reported that blood pressure was raised by L_{max} of 112 dB and high speed level increase (Michalak, et al. 1990). Yet another study of subjects exposed to varying levels of military aircraft or road noise found no significant relationship between noise level and blood pressure (Pulles, et al. 1990).

The U.S. Department of the Navy prepared a programmatic Environmental Assessment (EA) for the continued use of non-explosive ordnance on the Vieques Inner Range. Following the preparation of the EA, it was learned that research conducted by the University of Puerto Rico, Ponce School of Medicine, suggested that Vieques fishermen and their families were experiencing symptoms associated with vibroacoustic disease (VAD) (U.S. Department of the Navy 2002). The study alleged that exposure to noise and sound waves of large pressure amplitudes within lower frequency bands, associated with Navy training activities—specifically, air-to-ground bombing or naval fire support—was related to a larger prevalence of heart anomalies within the Vieques fishermen and their families. The Ponce School of Medicine study compared the Vieques group with a group from Ponce Playa. A 1999 study conducted on Portuguese aircraft-manufacturing workers from a single factory reported effects of jet aircraft noise exposure that involved a wide range of symptoms and disorders, including the cardiac issues on which the Ponce School of Medicine study focused. The 1999 study identified these effects as VAD.

Johns Hopkins University (JHU) conducted an independent review of the Ponce School of Medicine study, as well as the Portuguese aircraft workers study and other relevant scientific literature. Their findings concluded that VAD should not be accepted as a syndrome, given that exhaustive research across a number of populations has not yet been conducted. JHU also pointed out that the evidence supporting the existence of VAD comes largely from one group of investigators and that similar results would have to be replicated by other investigators. In short, JHU concluded that it had not been established that noise was the causal agent for the symptoms reported and no inference can be made as to the role of noise from naval gunfire in producing echocardiographic abnormalities (U.S. Department of the Navy 2002).

Most studies of nonauditory health effects of long-term noise exposure have found that noise exposure levels established for hearing protection will also protect against any potential nonauditory health effects, at least in workplace conditions. One of the best scientific summaries of these findings is contained in the lead paper at the National Institutes of Health Conference on Noise and Hearing Loss, held on 22 to 24 January 1990 in Washington, D.C.:

> "The nonauditory effects of chronic noise exposure, when noise is suspected to act as one of the risk factors in the development of hypertension, cardiovascular disease, and other nervous disorders, have never been proven to occur as chronic manifestations at levels below these criteria (an average of 75 dBA for complete protection against hearing loss for an 8-hour day). At the recent (1988) International Congress on Noise as a Public Health Problem, most studies attempting to clarify such health effects did not find them at levels below the criteria protective of noise-induced hearing loss, and even above these criteria, results regarding such health effects were ambiguous. Consequently, one comes to the conclusion that establishing and enforcing exposure levels protecting against noise-induced hearing loss would not only solve the noise-induced hearing loss problem, but also any potential nonauditory health effects in the work place" (von Gierke 1990).

Although these findings were specifically directed at noise effects in the workplace, they are equally applicable to aircraft noise effects in the community environment. Research studies regarding the nonauditory health effects of aircraft noise are ambiguous, at best, and often contradictory. Yet, even those studies that purport to find such health effects use time-average noise levels of 75 dB and higher for their research.

For example, two UCLA researchers apparently found a relationship between aircraft noise levels under the approach path to Los Angeles International Airport (LAX) and increased mortality rates among the exposed residents by using an average noise exposure level greater than 75 dB for the "noise-exposed" population (Meacham and Shaw 1979). Nevertheless, three other UCLA professors analyzed those same data and found no relationship between noise exposure and mortality rates (Frerichs, et al. 1980).

As a second example, two other UCLA researchers used this same population near LAX to show a higher rate of birth defects for 1970 to 1972 when compared with a control group residing away from the airport (Jones and Tauscher 1978). Based on this report, a separate group at the Center for Disease Control performed a more thorough study of populations near Atlanta's Hartsfield International Airport (ATL) for 1970 to 1972 and found no relationship in their study of 17 identified categories of birth defects to aircraft noise levels above 65 dB (Edmonds, et al. 1979).

In summary, there is no scientific basis for a claim that potential health effects exist for aircraft time-average sound levels below 75 dB.

The potential for noise to affect physiological health, such as the cardiovascular system, has been speculated; however, no unequivocal evidence exists to support such claims (Harris 1997). Conclusions drawn from a review of health effect studies involving military low-altitude flight noise with its unusually high maximum levels and rapid rise in sound level have shown no increase in cardiovascular disease (Schwartze and Thompson 1993). Additional claims that are unsupported include flyover noise producing increased mortality rates and increases in cardiovascular death, aggravation of post-traumatic stress syndrome, increased stress, increase in admissions to mental hospitals, and adverse effects on pregnant women and the unborn fetus (Harris 1997).

3.6 Performance Effects

The effect of noise on the performance of activities or tasks has been the subject of many studies. Some of these studies have established links between continuous high noise levels and performance loss. Noise-induced performance losses are most frequently reported in studies employing noise levels in excess of 85 dB. Little change has been found in low-noise cases. It has been cited that moderate noise levels appear to act as a stressor for more sensitive individuals performing a difficult psychomotor task.

While the results of research on the general effect of periodic aircraft noise on performance have yet to yield definitive criteria, several general trends have been noted including:

- A periodic intermittent noise is more likely to disrupt performance than a steady-state continuous noise of the same level. Flyover noise, due to its intermittent nature, might be more likely to disrupt performance than a steady-state noise of equal level.
- Noise is more inclined to affect the quality than the quantity of work.
- Noise is more likely to impair the performance of tasks that place extreme demands on the worker.

3.7 Noise Effects on Children

In response to noise-specific and other environmental studies, Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks (1997), requires federal agencies to ensure that policies, programs, and activities address environmental health and safety risks to identify any disproportionate risks to children.

A review of the scientific literature indicates that there has not been a tremendous amount of research in the area of aircraft noise effects on children. The research reviewed does suggest that environments with sustained high background noise can have variable effects, including noise effects on learning and cognitive abilities, and reports of various noise-related physiological changes.

3.7.1 Effects on Learning and Cognitive Abilities

In 2002 ANSI refers to studies that suggest that loud and frequent background noise can affect the learning patterns of young children (ANSI 2002). ANSI provides discussion on the relationships between noise and learning, and stipulates design requirements and acoustical performance criteria for outdoor-to-indoor noise isolation. School design is directed to be cognizant of, and responsive to surrounding land uses and the shielding of outdoor noise from the indoor environment. The ANSI acoustical performance criteria for schools include the requirement that the one-hour-average background noise level shall not exceed 35 dBA in core learning spaces smaller than 20,000 cubic-feet and 40 dBA in core learning spaces with enclosed volumes exceeding 20,000 cubic-feet. This would require schools be constructed such that, in quiet neighborhoods indoor noise levels are lowered by 15 to 20 dBA relative to outdoor levels. In schools near airports, indoor noise levels would have to be lowered by 35 to 45 dBA relative to outdoor levels (ANSI 2002).

The studies referenced by ANSI to support the new standard are not specific to jet aircraft noise and the potential effects on children. However, there are references to studies that have shown that children in noisier classrooms scored lower on a variety of tests. Excessive background noise or reverberation within schools causes interferences of communication and can therefore create an acoustical barrier to learning (ANSI 2002). Studies have been performed that contribute to the body of evidence emphasizing the importance of communication by way of the spoken language to the development of cognitive skills. The ability to read, write, comprehend, and maintain attentiveness, are, in part, based upon whether teacher communication is consistently intelligible (ANSI 2002).

Numerous studies have shown varying degrees of effects of noise on the reading comprehension, attentiveness, puzzle-solving, and memory/recall ability of children. It is generally accepted that young children are more susceptible than adults to the effects of background noise. Because of the developmental status of young children (linguistic, cognitive, and proficiency), barriers to hearing can cause interferences or disruptions in developmental evolution.

Research on the impacts of aircraft noise, and noise in general, on the cognitive abilities of school-aged children has received more attention in recent years. Several studies suggest that aircraft noise can affect the academic performance of schoolchildren. Although many factors could contribute to learning deficits in school-aged children (e.g., socioeconomic level, home environment, diet, sleep patterns), evidence exists that suggests that chronic exposure to high aircraft noise levels can impair learning.

Specifically, elementary school children attending schools near New York City's two airports demonstrated lower reading scores than children living farther away from the flight paths (Green, et al. 1982). Researchers have found that tasks involving central processing and language comprehension (such as reading, attention, problem solving,

and memory) appear to be the most affected by noise (Evans and Lepore 1993; Hygge 1994; and Evans, et al. 1998). It has been demonstrated that chronic exposure of first- and second-grade children to aircraft noise can result in reading deficits and impaired speech perception (i.e., the ability to hear common, low-frequency [vowel] sounds but not high frequencies [consonants] in speech) (Evans and Maxwell 1997).

The Evans and Maxwell (1997) study found that chronic exposure to aircraft noise resulted in reading deficits and impaired speech perception for first- and second-grade children. Other studies found that children residing near the Los Angeles International Airport had more difficulty solving cognitive problems and did not perform as well as children from quieter schools in puzzle-solving and attentiveness (Bronzaft 1997; Cohen, et al. 1980). Children attending elementary schools in high aircraft noise areas near London's Heathrow Airport demonstrated poorer reading comprehension and selective cognitive impairments (Haines, et al. 2001a, and 2001b). Similarly, a 1994 study found that students exposed to aircraft noise of approximately 76 dBA scored 20% lower on recall ability tests than students exposed to ambient noise of 42-44 dBA (Hygge 1994). Similar studies involving the testing of attention, memory, and reading comprehension of school children located near airports showed that their tests exhibited reduced performance results compared to those of similar groups of children who were located in quieter environments (Evans, et al. 1998; Haines, et al. 1998). The Haines and Stansfeld study indicated that there may be some long-term effects associated with exposure, as one-year follow-up testing still demonstrated lowered scores for children in higher noise schools (Haines, et al. 2001a, and 2001b). In contrast, a 2002 study found that although children living near the old Munich airport scored lower in standardized reading and long-term memory tests than a control group, their performance on the same tests was equal to that of the control group once the airport was closed. (Hygge, et al. 2002).

Finally, although it is recognized that there are many factors that could contribute to learning deficits in school-aged children, there is increasing awareness that chronic exposure to high aircraft noise levels may impair learning. This awareness has led the World Health Organization and a North Atlantic Treaty Organization working group to conclude that daycare centers and schools should not be located near major sources of noise, such as highways, airports, and industrial sites (World Health Organization 2000; North Atlantic Treaty Organization 2000).

3.7.2 Health Effects

Physiological effects in children exposed to aircraft noise and the potential for health effects have also been the focus of limited investigation. Studies in the literature include examination of blood pressure levels, hormonal secretions, and hearing loss.

As a measure of stress response to aircraft noise, authors have looked at blood pressure readings to monitor children's health. Children who were chronically exposed to aircraft noise from a new airport near Munich, Germany, had modest (although significant) increases in blood pressure, significant increases in stress hormones, and a decline in quality of life (Evans, et al. 1998). Children attending noisy schools had statistically significant average systolic and diastolic blood pressure ($p<0.03$). Systolic blood pressure means were 89.68 mm for children attending schools located in noisier environments compared to 86.77 mm for a control group. Similarly, diastolic blood pressure means for the noisier environment group were 47.84 mm and 45.16 for the control group (Cohen, et al. 1980).

Although the literature appears limited, studies focused on the wide range of potential effects of aircraft noise on school children have also investigated hormonal levels between groups of children exposed to aircraft noise compared to those in a control group. Specifically, two studies analyzed cortisol and urinary catecholamine levels in school children as measurements of stress response to aircraft noise (Haines, et al. 2001b and 2001c). In both instances, there were no differences between the aircraft-noise-exposed children and the control groups.

Other studies have reported hearing losses from exposure to aircraft noise. Noise-induced hearing loss was reportedly higher in children who attended a school located under a flight path near a Taiwan airport, as compared to children at another school far away (Chen, et al. 1997). Another study reported that hearing ability was reduced significantly in individuals who lived near an airport and were frequently exposed to aircraft noise (Chen and Chen 1993). In that study, noise exposure near the airport was reportedly uniform, with DNL greater than 75 dB and maximum noise levels of about 87 dB during overflights. Conversely, several other studies that were reviewed reported no difference in hearing ability between children exposed to high levels of airport noise and children located in quieter areas (Fisch 1977; Andrus, et al. 1975; Wu, et al. 1995).

3.8 Effects on Domestic Animals and Wildlife

Hearing is critical to an animal's ability to react, compete, reproduce, hunt, forage, and survive in its environment. While the existing literature does include studies on possible effects of jet aircraft noise and sonic booms on wildlife, there appears to have been little concerted effort in developing quantitative comparisons of aircraft noise effects on normal auditory characteristics. Behavioral effects have been relatively well described, but the larger ecological context issues, and the potential for drawing conclusions regarding effects on populations, has not been well developed.

The relationships between potential auditory/physiological effects and species interactions with their environments are not well understood. Manci, et al. (1988), assert that the consequences that physiological effects may have on behavioral patterns is vital to understanding the long-term effects of noise on wildlife. Questions regarding the effects (if any) on predator-prey interactions, reproductive success, and intra-inter specific behavior patterns remain.

The following discussion provides an overview of the existing literature on noise effects (particularly jet aircraft noise) on animal species. The literature reviewed here involves those studies that have focused on the observations of the behavioral effects that jet aircraft and sonic booms have on animals.

A great deal of research was conducted in the 1960's and 1970's on the effects of aircraft noise on the public and the potential for adverse ecological impacts. These studies were largely completed in response to the increase in air travel and as a result of the introduction of supersonic jet aircraft. According to Manci, et al. (1988), the foundation of information created from that focus does not necessarily correlate or provide information specific to the impacts to wildlife in areas overflown by aircraft at supersonic speed or at low altitudes.

The abilities to hear sounds and noise and to communicate assist wildlife in maintaining group cohesiveness and survivorship. Social species communicate by transmitting calls of warning, introduction, and other types that are subsequently related to an individual's or group's responsiveness.

Animal species differ greatly in their responses to noise. Noise effects on domestic animals and wildlife are classified as primary, secondary, and tertiary. Primary effects are direct, physiological changes to the auditory system, and most likely include the masking of auditory signals. Masking is defined as the inability of an individual to hear important environmental signals that may arise from mates, predators, or prey. There is some potential that noise could disrupt a species' ability to communicate or could interfere with behavioral patterns (Manci, et al. 1988). Although the effects are likely temporal, aircraft noise may cause masking of auditory signals within exposed faunal communities. Animals rely on hearing to avoid predators, obtain food, and communicate with, and attract, other members of their species. Aircraft noise may mask or interfere with these functions. Other primary effects, such as ear drum rupture or temporary and permanent hearing threshold shifts, are not as likely given the subsonic noise levels produced by aircraft overflights. Secondary effects may include non-auditory effects such as stress and hypertension; behavioral modifications; interference with mating or reproduction; and impaired ability to obtain adequate food, cover, or water. Tertiary effects are the direct result of primary and secondary effects, and include population decline and habitat loss. Most of the effects of noise are mild enough that they may never be detectable as variables of change in population size or population growth against the background of normal variation (Bowles 1995). Other environmental variables (e.g., predators, weather, changing prey base, ground-based disturbance) also influence secondary and tertiary effects, and confound the ability to identify the ultimate factor in limiting

productivity of a certain nest, area, or region (Smith, et al. 1988). Overall, the literature suggests that species differ in their response to various types, durations, and sources of noise (Manci, et al. 1988).

Many scientific studies have investigated the effects of aircraft noise on wildlife, and some have focused on wildlife "flight" due to noise. Apparently, animal responses to aircraft are influenced by many variables, including size, speed, proximity (both height above the ground and lateral distance), engine noise, color, flight profile, and radiated noise. The type of aircraft (e.g., fixed wing versus rotor-wing [helicopter]) and type of flight mission may also produce different levels of disturbance, with varying animal responses (Smith, et al. 1988). Consequently, it is difficult to generalize animal responses to noise disturbances across species.

One result of the 1988 Manci, et al., literature review was the conclusion that, while behavioral observation studies were relatively limited, a general behavioral reaction in animals from exposure to aircraft noise is the startle response. The intensity and duration of the startle response appears to be dependent on which species is exposed, whether there is a group or an individual, and whether there have been some previous exposures. Responses range from flight, trampling, stampeding, jumping, or running, to movement of the head in the apparent direction of the noise source. Manci, et al. (1988), reported that the literature indicated that avian species may be more sensitive to aircraft noise than mammals.

3.8.1 Domestic Animals

Although some studies report that the effects of aircraft noise on domestic animals is inconclusive, a majority of the literature reviewed indicates that domestic animals exhibit some behavioral responses to military overflights but generally seem to habituate to the disturbances over a period of time. Mammals in particular appear to react to noise at sound levels higher than 90 dB, with responses including the startle response, freezing (i.e., becoming temporarily stationary), and fleeing from the sound source. Many studies on domestic animals suggest that some species appear to acclimate to some forms of sound disturbance (Manci, et al. 1988). Some studies have reported such primary and secondary effects as reduced milk production and rate of milk release, increased glucose concentrations, decreased levels of hemoglobin, increased heart rate, and a reduction in thyroid activity. These latter effects appear to represent a small percentage of the findings occurring in the existing literature.

Some reviewers have indicated that earlier studies, and claims by farmers linking adverse effects of aircraft noise on livestock, did not necessarily provide clear-cut evidence of cause and effect (Cottereau 1978). In contrast, many studies conclude that there is no evidence that aircraft overflights affect feed intake, growth, or production rates in domestic animals.

Cattle

In response to concerns about overflight effects on pregnant cattle, milk production, and cattle safety, the U.S. Air Force prepared a handbook for environmental protection that summarizes the literature on the impacts of low-altitude flights on livestock (and poultry) and includes specific case studies conducted in numerous airspaces across the country. Adverse effects have been found in a few studies but have not been reproduced in other similar studies. One such study, conducted in 1983, suggested that 2 of 10 cows in late pregnancy aborted after showing rising estrogen and falling progesterone levels. These increased hormonal levels were reported as being linked to 59 aircraft overflights. The remaining eight cows showed no changes in their blood concentrations and calved normally (U.S. Air Force 1994b). A similar study reported abortions occurred in three out of five pregnant cattle after exposing them to flyovers by six different aircraft (U.S. Air Force 1994b). Another study suggested that feedlot cattle could stampede and injure themselves when exposed to low-level overflights (U.S. Air Force 1994b).

A majority of the studies reviewed suggests that there is little or no effect of aircraft noise on cattle. Studies presenting adverse effects to domestic animals have been limited. A number of studies (Parker and Bayley 1960; Casady and Lehmann 1967; Kovalcik and Sottnik 1971) investigated the effects of jet aircraft noise and sonic booms on the milk production of dairy cows. Through the compilation and examination of milk production data from areas exposed to jet aircraft noise and sonic boom events, it was determined that milk yields were not affected. This was particularly evident in those cows that had been previously exposed to jet aircraft noise.

A study examined the causes of 1,763 abortions in Wisconsin dairy cattle over a one-year time period and none were associated with aircraft disturbances (U.S. Air Force 1993). In 1987, Anderson contacted seven livestock operators for production data, and no effects of low-altitude and supersonic flights were noted. Three out of 43 cattle previously exposed to low-altitude flights showed a startle response to an F/A-18 aircraft flying overhead at 500 feet above ground level and 400 knots by running less than 10 meters. They resumed normal activity within one minute (U.S. Air Force 1994b). Beyer (1983) found that helicopters caused more reaction than other low-aircraft overflights, and that the helicopters at 30 to 60 feet overhead did not affect milk production and pregnancies of 44 cows and heifers in a 1964 study (U.S. Air Force 1994b).

Additionally, Beyer reported that five pregnant dairy cows in a pasture did not exhibit fright-flight tendencies or disturb their pregnancies after being overflown by 79 low-altitude helicopter flights and 4 low-altitude, subsonic jet aircraft flights (U.S. Air Force 1994b). A 1956 study found that the reactions of dairy and beef cattle to noise from low-altitude, subsonic aircraft were similar to those caused by paper blowing about, strange persons, or other moving objects (U.S. Air Force 1994b).

In a report to Congress, the U. S. Forest Service concluded that "evidence both from field studies of wild ungulates and laboratory studies of domestic stock indicate that the risks of damage are small (from aircraft approaches of 50 to 100 meters), as animals take care not to damage themselves (U.S. Forest Service 1992). If animals are overflown by aircraft at altitudes of 50 to 100 meters, there is no evidence that mothers and young are separated, that animals collide with obstructions (unless confined) or that they traverse dangerous ground at too high a rate." These varied study results suggest that, although the confining of cattle could magnify animal response to aircraft overflight, there is no proven cause-and-effect link between startling cattle from aircraft overflights and abortion rates or lower milk production.

Horses

Horses have also been observed to react to overflights of jet aircraft. Several of the studies reviewed reported a varied response of horses to low-altitude aircraft overflights. Observations made in 1966 and 1968 noted that horses galloped in response to jet flyovers (U.S. Air Force 1993). Bowles (1995) cites Kruger and Erath as observing horses exhibiting intensive flight reactions, random movements, and biting/kicking behavior. However, no injuries or abortions occurred, and there was evidence that the mares adapted somewhat to the flyovers over the course of a month (U.S. Air Force 1994b). Although horses were observed noticing the overflights, it did not appear to affect either survivability or reproductive success. There was also some indication that habituation to these types of disturbances was occurring.

LeBlanc, et al. (1991), studied the effects of F-14 jet aircraft noise on pregnant mares. They specifically focused on any changes in pregnancy success, behavior, cardiac function, hormonal production, and rate of habituation. Their findings reported observations of "flight-fright" reactions, which caused increases in heart rates and serum cortisol concentrations. The mares, however, did habituate to the noise. Levels of anxiety and mass body movements were the highest after initial exposure, with intensities of responses decreasing thereafter. There were no differences in pregnancy success when compared to a control group.

Swine

Generally, the literature findings for swine appear to be similar to those reported for cows and horses. While there are some effects from aircraft noise reported in the literature, these effects are minor. Studies of continuous noise exposure (i.e., 6 hours, 72 hours of constant exposure) reported influences on short-term hormonal production and release. Additional constant exposure studies indicated the observation of stress reactions, hypertension, and electrolyte imbalances (Dufour 1980). A study by Bond, et al. (1963), demonstrated no adverse effects on the feeding efficiency, weight gain, ear physiology, or thyroid and adrenal gland condition of pigs subjected to observed aircraft noise. Observations of heart rate increase were recorded, noting that cessation of the noise resulted in the return to normal heart rates. Conception rates and offspring survivorship did not appear to be influenced by exposure to aircraft noise.

Similarly, simulated aircraft noise at levels of 100 dB to 135 dB had only minor effects on the rate of feed utilization, weight gain, food intake, or reproduction rates of boars and sows exposed, and there were no injuries or inner ear changes observed (Manci, et al. 1988; Gladwin, et al. 1988).

Domestic Fowl

According to a 1994 position paper by the U.S. Air Force on effects of low-altitude overflights (below 1,000 ft) on domestic fowl, overflight activity has negligible effects (U.S. Air Force 1994a). The paper did recognize that given certain circumstances, adverse effects can be serious. Some of the effects can be panic reactions, reduced productivity, and effects on marketability (e.g., bruising of the meat caused during "pile-up" situations).

The typical reaction of domestic fowl after exposure to sudden, intense noise is a short-term startle response. The reaction ceases as soon as the stimulus is ended, and within a few minutes all activity returns to normal. More severe responses are possible depending on the number of birds, the frequency of exposure, and environmental conditions. Large crowds of birds, and birds not previously exposed, are more likely to pile up in response to a noise stimulus (U.S. Air Force 1994a). According to studies and interviews with growers, it is typically the previously unexposed birds that incite panic crowding, and the tendency to do so is markedly reduced within five exposures to the stimulus (U.S. Air Force 1994a). This suggests that the birds habituate relatively quickly. Egg productivity was not adversely affected by infrequent noise bursts, even at exposure levels as high as 120 to 130 dBA.

Between 1956 and 1988, there were 100 recorded claims against the Navy for alleged damage to domestic fowl. The number of claims averaged three per year, with peak numbers of claims following publications of studies on the topic in the early 1960s (U.S. Air Force 1994a). Many of the claims were disproved or did not have sufficient supporting evidence. The claims were filed for the following alleged damages: 55% for panic reactions, 31% for decreased production, 6% for reduced hatchability, 6% for weight loss, and less than 1% for reduced fertility (U.S. Air Force 1994a).

Turkeys

The review of the existing literature suggests that there has not been a concerted or widespread effort to study the effects of aircraft noise on commercial turkeys. One study involving turkeys examined the differences between simulated versus actual overflight aircraft noise, turkey responses to the noise, weight gain, and evidence of habituation (Bowles, et al. 1990a). Findings from the study suggested that turkeys habituated to jet aircraft noise quickly, that there were no growth rate differences between the experimental and control groups, and that there were some behavioral differences that increased the difficulty in handling individuals within the experimental group.

Low-altitude overflights were shown to cause turkey flocks that were kept inside turkey houses to occasionally pile up and experience high mortality rates due to the aircraft noise and a variety of disturbances unrelated to aircraft (U.S. Air Force 1994a).

3.8.2 Wildlife

Studies on the effects of overflights and sonic booms on wildlife have been focused mostly on avian species and ungulates such as caribou and bighorn sheep. Few studies have been conducted on marine mammals, small terrestrial mammals, reptiles, amphibians, and carnivorous mammals. Generally, species that live entirely below the surface of the water have also been ignored due to the fact they do not experience the same level of sound as terrestrial species (National Park Service 1994). Wild ungulates appear to be much more sensitive to noise disturbance than domestic livestock (Manci, et al. 1988). This may be due to previous exposure to disturbances. One common factor appears to be that low-altitude flyovers seem to be more disruptive in terrain where there is little cover (Manci, et al. 1988).

3.8.2.1 MAMMALS

Terrestrial Mammals

Studies of terrestrial mammals have shown that noise levels of 120 dBA can damage mammals' ears, and levels at 95 dBA can cause temporary loss of hearing acuity. Noise from aircraft has affected other large carnivores by causing changes in home ranges, foraging patterns, and breeding behavior. One study recommended that aircraft not be allowed to fly at altitudes below 2,000 feet above ground level over important grizzly and polar bear habitat (Dufour 1980). Wolves have been frightened by low-altitude flights that were 25 to 1,000 feet off the ground. However, wolves have been found to adapt to aircraft overflights and noise as long as they were not being hunted from aircraft (Dufour 1980).

Wild ungulates (American bison, caribou, bighorn sheep) appear to be much more sensitive to noise disturbance than domestic livestock (Weisenberger, et al. 1996). Behavioral reactions may be related to the past history of disturbances by such things as humans and aircraft. Common reactions of reindeer kept in an enclosure exposed to aircraft noise disturbance were a slight startle response, raising of the head, pricking ears, and scenting of the air. Panic reactions and extensive changes in behavior of individual animals were not observed. Observations of caribou in Alaska exposed to fixed-wing aircraft and helicopters showed running and panic reactions occurred when overflights were at an altitude of 200 feet or less. The reactions decreased with increased altitude of overflights, and, with more than 500 feet in altitude, the panic reactions stopped. Also, smaller groups reacted less strongly than larger groups. One negative effect of the running and avoidance behavior is increased expenditure of energy. For a 90-kg animal, the calculated expenditure due to aircraft harassment is 64 kilocalories per minute when running and 20 kilocalories per minute when walking. When conditions are favorable, this expenditure can be counteracted with increased feeding; however, during harsh winter conditions, this may not be possible. Incidental observations of wolves and bears exposed to fixed-wing aircraft and helicopters in the northern regions suggested that wolves are less disturbed than wild ungulates, while grizzly bears showed the greatest response of any animal species observed.

It has been proven that low-altitude overflights do induce stress in animals. Increased heart rates, an indicator of excitement or stress, have been found in pronghorn antelope, elk, and bighorn sheep. As such reactions occur naturally as a response to predation, infrequent overflights may not, in and of themselves, be detrimental. However, flights at high frequencies over a long period of time may cause harmful effects. The consequences of this disturbance, while cumulative, is not additive. It may be that aircraft disturbance may not cause obvious and serious health effects, but coupled with a harsh winter, it may have an adverse impact. Research has shown that stress induced by other types of disturbances produces long-term decreases in metabolism and hormone balances in wild ungulates.

Behavioral responses can range from mild to severe. Mild responses include head raising, body shifting, or turning to orient toward the aircraft. Moderate disturbance may be nervous behaviors, such as trotting a short distance. Escape is the typical severe response.

Marine Mammals

The physiological composition of the ear in aquatic and marine mammals exhibits adaptation to the aqueous environment. These differences (relative to terrestrial species) manifest themselves in the auricle and middle ear (Manci, et al. 1988). Some mammals use echolocation to perceive objects in their surroundings and to determine the directions and locations of sound sources (Simmons 1983 in Manci, et al. 1988).

In 1980, the Acoustical Society of America held a workshop to assess the potential hazard of manmade noise associated with proposed Alaska Arctic (North Slope-Outer Continental Shelf) petroleum operations on marine wildlife and to prepare a research plan to secure the knowledge necessary for proper assessment of noise impacts (Acoustical Society of America, 1980). Since 1980 it appears that research on responses of aquatic mammals to aircraft noise and sonic booms has been limited. Research conducted on northern fur seals, sea lions, and ringed seals indicated that there are some differences in how various animal groups receive frequencies of sound. It was observed that these species exhibited varying intensities of a startle response to airborne noise, which was habituated over time. The rates of habituation appeared to vary with species, populations, and demographics (age, sex). Time of day of exposure was also a factor (Muyberg 1978 in Manci, et al. 1988).

Studies accomplished near the Channel Islands were conducted near the area where the space shuttle launches occur. It was found that there were some response differences between species relative to the loudness of sonic booms. Those booms that were between 80 and 89 dBA caused a greater intensity of startle reactions than lower-intensity booms at 72 to 79 dBA. However, the duration of the startle responses to louder sonic booms was shorter (Jehl and Cooper 1980 in Manci, et al. 1988).

Jehl and Cooper (1980) indicated that low-flying helicopters, loud boat noises, and humans were the most disturbing to pinnipeds. According to the research, while the space launch and associated operational activity noises have not had a measurable effect on the pinniped population, it also suggests that there was a greater "disturbance level" exhibited during launch activities. There was a recommendation to continue observations for behavioral effects and to perform long-term population monitoring (Jehl and Cooper 1980).

The continued presence of single or multiple noise sources could cause marine mammals to leave a preferred habitat. However, it does not appear likely that overflights could cause migration from suitable habitats as aircraft noise over water is mobile and would not persist over any particular area. Aircraft noise, including supersonic noise, currently occurs in the overwater airspace of Eglin, Tyndall, and Langley AFBs from sorties predominantly involving jet aircraft. Survey results reported in Davis, et al. (2000), indicate that cetaceans (i.e., dolphins) occur under all of the Eglin and Tyndall marine airspace. The continuing presence of dolphins indicates that aircraft noise does not discourage use of the area and apparently does not harm the locally occurring population.

In a summary by the National Parks Service (1994) on the effects of noise on marine mammals, it was determined that gray whales and harbor porpoises showed no outward behavioral response to aircraft noise or overflights. Bottlenose dolphins showed no obvious reaction in a study involving helicopter overflights at 1,200 to 1,800 feet above the water. Neither did they show any reaction to survey aircraft unless the shadow of the aircraft passed over them, at which point there was some observed tendency to dive (Richardson, et al. 1995). Other anthropogenic noises in the marine environment from ships and pleasure craft may have more of an effect on marine mammals than aircraft noise (U.S. Air Force 2000). The noise effects on cetaceans appear to be somewhat attenuated by the air/water interface. The cetacean fauna along the coast of California have been subjected to sonic booms from military aircraft for many years without apparent adverse effects (Tetra Tech, Inc. 1997).

Manatees appear relatively unresponsive to human-generated noise to the point that they are often suspected of being deaf to oncoming boats [although their hearing is actually similar to that of pinnipeds (Bullock, et al. 1980)]. Little is known about the importance of acoustic communication to manatees, although they are known to produce at least ten different types of sounds and are thought to have sensitive hearing (Richardson, et al. 1995). Manatees continue to occupy canals near Miami International Airport, which suggests that they have become habituated to human disturbance and noise (Metro-Dade County 1995). Since manatees spend most of their time below the surface and do not startle readily, no effect of aircraft overflights on manatees would be expected (Bowles, et al. 1991b).

3.8.2.2 BIRDS

Auditory research conducted on birds indicates that they fall between the reptiles and the mammals relative to hearing sensitivity. According to Dooling (1978), within the range of one to five kHz, birds show a level of hearing sensitivity similar to that of the more sensitive mammals. In contrast to mammals, bird sensitivity falls off at a greater rate to increasing and decreasing frequencies. Passive observations and studies examining aircraft bird strikes indicate that birds nest and forage near airports. Aircraft noise in the vicinity of commercial airports apparently does not inhibit bird presence and use.

High-noise events (like a low-altitude aircraft overflight) may cause birds to engage in escape or avoidance behaviors, such as flushing from perches or nests (Ellis, et al. 1991). These activities impose an energy cost on the birds that, over the long term, may affect survival or growth. In addition, the birds may spend less time engaged in necessary activities like feeding, preening, or caring for their young because they spend time in noise-avoidance activity. However, the long-term significance of noise-related impacts is less clear. Several studies on nesting raptors have indicated that birds become habituated to aircraft overflights and that long-term reproductive success is not affected (Grubb and King 1991; Ellis, et al. 1991). Threshold noise levels for significant responses range from 62 dB for Pacific black brant (Branta bernicla nigricans) (Ward and Stehn 1990) to 85 dB for crested tern (Sterna bergii) (Brown 1990).

Songbirds were observed to become silent prior to the onset of a sonic boom event (F-111 jets), followed by "raucous discordant cries." There was a return to normal singing within 10 seconds after the boom (Higgins 1974 in Manci, et al. 1988). Ravens responded by emitting protestation calls, flapping their wings, and soaring.

Manci, et al. (1988), reported a reduction in reproductive success in some small territorial passerines (i.e., perching birds or songbirds) after exposure to low-altitude overflights. However, it has been observed that passerines are not driven any great distance from a favored food source by a nonspecific disturbance, such as aircraft overflights (U.S. Forest Service 1992). Further study may be warranted.

A recent study, conducted cooperatively between the DoD and the USFWS, assessed the response of the red-cockaded woodpecker to a range of military training noise events, including artillery, small arms, helicopter, and maneuver noise (Pater, et al. 1999). The project findings show that the red-cockaded woodpecker successfully acclimates to military noise events. Depending on the noise level that ranged from innocuous to very loud, the birds responded by flushing from their nest cavities. When the noise source was closer and the noise level was higher, the number of flushes increased proportionately. In all cases, however, the birds returned to their nests within a relatively short period of time (usually within 12 minutes). Additionally, the noise exposure did not result in any mortality or statistically detectable changes in reproductive success (Pater, et al. 1999). Red-cockaded woodpeckers did not flush when artillery simulators were more than 122 meters away and SEL noise levels were 70 dBA.

Lynch and Speake (1978) studied the effects of both real and simulated sonic booms on the nesting and brooding eastern wild turkey (Meleagris gallopavo silvestris) in Alabama. Hens at four nest sites were subjected to between 8 and 11 combined real and simulated sonic booms. All tests elicited similar responses, including quick lifting of the head and apparent alertness for between 10 and 20 seconds. No apparent nest failure occurred as a result of the sonic booms.

Twenty-one brood groups were also subjected to simulated sonic booms. Reactions varied slightly between groups, but the largest percentage of groups reacted by standing motionless after the initial blast. Upon the sound of the boom, the hens and poults fled until reaching the edge of the woods (approximately 4 to 8 meters). Afterward, the poults resumed feeding activities while the hens remained alert for a short period of time (approximately 15 to 20 seconds). In no instances were poults abandoned, nor did they scatter and become lost. Every observation group returned to normal activities within a maximum of 30 seconds after a blast.

3.8.2.2.1 RAPTORS

In a literature review of raptor responses to aircraft noise, Manci, et al. (1988), found that most raptors did not show a negative response to overflights. When negative responses were observed they were predominantly associated with rotor-winged aircraft or jet aircraft that were repeatedly passing within 0.5 mile of a nest.

Ellis, et al. (1991), performed a study to estimate the effects of low-level military jet aircraft and mid- to high-altitude sonic booms (both actual and simulated) on nesting peregrine falcons and seven other raptors (common black-hawk, Harris' hawk, zone-tailed hawk, red-tailed hawk, golden eagle, prairie falcon, bald eagle). They observed responses to test stimuli, determined nest success for the year of the testing, and evaluated site occupancy the following year. Both long- and short-term effects were noted in the study. The results reported the successful fledging of young in 34 of 38 nest sites (all eight species) subjected to low-level flight and/or simulated sonic booms. Twenty-two of the test sites were revisited in the following year, and observations of pairs or lone birds were made at all but one nest.

Nesting attempts were underway at 19 of 20 sites that were observed long enough to be certain of breeding activity. Reoccupancy and productivity rates were within or above expected values for self-sustaining populations.

Short-term behavior responses were also noted. Overflights at a distance of 150 m or less produced few significant responses and no severe responses. Typical responses consisted of crouching or, very rarely, flushing from the perch site. Significant responses were most evident before egg laying and after young were "well grown." Incubating or brooding adults never burst from the nest, thus preventing egg breaking or knocking chicks out of the nest. Jet passes and sonic booms often caused noticeable alarm; however, significant negative responses were rare and did not appear to limit productivity or reoccupancy. Due to the locations of some of the nests, some birds may have been habituated to aircraft noise. There were some test sites located at distances far from zones of frequent military aircraft usage, and the test stimuli were often closer, louder, and more frequent than would be likely for a normal training situation.

Manci, et al. (1988), noted that a female northern harrier was observed hunting on a bombing range in Mississippi during bombing exercises. The harrier was apparently unfazed by the exercises, even when a bomb exploded within 200 feet. In a similar case of habituation/non-disturbance, a study on the Florida snail-kite stated the greatest reaction to overflights (approximately 98 dBA) was "watching the aircraft fly by." No detrimental impacts to distribution, breeding success, or behavior were noted.

Bald Eagle

A study by Grubb and King (1991) on the reactions of the bald eagle to human disturbances showed that terrestrial disturbances elicited the greatest response, followed by aquatic (i.e., boats) and aerial disturbances. The disturbance regime of the area where the study occurred was predominantly characterized by aircraft noise. The study found that pedestrians consistently caused responses that were greater in both frequency and duration. Helicopters elicited the highest level of aircraft-related responses. Aircraft disturbances, although the most common form of disturbance, resulted in the lowest levels of response. This low response level may have been due to habituation; however, flights less than 170 meters away caused reactions similar to other disturbance types. Ellis, et al. (1991), showed that eagles typically respond to the proximity of a disturbance, such as a pedestrian or aircraft within 100 meters, rather than the noise level. Fleischner and Weisberg (1986) stated that reactions of bald eagles to commercial jet flights, although minor (e.g., looking), were twice as likely to occur when the jets passed at a distance of 0.5 mile or less. They also noted that helicopters were four times more likely to cause a reaction than a commercial jet and 20 times more likely to cause a reaction than a propeller plane.

The USFWS advised Cannon AFB that flights at or below 2,000 feet AGL from October 1 through March 1 could result in adverse impacts to wintering bald eagles (U.S. Fish and Wildlife Serice 1998). However, Fraser, et al. (1985), suggested that raptors habituate to overflights rapidly, sometimes tolerating aircraft approaches of 65 feet or less.

Osprey

A study by Trimper, et al. (1998), in Goose Bay, Labrador, Canada, focused on the reactions of nesting osprey to military overflights by CF-18 Hornets. Reactions varied from increased alertness and focused observation of planes to adjustments in incubation posture. No overt reactions (e.g., startle response, rapid nest departure) were observed as a result of an overflight. Young nestlings crouched as a result of any disturbance until they grew to 1 to 2 weeks prior to fledging. Helicopters, human presence, float planes, and other ospreys elicited the strongest reactions from nesting ospreys. These responses included flushing, agitation, and aggressive displays. Adult osprey showed high nest occupancy rates during incubation regardless of external influences.

The osprey observed occasionally stared in the direction of the flight before it was audible to the observers. The birds may have been habituated to the noise of the flights; however, overflights were strictly controlled during the experimental period. Strong reactions to float planes and helicopter may have been due to the slower flight and therefore longer duration of visual stimuli rather than noise-related stimuli.

Red-tailed Hawk

Anderson, et al. (1989), conducted a study that investigated the effects of low-level helicopter overflights on 35 red-tailed hawk nests. Some of the nests had not been flown over prior to the study. The hawks that were naïve (i.e., not previously exposed) to helicopter flights exhibited stronger avoidance behavior (nine of 17 birds flushed from their nests) than those that had experienced prior overflights. The overflights did not appear to affect nesting success in either study group. These findings were consistent with the belief that red-tailed hawks habituate to low-level air traffic, even during the nesting period.

3.8.2.2.2 MIGRATORY WATERFOWL

A study of caged American black ducks was conducted by Fleming, et al. in 1996. It was determined that noise had negligible energetic and physiologic effects on adult waterfowl. Measurements included body weight, behavior, heart rate, and enzymatic activity. Experiments also showed that adult ducks exposed to high noise events acclimated rapidly and showed no effects.

The study also investigated the reproductive success of captive ducks, which indicated that duckling growth and survival rates at Piney Island, North Carolina, were lower than those at a background location. In contrast, observations of several other reproductive indices (i.e., pair formation, nesting, egg production, and hatching success) showed no difference between Piney Island and the background location. Potential effects on wild duck populations may vary, as wild ducks at Piney Island have presumably acclimated to aircraft overflights. It was not demonstrated that noise was the cause of adverse impacts. A variety of other factors, such as weather conditions, drinking water and food availability and variability, disease, and natural variability in reproduction, could explain the observed effects. Fleming noted that drinking water conditions (particularly at Piney Island) deteriorated during the study, which could have affected the growth of young ducks. Further research would be necessary to determine the cause of any reproductive effects.

Another study by Conomy, et al. (1998) exposed previously unexposed ducks to 71 noise events per day that equaled or exceeded 80 dBA. It was determined that the proportion of time black ducks reacted to aircraft activity and noise decreased from 38 percent to 6 percent in 17 days and remained stable at 5.8 percent thereafter. In the same study, the wood duck did not appear to habituate to aircraft disturbance. This supports the notion that animal response to aircraft noise is species-specific. Because a startle response to aircraft noise can result in flushing from nests, migrants and animals living in areas with high concentrations of predators would be the most vulnerable to experiencing effects of lowered birth rates and recruitment over time. Species that are subjected to infrequent overflights do not appear to habituate to overflight disturbance as readily.

Black brant studied in the Alaska Peninsula were exposed to jets and propeller aircraft, helicopters, gunshots, people, boats, and various raptors. Jets accounted for 65% of all the disturbances. Humans, eagles, and boats caused a greater percentage of brant to take flight. There was markedly greater reaction to Bell-206-B helicopter flights than fixed wing, single-engine aircraft (Ward, et al. 1986).

The presence of humans and low-flying helicopters in the Mackenzie Valley North Slope area did not appear to affect the population density of Lapland longspurs, but the experimental group was shown to have reduced hatching and fledging success and higher nest abandonment. Human presence appeared to have a greater impact on the incubating behavior of the black brant, common eider, and Arctic tern than fixed-wing aircraft (Gunn and Livingston 1974).

Gunn and Livingston (1974) found that waterfowl and seabirds in the Mackenzie Valley and North Slope of Alaska and Canada became acclimated to float plane disturbance over the course of three days. Additionally, it was observed that potential predators (bald eagle) caused a number of birds to leave their nests. Non-breeding birds were observed to be more reactive than breeding birds. Waterfowl were affected by helicopter flights, while snow geese were disturbed by Cessna 185 flights. The geese flushed when the planes were under 1,000 feet, compared to higher flight elevations. An overall reduction in flock sizes was observed. It was recommended that aircraft flights be reduced in the vicinity of premigratory staging areas.

Manci, et al. 1988 reported that waterfowl were particularly disturbed by aircraft noise. The most sensitive appeared to be snow geese. Canada geese and snow geese were thought to be more sensitive than other animals such as turkey vultures, coyotes, and raptors (Edwards, et al. 1979).

3.8.2.2.3 WADING AND SHORE BIRDS

Black, et al. (1984), studied the effects of low-altitude (less than 500 feet AGL) military training flights with sound levels from 55 to 100 dBA on wading bird colonies (i.e., great egret, snowy egret, tricolored heron, and little blue heron). The training flights involved three or four aircraft, which occurred once or twice per day. This study concluded that the reproductive activity--including nest success, nestling survival, and nestling chronology--was independent of F-16 overflights. Dependent variables were more strongly related to ecological factors, including location and physical characteristics of the colony and climatology. Another study on the effects of circling fixed-wing aircraft and helicopter overflights on wading bird colonies found that at altitudes of 195 to 390 feet, there was no reaction in nearly 75 percent of the 220 observations. Ninety percent displayed no reaction or merely looked toward the direction of the noise source. Another 6 percent stood up, 3 percent walked from the nest, and 2 percent flushed (but were without active nests) and returned within 5 minutes (Kushlan 1978). Apparently, non-nesting wading birds had a slightly higher incidence of reacting to overflights than nesting birds. Seagulls observed roosting near a colony of wading birds in another study remained at their roosts when subsonic aircraft flew overhead (Burger 1981). Colony distribution appeared to be most directly correlated to available wetland community types and was found to be distributed randomly with respect to military training routes. These results suggest that wading bird species presence was most closely linked to habitat availability and that they were not affected by low-level military overflights (U.S. Air Force 2000).

Burger (1986) studied the response of migrating shorebirds to human disturbance and found that shorebirds did not fly in response to aircraft overflights, but did flush in response to more localized intrusions (i.e., humans and dogs on the beach). Burger (1981) studied the effects of noise from JFK Airport in New York on herring gulls that nested less than 1 kilometer from the airport. Noise levels over the nesting colony were 85 to 100 dBA on approach and 94 to 105 dBA on takeoff. Generally, there did not appear to be any prominent adverse effects of subsonic aircraft on nesting, although some birds flushed when the concorde flew overhead and, when they returned, engaged in aggressive behavior. Groups of gulls tended to loaf in the area of the nesting colony, and these birds remained at the roost when the Concorde flew overhead. Up to 208 of the loafing gulls flew when supersonic aircraft flew overhead. These birds would circle around and immediately land in the loafing flock (U.S. Air Force 2000).

In 1970, sonic booms were potentially linked to a mass hatch failure of Sooty Terns on the Dry Tortugas (Austin, et al. 1970). The cause of the failure was not certain, but it was conjectured that sonic booms from military aircraft or an overgrowth of vegetation were factors. In the previous season, Sooties were observed to react to sonic booms by rising in a “panic flight,” circling over the island, then usually settling down on their eggs again. Hatching that year was normal. Following the 1969 hatch failure, excess vegetation was cleared and measures were taken to reduce supersonic activity. The 1970 hatch appeared to proceed normally. A colony of Noddies on the same island hatched successfully in 1969, the year of the Sooty hatch failure.

Subsequent laboratory tests of exposure of eggs to sonic booms and other impulsive noises (Bowles, et al. 1991a; Bowles, et al. 1994; Cottereau 1972; Cogger and Zegarra 1980) failed to show adverse effects on hatching of eggs. A structural analysis (Ting, et al. 2002) showed that, even under extraordinary circumstances, sonic booms would not damage an avian egg.

Burger (1981) observed no effects of subsonic aircraft on herring gulls in the vicinity of JFK International Airport. The Concorde aircraft did cause more nesting gulls to leave their nests (especially in areas of higher density of nests), causing the breakage of eggs and the scavenging of eggs by intruder prey. Clutch sizes were observed to be smaller in areas of higher-density nesting (presumably due to the greater tendency for panic flight) than in areas where there were fewer nests.

3.8.3 Fish, Reptiles, and Amphibians

The effects of overflight noise on fish, reptiles, and amphibians have been poorly studied, but conclusions regarding their expected responses have involved speculation based upon known physiologies and behavioral traits of these taxa (Gladwin, et al. 1988). Although fish do startle in response to low-flying aircraft noise, and probably to the shadows of aircraft, they have been found to habituate to the sound and overflights. Reptiles and amphibians that respond to low frequencies and those that respond to ground vibration, such as spadefoots (genus Scaphiopus), may be affected by noise. Limited information is available on the effects of short-duration noise events on reptiles. Dufour (1980) and Manci, et al. (1988), summarized a few studies of reptile responses to noise. Some reptile species tested under laboratory conditions experienced at least temporary threshold shifts or hearing loss after exposure to 95 dB for several minutes. Crocodilians in general have the most highly developed hearing of all reptiles. Crocodile ears have lids that can be closed when the animal goes under water. These lids can reduce the noise intensity by 10 to 12 dB (Wever and Vernon 1957). On Homestead Air Reserve Station, Florida, two crocodilians (the American Alligator and the Spectacled Caiman) reside in wetlands and canals along the base runway suggesting that they can coexist with existing noise levels of an active runway including DNLs of 85 dB.

3.8.4 Summary

Some physiological/behavioral responses such as increased hormonal production, increased heart rate, and reduction in milk production have been described in a small percentage of studies. A majority of the studies focusing on these types of effects have reported short-term or no effects.

The relationships between physiological effects and how species interact with their environments have not been thoroughly studied. Therefore, the larger ecological context issues regarding physiological effects of jet aircraft noise (if any) and resulting behavioral pattern changes are not well understood.

Animal species exhibit a wide variety of responses to noise. It is therefore difficult to generalize animal responses to noise disturbances or to draw inferences across species, as reactions to jet aircraft noise appear to be species-specific. Consequently, some animal species may be more sensitive than other species and/or may exhibit different forms or intensities of behavioral responses. For instance, wood ducks appear to be more sensitive and more resistant to acclimation to jet aircraft noise than Canada geese in one study. Similarly, wild ungulates seem to be more easily disturbed than domestic animals.

The literature does suggest that common responses include the “startle” or “fright” response and, ultimately, habituation. It has been reported that the intensities and durations of the startle response decrease with the numbers and frequencies of exposures, suggesting no long-term adverse effects. The majority of the literature suggests that domestic animal species (cows, horses, chickens) and wildlife species exhibit adaptation, acclimation, and habituation after repeated exposure to jet aircraft noise and sonic booms.

Animal responses to aircraft noise appear to be somewhat dependent on, or influenced by, the size, shape, speed, proximity (vertical and horizontal), engine noise, color, and flight profile of planes. Helicopters also appear to induce greater intensities and durations of disturbance behavior as compared to fixed-wing aircraft. Some studies showed that animals that had been previously exposed to jet aircraft noise exhibited greater degrees of alarm and disturbance to other objects creating noise, such as boats, people, and objects blowing across the landscape. Other factors influencing response to jet aircraft noise may include wind direction, speed, and local air turbulence; landscape structures (i.e., amount and type of vegetative cover); and, in the case of bird species, whether the animals are in the incubation/nesting phase.

3.9 Property Values

Property within a noise zone (or Accident Potential Zone) may be affected by the availability of federally guaranteed loans. According to U.S. Department of Housing and Urban Development (HUD), Federal Housing Administration (FHA), and Veterans Administration (VA) guidance, sites are acceptable for program assistance, subsidy, or insurance for housing in noise zones of less than 65 dB DNL, and sites are conditionally acceptable with special approvals and noise attenuation in the 65 to 75 dB DNL noise zone and the greater than 75 dB DNL noise zone. HUD's position is that noise is not the only determining factor for site acceptability, and properties should not be rejected only because of airport influences if there is evidence of acceptability within the market and if use of the dwelling is expected to continue. Similar to the Navy's and Air Force's Air Installation Compatible Use Zone Program, HUD, FHA, and VA recommend sound attenuation for housing in the higher noise zones and written disclosures to all prospective buyers or lessees of property within a noise zone (or Accident Potential Zone).

Newman and Beattie (1985) reviewed the literature to assess the effect of aircraft noise on property values. One paper by Nelson (1978), reviewed by Newman and Beattie, suggested a 1.8 to 2.3 percent decrease in property value per decibel at three separate airports, while at another period of time, they found only a 0.8 percent devaluation per decibel change in DNL. However, Nelson also noted a decline in noise depreciation over time which he theorized could be due to either noise sensitive people being replaced by less sensitive people or the increase in commercial value of the property near airports; both ideas were supported by Crowley (1978). Ultimately, Newman and Beattie summarized that while an effect of noise was observed, noise is only one of the many factors that is part of a decision to move close to, or away from, an airport, but which is sometimes considered an advantage due to increased opportunities for employment or ready access to the airport itself. With all the issues associated with determining property values, their reviews found that decreases in property values usually range from 0.5 to 2 percent per decibel increase of cumulative noise exposure.

More recently Fidell, et al. (1996) studied the influences of aircraft noise on actual sale prices of residential properties in the vicinity of two military facilities and found that equations developed for one area to predict residential sale prices in areas unaffected by aircraft noise worked equally well when applied to predicting sale prices of homes in areas with aircraft noise in excess of 65 dB DNL. Thus, the model worked equally well in predicting sale prices in areas with and without aircraft noise exposure. This indicates that aircraft noise had no meaningful effect on residential property values. In some cases, the average sale prices of noise exposed properties were somewhat higher than those elsewhere in the same area. In the vicinity of Davis-Monthan AFB in Tucson, AZ, Fidell found the homes near the AFB were much older, smaller and in poorer condition than homes elsewhere. These factors caused the equations developed for predicting sale prices in areas further away from the base to be inapplicable with those nearer the AFB. However, again Fidell found that, similar to other researchers, differences in sale prices between homes with and without aircraft noise were frequently due to factors other than noise itself.

3.10 Noise Effects on Terrain

It has been suggested that noise levels associated with low-flying aircraft may affect the terrain under the flight path by disturbing fragile soil or snow, especially in mountainous areas, causing landslides or avalanches. There are no known instances of such effects, and it is considered improbable that such effects would result from routine, subsonic aircraft operations.

3.11 Noise Effects on Historical and Archaeological Sites

Because of the potential for increased fragility of structural components of historical buildings and other historical sites, aircraft noise may affect such sites more severely than newer, modern structures. Particularly in older structures, seemingly insignificant surface cracks initiated by vibrations from aircraft noise may lead to greater damage from natural forces (Hanson, et al. 1991). There are few scientific studies of such effects to provide guidance for their assessment.

One study involved the measurements of sound levels and structural vibration levels in a superbly restored plantation house, originally built in 1795, and now situated approximately 1,500 feet from the centerline at the departure end of Runway 19L at Washington Dulles International Airport. These measurements were made in connection with the proposed scheduled operation of the Concorde airplane at Dulles (Wesler 1977). There was special concern for the building's windows, since roughly half of the 324 panes were original. No instances of structural damage were found. Interestingly, despite the high levels of noise during Concorde takeoffs, the induced structural vibration levels were actually less than those induced by touring groups and vacuum cleaning.

As noted above for the noise effects of noise-induced vibrations of conventional structures, assessments of noise exposure levels for normally compatible land uses should also be protective of historic and archaeological sites.

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Appendix B

Land Use Compatibility Recommendations
OPNAVINST 3550.1A

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DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
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OPNAVINST 3550.1A
MCO 3550.11
N4/CMC (I&L)
28 Jan 08

OPNAV INSTRUCTION 3550.1A
MARINE CORPS ORDER 3550.11

From: Chief of Naval Operations
Commandant of the Marine Corps

Subj: RANGE AIR INSTALLATIONS COMPATIBLE USE ZONES (RAICUZ) PROGRAM

Ref: (a) OPNAVINST 11010.36B
(b) OPNAVINST 5090.1B
(c) MCO P5090.2 (NOTAL)
(d) MCO 3550.10
(e) MCO 3570.1B
(f) OPNAVNOTE 11010 (NOTAL)
(g) DOD Directive 3200.15 of 10 Jan 03
(h) OPNAVINST 5100.27A/MCO 5104.1B
(i) OPNAVINST 3770.2

Encl: (1) RAICUZ Program Procedures and Guidelines for Air-to-Ground Range Installations

1. Purpose. To revise Department of the Navy policy, procedures, and guidelines for implementation of the RAICUZ Program. This instruction provides guidance from the Chief of Naval Operations and Commandant of the Marine Corps.

2. Cancellation. OPNAVINST 3550.1.

3. Background. The Department of the Navy's RAICUZ program is designed to protect public health, safety, and welfare, and to prevent encroachment from degrading the operational capabilities of air-to-ground ranges. This program is similar to the Air Installations Compatible Use Zones (AICUZ) Program issued by reference (a). The RAICUZ program includes range safety and noise analyses, and provides land use recommendations which will be compatible with Range Compatibility Zones (RCZs) and noise

levels associated with the military range operations. Program implementation procedures for the Navy and Marine Corps are contained in enclosure (1).

4. Discussion. The RAICUZ Program depends upon the installation commander's efforts to work with the nearby communities and other federal, state, local agencies and federally recognized Native American tribes to prevent incompatible development of land adjacent to military training ranges. The RAICUZ process involves four steps:

a. Develop, and periodically update, a RAICUZ Study for each air-to-ground range installation to quantify range compatibility zones and aircraft noise zones; consult with stakeholders to develop strategies for lands affected by potentia1 weapons or noise impacts, both on and off the range; prepare a compatible land use plan for the range and surrounding areas; and develop a strategy to promote compatible development on land within these areas.

b. Develop a near-term RAICUZ analysis to illustrate impact of known future missions on RAICUZ implementation.

c. Implement the RAICUZ Study for the installation including coordination with federal, state, and local officials to maintain public awareness of RAICUZ.

d. Identify and program land acquisition in critical areas where actions to achieve compatibility within the RAICUZ through local land controls appears unlikely.

5. Responsibilities. The Deputy Chief of Naval Operations, CNO for Fleet Readiness and Logistics (N4), provides relevant policy, resources, structures, and mechanisms to meet leadership

defined readiness requirements of Navy operating forces and their associated shore installations.

a. CNO (N46) (Director, Ashore Readiness) plans and programs resources for the RAICUZ program.

b. CNO (N43) (Director, Fleet Readiness) as director of the Navy Range Office, ensures Navy Policy and decision making support the Fleet's tactical warfighter requirements.

c. Commander Fleet Forces Command (CFFC), is responsible for approving all operational requirements on Navy training

ranges, programming resources for new Weapon Danger Zones (WDZs) tool and approving waivers to standard modeling protocols for training ranges and the WDZ (SAFE-RANGE) computer software tool.

d. Commander, Naval Strike and Air Warfare Center (NSAWC), is responsible for developing all Navy tactics, techniques and procedures (TTP) that are employed on Navy ranges. Marine Corps aviation TTP tactics are standardized and taught by Marine Air Ground Task Force Training Command and Marine Aviation Weapons and Tactics Squadron One.

e. Commander Navy Installations Command (CNI)(N5), as the RAICUZ program executive agent, provides technical expertise, policy oversight and program management for the Navy.

f. The Deputy Commandant for Installations & Logistics (DC I&L) acts on behalf of the Commandant in designated matters of installations and logistics policy and management. DC I&L shall exercise approval authority and responsibility for the RAICUZ program within the Marine Corps.

g. The Commanding General, Marine Corps Combat Development Command (CG MCCDC) (C465) is the executive agent and resources sponsor for aviation and ground range and training area (RTA) management programs, and the proponent for all range safety matters.

6. Applicability. This instruction applies to all Navy and Marine Corps air-to-ground range installations within the confines of the United States, its territories, trusts, and possessions. RAICUZ studies, or portions thereof, may be developed for U.S. activities in foreign countries if such action supports host nation policy for protecting the operational capabilities of those activities, or for on base U.S. facility planning goals.

7. Action. Addressees shall comply with the procedures outlined here.

E. G. USHER III
Deputy Commandant for
Installations and Logistics

M. H. LOOSE
Vice Admiral, CEC, U.S. Navy
Deputy Chief of Naval Operations
(Fleet Readiness and Logistics)

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OPNAVINST 3550.1A
MCO 3550.11
28 Jan 08

DEPARTMENT OF THE NAVY

RANGE AIR INSTALLATIONS COMPATIBLE USE ZONES

RAICUZ

PROGRAM PROCEDURES

TABLE OF CONTENTS

SECTION I

1. OBJECTIVE

1.1. THE RAICUZ PROGRAM OBJECTIVES

The objective of the RAICUZ program is to achieve compatibility between air-to-ground ranges, existing and proposed land use, and airspace in the vicinity of the range installation by meeting the following primary objectives:

1.1.1. Precluding public exposure to hazards and noise associated with air-to-ground ranges;

1.1.2. Protecting Navy and Marine Corps investment by safeguarding the current and potential operational capabilities of those ranges;

1.1.3. Promote compatible land use near air-to-ground ranges;

1.1.4. Informing the public about the RAICUZ program and seeking cooperative efforts to minimize potential safety and noise impacts in the vicinity of the air-to-ground ranges;

1.1.5. Establishing working relationships between the installation and appropriate local, regional and state community councils, commissions, Indian tribes and planning and zoning departments in order to mutually communicate proposed actions that could affect public health, safety and welfare as well as operational and training capabilities and compatible land use recommendations.

1.2. REQUIREMENTS

Each Navy and Marine Corps air-to-ground range shall have a RAICUZ study including a detailed analysis of current and future range utilization, special use airspace, range compatibility use zones, aircraft noise, ordnance noise, and land use compatibility. Plans shall be updated as necessary to account for new aircraft, weapons, and/or tactics or when special circumstances, such as an approved training requirement, dictate such action.

1.3. APPROACH

Developing the RAICUZ study requires establishing Range Compatibility Zones (RCZs) and modeling aircraft noise and ordnance noise. Should the weapon danger zone footprint extend beyond the range boundary, or excessive noise levels present an unacceptable potential impact to off-range sites, the RAICUZ plan will require an analysis of alternatives to achieve land use compatibility. Alternatives must balance changes in potential weapons and noise impacts with effects on safety, operational capability, and training/testing requirements. For the Marine Corps, reference (e) provides guidance regarding the establishment of weapon danger zone footprints. Approval by the cognizant service (CNO (N46)/CMC (LF)) is required prior to plan implementation.

1.4. AIRSPACE CONSIDERATIONS

Special Use Airspace (SUA) associated with ranges includes restricted areas for ordnance delivery and Military Operations Areas (MOA) for high-speed air combat maneuvering. In addition, low-level Military Training Routes (MTR) are sometimes established and utilized to provide ingress and egress to the training ranges. This airspace is critical to flight safety to ensure the proper degree of separation exists between non-participating aircraft and hazardous operations.

To insure that sufficient range and airspace capacity will be available to support existing and future mission requirements, an analysis of special use airspace may need to be conducted for each range/range complex. Findings and recommendations will be administered per reference (i).

The Department of the Navy's Naval Aviation Simulation Model (NASMOD) was developed to enable planners to evaluate complex airfield, range, and airspace scenarios. NASMOD is an effective tool in determining range and airspace capacity and for supporting proposals for new special use airspace, if required, to meet mission requirements. In addition to providing the capability to fully assess military airspace training requirements, the impact to military training requirements from proposed changes in civilian and general aviation operations can be fully evaluated.

1.5. OTHER CONSIDERATIONS

1.5.1. NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

Potential changes in operational procedures or aircraft activity at the range may require preparation of a RAICUZ study or an update. These changes may constitute a major federal action requiring the action proponent to prepare appropriate National Environmental Policy Act (NEPA) documentation, in accordance with references (b) and (c). Proposals for use of new platforms, weapons or tactics that could result in a change to the environmental status quo (such as increases in off range noise or the size/location of RCZs) require preparation of NEPA documentation prior to implementation.

If NEPA documentation is required, it is important to remember that some range operations may have the potential to adversely impact cultural resources such as historic structures, archeological sites, Native American rock art, traditional cultural properties and Native American sacred sites, located within the RAICUZ zones. Such impacts may require Section 106 consultation of the National Historic Preservation Act (NHPA) as well as other historic preservation legislation. Thus, consultation with appropriate State Historic Preservation Officers (SHPO) and other interested parties is an integral part of the NEPA study and should be initiated early in the NEPA process. Consultation between Federal agencies and Native American tribes is also mandated under several Federal laws. Issues that are often a concern for Native American tribes include construction, training, land use, low-level over flights, ecosystem management of ancestral lands, protection of ancestral sites and sacred sites from vandalism, and access to sacred sites, subsistence and medicinal natural resources.

1.5.2. LASER ANALYSIS

The use of lasers within the range and training area will be governed by the appropriate service range safety policies per reference (h).

1.5.3. IMPLEMENTATION

RAICUZ implementation must be a continuous effort at each installation, range and training area. Respective Installation Commanders should support the personnel responsible for working toward achieving compatible land uses between the range and the

surrounding area; for the Marine Corps, this is the Community Plans and Liaison Office (CPLO) or other officials as appropriate. The responsible personnel should consider available strategies including land use controls, compatible zoning, land acquisition in fee or restrictive easements, special use permits, encroachment partnering, and withdrawal of public domain lands. As a means of accomplishing compatibility, local commands are encouraged to participate in partnering efforts with adjacent landowners, users, community councils, commissions, and planning and zoning agencies. Installation Commanders have the primary responsibility to provide input to the local community on installation activities that might impact them. This includes noise emanating from military ranges and training. Successful implementation of a RAICUZ study involves coordination with federal, state, regional, local agencies and federally recognized Indian tribes as appropriate.

SECTION II

2. RESPONSIBILITIES

2.1 The Deputy Chief of Naval Operations CNO for Fleet Readiness and Logistics (N46) plans and programs for afloat/ashore readiness and logistics programs, and ensures the effective and efficient employment of resources in meeting validated requirements. N46 shall:

2.1.1. Fund all Navy RAICUZ studies and RAICUZ Updates.

2.1.2. Exercise approval authority over Navy RAICUZ studies.

2.2. Commander Navy Installations Command (CNIC)(N5), as the executive agent for N46, directs the Navy RAICUZ program and is responsible for ensuring that a RAICUZ is prepared for each Range/Range Complex; and that updates are prepared when changes to the Range or its mission occur. CNIC shall:

2.2.1. Directs the Navy Centers of Excellence (COE) and Navy Regions, in the implementation of the policies and principles of the RAICUZ program;

2.2.2. Direct CNI subordinate components to implement the Navy RAICUZ recommendations;

2.2.3. Develop and conduct an education program for installation, chain of command and other cognizant DOD and non-DOD individuals regarding the policies, purposes and strategies of the Navy RAICUZ program;

2.3. The Commander, Naval Facilities Engineering Command shall:

2.3.1. Integrate the Navy RAICUZ planning process into Shore Infrastructure Program (SIP) for Navy complexes or activities and activity master plans for the Marine Corps.

2.3.2. Provide technical direction and planning support for the reduction of noise emanating from aircraft flight and test operations on Navy and Marine Corps ranges.

2.3.3. Ensure that program tools are available.

2.3.4. Establish East and West Coast Centers of Excellence (COE) to coordinate Navy RAICUZ issues with Regional Commanders and installations within their area of responsibility.

2.4. Navy Regional Commanders provide implementation guidance, priorities and recommendations in RAICUZ plans submitted under their cognizance; and

2.4.1. Coordinate with Mission Component Commands who establish operational requirements.

2.4.2. Ensure that ranges within their AOR have current RAICUZ Studies.

2.4.3. And ensures that any approved operational changes to their range are included within the RAICUZ study and updated local Range Operating Instructions.

2.5. Commander Fleet Forces Command, (N7), Fleet Training Directorate is responsible for developing requirements for all Navy ranges. FFC (N7) shall:

2.5.1. Fund and approve weapon safety analysis studies which will directly feed RAICUZ studies per reference (d) and possible follow on NEPA documentation, if required.

2.5.2. Review all Navy RAICUZ Studies.

2.5.3. Fund, review and approve all new WDZ's.

2.5.4. Approve all waivers for alternative modeling methodologies and WDZ's. FFC has the authority to delegate this authority and to develop guidance for alternative modeling methodologies.

2.5.5. Fund the development and sustainability of WDZ program tools.

2.5.6. Provide subordinate commanders assistance in identifying future training requirements that may require additional range training resources.

2.6. The Naval Strike and Air Warfare Center (NSAWC) shall develop and or approve all Strike Warfare tactics used on Navy ranges.

2.7. The Assistant Deputy Commandant for Installations & Logistics, Facilities and Services Division (ADC I&L-LF) as the Marine Corps RAICUZ program executive agent, provides environmental and compatible land use policies, plans, and programs related to Range and Training Area (RTA) operations, and provides concept review for Marine Corps Land and Airspace Use Requirements studies. ADC I&L (LF) shall:

2.7.1. Exercise management responsibility for the Marine Corps RAICUZ Program.

2.7.2. Provide technical assistance and guidance to Marine Corps organizations regarding RAICUZ policy decisions and implementation.

2.7.3. Promote a RAICUZ education program in cooperation with CNIC (N5).

2.7.4. Provide concept review and recommendations for Marine Corps RAICUZ plans.

2.7.5. Fund Marine Corps RAICUZ Studies.

2.7.6. Coordinate with Commanding General (CG), Marine Corps Combat Development Command (MCCDC) (C465) on all matters pertaining to Weapon Danger Zones (WDZ) development.

2.8. CGMCCDC (C465) is the executive agent and resources sponsor for aviation and ground Range and Training Area (RTA) management programs, and the proponent for all range safety matters.

2.9. The Commanding General, Training and Education Command (TECOM) provides for the development, coordination, resourcing, execution, and evaluation of training and education concepts, policies, plans and programs.

2.10. Commanders, Marine Forces (COMMARFORs) are responsible for approving operational requirements for RTAs within their respective geographic Area Of Responsibility (AOR) and shall:

2.10.1. Review Marine Corps RAICUZ Studies

2.10.2. Coordinate with Mission Component Commands who establish operational requirements, to be included in the RAICUZ analysis.

2.10.3. Ensure that ranges in their AOR have current RAICUZ Studies.

2.10.4. Ensure that any approved operational changes to the range are included within the RAICUZ Study and local Installation Range Standard Operating procedures (SOP).

2.10.5. Endorse RAICUZ studies prior to approval by CMC.

2.11. Commanding Generals, Marine Corps Installation (MCI) regions identify, prioritize, and support installation facility requirements for RTAs and provide implementation guidance, priorities and recommendations in RAICUZ Studies submitted under their cognizance.

2.12. Commanding Officers, Marine Corps Bases and Air stations implement the RAICUZ Study at the respective installation, range and training area.

2.12.1. Maintain documentation on the implementation of the RAICUZ Study. Such documentation should contain, among other things, a chronological narrative of important events, newspaper articles, operational data and references aerial and ground photographs, and pertinent correspondence.

2.12.2. Comply with Marine Corps range safety instructions for the development and maintenance of a composite Weapons Danger Zone footprint for all air-to-ground ranges under the control of the command.

SECTION III

3. RANGE COMPATIBILITY ZONES (RCZs)

3.1. GENERAL

A principal component of the RAICUZ study is a compatible land use plan specifically tailored for each range.

For land use planning purposes, RCZ's define areas based on a level of protection to public health, safety, and welfare and to recommend compatible land uses to prevent encroachment from degrading the operational capability of the air to ground ranges. Range Compatibility Zone-I (RCZ-I) defines the area of the greatest potential safety hazard and designates the minimum range surface area needed to contain all ordnance delivered at air-to-ground ranges. Range Compatibility Zone-II (RCZ-II) defines the area of armed over flight. Range Compatibility Zone-III (RCZ-III) is the area under the restricted airspace used by aircraft for tactical maneuvering over the range. RCZ's are not predictors of safety hazards but depict areas where mishaps are likely to occur if they occur.

It is the responsibility of range control/safety officials to determine the appropriate positioning of range structures, personnel, and troops conducting training.

3.2. DEVELOPMENT OF AIR-TO-GROUND RCZ's

RCZ's translate aviation safety and ordnance delivery safety concerns into recommended compatible land use zones. RSZ size is not affected by the number of annual range operations, but is based upon the types of operations performed as outlined in current local Range Operations Manuals or Instructions. RCZ's are used as the basis for designating types of compatible land use with the public's safety in mind both on and off the military range. RCZ land use recommendations are more stringent than those for noise impacts because the possible consequences of incompatible development are more serious. For land use planning purposes, the RCZ's are divided into three zones: RCZ-I, RCZ-II and RCZ-III.

3.2.1. Range Compatibility Zone-I (RCZ-I)

RCZ-I is the composite footprint based on each of the individual Weapons Danger Zones (WDZ), associated with air-to-ground weapons delivery, and represents the entire weapons impact area (including potential ricochets). WDZ is a new term replacing Weapon Safety Footprint Area, thereby making all DoD Service technology uniform and consistent with NATO.

The Weapons Danger Zone (WDZ) encompasses the ground and airspace for lateral and vertical containment of projectiles, fragments, debris and components resulting from the firing, launching and/or detonation of aviation delivered ordnance. This three-dimensional zone accounts for weapon accuracy, failures, ricochets, and broaches/porpoising of a specific weapon/munitions type delivered by a specific aircraft type. WDZ's represent the minimum safety requirements designed for aviation weapons training on DoD ranges.

The composite WDZ is developed in accordance with the respective services' range safety policies. RCZ-I is the most restrictive of the three RCZ's; there are no compatible land uses permitted within the RCZ-I (see Appendix A). If specific situations require the establishment of the RCZ-I outside the range boundary, efforts to either acquire the necessary property or negotiate a use agreement with the owner or agent controlling the land should be made and forwarded for approval. Again, the composite WDZ (RCZ-I), which is the summation of all applicable WDZ's acceptable for a particular range, is the minimum area needed to contain approved ordnance delivered from aircraft.

The composite WDZ (CWDZ) will be constructed utilizing service approved modeling software.

Multiple CWDZ's is an acceptable means to accurately depict operational risk (e.g., a CWDZ for routine training and a more heavily mitigated CWDZ for less frequent and/or non-routine operations.)

The currently approved model for developing WDZ's is SAFE-RANGE, a multi-Service approved modeling software based on algorithms (WDZ Tool is currently being developed and will replace SAFE-RANGE). For the Navy, other modeling methodologies may be approved on a case by case basis by Commander, Fleet Forces Command (N7). Modeling shall incorporate the best scientific methodologies and Operational Risk management Procedures. For the Marine Corps, reference (e) provides guidance for the development of WDZs and the policy and procedures for deviations.

In some instances, multiple RCZ-I footprints may be required to properly document the activities at a range and accurately communicate risks and required mitigation in support of air-to-ground operations. Multiple RCZ-I development is generally beneficial at small ranges that only occasionally support higher risk operations on an annual basis. Examples include individual RCZ-I depictions for unit level training (ULT), precision guided munitions (PGM) or larger scale exercises (LSE). Separate mitigation would be developed and executed for each RCZ-I requirement.

There will be a final Composite RCZ-I developed for Joint Land Use Studies, Navy Encroachment Action Plans, and Marine Corps Encroachment Control Plans.

3.2.2. Range Compatibility Zone-II (RCZ-II)

RCZ-II is the area of armed over flight as defined in accordance with specific range safety policy.

RCZ-II is less restrictive than RCZ-I and supports compatible land use (See appendix A). However, RCZ-II still poses a level of potential safety concern and does come with recommended land use restrictions. Land uses, which have the potential to attract congregations of people, are not recommended with RCZ-II.

3.2.3. Range Compatibility Zone-III (RCZ-III)
RCZ-III defines the area within the designated Special Use Airspace (SUA)associated with the Range outside of the areas designated as RCZ I and RCZ II that is required to provide access to and from the range, permit tactical

maneuvering, and safely separate participating and non-participating aircraft. While RCZ-III correlates to required airspace, it is the land use underlying the airspace that is considered for safety reasons.

3.2.4. Disclosure Zones

It is important that potential buyers, renters or lessees be notified of possible noise and safety issues associated with range operations. This disclosure is strongly encouraged in the noise zones greater than 60 DNL (or 60 CNEL) and Range Compatibility Zones, and encouraged within the general vicinity of the air-to-ground range where air operations may result in public annoyance.

3.3. COMPATIBLE LAND USE GUIDELINES

RCZ land use compatibility information and general guidance, listed by land use category, is presented in Appendix A for use by local governments in their land use planning and zoning deliberations. Consistency in the application of these land use recommendations at the installation is important. Further amplification is available from "Standard Land Use Coding Manual" U.S. Department of Transportation, Federal Highway Administration, March 1977). Where a specific local land use is not adequately described in the standard guidance document, refinement and interpretation of the basic data is encouraged, within the constraints of accepted land use planning practice and with the approval of CNIC (N5) or CMC (LF).

Where local authorities have adopted specific land use recommendations that are more stringent than the criteria herein provided, the RAICUZ plan may incorporate and support the specific local criteria. However, land use planning recommendations proposed for publication in RAICUZ documents that vary from Appendix A require CNI/CMC approval prior to public dissemination. In all cases, the land use recommendations must consider the allowed aircraft operating altitudes in the corresponding airspace and preclude uses or building or structure heights that would pose a safety hazard to aircraft operations.

3.4. HEIGHT AND OBSTRUCTION CONCERNS

This instruction addresses recommended compatible land use with respect to aircraft noise and potential safety concerns. Land uses in the vicinity of air installations are also subject to aircraft safety clearances, height restrictions and other obstruction concerns. Within the RCZ's, any buildings, towers or other structures taller than 100 feet above ground level (agl) are coordinated with range safety officials to ensure compatibility. Any structures exceeding 199 feet agl should also be coordinated with the FAA per FAA guidelines.

Additionally, the following land uses should be examined for compatibility within the range environs:

3.4.1 Uses that may cause smoke, dust or steam that could obscure pilot and range safety personnel vision;

3.4.2 Direct and indirect lighting that could interfere with pilot vision, including, but not limited to, searchlights, lasers, and fireworks;

3.4.3 Uses that may cause electromagnetic interference (EMI) with aircraft navigation, communication or weapons systems;

3.4.4 Uses that may attract birds, such as landfills, wastewater treatment facilities, dredge disposal sites, seafood processing plants, etc; and

3.4.5 Uses that may affect aircraft radar or low-level training capability such as with the increasing height and dispersal of wind turbine farms.

SECTION IV

4. NOISE EXPOSURE

4.1. GENERAL

In addition to Range Compatibility Zones, the RAICUZ study should consider potential noise impacts in the vicinity of the range. For air-to-ground ranges where adjacent or nearby noise-sensitive land uses exist or the potential for development is present, a detailed noise impact analysis is warranted. Such noise analysis should address aircraft noise, ordnance (blast noise), and supersonic operations, if applicable.

4.2. DEVELOPMENT OF NOISE EXPOSURE CONTOURS

Part of the RAICUZ study includes preparation of a noise plan to develop noise exposure contours and compare them to prior noise contours published in the last approved RAICUZ document. The noise contours are developed by a computerized simulation of aircraft activity at the range and reflect site-specific conditions (e.g., terrain) and operational data (e.g., flight tracks, type and mix of aircraft, aircraft profiles (airspeed, altitude, power settings)), and number/types of weapons employed as well as the frequency and times of operations. RAICUZ program experience indicates that future year planning is necessary to consider the effects of expected changes in mission, aircraft, and range operational levels, etc. Therefore, in addition to the current year analysis of operations, RAICUZ updates will include an analysis of projected operations. The resultant noise contours will be referred to as the "prospective" noise contours. Projections of aircraft and range operations will be based upon currently available unclassified estimates of future mission requirements. Where such estimates are not available, or where little or no change is expected in the next 5 to 10 years, the current year noise contours may also be used as the prospective noise contours. Noise impacts from aircraft and ordnance operations will be graphically portrayed, and operational alternatives that could reduce noise impact on the installation and on the nearby community should be evaluated when practicable from the perspectives of aircraft safety and ability to maintain operational and training requirements. The activity shall

recommend the most appropriate noise footprints for approval by CNO/CMC.

4.2.1. General

Since land use compatibility guidelines are based on yearly average noise levels, noise contours should be developed based on Average Annual Day (AAD) operations. However, where the documented nature of AAD air operations at a specific range does not adequately represent the noise impacts at that range, the Average Busy Day (ABD) can be used with supporting rationale (i.e., there are times when a detachment uses the range creating several days of higher noise impact). Range Managers are encouraged to contact CNI (N531)/ CMC (LF) for further guidance.

The operations level on an AAD is calculated by dividing the total annual range operations by 365 days. An ABD occurs when the range operations levels on a given day are at least 50 percent of the Average Annual Day operations level. The ABD is calculated by determining the number of operations on busy days and dividing the total number of operations on those busy days by the number of busy days.

4.2.2. Noise Zones and Noise Models

4.2.2.1 Day-Night Average Sound Level (DNL) shall be used in all RAICUZ Studies except at California ranges, which will use Community Noise Equivalent Level (CNEL). Where applicable, noise contours 60, 65, 70, 75, and 80 shall be plotted on maps for Navy and Marine Corps ranges as part of RAICUZ studies. Contours below 60 DNL/CNEL are not required but may be provided if local conditions warrant discussion of lower noise levels or where significant noise complaints have been received in areas outside DNL/CNEL 60.

4.2.2.2. The NOISEMAP program or MR_NMAP may be used for developing noise contours for fixed-wing aircraft and the Rotorcraft-Noise Model (RNM) program will be used for developing noise contours for rotary-wing and tilt-rotor aircraft operations.

4.2.2.3 For ranges with a fixed run-in heading, NOISEMAP will be utilized.

4.2.2.4 For ranges with variable run-in headings, the MOA and Range Noise Map program (MR_NMAP) will be utilized.

4.2.2.5. For low-level military training routes (MTR) to and from the range, MR_NMAP will be utilized.

4.2.2.6. Noise from ordnance delivery (blast noise) is impulsive in nature and of short duration. Blast noise is often a source of discomfort for persons, and vibrations of buildings and structures included by blast noise may result in increased annoyance. Where noise sensitive uses are located in the vicinity of a range, blast noise contours will be developed using the latest version of the Department of Defense BNOISE program.

4.2.2.7. The use of the C-weighted average sound level (CDNL) is an appropriate noise metric to represent the effects of blast noise from both air-to-ground ranges using live ordnance and Marine Corps ground training ranges. Initial BNOISE analysis input data should be coordinated with the Noise Staff of the U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM). Blast noise C-weighted contours of 57, 62, 70, 75 and 80 CDNL should be included.

4.2.2.8. Supplemental metrics can also help explain special situations (e.g., noise at a school during school hours; noise at certain peak periods of the year when a major exercise is conducted, etc.). Single event noise data (e.g., SELs at various distances during a single aircraft over flight; peak PK15 (events), etc.) may be employed where appropriate to provide additional information on the effects of noise in certain situations.

4.2.3. Selection of Final Noise Contours to be used in the RAICUZ Plan

The selection criteria and rationale for the noise contours (e.g., current year or prospective used to reflect aircraft noise and blast noise must be documented in the request for

approval of the RAICUZ plan) shall be made by the installation, concurred with by the chain of command, and approved by CNO (N5) or CMC (LF).

4.3. COMPATIBLE LAND USE GUIDELINES FOR NOISE ZONES

For land use planning purposes, the noise exposure from aircraft is divided into three noise zones: Noise Zone 1 (DNL/CNEL less than 65) is an area of lesser impact where sound attenuation is not normally recommended; Noise Zone 2 (DNL/CNEL 65-74) is an area of moderate impact where some land use controls for noise-sensitive uses are desired; and Noise Zone 3 (DNL/CNEL 75 and above) is the area of highest potential noise impact and requires the greatest degree of compatible land use control. In addition to the noise zones, areas of concern may be defined where noise levels are not considered to be objectionable (less than 65 DNL/CNEL,), but some degree of land use controls are recommended (e.g., areas under ingress and egress routes to and from training ranges). Appendix B provides compatibility guidelines for noise zones.

Where specific local land uses are not adequately described in the standard guidance documents, refinement and interpretation of the basic data is encouraged, within the constraints of accepted land use planning practice and with prior coordination with CNO(N53)or CMC(LF).

SECTION V

5. THE RANGE AIR INSTALLATIONS COMPATIBLE USE ZONES (RAICUZ) PLAN

5.1. PLAN CONTENT

The RAICUZ study or RAICUZ study update can be prepared by the RAICUZ project manager with assistance from the area COE or by a contractor. The plan should include the following Sections and content:

5.1.1. Executive Summary

A concise summary of the findings, conclusions, and recommendations of the RAICUZ study will be included in the Executive Summary. This section will also include a brief discussion of any extenuating or mitigating requirements necessary for safe range operations.

5.1.2. Introduction

The Introduction includes a discussion of the RAICUZ program and provides the plan user with a familiarity of the operational aspects of the range. In particular, information relating to the RAICUZ program will include a general description of the purpose, scope, authority, objectives, program history, and roles and responsibilities for implementing the RAICUZ Program. Range specific information will include the mission that this range fulfills and how its role supports Fleet or Joint Service air-to-ground weapons delivery training or testing, a description of applicable NEPA documentation, a list of any assumptions that were utilized, software(s) and versions utilized to complete RCZ modeling, and changes in operations, aircraft or weapons that have or are proposed to occur that necessitate an update of the previous RAICUZ plan.

5.1.3. Range and Airspace Overview

This section includes a discussion and appropriate figures to depict the location of the range, associated special use airspace, military training routes, other local features of

concern that may affect range utilization such as nearby airfields, towers, or other man-made or natural features that may be of concern. Also include a description of the range itself, including features of importance, impact areas, targets, restrictions, types and numbers of annual, current, and future operations, users of the range, normal days and times of operations, range utilization, etc. Other pertinent information that may add value to the overall analysis and land planning should be included as well. This may include information relating to locations of past aircraft mishaps, locations of off-site ordnance drops, history of the area (especially if range boundaries have changed over time), use of lasers and footprints or safety considerations that they introduce, etc.

All airspace maters shall be coordinated through the appropriate Regional Airspace Coordinator (RAC) in accordance with reference (i).

5.1.4. Range Compatibility Zones (RCZs)

This section introduces what RCZs are and how they are developed. For updates to an existing RAICUZ study, this section should include a comparison of the new RCZs to the RCZs presented in the previous approved RAICUZ study with a description of the notable differences.

5.1.5. Noise Analysis

This section describes the methodology to develop noise contours and provide the aircraft and ordnance noise contours as appropriate. Contours presented should reflect operations into the future as best available data allows. Inclusion of the long-range prospective noise contours should minimize the requirement to update the plan as often. This is important as most state or local planning offices update their plans on long-term intervals and installations should strive to coordinate their planning with these agencies for best results. As necessary, prepare any single event noise analyses and develop the appropriate rationale to incorporate this information into the plan. Discuss alternatives considered to minimize off-site noise impacts if appropriate. Include a discussion of other local factors that may influence noise such as natural geographic conditions, local weather anomalies, or other items and discuss how these may influence range

operations. Provide a discussion of noise complaints that have been received associated with range operations. For updates to an existing RAICUZ plan, this section should include a comparison of new noise contours to contours presented in the previous approved RAICUZ plan with a description of the differences.

5.1.6. Alternative Noise Analysis

Alternatives analysis is normally presented when high noise impacts are outside the range boundary. The alternatives analysis should consider altering flight tracks, run-ins, target placement, operational parameters (altitude, dive angle, airspeed), without compromising flight safety or essential mission requirements in order to examine impacts of high noise.

5.1.7. Land Use Compatibility Analysis

This section must include a map and description of existing land uses in the study area, a discussion of land use compatibility guidelines for the RCZ and noise zones, a discussion of any incompatibilities of existing land uses, identification of local planning authorities and existing measures, tools, or regulations available to control zoning or land use. This section should also discuss the conclusions or recommendations from any existing planning studies, development plans, comprehensive plans, or any similar types of studies or plans that may be applicable.

5.1.8. Land Use Recommendations

This section should provide conclusions and recommendations to implement the RAICUZ program for the range. Recommendations for specific land use changes, zoning, residential disclosure zones and implementation of other strategies should be presented. These recommendations should include specific roles, responsibilities, and expectations for each stakeholder that has a role in implementation of the RAICUZ program.

5.1.9. Appendices

Appendices should include any pertinent information, such as existing land use agreements that do not fit into the

body of the plan, but add valuable information to users of the plan.

5.2. RAICUZ STUDY REVIEW AND APPROVAL

Once the RAICUZ study or update has been prepared, it must be reviewed and approved by CNO/CMC prior to any release of data contained therein outside of DOD and prior to implementation. Information developed, such as noise or RCZ footprints should not be shared with other agencies including local government agencies and planning offices until the new RAICUZ plan has been formally approved by either CNO or CMC, as appropriate. Once prepared, the installation must submit the plan requesting approval from CNO/N46 or CMC (LF) via the chain-of-command. For Navy RAICUZ studies, the plan must be reviewed and endorsed by the appropriate Navy Region, and the appropriate AICUZ/RAICUZ Center of Excellence, prior to CNO/N46 approval. For Marine Corps RAICUZ studies, plans must be endorsed by the appropriate COMMARFOR prior to approval by CMC (LF). Once the plan has been approved by CNO/CMC, a letter acknowledging approval of the plan shall be sent by CNO/CMC to the installation, range and training area command. The letter of approval shall be inserted in the front of the RAICUZ study prior to final printing and dissemination.

5.3. RAICUZ PLAN DISTRIBUTION

After CNO/CMC approval of the RAICUZ study, an appropriate number of copies of the plan should be printed and distributed. In addition, as required by reference (e),information developed in support of the preparation of the plan will be delivered on a CD or DVD including the word document, an Adobe Pdf version of the complete study and GIS geo-referenced data and formatted to meet Tri-Service Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) geo-database and Federal Geographic Data Committee (FGDC) metadata standards. The RCZ and noise footprints along with any land use layers will be incorporated into the activity, NAVFAC, Region, and/or CNI Geographic Information Systems. Because the intent of this plan is to implement a successful RAICUZ program with other Federal, state and local agencies, copies of the plan (printed or electronic) will be distributed to the appropriate agencies for information purposes.

SECTION VI

6. RAICUZ IMPLEMENTATION

6.1. GENERAL

Each Navy and Marine Corps air-to-ground range installation listed in Appendix C shall comply with the RAICUZ program. Program implementation includes developing current and future RCZs and current and prospective noise analysis for the range, partnering with appropriate federal, state, and local government agencies (working with these agencies for compatible land use near and around the ranges), considering operational alternatives as necessary, implementing a complaint response program in the surrounding communities, and developing strategies to protect the long term viability of the range while maintaining a high degree of public safety.

6.2. COMMUNITY IMPLEMENTATION

The Department of the Navy's RAICUZ policy is predicated on promoting compatibility between air-to-ground range installations, neighboring communities, States, other federal agencies, and Native American tribes responsible for land management in the vicinity of Navy and Marine Corps ranges. This policy recognizes the local governments' responsibility to protect public health, safety and welfare through controls like zoning ordinances, building codes, subdivision regulations, building permits, and disclosure statements. Local government implementation of RAICUZ land use recommendations, through their local land use planning and zoning processes, allow areas within and surrounding established RCZs and noise zones to develop as compatible uses. Successful implementation of the RAICUZ program depends on a close working relationship between the range installation and local community.

Pursuit of an acquisition or withdrawal of land near the range may be appropriate if local, regional or state initiatives to prevent incompatible development prove unsuccessful or where alternatives analysis indicates other alternatives are not practicable to prevent encroachment. The activity should on a regular basis inform local governments, state governments, Native American Indian tribes other federal agencies, citizens groups, and the general public on: (a) the requirements of

military aviation; (b) range operations; (c) the efforts underway and planned to reduce potential off range weapons impacts and noise; and (d) the DON's recommendation on specific land use issues.

Range installation representatives, primarily commanders and their range manager or if they have a Community Plans & Liaison Officer (CP&LO), should meet with and make presentations to local governments, particularly the planning and zoning agencies about the RAICUZ plan. To most effectively communicate DON requirements and have open discussions with various agencies, tribes, and community organizations, it is recommended that each installation commander take actions to create a Land Use Planning Partnering Team. Partnering teams should meet on a regular basis to discuss current topics of concern or interest and present information to other team members on foreseeable actions that may be occurring within the affected areas.

Although the emphasis of the RAICUZ implementation effort must be on areas within the RAICUZ footprint (noise zones and RCZs), the range installation can comment on land use issues outside the footprint, which might impact on it (e.g., large scale developments near the RAICUZ footprint), or transportation system or utility corridor developments which could make the RAICUZ area more desirable for development. The range commanding officer should convey to the local land use agencies that the range is a major land use in the local community and merits special consideration and protection. Development which occurs near the RCZs and noise zones could prevent mission changes or expansion in the future. Therefore, commanders through their staffs should monitor proposed development beyond the RCZs and noise zones, and, if needed, to present those concerns in appropriate local forums. CNI, CMC (LF) or COE on the East and West coasts can provide assistance as needed.

6.3. DOCUMENTATION OF LOCAL EFFORTS

Records of important discussions, negotiations, testimony, etc., with and before local officials, boards, etc., should be maintained by the local command for at least seven years. This will ensure that documentation is available to indicate reasonable and prudent efforts were made to preclude incompatible land use through cooperation with local and state government officials and other federal agencies as appropriate, and that recourse to such actions has been exhausted.

SECTION VII

7. REAL PROPERTY GUIDANCE

7.1. ACQUISITION POLICY

When threats to operational integrity from incompatible development (encroachment) are anticipated, and when local communities are unwilling or unable to take the initiative in combating the threat via their own authority, consideration can be given to pursue land acquisition or withdrawal of public lands when appropriate. Documentation of community unwillingness or inability will be required to support acquisition projects. Where the mission of the air-to-ground range is imminently threatened, acquisition of fee title or restrictive easements over the impacted lands in any RCZ or noise zone may be appropriate to maintain operational integrity.

7.2. ENCROACHMENT INDICATORS

The importance of the air-to-ground range having sensitivity to long-range encroachment indicators cannot be overemphasized. Local community capital improvement plans and long-range land-use plans provide clues far in advance of actual encroachment actions. These plans generally address land areas far greater than the RAICUZ and must be evaluated to determine their influence on the RCZs and noise zones either directly or indirectly.

7.3. REAL PROPERTY UTILIZATION SURVEY INTERFACE

Executive Order 12512 calls for continual review of Federal real property holdings and the conduct of surveys in order to determine the level of their utilization. Properties found to be excess to the requirements of the holding agency are reported for disposal. The RAICUZ provides protection to ranges, but increased pressure to excess property can dilute that protection. To avoid the forced disposal of lands required for the protection of the range from encroachment, ranges will ensure that required lands or easements are fully justified. Where disposal is directed, those rights and interests required for the protection of the future operational integrity of the

installation through restrictions to ensure compatible land use will be retained.

Particular attention must be paid to property located outside of RCZ-II - area of armed over flight, which if excessed, would attract uses that would induce incompatible developments within the RAICUZ area (e.g., water, sewer, or highway development). Additionally, the prior history of RAICUZ areas and potential growth should be fully considered. Once property rights are relinquished, they are not easily, if ever, regained. The dynamic nature of Navy and Marine Corps operational needs must be evaluated in encroachment protection decisions.

7.4. GUIDELINES FOR ACQUISITION/RETENTION OF REAL ESTATE WITHIN RAICUZ

This instruction shall not be used as the sole justification for either the acquisition or the retention of owned interests beyond the minimum required to protect the Government. Detailed procedural requirements related to the Navy's real estate program are set forth in NAVFAC P-73 (Real Estate Procedural manual) (NOTAL), or as implemented within the Marine Corps by MCO P11000.14 (NOTAL).

7.5. REAL ESTATE INTERESTS TO BE CONSIDERED FOR RAICUZ

When it is necessary for the Department of the Navy to acquire interests in land, a careful assessment must be made of the type of interest to be acquired either in the form of restricted use easements or in fee simple. In deciding what interest to acquire, the following factors are examined: The minimum interest necessary to protect the DON; when the property is needed; available funds; type of acquisition (e.g., fee v. restrictive easements); and environmental considerations (e.g., contaminated property, NEPA).

Real property interest to be considered for acquisition include but are not limited to; making low and frequent over flights, high aircraft noise, prohibiting light emissions that interfere with pilot vision, prohibiting electromagnetic and radio frequency emissions that interfere with aircraft communication or navigation equipment, control of the height of buildings, structures, towers, trees or other obstructions that interfere with aircraft operations, and access by government representatives, prohibiting entry of non-authorized persons.

7.6. ENCROACHMENT PARTNERING

Encroachment Partnering (EP) is a specific land acquisition authority (10 USC 2684a, as amended) that can be used to reduce or eliminate current encroachment or prevent future restrictions on military operations. The statute authorizes the military departments to execute agreements with public and private partners to acquire real property interests from willing sellers adjacent to or near military installations (including ranges) to; (1) to acquire buffer zones to prevent incompatible land use from impacting military missions, and (2) to preserve off-base habitat to relieve current or avoid future environmental restrictions on operations. This statute authorizes the Military Departments to enter into "encroachment partnering" agreements with states, political subdivisions thereof, and private conservation entities. Private conservators specialize in identifying and acquiring private land for conservation purposes and can respond quicker than the DON to purchase opportunities. Both public and private conservators offer valuable resources to leverage DON's encroachment prevention efforts. The Navy's Encroachment Partnering program is outlined in OPNAVINST 11010.40, Shore Installation Encroachment Management Program, dated 27 March 2007. The Installation Commanders' Guide to Encroachment Partnering dated 10 Feb 2006 provides Marine Corps installation commanders and their staffs with the information they need to help plan and execute successful encroachment partnering projects.

7.7. REAL PROPERTY MANAGEMENT

Regional Commanders/area coordinators Range Installations Commanding Officers and Marine Corps Base and Station Commanding Officers shall be responsible for the administration, use, and management of real property assets as related to the readiness and effectiveness of Department of the Navy ranges. This responsibility is particularly relevant to documentation, oversight, and enforcement of Navy and Marine Corps interests in land outside the installation boundary as encroachment protection, whether that land is acquired in fee, easement, or through local zoning actions.

Installation Commanders shall develop a real property management plan to establish standard operating procedures to maintain Navy and Marine Corps control of acquired property interests. This plan should also include updated base mapping incorporating RAICUZ areas containing land use restrictions.

APPENDIX A

SUGGESTED LAND USE COMPATIBILITY IN RANGE COMPATIBILITY ZONES

LAND USE	RCZ I	RCZ II	RCZ III
RESIDENTIAL - SINGLE FAMILY, DUPLEX, MOBILE HOMES	N	N	Y[3]
RESIDENTIAL - MULTIPLE FAMILY HOMES	N	N	N
TRANSIENT LODGING	N	N	N
SCHOOL CLASSROOMS, LIBRARIES, CHURCHES	N	N	N
HOSPITALS	N	N	N
NURSING HOME	N	N	N
AUDITORIUMS, CONCERT HALLS	N	N	N
OFFICE BUILDINGS - PERSONAL, BUSINESS, PROFESSIONAL	N	N	Y[2]
COMMERCIAL, RETAIL	N	N	Y[2]
MANUFACTURING	N	N	Y[2]
UTILITIES	N	N	Y
PLAYGROUNDS, NEIGHBORHOOD PARKS	N	N	Y[2]
GOLF COURSES, RIDING STABLES, WATER RECREATION, CEMETERIES	N	Y[4]	Y[2]
OUTDOOR SPECTATOR SPORTS	N	N	Y[2]
INDUSTRIAL, WAREHOUSE, SUPPLIES	N	N	Y
LIVESTOCK, FARMING, ANIMAL BREEDING	N	Y[1]	Y[2]
AGRICULTURAL (EXCEPT LIVESTOCK), MINING, FISHING	N	Y[1]	Y
RECREATIONAL, WILDERNESS AREAS	N	Y[2]	Y[2]

NOTES:

1. Range Compatible Use Zone-II is an area of armed overflight. Land uses which have the potential to attract congregations of people are not compatible. For scored targets, no development within 500 feet either side of the run-in line centerline. For tactical targets, further analysis is required. Factors to be considered: labor intensity, structural coverage.
2. Incompatible when the training mission requires low altitude overflight (less than 500 ft).
3. Suggested maximum density in RCZ-III is no more than 1-2 dwelling units per acre.
4. Clubhouses, chapels and other facilities where people congregate are not compatible in RCZ-III.

APPENDIX B

SUGGESTED LAND USE COMPATIBILITY IN NOISE ZONES

LAND USE	Noise Zone 1		Noise Zone 2		Noise Zone 3		
	< 55	55-64	65-69	70-74	75-79	80-84	85+
RESIDENTIAL - SINGLE FAMILY, DUPLEX, MOBILE HOMES	Y	Y[1]	N[1]	N[1]	N	N	N
RESIDENTIAL - MULTIPLE FAMILY HOMES	Y	Y[1]	N[1]	N[1]	N	N	N
TRANSIENT LODGING	Y	Y[1]	N[1]	N[1]	N	N	N
SCHOOL CLASSROOMS, LIBRARIES, CHURCHES	Y	Y[1]	25	30	N	N	N
HOSPITALS	Y	Y[1]	25	30	N	N	N
NURSING HOMES	Y	Y	N[1]	N[1]	N	N	N
AUDITORIUMS, CONCERT HALLS	Y	Y[1]	25	30	N	N	N
OFFICE BUILDINGS - PERSONAL, BUSINESS, PROFESSIONAL	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
COMMERCIAL, RETAIL	Y	Y[1]	Y	25	30	N	N
MANUFACTURING	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
UTILITIES	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
PLAYGROUNDS, NEIGHBORHOOD PARKS	Y	Y[1]	Y[1]	Y[1]	N	N	N
GOLFCOURSES, RIDING STABLES, WATER RECREATION, CEMETARIES	Y	Y[1]	Y[1]	25	30	N	N
OUTDOOR SPECTATOR SPORTS	Y	Y[1]	Y[5]	Y[5]	N	N	N
INDUSTRIAL, WAREHOUSE, SUPPLIES	Y	Y	Y	Y[2]	Y[3]	Y[4]	N
LIVESTOCK, FARMING, ANIMAL BREEDING	Y	Y	Y[6]	Y[7]	N	N	N
AGRICULTURAL (EXCEPT LIVESTOCK), MINING, FISHING	Y	Y	Y	Y	Y	Y	Y
RECREATIONAL, WILDERNESS AREAS	Y	Y[1]	Y[1]	Y[1]	N	N	N

NOTES:

Y (Yes)	Land Use and related structure compatible withot restrictions.
N (NO)	Land Use and related structures are not compatible and should be prohibited.
Y^X (Yes with Restrictions)	The land use and related structures are generaly compatible. However, see note(s) indicated by the superscript.

NOTES FOR APPENDIX B - SUGGESTED LAND USE COMPATIBILITY IN NOISE ZONES

1.
a) Although local conditions regarding the need for housing may require residential use in these Zones, residential use is discouraged in DNL 65-69 and strongly discouraged in DNL 70-74. The absence of viable alternative development options should be determined and an evaluation should be conducted locally prior to local approvals indicating that a demonstrated community need for the residential use would not be met if development were prohibited in these Zones.

b) Where the community determines that these uses must be allowed, measures to achieve and outdoor to indoor Noise Level Reduction (NLR) of at least 25 dB in DNL 65-69 and NLR of 30 dB in DNL 70-74 should be incorporated into building codes and be in individual approvals; for transient housing a NLR of at least 35 dB should be incorporated in DNL 75-79.

c) Normal permanent construction can be expected to provide a NLR of 20 dB, thus the reduction requirements are often stated as 5, 10 or 15 dB over standard construction and normally assume mechanical ventilation, upgraded Sound Transmission Class (STC) ratings in windows and doors and closed windows year round. Additional OPNAVINST 11010.36B 19 Dec 2002 consideration should be given to modifying NLR levels based on peak noise levels or vibrations.

d) NLR criteria will not eliminate outdoor noise problems.
However, building location and site planning, design and use of berms and barriers can help mitigate outdoor noise exposure NLR particularly from ground level sources. Measures that reduce noise at a site should be used wherever practical in preference to measures that only protect interior spaces.

2. Measures to achieve NLR of 25 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

3. Measures to achieve NLR of 30 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas or where the normal noise level is low.

4. Measures to achieve NLR of 35 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.

APPENDIX C

NAVY MARINE CORPS RANGES REQUIRING RAICUZ STUDIES

CINCPACFLT

WHIDBEY ISLAND COMPLEX:

R-5701/5706 BOARDMAN

FALLON COMPLEX:

R-4803 B-16

R-4804 B-17

R-4810 B-19

R-4802/R-4813 B-20

BOB STUMP RANGE COMPLEX:

R-2512 INKEY BARLEY/KITTY BAGGAGE

R-2510 SHADE TREE/LOOM LOBBY

CHINA LAKE COMPLEX

R-2524 ELECTRONIC COMBAT RANGE (echo)

NAVAIR

R-4002 BLOODSWORTH ISLAND

CFFC

VIRGINIA CAPES COMPLEX:

R-5313 STUMPY POINT RANGE

R-5314 NAVY DARE COUNTY RANGE

JACKSONVILLE COMPLEX:

R-2906 RODMAN TARGET

R-2907 LAKE GEORGE COMPLEX TARGETS

R-2910 PINECASTLE COMPLEX TARGETS

NETC

R-6312 MCMULLEN COUNTY RANGE

R-4404 NOXUBEE COUNTY RANGE

COMMANDANT MARINE CORPS

MCB TWENTY-NINE PALMS (R-2501)

MCB CAMP PENDLETON (R2503)

MCAS YUMA:
CHOCOLATE MOUNTAINS AERIAL GUNNERY RANGE (R-2507N/S)

BARRY M. GOLDWATER RANGE (R-2301W)

MCB QUANTICO (R-6608)

MCB CAMP LEJEUNE (R-5303, R-5304, R-5306D, R-5306E)

MCAS CHERRY POINT (R-5306A)

MCAS BEAUFORT (TOWNSEND RANGE) (R-3307)

Appendix C

Land Use Definitions

Land Use	Definition
Agriculture	Open spaces used for agricultural uses, farms, barns, etc.
Commercial	Retail, food stores, hotels and motels, professional and medical offices, sales, service establishments, and other businesses uses
Developed Area/Mixed Use	Areas with a combination of land use, usually residential and commercial
Industrial	Boat building facilities, contractor's offices, warehouses, manufacturing, concrete plants, wholesale and distribution facilities
Managed Lands	Wilderness areas and wildlife refuge areas
Military Property	Military owned or leased property
Multi-Family Residential	Duplexes, multifamily structures
Public Use/Institutional	Churches and religious facilities, schools, cemeteries, public and private utilities, fire stations, community buildings, improved federal, state, or county property
Recreation/Parks and Open Space	Recreation areas, parks, camp sites, and RV parks
Rural Residential	Single-family homes in rural areas, usually spaced apart by significant distances
Single-Family Residential	Single-family homes
Transportation/Roadways	Transportation corridors
Undeveloped (Federally Managed Lands)	Federally-owned vacant land
Undeveloped (Unmanaged Lands)	Privately-owned vacant land
Utility	Private/public utilities, service areas
Water	Open waters