6 NOISE RELATED LAND USE PLANNING, POLICY, AND SUPPLEMENTAL ANALYSIS

6.1 INTRODUCTION

Implementation of the ICUZ program is intended to be a joint effort between UTARNG and the adjacent communities. The role of UTARNG is to minimize operational noise impacts on the surrounding local communities. The role of communities is to ensure that development in the surrounding area is compatible with accepted planning, zoning, and development principles and practices to protect the UTARNG mission.

Achieving land use compatibility requires both flexibility and creativity from land use planners, installation commanders, and the local communities. The previous sections of this document detailed the environmental noise impacts. The following section summarizes several land use planning organizations, programs, and tools which are available to both the installation and local communities.

6.2 OLDCC COMPATIBLE USE PROGRAM

The Office of Local Defense Community Cooperation (OLDCC) (formerly the Office of Economic Adjustments (OEA)) Compatible Use Program (formerly the Joint Land Use Study or JLUS) is a collaborative land use planning effort involving the military installation and adjacent local governments that evaluate the planning rationale necessary to support and encourage compatible development of land surrounding the installation. It is a means for the installation and local governments to develop a 'Compatible Use Plan' that effectively addresses the long-term land use needs of the surrounding communities, yet still provides the military with the mission flexibility it needs to meet its training doctrine.

The Compatible Use Program is sponsored by the OLDCC (DODI, 2004), which provides technical and financial assistance to the planning agencies for developing plans that are consistent, when economically feasible, with the noise, accident potential, and safety concerns from an installation's training and operations. The scope of the program is divided into three major tasks:

1. Impact Analysis. Impact analysis provides an in-depth review of existing and proposed land use patterns; drainage (as it effects land use designations); mission encroachment; transportation improvements, existing and proposed routes; noise/vibration; and other compatibility issues deemed pertinent to the partners.
2. Land Use and Mission Compatibility Plan. Examines the above findings to identify conflicts in land use and provide alternative land use solutions; to project the impact on growth potential for adjacent areas; and to project the impact of military missions on the surrounding jurisdictions.
3. Implementation. Lists a series of actions and/or recommendations for adoption by local jurisdictions to resolve land use conflicts and move toward a compatible land use plan for the installation, the adjacent counties and municipalities, and the communities therein.

In October 2022, the West Traverse Mountain (WTM) Compatibility Area Study (CAS) was completed which expanded upon the 2012 Camp Williams JLUS[7],[8]. The WTM CAS is a collaborative planning effort between Camp Williams and the Cities of Lehi, Saratoga Springs, Eagle Mountain, Herriman, and Bluffdale, the Town of Cedar Fort, as well as Salt Lake County, Utah County, and other local and regional stakeholders. The purpose of the Compatibility Area Study is to encourage cooperative land use planning between Camp Williams and the surrounding communities to ensure future growth and development are compatible with military training operations and vice versa.

6.2.1 WTM COMPATIBILITY AREA STUDY RECOMMENDATIONS

Multiple issues were identified and recommendations made in the 2012 JLUS were carried over into the 2022 WTM CAS. The goal of the WTM Study was to address community/military collaboration, land use, noise, and public awareness (Table 6-1). As shown in Table 6-1 there has been significant progress in Collaboration, Land Use, and Noise.

6.2.1.1 LAND USE RECOMMENDATIONS COMPLETED

In March 2023, the Utah State Legislature passed a bill which addresses compatible planning around military installations.[9] Utah Code Section **10-9a-537** (**Land Use Compatibility With Military Use**) requires a municipality within 5,000 feet of a boundary of military land to develop and maintain a compatible use plan to ensure permitted uses and conditional uses are compatible with the military operations. The statute requires the municipality or county to notify the installation of a land use application relevant to military land and requires the installation to evaluate the proposed land use for compatibility. Additionally, a new website (westtraverse@utah.gov) which will provide educational information is projected to be operational by the end of 2023. An additional recommendation included "Update City and County General Plans to Include Military Compatibility Policies That Support the Military Compatibility Area Overlay District and Promote Compatible Land Uses". The purpose of this recommendation is to identify development character consistent with the goals of the JLUS program that can be easily adopted into existing local regulations. As of March 2023, the Cities of Herriman and Lehi and Utah County have incorporated this JLUS recommendation into their planning documents and/or zoning polices.

- **Herriman:** Addressed Camp Williams in the 2025 General Plan Amendment (revised and adopted in July 2022) via the Military Camp Overlay. In the City Zoning Map, the area north of Camp Williams is zoned large-lot forest recreation to reduce potential conflicts and encourage a long-term, compatible relationship with Camp Williams. Development within this area should focus on park, recreation, trails, and similar open space uses, with buildings and permanent structures allowed according to agreements to be established in the JLUS. Additionally, the National Guard Bureau and Herriman City

[7] https://www.westtraversecompatibilitystudy.com/
[8] https://www.herriman.org/uploads/files/1251/campwilliamsjlus.pdf
[9] https://le.utah.gov/xcode/Title10/Chapter9a/C10-9a_1800010118000101.pdf

have entered into a Special Military Cooperative Agreement to establish the terms and conditions applicable to the contribution of federal funds to assist Herriman City's acquisition of long-term interests in, or title to parcels of, land in the vicinity of (or ecologically related to) Camp Williams.

- **Lehi:** The January 2022 plan includes coordination with Camp Williams ensuring compatibility of new development with the current and planned mission and operations of the Camp. The Camp Williams Joint Land Use Study as a guide for development types located adjacent to the facility. Land adjacent to Camp Williams is zoned Planned Community (PC) and Transitional Holdings-5 (TH-5). The PC district allows the City to establish land use and site-specific provisions to address unique areas within the community that warrant a comprehensive set of specific land use policies and standards. TH-5 is designated primarily for the annexation of land where no water is dedicated upon annexation and where no city culinary water or pressurized irrigation water services will be provided. Characteristic of this district is a continuation of uses and services existing at the time of annexation.

- **Utah County:** As identified in the 2014 Utah County General Plan, the unincorporated areas of the county within the WTM CAS are primarily agricultural in nature, with allowed uses of mining and grazing, and agricultural residential. The county furthermore identifies the Camp Williams Military Compatibility Overlay Area, encouraging uses consistent with military operations per the 2012 JLUS.

6.2.1.2 NOISE RECOMMENDATIONS COMPLETED

Camp Williams has increased public notifications of its training as well as limits training hours between 2300-0600 (11pm and 6 am), whenever feasible.

This ICUZ Study will fulfill the recommendation of an updated acoustic study. The supplemental noise analysis should be used to develop the Impulse Noise Military Compatibility Area (MCA) (See Sections 6.5 and 6.6). An MCA is a designated geographic area where military operations may impact local communities, and conversely, where local activities may affect the military's ability to carry out its training mission.

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Table 6-1. WTM Compatibility Area Study Recommendations

AREA	ISSUE	RECOMMENDATION	RESPONSIBILITY	STATUS
Collaboration	Lack Of Coordination Between Camp Williams And Adjacent Jurisdictions / Stakeholders To Address Mutual Issues. No formal coordination exists between the surrounding jurisdictions and Camp Williams in order to proactively address land use, transportation, and other infrastructure compatibility issues.	Invite A Camp Williams Representative To Serve As An Ex-Officio Member Of The Jurisdiction Planning Commission.	Local Communities	Completed
		Foster Enhanced Public Awareness Through Accurate Mapping. Provide all of the surrounding local, county, regional, and state governments with an accurate geographic information system (GIS) data layer of the installation boundaries for inclusion on all land use, transportation, park and recreation, public facilities, and other related planning efforts.	Local Communities	Completed
		Incorporate Camp Williams As One Of The Agencies That Review Pre-Development Applications / Proposals.	Local Communities	Completed
	Absence Of State Legislation Addressing Compatible Planning Around Military Installations Encourages Unregulated/Uncontrolled Development Near Military Installations.	Military Compatible Planning Legislation. Utah State Land Use Planning Laws do not consider the impacts of military training operations on the general public, nor do they account for the community growth impacts and activities on military mission readiness and training. Develop legislation that requires local jurisdictions within a defined distance from military installations to establish formal notice / comment process on submitted development plans, impacts associated with general / comprehensive plans, and their compatibility with the installation's mission.	Local Communities - State Legislator	Completed
Land Use	Incompatible Future Land Use Designations.	Create Zoning Overlay District Titled Military Compatibility Area Overlay District (MCAOD), Comprised Of -Land Use Military Compatibility Areas (MCA), Impulse Noise MCA, Aviation Safety MCA, and a Light MCA.	Local Communities	In Progress
		Update City And County General Plans To Include Military Compatibility Policies That Support The MCAOD And Promote Compatible Land Uses.	Local Communities	In Progress
		Camp Williams Should Develop An Installation Master Plan Illustrating Existing Land Uses And Any Future Land Use Changes.	Camp Williams - UTARNG	Completed
	Development Pressures Within Close Proximity To Camp Williams.	Update Jurisdiction Zoning Codes.	Local Communities	In Progress. Ongoing
		Evaluate The Potential For A Conservation Easement Program. Consider A Multi-Jurisdictional Agriculture Protection Overlay (APO) Zone.	Local Communities	Completed
		Coordinate School District Master Plans With Camp Williams.	Local Communities	Completed
		Conduct Proactive Information Program With Agencies That Manage Land Uses. Inform key sensitive users (i.e., school districts, religious institutions, contractors, etc.) relative to location, site design, and construction standards within the Impulse Noise MCA subzone.	Local Communities	In Progress
		Require Real Estate Disclosures.	Local Communities	In Progress. Ongoing
Noise	Camp Williams receives noise complaints when significant live-fire or artillery-fire training schedules extend into evening hours and / or due to weather conditions.	Increase Public Notification Of High Activity Night Training Schedules. Review and enhance existing website, newspaper, television, and press conference protocols to increase public knowledge in advance of major training / live-fire exercises.	Camp Williams - UTARNG	Ongoing
		Enhance Public Education Of The Camp Williams Mission. Develop fact sheets or brochures which outline the mission and the community benefits that accrue from the training activities that take place on Camp Williams. Public education materials should be made available on the Camp Williams website.	Camp Williams - UTARNG	In Progress
	Live Fire, Artillery Fire, And Munitions Demolition On-Base Generates Off-Base Noise And Vibration.	Update the Intensity And Frequency Of Military Generated Noise in the data collected. Conduct a comprehensive acoustic and vibration study of training / firing / maneuver / detonation activities to model current noise contours and identify areas off installation impacted by noise levels in excess of Army guidelines.	Camp Williams - UTARNG	In Progress
	Military Rotary-Wing Aircraft (Helicopters) Generates Noise And Vibration Impacts Off-Base.	Enforce And Inform About The "Fly Neighbor- Friendly" Protocol. Camp Williams should continue to follow the policy to "fly neighbor-friendly," routing their rotary-wing routes over rural areas.	Camp Williams - UTARNG	Ongoing
	Ground Training Missions From The IED Defeat Course Generate Off-Base Noise And Vibration Impacts.	Minimize Noise Disturbance On The Local Community. Schedule artillery, live-fire, helicopter flights, and IED course use between the hours of 6 am and 11 pm, whenever feasible. Issue public service announcements and / or e-mail announcements in advance when training will occur between 11 pm and 6 am.	Camp Williams - UTARNG	Ongoing

6.2.2 FUTURE RECOMMENDATIONS TO ADDRESS

Of the remaining WTS CAS recommendations, efforts should focus on the following two strategies: developing the Military Compatibility Area Overlay District (MCAOD) and real estate disclosure.

Military Compatibility Area Overlay District (MCAOD)

Develop and publish the MCAOD for Camp Williams. The MCAOD in conjunction with the individual MCAs (Impulse Noise, Light, Aviation Safety, and Land Use) are used to define the areas where the WTM CAS/JLUS strategies are to be applied. This technique ensures the strategies are applied to the appropriate areas, and that locations deemed to not be subject to a specific compatibility issue are not adversely impacted by regulations that are not appropriate for their location or circumstance. See Section 6.6 for the suggested Impulse Noise MCA.

Real Estate Disclosures

Continue to pursue real estate disclosure either at the local or state level. Real estate disclosure would advise buyers of their proximity to a military installation and that operations conducted may have an impact on the community such as noise and/or vibration. Disclosure may also include if the subject parcel is in a noise zone or accident potential zone, or both, if so, designated on the official zoning map by the locality in which the property is located. Disclosure of proximity to a military installation is also recommended to be incorporated into and made part of residential lease agreements.

6.3 READINESS AND ENVIRONMENTAL PROTECTION INTEGRATION

The DoD's Readiness and Environmental Protection Integration Program (REPI) is administered by the Office of the Secretary of Defense (OSD) and serves to combat encroachment around military installations that can limit or restrict training, testing, and operations. A key component of the REPI Program is the use of buffer partnerships among the Military Services, private conservation groups, and state and local governments, authorized by Congress at 10 U.S.C. § 2684a. These win-win partnerships share the cost of acquisition of easements or other interests in land from willing sellers to preserve compatible land uses and natural habitats near installations and ranges that helps sustain critical, at-risk military mission capabilities. In addition, REPI gives base commanders supportive tools through education, innovative strategies and pilot projects, and transfer of case studies addressing regulatory barriers to help increase their flexibility in meeting mission requirements.

OSD provides overarching REPI Program policy, guidance, and funding support for Service efforts to protect missions and installations. Within this overall framework, each Service has its own approach to utilizing the REPI Program that works best for that Service (www.repi.mil). The Army implements the REPI authority through its own specific program titled the Army Compatible Use Buffer (ACUB) program. The ACUB program is designed to limit the effects of

encroachment by partnering with private landowners and organizations to establish conservation easements or buffer areas around Army installations.

The Camp Williams ACUB was approved in FY2015. There are multiple ACUB partners including: Herriman City, Herriman Trails Committee, Rocky Mountain Power, Salt Lake County Parks and Recreation, State of Utah, The Conservation Fund, Utah Division of Natural Resources, Utah Open Lands, Vivent Solar, Inc., and West Traverse Community Partnership. These partnerships are beneficial in several ways:

- Manages development adjacent to installation.
- Protects effective training space up to the installation boundary.
- Averts training restrictions and alleviates safety concerns.
- Mitigates against noise complaints.
- Does not remove lands from tax base.
- Maintains local agricultural and wildlife habitat lands.
- Retains rights to ownership and management of land.

Figure 6-1 depicts ACUB parcels under easement and the Priority Areas surrounding Camp Williams[10]. As of December 2022, 3,117 acres of land have been preserved (under easement). An additional 1,828 acres are considered compatible because of local community zoning protection or landowner and associated use (utility company, Department of Transportation). The ACUB areas and the updated noise contours are in close agreement. Should the opportunity arise to expand the ACUB priority areas, the Arnold Hollow area (Step Mountain Road) should be considered.

[10] https://www.repi.mil/Portals/44/Documents/State_Packages/Utah_ALLFacts.pdf

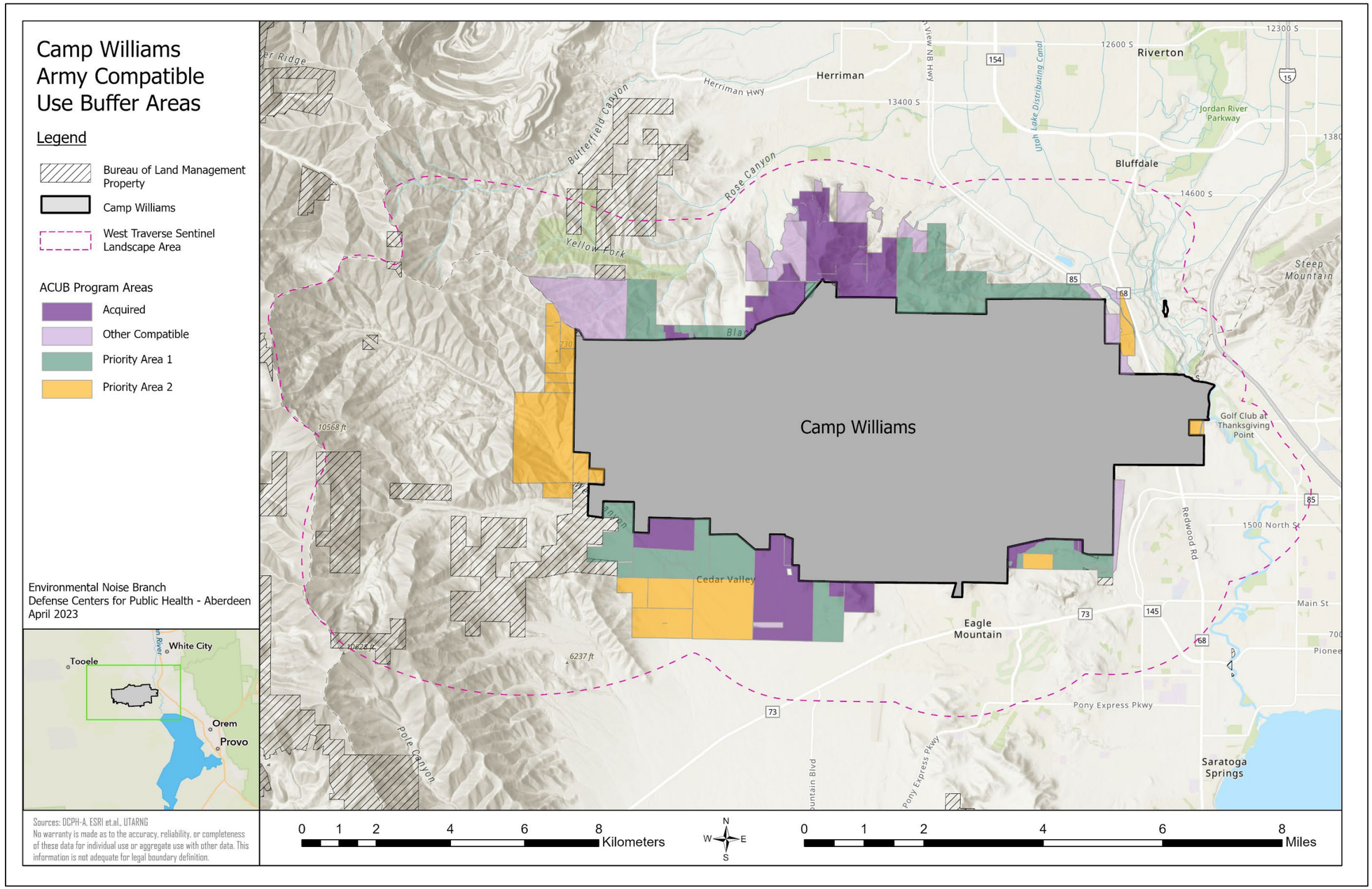


Figure 6-1. Camp Williams ACUB Easements and Priority Areas

6.4 WEST TRAVERSE SENTINEL LANDSCAPE

Utah Code Section § 39A-8-101 West Traverse Sentinel Landscape (WTSL) Act directly aims to maintain the mission of the base by creating the WTSL Coordinating Committee and by facilitating a buffer zone around Camp Williams[11]. The purpose of this act is to: (1) identify lands adjacent to Camp Williams that are important to the nation's defense mission; (2) preserve and enhance the relationship between adjacent landowners and Camp Williams; and (3) create incentives to encourage adjacent landowners to adopt land management practices consistent with Camp Williams's military mission.

As part of the Landscape Act, lands acquired through the ACUB program are incorporated in the Sentinel Landscape. Under the ACUB program 3,077 acres have an easement to act as a buffer between civilian land use and military uses as well as provide areas for wildlife preservation. The City of Herriman has already built eight miles of trail on the conserved land under the ACUB program. As of 2020, the WTSL funding coordinating committee has identified 11,314 acres for participation in the program.

Figure 6-1 depicts the WTSL area around Camp Williams that is part of the land conservation efforts. The map shows areas where land/easement transactions have been completed as well as priority areas for future efforts.

[11] https://le.utah.gov/xcode/Title39A/Chapter8/C39A-8_2022050420220504.pdf

6.5 SECONDARY ASSESSMENT - LARGE CALIBER AND DEMOLITION NOISE

As discussed previously, received sound level depends greatly on atmospheric propagation conditions (Schomer and Luz 1978). Sound propagation within the atmosphere is determined primarily by temperature and wind velocity (speed and direction), with second-order dependence on relative humidity and barometric pressure. These parameters vary with time and height above the ground, particularly near the earth's surface in what is termed the boundary layer, and at higher altitudes at an inversion layer. The resultant variation of sound propagation velocity with altitude causes sound to refract in much the same way as a lens refracts light. Atmospheric turbulence has been known to create measured variations as much as 30 dB during time periods of only a few minutes (Pater 1981). To put these variations into perspective, a 10 dB increase represents roughly a doubling in subjective loudness for many types of noise (Crocker 1998). At Camp Williams, temperature inversions and downwind conditions can work to increase sound levels in neighborhoods normally shielded by high ridges or mountains, such as those along the northern boundary. Conversely, temperature lapses and upwind conditions can further reduce sound levels in neighborhoods protected by the same topographic feature.

At the request of the UTARNG, a secondary assessment of large caliber and demolition operations was completed. This analysis reflects a conservative approach, where the terrain algorithm was omitted from the computer model to show potential areas that may experience higher noise levels than those presented in Section 4.3.3.2. These additional noise contours are useful in advising nearby residences of their potential noise exposure. It should be noted that the noise levels depicted in this conservative analysis (unfavorable weather conditions) would not occur frequently. Based on the modeling parameters, the likelihood of reaching the levels shown (PK15) would occur in 150 out of every 1,000 events.

The secondary assessment (conservative) Peak levels are for informative purposes and not intended for National Environmental Policy Act documentation. The Impulse Noise MCA identified in the Camp Williams JLUS was created from a single event Peak contour which was modeled without the terrain algorithm.

Secondary Assessment (Conservative) Routine Training Activity

Without terrain calculations and under unfavorable weather Peak levels above 115 dB extend beyond the boundary in most directions (Figure 6-2 and Tables 6-2 through 6-7). Land use within the 115 to 130 dB Peak area includes portions of the Cities of Bluffdale, Eagle Mountain, Lehi, Saratoga Springs, and Herriman. Peak sound levels above 130 dB extend beyond the southern boundary in two small areas, encompassing multiple residences in the Hidden Hills Road and Patriot Drive areas abutting the boundary. These noise contours, like others in this study, establish the most common or concentrated areas of noise generated by the various training and operational activities at Camp Williams. On occasion, noise from a particular event may extend into an area not covered by a depicted noise contour.

Figures 6-3 through 6-5 depict detailed view of the Peak sound levels in the more populated areas adjacent to Camp Williams (Bluffdale, Eagle Mountain, Herriman). Residences in these neighborhoods would be expected to occasionally experience high noise levels from artillery firing activity, particularly given the right meteorological conditions.

Table 6-2. Secondary Assessment (Conservative) Demolition and Large Caliber Weapons Single Event Peak Levels without Terrain – Northern Boundary

	Unfavorable Weather Conditions		
	Distance		
dB Peak	Kilometer[1]	Mile[2]	Affected Land Use
115 – 130	6.2	3.9	City of Herriman & Bluffdale[3]
> 130	1	0.6	Residential (low density – Step Mountain Rd) Undeveloped (Scrub Land)

Legend: dB = decibels
Notes:
[1] Distance listed reflects maximum extension beyond the boundary.
[2] Mileage conversion is rounded for simplicity.
[3] Land use includes medium to high density residential, seven education facilities and multiple religious facilities.

Table 6-3. Secondary Assessment (Conservative) Demolition and Large Caliber Weapons Single Event Peak Levels without Terrain – Northeastern Boundary (Highway 68)

	Unfavorable Weather Conditions		
	Distance		
dB Peak	Kilometer[1]	Mile[2]	Affected Land Use
115 – 130	1	0.6	Residential (medium density)
> 130	0	0	n/a

Legend: dB = decibels
Notes:
[1] Distance listed reflects maximum extension beyond the boundary.
[2] Mileage conversion is rounded for simplicity.

Table 6-4. Secondary Assessment (Conservative) Demolition and Large Caliber Weapons Single Event Peak Levels without Terrain – Southeastern Boundary (Mountain View Corridor)

	Unfavorable Weather Conditions		
	Distance		
dB Peak	Kilometer[1]	Mile[2]	Affected Land Use
115 – 130	1.5	0.9	Undeveloped (Scrub Land)[3]
> 130	0	0	n/a

Legend: dB = decibels, n/a = not applicable
Notes:
[1] Distance listed reflects maximum extension beyond the boundary.
[2] Mileage conversion is rounded for simplicity.
[3] Mountain View Corridor area is undergoing continuing development which could result in residential development in the 115-130 dB area.

Table 6-5. Secondary Assessment (Conservative) Demolition and Large Caliber Weapons Single Event Peak Levels without Terrain – Southern Boundary (Eagle Mountain)

	Unfavorable Weather Conditions		
	Distance		
dB Peak	Kilometer[1]	Mile[2]	Affected Land Use
115 – 130	2.5	1.6	City of Eagle Mountain[3]
> 130	0.4	0.25	City of Eagle Mountain[4]

Legend: dB = decibels, n/a = not applicable
Notes:
[1] Distance listed reflects maximum extension beyond the boundary.
[2] Mileage conversion is rounded for simplicity.
[3] Land use includes medium to high density residential, one education facility, and a religious facility.
[4] Within the total encompassed area there are less than a dozen residential properties ((three properties in the Vande Way - East Hidden Hills Road area); (seven properties in the East Tickville Gulch Road – North Outlook Way - Patriot Drive area)). The > 130 dB area is undergoing continuing development which may increase the number of residential properties.

Table 6-6. Secondary Assessment (Conservative) Demolition and Large Caliber Weapons Single Event Peak Levels without Terrain – Southern Boundary (Cedar Mountain)

	Unfavorable Weather Conditions		
	Distance		
dB Peak	Kilometer[1]	Mile[2]	Affected Land Use
115 – 130	3.6	2.2	Undeveloped (Scrub Land)
> 130	0.4	0.25	

Legend: dB = decibels, n/a = not applicable
Notes:
[1] Distance listed reflects maximum extension beyond the boundary.
[2] Mileage conversion is rounded for simplicity.

Table 6-7. Secondary Assessment (Conservative) Demolition and Large Caliber Weapons Single Event Peak Levels without Terrain – Western Boundary

	Unfavorable Weather Conditions		
	Distance		
dB Peak	Kilometer[1]	Mile[2]	Affected Land Use
115 – 130	1.5	0.9	Undeveloped (Scrub Land)
> 130	0	0	n/a

Legend: dB = decibels, n/a = not applicable
Notes:
[1] Distance listed reflects maximum extension beyond the boundary.
[2] Mileage conversion is rounded for simplicity.

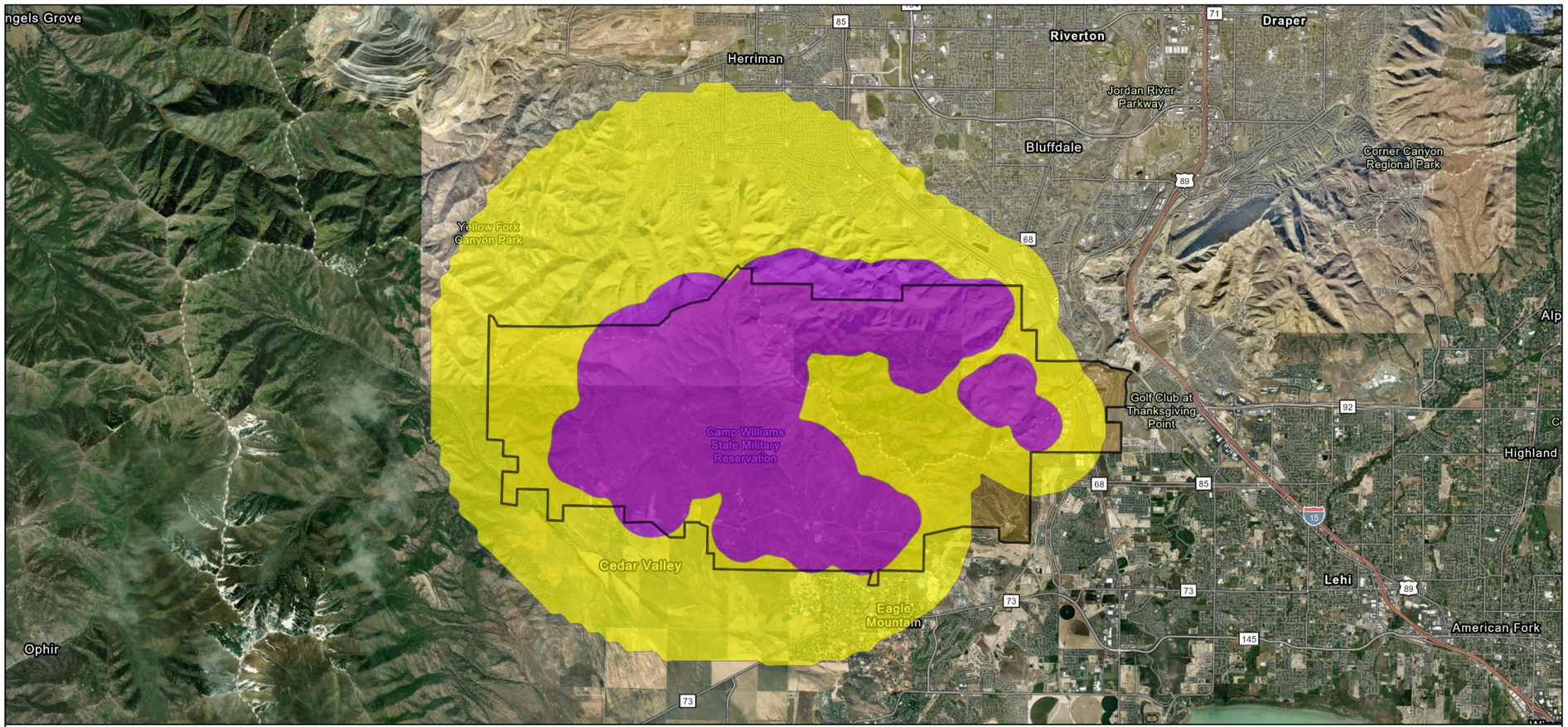


Figure 6-2. Secondary Assessment (Conservative) Single Event Peak Levels without Terrain: Routine Training Activity

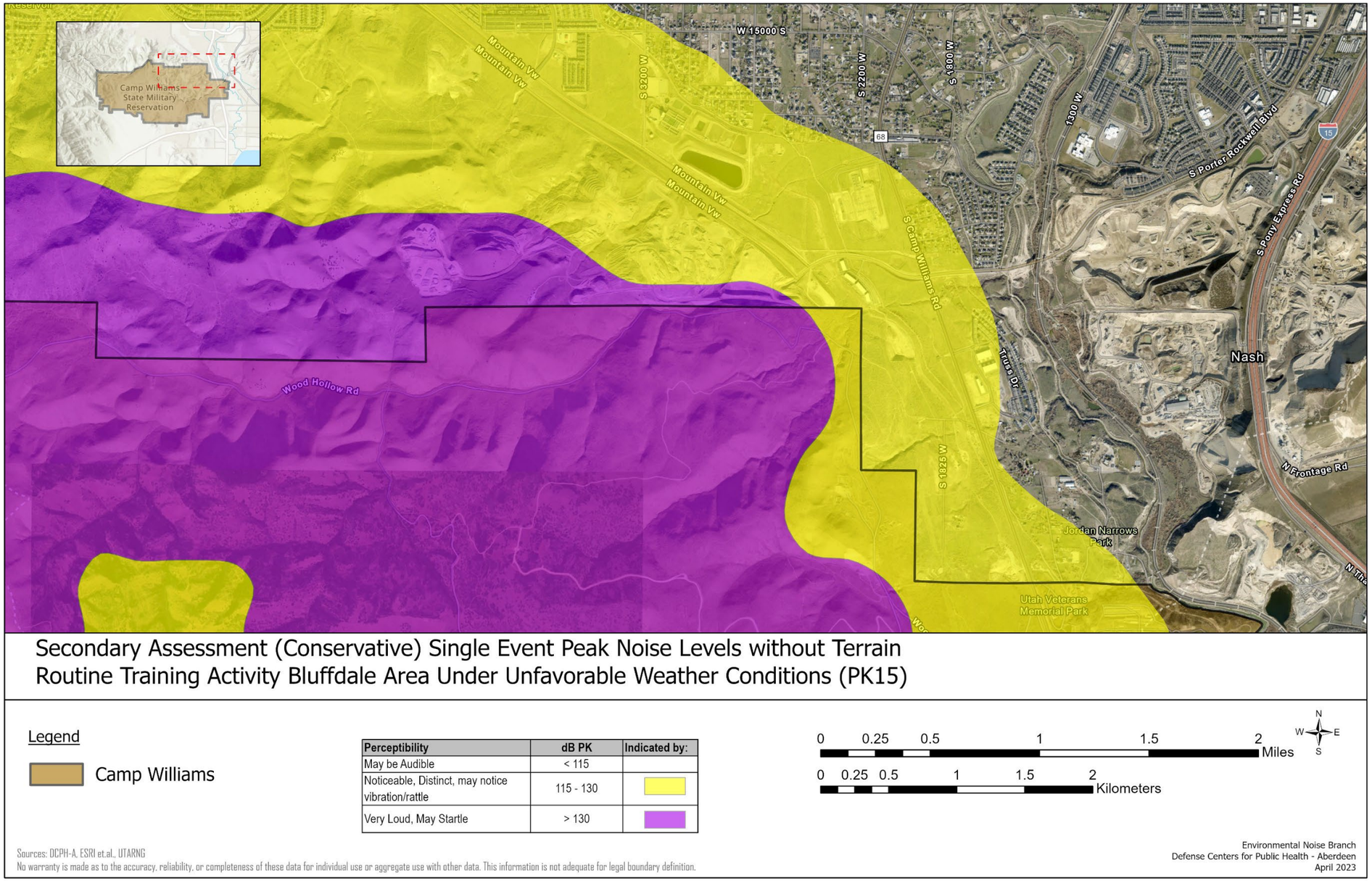


Figure 6-3. Secondary Assessment (Conservative) Single Event Peak Levels without Terrain: Routine Training Activity Bluffdale Area

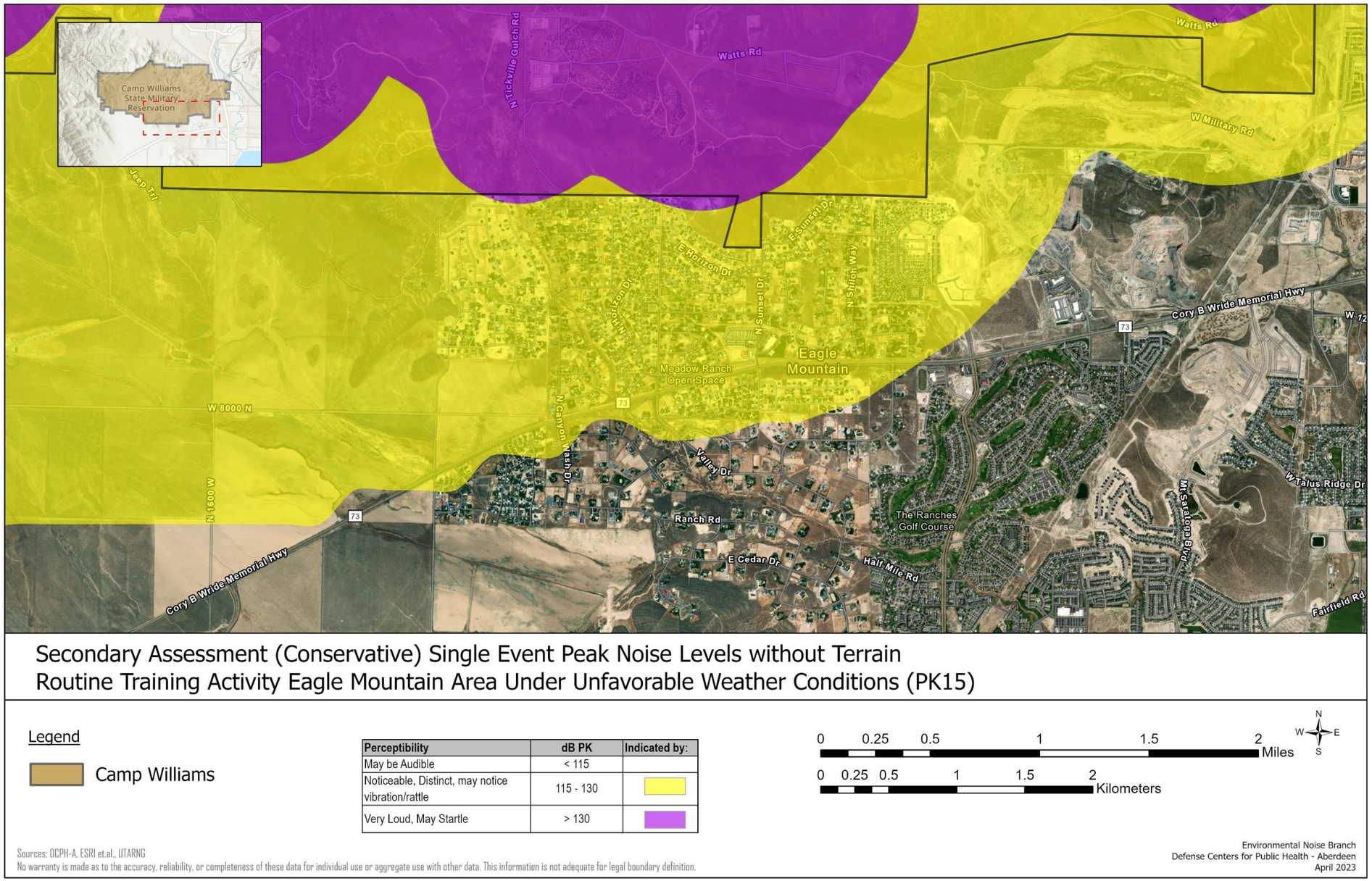


Figure 6-4. Secondary Assessment (Conservative) Single Event Peak Levels without Terrain: Routine Training Activity Eagle Mountain Area

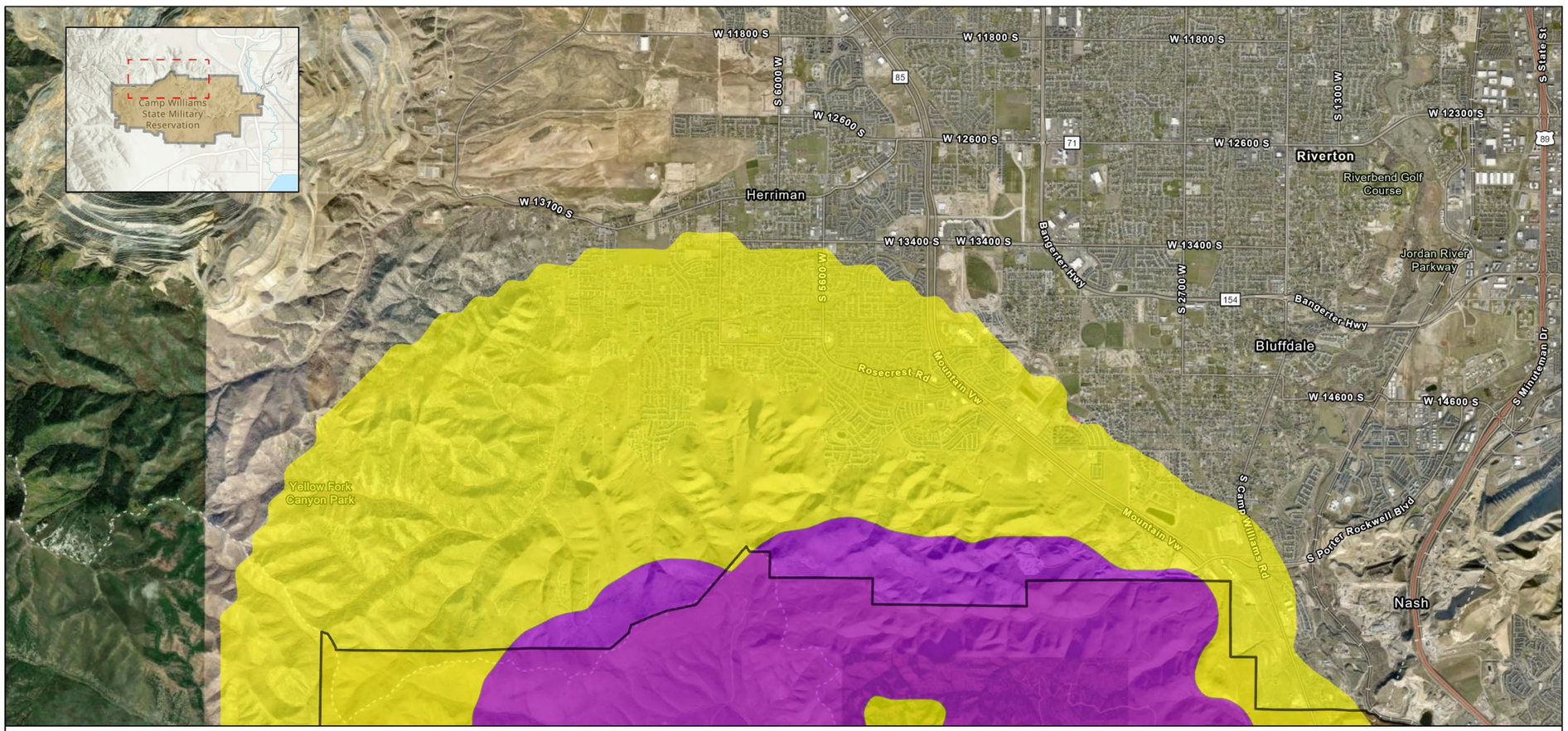


Figure 6-5. Secondary Assessment (Conservative) Single Event Peak Levels without Terrain: Routine Training Activity Herriman Area

Secondary Assessment (Conservative) All Artillery Firing Points (AFP)

At Camp Williams, training activities and in particular training ranges and AFPs may be used more often or less frequently from year-to-year and, in the case of AFPs, sometimes not at all. As previously mentioned, Camp Williams has over 30 separate AFP areas available for artillery training. To account for variations in artillery training, a modeling scenario was generated which includes the current operations (i.e., FY19 through FY22) with the addition of all AFPs actively firing. The addition of a 155mm High Explosive artillery round at each AFP, in conjunction with unfavorable weather propagation, creates a conservative assessment of routine Peak sound levels at Camp Williams.

Figure 6-6 illustrates the single event Peak sound level contours with all AFPs and current (routine) operations (demolition and large caliber weapons). Most of the changes occurred in the immediate area of the AFPs. Beyond the boundary of Camp Williams, the only area with a significant change is near the 200 Series AFPs (Figure 6-7 and Table 6-8). This scenario also presents the most potential impact for the cities of Lehi and Saratoga Springs.

Table 6-8. Secondary Assessment (Conservative) Single Event Peak Levels without Terrain: Routine Training Activity with All Artillery Firing Points – Mountain View Corridor

	Unfavorable Weather Conditions		
	Distance		
dB Peak	Kilometer[1]	Mile[2]	Affected Land Use
115 – 130	1.6	1	Residential (medium density)[3]
> 130	0	0	n/a

Legend: dB = decibels, n/a = not applicable

Notes:

[1] Distance listed reflects maximum extension beyond the boundary.

[2] Mileage conversion is rounded for simplicity.

[3] Mountain View Corridor area is undergoing continuing development which could increase residential development in the 115-130 dB area.

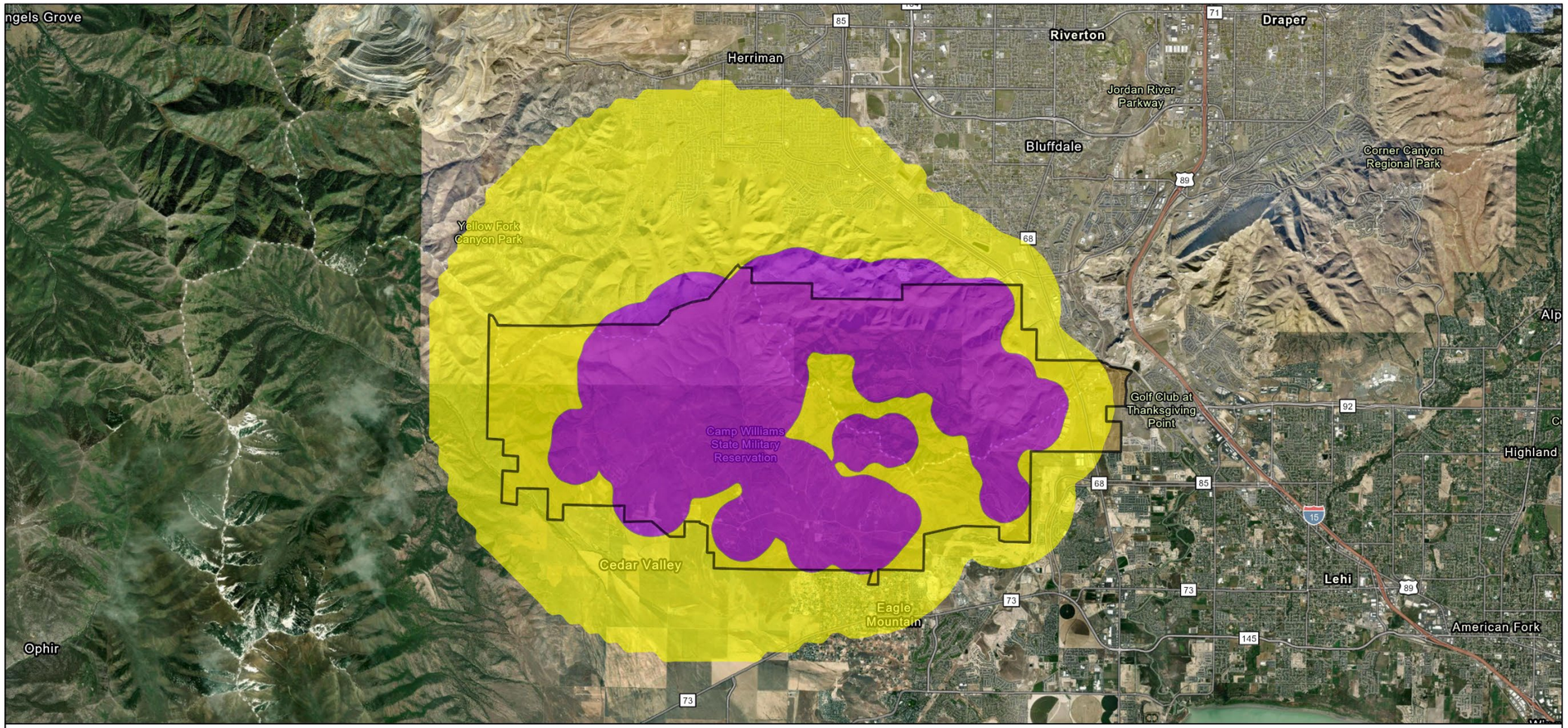


Figure 6-6. Secondary Assessment (Conservative) Single Event Peak Levels without Terrain: All Artillery Firing Points with Routine Training Activity

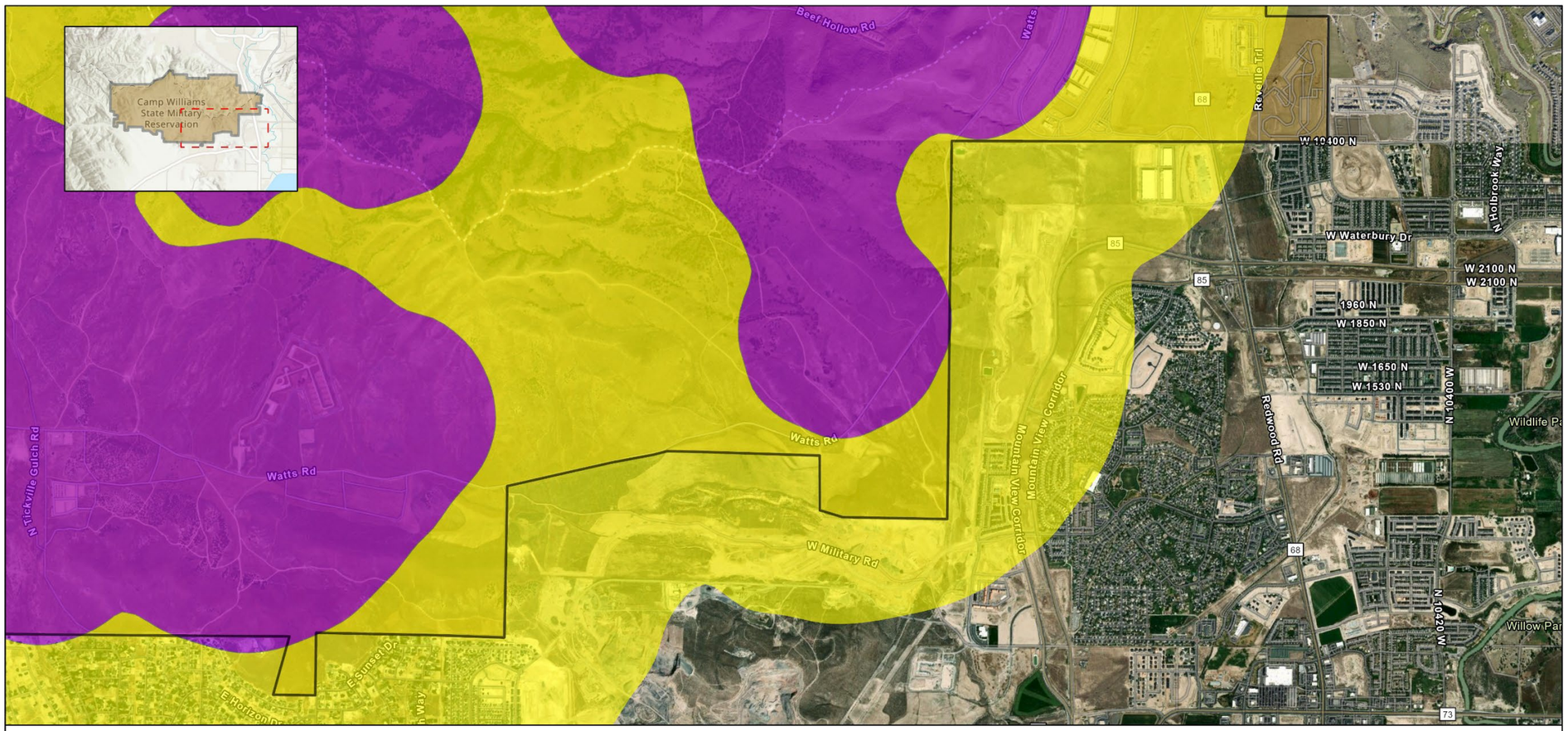


Figure 6-7. Secondary Assessment (Conservative) Single Event Peak Levels without Terrain: All Artillery Firing Points with Routine Training Activity Mountain View Corridor Area

Secondary Assessment (Conservative) Light Demolition Range

The light demolition range located in the southwest corner of Camp Williams has been inactive for the past few years. Figure 6-8 depicts the maximum Net Explosive Weight (NEW) authorized on the light demolition range (40 lbs). As indicated in Table 6-9, a 40-lb event at light demolition range would be audible in the City of Eagle Mountain. Neighbors located closest to the light demo range would likely notice picture or window rattling from air-borne vibration.

Table 6-9. Secondary Assessment (Conservative) Single Event Peak Levels without Terrain: Light Demolition Range 40-lbs NEW – Southern Boundary (Eagle Mountain)

	Unfavorable Weather Conditions		
	Distance		
dB Peak	**Kilometer[1]**	**Mile[2]**	**Affected Land Use**
115 – 130	7	4.4	City of Eagle Mountain
> 130	2	1.2	Residential (low to medium density in northwest section of the City of Eagle Mountain) Undeveloped (Scrub Land)

Legend: dB = decibels, n/a = not applicable
Notes:
[1] Distance listed reflects maximum extension beyond the boundary.
[2] Mileage conversion is rounded for simplicity.

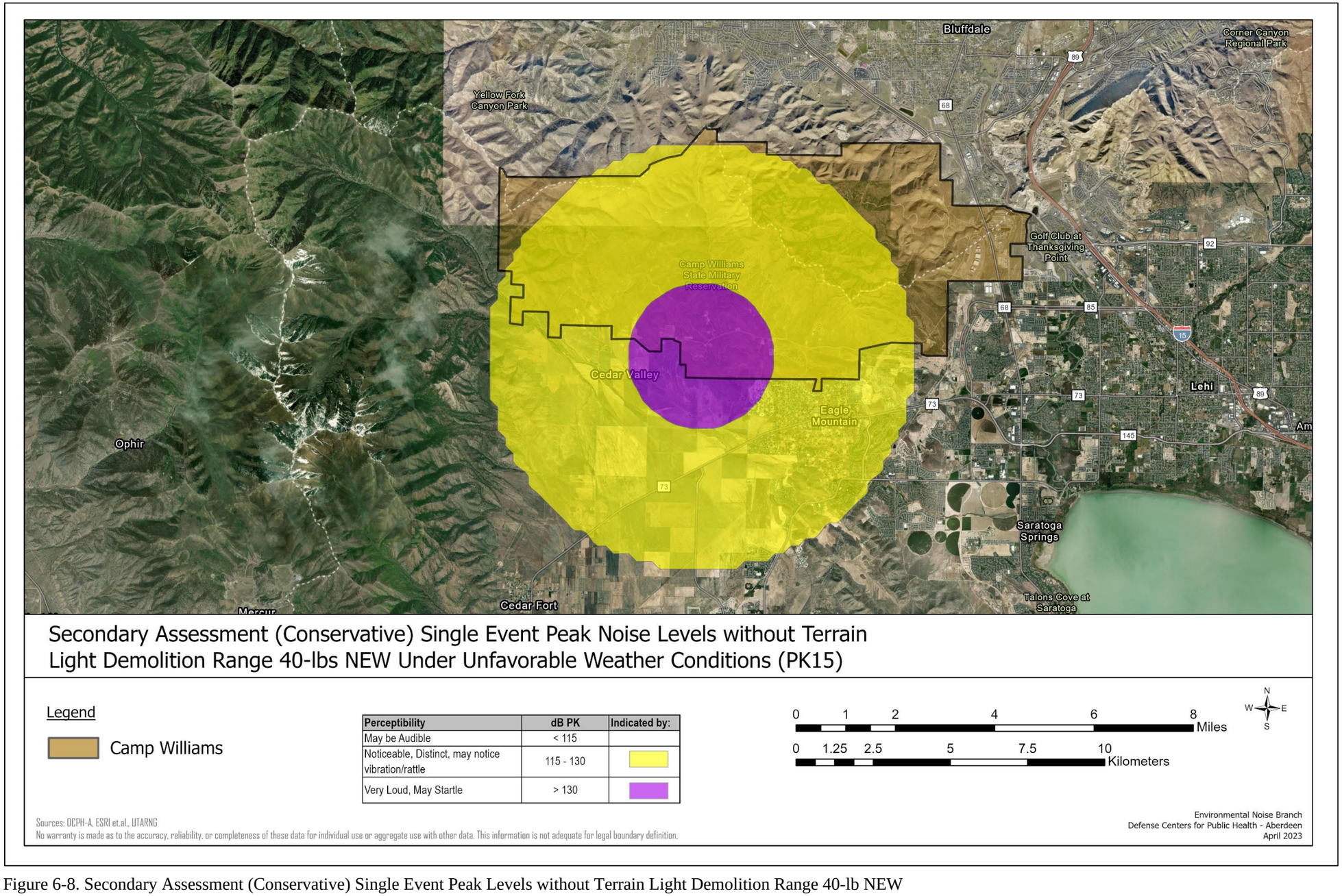


Figure 6-8. Secondary Assessment (Conservative) Single Event Peak Levels without Terrain Light Demolition Range 40-lb NEW

Secondary Assessment (Conservative) Infrequent Large Demolition Events

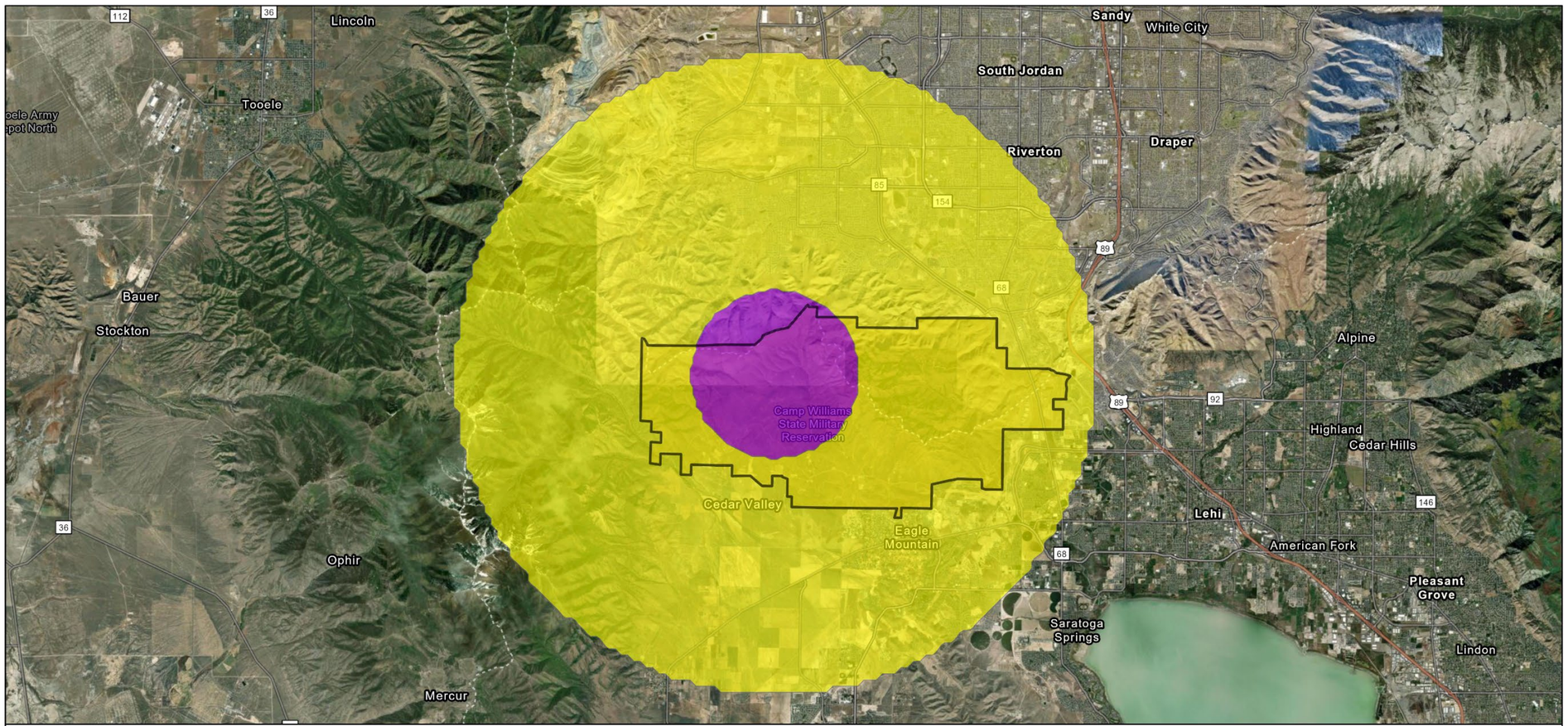
The maximum NEW at EQA Pad #2 is 320 lbs and at EQA Pad #3 it is 105 lbs. Although this activity rarely occurs, Peak sound level contours for these infrequent demolition activities were also generated to provide full disclosure of the potential noise emanating from Camp Williams. Note: at EQA Pad #1 the maximum NEW is accounted for in the routine operations (40-lb Cratering Charges).

EQA PAD #2: 320-LBS

As shown in Figure 6-9, under unfavorable weather conditions a 320-lb event at EQA Pad #2 maybe audible to residents within 6.5-miles of the northern boundary. To the south, residents within 4-miles may also notice these large events.

EQA PAD #3: 105-LBS

As shown in Figure 6-10, under unfavorable weather conditions a 105-lb event at EQA Pad #3 maybe audible to residents within 4.5-miles of the northern boundary. To the south, residents within 1.5-miles may also notice these large events. Neighbors located closest to the northern boundary would likely notice picture or window rattling from air-borne vibration, particularly those in the Step Mountain Road area.



Secondary Assessment (Conservative) Single Event Peak Noise Levels without Terrain
EQA Pad #2 320-lbs NEW Under Unfavorable Weather Conditions (PK15)

Legend

Camp Williams

Perceptibility	dB PK	Indicated by:
May be Audible	< 115	
Noticeable, Distinct, may notice vibration/rattle	115 - 130	
Very Loud, May Startle	> 130	

0 1.5 3 6 9 12 Miles

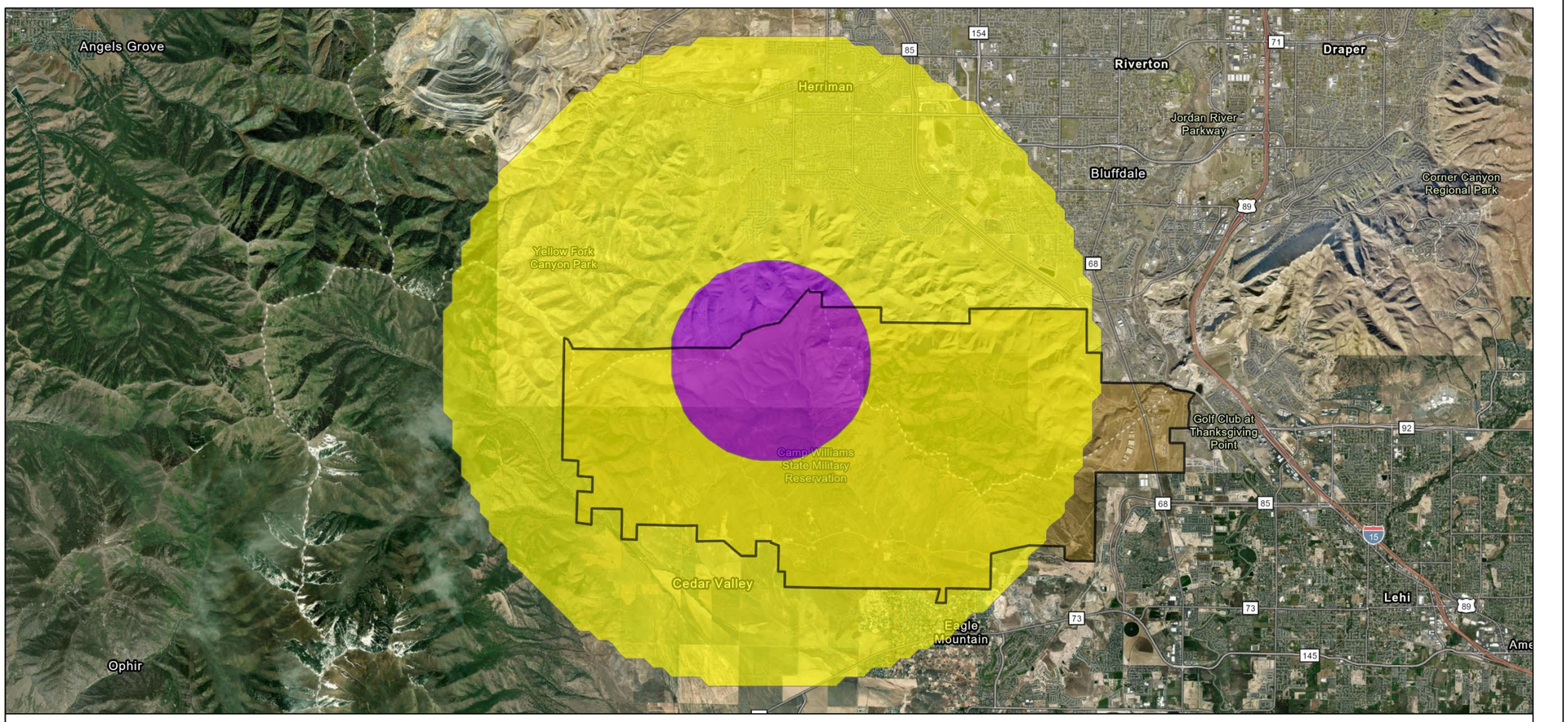
0 1.5 3 6 9 12 Kilometers

N W E S

Sources: DCPH-A, ESRI et.al., UTARNG
No warranty is made as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. This information is not adequate for legal boundary definition.

Environmental Noise Branch
Defense Centers for Public Health - Aberdeen
April 2023

Figure 6-9. Secondary Assessment (Conservative) Single Event Peak Levels without Terrain EQA Pad #2 320-lbs NEW



Secondary Assessment (Conservative) Single Event Peak Noise Levels without Terrain
EQA Pad #3 105-lbs NEW Under Unfavorable Weather Conditions (PK15)

Legend

Camp Williams

Perceptibility	dB PK	Indicated by:
May be Audible	< 115	
Noticeable, Distinct, may notice vibration/rattle	115 - 130	
Very Loud, May Startle	> 130	

0 1 2 4 6 8 Miles

0 1.25 2.5 5 7.5 10 Kilometers

N W E S

Sources: DCPH-A, ESRI et.al., UTARNG
No warranty is made as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data. This information is not adequate for legal boundary definition.

Environmental Noise Branch
Defense Centers for Public Health - Aberdeen
April 2023

Figure 6-10. Secondary Assessment (Conservative) Single Event Peak Levels without Terrain EQA Pad #3 105-lbs NEW

6.6 IMPULSE NOISE MCA

As recommended in the JLUS and in WTM Compatibility Area Study an Impulse Noise MCA was developed. An MCA is a designated geographic area where military operations may impact local communities, and conversely, where local activities may affect the military's ability to carry out its mission. The "Supplemental Single Event Peak Levels without Terrain All Artillery Firing Points with Routine Training Activity" (Figure 6-6) were selected as the basis for the Impulse Noise MCA. These contours reflect a conservative assessment and show areas that may experience higher noise levels given the right meteorological conditions.

Overall, the suggested Impulse Noise MCA falls within the West Traverse Sentinel Landscape area (an approximate 2-mile area surrounding Camp Williams) (Figure 6-11). Although Peak levels between 115 and 130 dB extend beyond the northern boundary of the Sentinel Landscape Area the identified area is sufficient.

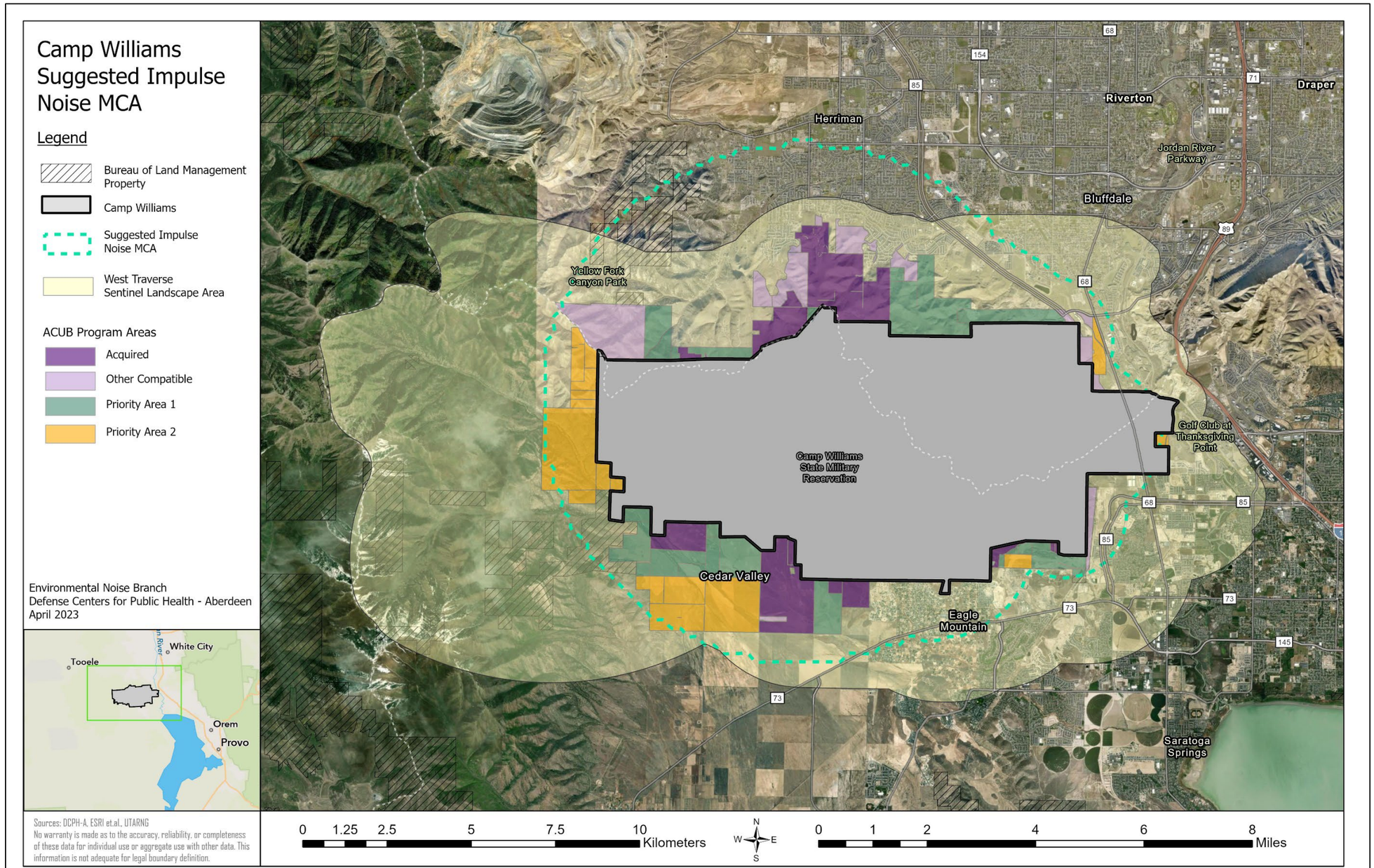


Figure 6-11. Suggested Impulse Noise MCA

6.7 LAND USE PLANNING OPTIONS

The following land use planning tools are available to help local governments create areas of compatible use around military installations. Many on the list are already in use; however, the UTARNG and local governments are strongly encouraged to revisit and/or update any of these options to find the equitable solutions that best work for their situation. These planning tools may be used individually or in combination.

Zoning. The most common method of land use control is *zoning*, or the partitioning of areas into sections reserved for different purposes. This method is an exercise of the police powers of state and local governments that designates the uses permitted in each parcel of land. It normally consists of a zoning ordinance that delineates the various use districts and a zoning map based on the land use element of the community's comprehensive general plan.

Easements. Easements can be an effective and permanent form of land use control; in many instances, better than zoning when trying to resolve an installation's compatibility issues. Easements are permanent (with the title held by the purchaser until sold or released), work equally well within different jurisdictions, are enforceable through civil courts, and may be acquired often at a fraction of the cost of the land value.

Subdivision Regulations. Subdivision regulations are a means by which local governments can ensure that proper lot layout, design, and improvements are included in new residential or commercial developments. These requirements may be anything from dictating the width of the roads to placement of the water and/or sewer systems. Since most local governments require some type of public dedication of open space when approving development plans, the installation may lobby to have a provision added to the subdivision regulations that requires this open space to be located nearest the installation boundary to create a buffer.

Disclosure of Noise Levels. Since noise levels in a community can be effectively modeled, as well as measured and recorded, making noise level information readily available can sometimes be all it takes to discourage incompatible land uses. These noise levels can be disclosed in several ways, including ordinances (or amendments to existing ordinances), deeds, posting noise levels on any sale/lease/rent sign, and initiating voluntary programs among local realtors to provide potential buyers with installation-provided information and noise level/contour mapping.

Deed Restrictions/Covenants. A deed is a document conveying ownership of land from one party to another, and restrictions called *covenants* can be added to the deed to specify restrictions on the use of the land. These covenants are on top of the restrictions already imposed by the current zoning of the property and in many instances may supersede zoning by prohibiting specified uses that would otherwise be allowed. Restrictive covenants "run with the land;" that is, no matter how often the land is resold, these covenants remain in effect until the specified length of the covenant has expired. In order to utilize this option, the installation must already own or must acquire the property. Then, when reselling the property, the installation specifies which uses are permitted on the land thereby preventing incompatible uses (such as residential housing) for as long as the restrictions remain in effect.

7 SUMMARY

7.1 SMALL ARMS WEAPONS

According to Army guidelines, the surrounding land use is compatible with the noise from small arms weapons operations. Noise Zone III extends beyond the boundary in several areas encompassing undeveloped scrub lands. Zone II extends beyond the boundary southwest and northwest from firing at the main range complex, as well as to the east from firing at the Post ranges. At the time of publication there are two single-family residences within Zone II (one along South 1825 West and one on Step Mountain Road). The Step Mountain Road area is undergoing increased development which could increase the number of noise-sensitive land uses within Zone II. The remaining areas offpost are undeveloped scrub land.

7.2 DEMOLITION AND LARGE CALIBER WEAPONS

LAND USE GUIDELINES

The Noise Zones do not extend beyond the boundary indicating noise from demolition and large caliber weapons activity is compatible with the surrounding land use. Although the Noise Zones remain within Camp Williams, individual training events can be audible outside of a Noise Zone and in some cases objectionable to the surrounding community. Peak level assessments can forecast where sound may be audible or loud from singular events.

SINGLE EVENT PEAK SOUND LEVELS

Under unfavorable weather Peak levels above 115 dB extend beyond the northern and southern boundaries. The areas inside the contours north do not contain any sensitive land uses (undeveloped scrub lands). To the southeast Peak levels between 115 and 130 dB encompass residential land use concentrated in medium to high density subdivisions (Arrival, Cedar Pass Ranch, Meadow Ranch, North Ranch, Spring Run, Valley View, Valley View Foothills, Valley View South, Westview Heights) in the city of Eagle Mountain. Peak sound levels above 130 dB extend beyond the southern boundary, encompassing multiple residences in the Hidden Hills Road and Vande Way area (northern area of the North Ranch and Arrival Subdivisions). Residences in these neighborhoods would be expected to occasionally experience high noise levels from artillery firing activity, particularly given the right meteorological conditions. These noise contours, like others in this study, establish the most common or concentrated areas of noise generated by the various training and operational activities at Camp Williams. On occasion, noise from a particular event may extend into an area not covered by a depicted noise contour.

Although the contours contract considerably under neutral conditions, Peak levels between 115 and 130 dB still extend beyond the northern and southern boundaries, but to a much lesser degree. Peak levels between 115 and 130 dB encompass several single-family homes south of the boundary.

SECONDARY ASSESSMENT SINGLE EVENT PEAK SOUND LEVELS

The secondary assessment of large caliber and demolition operations reflects a conservative approach, where the terrain algorithm was omitted from the computer model to show potential areas that may experience higher noise levels under adverse meteorological conditions. These additional noise contours are useful in advising nearby residences of their potential noise exposure. This assessment is intended for informative purposes and not for National Environmental Policy Act documentation.

Without terrain calculations and under unfavorable weather Peak levels above 115 dB extend beyond the boundary in most directions. Land use within the 115 to 130 dB Peak area includes portions of the Cities of Bluffdale, Eagle Mountain, Lehi, Saratoga Springs, and Herriman. Residences in these neighborhoods would be expected to occasionally experience high noise levels from artillery firing activity, particularly given the right meteorological conditions. Peak sound levels above 130 dB extend beyond the southern boundary in two small areas, encompassing multiple residences in the Hidden Hills Road and Patriot Drive areas abutting the boundary.

7.3 AVIATION ACTIVITY

Although aircraft activity occurs on a regular basis, there are not enough flights at Camp Williams or the AASF to generate cumulative aircraft ADNL Noise Zones. Nevertheless, noise from individual overflights arriving and departing, and transitioning between training areas have the potential to be disruptive and/or annoying. Sufficient measures to mitigate the effects of aircraft noise are currently in place, including no-fly and avoidance areas, as well as minimum flight altitudes over noise-sensitive land use. However, there is always the possibility that an individual overflight could lead to a complaint. Pilots should remain vigilant in adhering to noise abatement procedures and fly-neighborly programs.

7.4 RECOMMENDATIONS

The ICUZ is a proactive planning tool, which can help guide future development in surrounding communities. Local municipal governments are encouraged to support public disclosure of all Noise Zones and supplemental metrics which convey how military training operations affect the noise environment.

The completion of WTM Compatibility Area Study demonstrates the strong relationship the UTARNG has with the surrounding local communities. It is recommended that all parties involved continue to pursue the recommendations made within the WTM Study, contributing to the program’s success, as well as monitoring any changes in current land use around Camp Williams to avoid future incompatibilities and sustain its viability. Key recommendations from the WTM Area Study to address are:

- Create Zoning Overlay District Titled Military Compatibility Area Overlay District, Comprised of Land Use Military Compatibility Areas (MCA), Impulse Noise MCA, Aviation Safety MCA, and a Light MCA.

- Continue to pursue real estate disclosure at the local and/or state legislative level. Disclosure provides information on possible impacts (noise/vibration, air safety zones) to prospective buyers or renters as part of real estate transactions for properties close to military installations. Real estate disclosure enhances the ability to promote compatible land use around military installations that will protect both the military's mission and potential homeowners from unnecessary conflicts.

The ICUZ study describes the noise characteristics of a specific operational environment, and as such, will change if a significant operational change is made. Therefore, if the UTARNG mission, training, or training facilities undergo changes, the ICUZ should be reviewed to determine if the current noise assessment is sufficient. The Army recommends ICUZ Studies be reviewed every 5-years or updated if mission changes occur which are substantial, and/or permanently alter the noise environment.

A GLOSSARY OF TERMS

A-Weighted Sound Level – a sound level (in decibels) that has been weighted to correspond with the non-linear sensitivity of the human ear. A-weighting discriminates against the lower frequencies and is used to measure most common military sounds such as transportation and small-arms fire.

Ambient Noise – the background noise that is usually present at a particular location; anything from cars on a highway, to insects in the woods.

Atmospheric Refraction – the bending and/or focusing of sound waves by the varying layers and densities of the earth's atmosphere.

C-Weighted Sound Level – like A-weighting, this is another sound level weighting technique that is used to normalize the low, impulsive sounds to the range of human hearing. It is used when measuring low frequency sound such as those from large caliber, demolitions, and sonic booms.

Day-Night Average Sound Level (DNL) – the 24-hour average frequency-weighted sound level, in decibels, from midnight to midnight, obtained after the addition of 10 decibel "penalties" to sound levels between midnight and 7 a.m. and 10 p.m. to midnight (0000 to 0700 hours and 2200 to 2400 hours). A-weighting (ADNL) is understood unless otherwise specified, but C-weighting (CDNL) is also common.

Decibels (dB) – a logarithmic sound pressure unit of measure.

Equivalent Sound Level (LEQ) – the level of a constant sound which, in a given situation and time period, has the same energy as does a time varying sound. For noise sources which are not in continuous operation, the equivalent sound level may be obtained by summing individual sound exposure level (SEL) values and normalizing them over the appropriate time period.

Frequency – the number of complete oscillation cycles per unit of time. The unit of frequency is the Hertz.

Frequency Weighting – the process of factoring in certain frequencies more or less heavily in order to bring the sound measurement more in line with the characteristics of the receiver (and thus make the numbers more meaningful to the task at hand). Example: A- or C-weighting to specifically parallel the sensitivity of the human ear.

Ground Track Distance – the distance between the receiver and the point on the Earth at which the aircraft is directly overhead.

Hertz – the unit of frequency equal to once cycle per second.

Impulse (or Impulsive) Noise – noise of short duration (typically less than one second), high intensity, abrupt onset and rapid decay, and often rapidly changing spectral composition. Impulsive noise is characteristically associated with such sources as explosions, impacts, the discharge of forearms, the passage of supersonic aircraft (creating sonic booms), and many industrial processes.

Land Use Planning Zone (LUPZ) – The Land Use Planning Zone (LUPZ) is a subdivision of Zone I. The LUPZ is 5 dB lower than the Zone II (57-62 dB CDNL and 60-65 dB ADNL).

Large Caliber/Arms – conventional military weapons over 20 millimeters in diameter.

Noise – any sound without value or unwanted sound.

Noise Level Reduction – the difference, in decibels, between the sound level outside a building and the sound level inside a designated room in the building (usually A-weighted). The NLR is dependent upon the transmission loss characteristics of the building surfaces exposed to an exterior noise source, the particular noise characteristics of the exterior noise source, and the acoustic properties if the designated room in the building.

Noise Zone III – the area around a noise source in which the C-weighted day-night sound level (CDNL) is greater than 70 dB (demolition and large caliber weapons), the A-weighted day-night level (ADNL) is greater than 75 dB (aviation), or the dB Peak is greater than 104 (small caliber weapons).

Noise Zone II – the area around a noise source in which the CDNL is 62-70 dB (demolition and large caliber weapons), the ADNL is 65-75 dB (aviation), or the dB Peak is 87-104 (small caliber weapons).

Noise Zone I – included all areas around a noise source in which the CDNL is less than 62 dB (demolition and large caliber weapons), the ADNL is less than 65 dB (aviation), or the dB Peak is less than 87 (small caliber weapons). This area is usually suited for all types of land use activities.

Peak – Peak is a single-event sound level without weighting.

PK15(Met) – PK15(met) is a computer modeled single-event peak level that is exceeded only 15 percent of the time by the loudest munitions type detonation. This metric accounts for variations caused by weather conditions and favors noise propagation. The PK15(met) metric does not communicate any information about how often the loudest munitions type is detonated.

PK50(Met) - is similar to the PK15(met) except that it represents the peak noise level that is exceeded 50 percent of the time. This metric also accounts for weather but assumes conditions which are not favorable for noise propagation.

Propagation – the process by which sound travels through space or material; may be affected by such things as weather, terrain, and barriers.

Slant Distance – the straight-line distance between two points not at the same elevation as contrasted with ground distance. Also known as slant range.

Small Arms – conventional military weapons .50 caliber and below in diameter.

Sound Exposure Level (SEL) – the total energy of a sound event normalized to a specific amount of time (e.g., one second) so that sounds of different durations may be compared directly.

Unweighted Peak Sound Level – the peak, single event sound level without weighting, without taking into account berms or other attenuation, and without any particular certainty.

B LAND USE GUIDELINES

Land use recommendations vary based on the type of noise source. The following tables are organized based on Standard Land Use Coding Manual (SLCUM) categories; however, it varies from SLUCM as the coding system does not differentiate based on noise-sensitivity. Some uses warrant additional evaluation due to potential for annoyance and activity interference. General notes and specific footnotes at the bottom of the tables provide additional information and considerations for compatibility determinations.

These recommendations are intended to support compatible land use planning both on and off-base; they do not constitute a Federal determination that any use of land is acceptable or unacceptable under local zoning. The primary land use objective is to discourage noise-sensitive land uses in areas of higher noise exposure.

Table B-1 provides compatibility recommendations for aviation operations, Table B-2 provides compatibility recommendations for small arms weapons, and Table B-3 for large caliber weapons and explosives.

TABLE B-1. LAND USE COMPATIBILITY IN AIRCRAFT NOISE ZONES

LAND USE NAME & SLUCM Category	A-Weighted DNL Levels					
	<65 dB	65-70 dB	70-75 dB	75-80 dB	80-85 dB	85+ dB
Residential Use Group (SLUCM Category10)						
Residential uses, inclusive of all residential units i.e. any type of single or multiple dwelling units.	Y	N1	N[1]	N	N	N
Mobile home parks or courts	Y	N	N	N	N	N
Transient lodgings	Y	N1	N[1]	N[1]	N	N
Manufacturing Use Group (SLUCM Categories 20 & 30)						
Manufacturing and industrial uses	Y	Y	Y[2]	Y[3]	Y[4]	N
Precision manufacturing	Y	Y	Y[2]	Y[3]	N	N
Transportation, communication and utilities Use Group (SLUCM Category 40)						
Rail, motor vehicle, aircraft, marine and other transportation, and communication systems and utilities	Y	Y	Y[2]	Y [3]	Y[4]	N
Highway and street right-of-way, automobile parking	Y	Y	Y	Y	Y	N
Telephone, cellular and radio communication	Y	Y	Y[2]	Y [3]	N	N
Trade (SLUCM Category 50)						
Wholesale trade	Y	Y	Y[2]	Y[3]	Y[4]	N
Building materials, hardware and farm equipment sales	Y	Y	Y[2]	Y[3]	Y[4]	N
Mass retailing, super stores, strip malls, shopping centers, discount clubs, home improvement stores, etc. eating and drinking establishments	Y	Y	Y[2]	Y[3]	N	N
Services (SLUCM Category 60)						
Finance, insurance and real estate, personal, professional and miscellaneous services; religious activities	Y	Y	Y[2]	Y[3]	N	N
Cemeteries	Y	Y	Y[2]	Y[3]	Y[4]	Y[5]
Warehousing/storage & repair services	Y	Y	Y[2]	Y[3]	Y[4]	N
Hospitals/medical, child care & development services, educational facilities	Y	Y[2]	Y[3]	N	N	N
Nursing homes	Y	N[1]	N[1]	N	N	N
Governmental	Y	Y	Y[2]	Y[3]	N	N

TABLE B-1. LAND USE COMPATIBILITY IN AIRCRAFT NOISE ZONES, cont'd

LAND USE NAME & SLUCM Category	A-Weighted DNL Levels					
	<65 dB	65-70 dB	70-75 dB	75-80 dB	80-85 dB	85+ dB
Cultural, entertainment and recreational (SLUCM Category 70)						
Cultural activities, auditoriums & concert halls	Y	Y[2]	Y[3]	N	N	N
Nature exhibits	Y	Y	N	N	N	N
Public assembly	Y	Y	N	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Outdoor sports arenas, spectator sports	Y	Y[6]	Y[6]	N	N	N
Amusements	Y	Y	Y	N	N	N
Outdoor recreational activities	Y	Y	Y[2]	Y[3]	N	N
Resorts, camps, parks & other c/e/r activities	Y	Y	Y[2]	N	N	N
Resource production and extraction (SLUCM Category 80)						
Agriculture and forestry	Y	Y[7]	Y[8]	Y[9]	Y[9]	Y[9]
Livestock farming, animal breeding	Y	Y[7]	Y[8]	N	N	N
Fishing, mining and other resource production or extraction	Y	Y	Y	Y	Y	Y

KEY TO TABLE B-1 – LAND USE COMPATIBILITY IN AIRCRAFT NOISE ZONES

LAND USE RECOMMENDATIONS

Y (Yes) – Land use and related structures compatible without 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 generally are compatible. However, see note(s) indicated by the superscript.

N^x – No with exceptions. The land use and related structures are generally incompatible. However, see note(s) indicated by the superscript.

NOTES FOR TABLE B-1 – LAND USE COMPATIBILITY IN AIRCRAFT NOISE ZONES

General notes for all uses:

a. Compatibility designations in Table B-1 generally refer to the principal use of the site. If other uses with greater sensitivity to noise are proposed, a determination of compatibility should be based on that use which is most adversely affected by noise.

b. When appropriate, noise level reduction (NLR) may be necessary to achieve compatibility. NLR (outdoor to indoor) is achieved through the incorporation of sound attenuation into the design and construction of a structure. Measures to achieve an indoor noise reduction do not necessarily solve noise issues outside the structure and additional evaluation may be warranted. Building location, site planning, design, and use of berms and barriers can help mitigate outdoor noise exposure, particularly from aircraft ground maintenance run-ups. Measures that reduce noise at a site should be used wherever practical in preference to measures that only protect interior spaces.

c. Land uses below 65db DNL are generally compatible. However, localities, when evaluating the application of these guidelines, should consider possible annoyance tied to land uses that involve predominately outdoor activities, or where quiet is a basis for the use.

d. Land use that involves outdoor activities in areas above 80db DNL are not recommended, but if the community allows such activities, hearing protection devices should be worn when noise sources are present. Long-term exposure (multiple hours per day over many years) to high noise levels can cause hearing loss in some unprotected individuals.

TABLE B-1. LAND USE COMPATIBILITY IN AIRCRAFT NOISE ZONES, cont'd

FOOTNOTES FOR TABLE B-1 – LAND USE COMPATIBILITY IN AIRCRAFT NOISE ZONES

Footnotes specific to certain land uses:

1. Residential
   a. Although local conditions regarding the need for housing may require residential use in these zones, residential use is discouraged in DNL 65-70 and strongly discouraged in DNL 70-75. The absence of viable alternative development options should be determined and an evaluation should be conducted locally prior to local approvals. These evaluations should clearly demonstrate that community's need for additional residential property could not be met if development were prohibited in these zones, and that the expense of additional noise attenuation will not undermine affordable housing goals.
   b. Where the community determines that these uses must be allowed, measures to achieve outdoor to indoor NLR of at least 25 decibels (dB) in DNL 65-70 and 30 dB in DNL 70-75 should be incorporated into building codes and be considered in individual approvals; for transient housing, an NLR of at least 35 dB should be incorporated in DNL 75-80.
   c. Normal permanent construction can be expected to provide an NLR of 20 dB, thus the reduction requirements are often stated as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation, upgraded sound transmission class ratings in windows and doors, and closed windows year-round. Additional consideration should be given to modifying NLR levels based on peak noise levels or vibrations.
2. Measures to achieve NLR of 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.
3. Measures to achieve NLR of 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.
4. Measures to achieve NLR of 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.
5. Buildings where public is received, are not recommended.
6. Land use is compatible provided special sound reinforcement systems are installed.
7. Where residences are permitted, measures to achieve outdoor to indoor NLR of at least 25dB should be incorporated into the design.
8. Where residences are permitted, measures to achieve outdoor to indoor NLR of at least 30dB should be incorporated into the design. Residences are not compatible.

TABLE B-2. LAND USE COMPATIBILITY IN SMALL ARMS NOISE

LAND USE	Peak Levels (unweighted)		
LAND USE NAME & SLUCM Category	<87dB	87-104dB	>104 dB
Residential Use Group (SLUCM Category10)			
Residential uses, inclusive of all residential units i.e. any type of single or multiple dwelling units.	Y	N[1]	N
Mobile home parks or courts	Y	N	N
Transient lodgings	Y	N[1]	N
Manufacturing Use Group (SLUCM Categories 20 & 30)			
Manufacturing and Industrial uses (Food and kindred products; Textile mill products; Stone, clay, glass, primary metal and fabricated metal products; Fabric products; leather and similar materials; chemicals and allied products; petroleum refining and related industries; Rubber and miscellaneous plastic products; Lumber and wood products; furniture and fixtures; paper and allied products; printing, publishing, and allied industries, other miscellaneous manufacturing)	Y	Y[2]	Y[3]
Precision manufacturing (professional scientific and controlling instruments; photographic and optical goods)	Y	Y[2]	Y[3]
Transportation, communication and utilities Use Group (SLUCM Category 40)			
Rail, motor vehicle, aircraft, marine and other transportation, and communication systems and utilities	Y	Y[2]	Y[3]
Highway and street right-of-way, automobile parking	Y	Y	Y
Telephone, cellular and radio communication	Y	Y[2]	Y[3]
Solid waste disposal, (landfills, incinerators, etc.)	Y	Y	Y
Trade (SLUCM Category 50)			
Wholesale trade	Y	Y2	Y3
Retail trade - building materials, hardware, paint, and farm equipment sales; food such as groceries, bakeries, confectionaries, meat markets, and fast food establishments; automotive, marine craft, aircraft, and accessories; apparel and accessories, furniture, home, furnishings and equipment; Other retail trade	Y	Y[2]	Y[3]
Mass retailing, super stores, strip malls, shopping centers, discount clubs, home improvement stores, etc. eating and drinking establishments.	Y	Y[2]	Y[3]
Services(SLUCM Category 60)			
Finance, insurance and real estate, personal, professional and miscellaneous services (office uses only)	Y	Y[2]	Y[3]
Cemeteries	Y	Y	Y[3]
Warehousing/storage & repair services	Y	Y[2]	Y[3]
Hospitals/medical, child care & development services, educational facilities, nursing homes	Y	N	N
Governmental	Y	Y[2]	Y[3]

TABLE B-2. LAND USE COMPATIBILITY IN SMALL ARMS NOISE, cont'd

LAND USE	Peak Levels (unweighted)		
LAND USE NAME & SLUCM Category	<87dB	87dB– 104dB	>104dB
Cultural, entertainment and recreational (SLUCM Category 70)			
Cultural activities, auditoriums & concert halls	Y	Y[2]	N
Nature exhibits, places of worship, public assembly, outdoor music shells, amphitheaters, outdoor sports arenas, spectator sports, resorts, campgrounds	Y	N	N
Amusements - fairgrounds, miniature golf, driving ranges; amusement parks, etc.	Y	Y[2]	N
Outdoor recreational activities - golf courses, riding stables, water recreation, parks, etc.	Y	Y[2]	N
Resource Production and Extraction[7] (SLUCM Category 80)			
Agriculture (including grazing and feedlots) and forestry	Y	Y[4]	Y[5]
Livestock farming, animal breeding	Y	Y[4]	N
Fishing, mining and other resource production or extraction	Y	Y	Y

KEY TO TABLE B-2 – LAND USE COMPATIBILITY IN SMALL ARMS NOISE ZONES

Y (Yes) – Land use and related structures compatible without 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 generally are compatible. However, see note(s) indicated by the superscript.

N^x – No with exceptions. The land use and related structures are generally incompatible. However, see note(s) indicated by the superscript.

SLUCM – Standard Land Use Coding Manual

Note: Small caliber is defined as a weapon with a bore diameter of .50 caliber and below.

NOTES FOR TABLE B-2 – LAND USE COMPATIBILITY IN SMALL ARMS NOISE ZONES

General notes for all uses:

a. Compatibility designations in Table B-2 generally refer to the principal use of the site. If other uses with greater sensitivity to noise are proposed, a determination of compatibility should be based on that use which is most adversely affected by noise.

b. Although local demand for on- or off-post housing may require noise-sensitive land uses within Noise Zone II, such land use is generally not recommended. The absence of viable alternative development options should be determined and an evaluation should be conducted locally, prior to local approvals. These evaluations should clearly demonstrate that community's need for additional residential property could not be met if development were prohibited in these zones, and that the expense of additional noise attenuation will not undermine affordable housing goals.

c. When appropriate, noise level reduction (NLR) may be necessary to achieve compatibility. NLR (outdoor to indoor) is achieved through the incorporation of sound attenuation into the design and construction of a structure. Measures to achieve an indoor noise reduction do not necessarily solve noise issues outside the structure and additional evaluation may be warranted. Measures that reduce noise at a site should be used wherever practical in preference to measures that only protect interior spaces.

TABLE B-2. LAND USE COMPATIBILITY IN SMALL ARMS NOISE, cont'd

FOOTNOTES FOR TABLE B-2 – LAND USE COMPATIBILITIES IN SMALL ARMS NOISE ZONES

1. Residential/Services
   a. Although local conditions regarding the need for housing and services may support noise-sensitive use in these zones, residential use is discouraged in 87-104 dB Peak and strongly discouraged in > 104 dB Peak.
   b. Where the community determines that these uses must be allowed, measures to achieve outdoor to indoor NLR of at least 30 decibels (dB) in 87-104 dB Peak should be incorporated into building codes and be considered in individual approvals. Normal permanent construction can be expected to provide an NLR of 20 dB, thus the reduction requirements are often stated as 10 dB over standard construction and normally assume mechanical ventilation, upgraded sound transmission class ratings in windows and doors, and closed windows year- round.
2. Measures to achieve NLR of 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.
3. Measures to achieve NLR of 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.
4. Where residences are permitted, measures to achieve outdoor to indoor NLR of at least 30dB should be incorporated into the design.
5. Residences are not compatible.
6. This compatibility table identifies places of worship as a cultural gathering. However, religious institutions provide a wide variety of services and in these instances refer to the applicable category.
7. The land uses within this category include necessary associated resource management activities, for example, wildfire management activities for forestry.

TABLE B-3. LAND USE COMPATIBILITY IN LARGE CALIBER AND EXPLOSIVE NOISE ZONES

LAND USE	C-weighted DNL Levels			
LAND USE NAME & SLUCM Category	<57dB	57-62dB	62-70dB	>70 dB
Residential Use Group (SLUCM Category10)				
Residential uses, inclusive of all residential units i.e. any type of single or multiple dwelling units.	Y	Y[1]	N[2,3]	N[3]
Mobile home parks or courts	Y	Y[1]	N[2,3]	N[3]
Transient lodgings	Y	Y[1]	Y	N
Manufacturing Use Group (SLUCM Categories 20 & 30)				
Manufacturing and Industrial uses (Food and kindred products; Textile mill products; Stone, clay, glass, primary metal and fabricated metal products; Fabric products; leather and similar materials; chemicals and allied products; petroleum refining and related industries; Rubber and miscellaneous plastic products; Lumber and wood products; furniture and fixtures; paper and allied products; printing, publishing, and allied industries, other miscellaneous manufacturing)	Y	Y	Y[4]	Y[4]
Precision manufacturing (professional scientific and controlling instruments; photographic and optical goods)	Y	Y	N	N
Transportation, communication and utilities Use Group (SLUCM Category 40)				
Rail, motor vehicle, aircraft, marine and other transportation, and communication systems and utilities	Y	Y	Y	Y[4]
Highway and street right-of-way, automobile parking	Y	Y	Y	Y
Telephone, cellular and radio communication	Y	Y	Y	Y[4]
Solid waste disposal, (landfills, incinerators, etc.)	Y	Y	Y	Y
Trade (SLUCM Category 50)				
Wholesale trade	Y	Y	Y	N
Retail trade - building materials, hardware, paint, and farm equipment sales; food such as groceries, bakeries, confectionaries, meat markets, and fast food establishments; automotive, marine craft, aircraft, and accessories; apparel and accessories, furniture, home, furnishings and equipment; Other retail trade	Y	Y	Y	N
Mass retailing, super stores, strip malls, shopping centers, discount clubs, home improvement stores, etc. eating and drinking establishments	Y	Y	Y	N
Services (SLUCM Category 60)				
Finance, insurance and real estate, personal, professional and miscellaneous services (office uses only)	Y	Y	Y	N
Cemeteries	Y	Y	Y	N
Warehousing/storage & repair services	Y	Y	Y[4]	Y[4]
Hospitals/medical, child care & development services, nursing homes, educational facilities	Y	Y[1]	N	N
Governmental	Y	Y	Y	N

TABLE B-3. LAND USE COMPATIBILITY IN LARGE CALIBER AND EXPLOSIVE NOISE ZONES, cont'd

LAND USE	C-weighted DNL Levels			
LAND USE NAME & SLUCM Category	<57dB	57-62dB	62-70dB	>70 dB
Cultural, entertainment and recreational (SLUCM Category 70)				
Cultural activities, auditoriums & concert halls	Y	Y[1]	N	N
Nature exhibits, cultural activities, auditoriums, concert halls, places of worship; outdoor music shells, museums, outdoor displays, amphitheaters, sports arenas, spectator sports, resorts and group camps, or other places of assembly	Y	Y[1]	N	N
Amusements - fairgrounds, miniature golf, driving ranges; amusement parks, etc.	Y	Y	Y	N
Outdoor recreational activities - golf courses, riding stables, water recreation, parks, etc.	Y	Y	Y	N
Resorts, campground	Y	Y	N	N
Resource Production and Extraction[5] (SLUCM Category 80)				
Agriculture (including grazing and feedlots) and forestry	Y	Y	Y	Y
Livestock farming, animal breeding	Y	Y	N	N
Fishing, mining and other resource production or extraction	Y	Y	Y	Y

KEY TO TABLE B-3 – LAND USE COMPATIBILITY IN LARGE CALIBER AND EXPLOSIVES NOISE ZONES:

Y (Yes) – Land use and related structures compatible without 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 generally are compatible. However, see note(s) indicated by the superscript.

N^x – No with exceptions. The land use and related structures are generally incompatible. However, see note(s) indicated by the superscript.

SLUCM – Standard Land Use Coding Manual

Note: Large caliber is defined as a weapon with a bore diameter of 20 millimeter and above.

NOTES FOR TABLE B-3 – LAND USE COMPATIBILITY IN LARGE CALIBER AND EXPLOSIVES NOISE ZONES

General notes for all uses:

Compatibility designations in Table B-3 generally refer to the principal use of the site. If other uses with greater sensitivity to noise are proposed, a determination of compatibility should be based on that use which is most adversely affected by noise.

FOOTNOTES TO TABLE B-3 – LAND USE COMPATIBILITY IN LARGE CALIBER AND EXPLOSIVES NOISE ZONES

1. The 57-62 dB CDNL (Land Use Planning Zone (LUPZ) functions as a buffer for the 62-70 dB CDNL area. Local governments have implemented land use planning measures in areas <62 dB CDNL. In addition to mitigating current noise impacts, implementing land use controls within this contour can create a buffer and limit development trends to prevent the possibility of future noise conflicts.
2. Although local demand for on- or off-installation housing may support noise-sensitive land uses within 62-70 dB CDNL, such land use is generally not compatible within 62-70 dB CDNL. Measures to achieve overall noise level reduction inside structures do not solve noise difficulties outside the structure. Barriers are not effective reducing the noise generated from large caliber military weapons firing (artillery, tank, etc.) or the detonation of explosives. Additionally, noise level reduction inside structures does not mitigate the vibration generated by the low-frequency energy of large caliber weapons firing and detonations.

TABLE B-3. LAND USE COMPATIBILITY IN LARGE CALIBER AND EXPLOSIVE NOISE ZONES, cont'd

FOOTNOTES TO TABLE B-3 – LAND USE COMPATIBILITY IN LARGE CALIBER AND EXPLOSIVES NOISE ZONES, Continued

1. Existing noise-sensitive land uses are considered as pre-existing incompatible land uses. In most cases these uses are not a risk to mission sustainment or a community's quality of life. Most long-term members near military installations or activities acknowledge hearing military operations and activities, but they are usually not alarmed or bothered by the noise. However, landowners, occupants, or other users may change over time, therefore the comfort or familiarity with military noise will not remain permanent or constant. Effort should be made to limit further incompatible development, seek mitigation efforts, and where practicable to roll back pre-existing incompatible land uses.
2. Although noise levels may be compatible, exercise caution in siting any activity that may be sensitive to vibration.
3. The land uses within this category include necessary associated resource management activities, for example, wildfire management activities for forestry.
4. This compatibility table identifies places of worship as a cultural gathering. However, religious institutions provide a wide variety of services and in these instances refer to the applicable category.

C DATA USED TO GENERATE NOISE CONTOURS

Weapon generated noise model inputs were extracted from the Range Facility Management Support System (RFMSS) ammunition expenditure report for Fiscal Years (FY) 2019 through 2022. C-1 lists the small arms activity and Table C-2 lists the demolition and large caliber activity. The FY 2022 demolition and large caliber expenditure are projected to be representative of the throughput for the next few years.

Table C-3 lists the range facilities and associated activities utilized in the development of the “all artillery firing points with routine training” and “infrequent demolition activity” single event Peak contours.

Table C-1. Small Arms Utilization

General Location with Camp Williams	Range Name	PISTOL, .22 CAL, LIVE	PISTOL, .40 CAL, LIVE	PISTOL, .45 CAL, LIVE	PISTOL, 9 MM, LIVE	TRAINER AT4, 9MM TPT	RIFLE, .22 CAL, LIVE	RIFLE, 300 MAG, LIVE	RIFLE, 5.56 MM, LIVE	RIFLE, 5.56 MM, BLANK*	MACHINE GUN, 7.62 MM, LIVE	MACHINE GUN, 7.62 MM, BLANK*	MACHINE GUN, .50 CAL, LIVE	MACHINE GUN, .50 CAL, BLANK*	SHOTGUN, 12 GAUGE
Northeast	Alternate Pistol (AP) Range	√		√	√				√						√
	Auxiliary Pistol (AU) Range	√	√	√	√										√
	Bobber (BO) Pistol Range	√	√	√	√										√
	10 Turner (20T) Pistol Range	√	√	√	√										√
	20 Turner (20T) Pistol Range	√	√	√	√										√
	Biathlon (BI) Range						√								√
	300 Meter Zero (300Z) Range				√				√		√				
South Central	25 Meter Zero Range Alpha (25M A)			√	√		√		√						√
	Combat Pistol (CP) Qualification Range			√	√				√						
	Grenade Launcher Range (GLR)										√				
	Modified Record Fire (MRF) Range				√				√	√	√				
Southwest	10 Meter (10M) Machine Gun Range			√	√				√		√	√			
	25 Meter Zero Range Bravo (25M B)			√	√				√						√
	25 Meter Zero Range Charlie (25M C)			√	√				√		√				
	Aerial Gunnery Range				√				√						√
	EQA #3 Pad					√							√		
	Infantry Squad Battle Course (ISBC)			√	√			√	√		√				
	Known Distance (KD) Range			√	√			√	√		√				
	Multipurpose Machine Gun (MPMG) Range				√			√	√	√	√	√	√	√	√

Note:
Blank is defined as any round that contains propellant without a bullet

Table C-2. Demolition and Large Caliber Expenditure

Facility	Nomenclature	Quantity Fired				4 Year Average	Average Annual Expenditure	
		FY19	FY20	FY21	FY22		0700-2200	2200-0700
100 FIR PT	105mm Howitzer High Explosive		72	97	425	149	149	0
	155mm Howitzer High Explosive		236	692	348	319	319	0
300 FIR PT	105mm Howitzer High Explosive				200	50	50	0
	155mm Howitzer High Explosive	1			400	100	100	0
400 SERIES	155mm Howitzer Inert	3				1	1	0
	105mm Howitzer High Explosive	34				9	9	0
	155mm Howitzer High Explosive	1335				334	334	0
	155mm Howitzer Inert	4				1	1	0
500 SERIES	105mm Howitzer High Explosive	34				9	9	0
	155mm Howitzer High Explosive	189				47	47	0
	155mm Howitzer Inert	3				1	1	0
AFGHAN VILLAGE	Demolition, Block C4 1.25 lb				1	1	1	0
EAST DIGGING AREA	155mm Howitzer High Explosive			66		17	17	0
EQA #1 PAD	Demolition, Block C4 1.25 lb	10	14			6	6	0
	Demolition, Cratering 40 lb	200				50	50	0
EQA #2 PAD	Demolition, Block C4 1.25 lb	110	3	3	24	35	35	0
	Demolition, Cratering 40 lb	2	6			2	2	0
EQA #3 PAD	40mm Grenade High Explosive	704			122	207	207	0
	60mm Mortar High Explosive			151	103	64	64	0
	81mm Mortar High Explosive			151	104	64	64	0
	AT-4 Rocket High Explosive				38	10	10	0
	Demolition Kit, Bangalore M1A2				1	1	1	0
	Demolition Kit, C4 16 @ 1.25 lb	62			1	16	16	0
	Demolition, Block C4 1.25 lb		43	5	262	78	78	0
	Demolition, Cratering 40 lb	200	2			51	51	0
	Mine, Claymore M18A1		3			1	1	0
GRENADE LAUNCHER	40mm Grenade High Explosive			216		54	54	0
HAND GRENADE	Hand Grenade M33/M67	328	398	716	202	411	411	0
HST LANE-SEARCH HOUSE-COP/HST LANE-WOOD HOLLOW HST	Demolition, Block C4 1.25 lb				13	4	4	0
	Demolition, Block TNT 0.25 lb				1	1	1	
ISBC	155mm Howitzer High Explosive	3		364		92	92	0

Table C-2. Demolition and Large Caliber Expenditure, cont'd

Facility	Nomenclature	Quantity Fired				4 Year Average	Average Annual Expenditure	
		FY19	FY20	FY21	FY22		0700-2200	2200-0700
LIVE-FIRE-SHOOTHOUSE-USASOC	Demolition, Block C4 1.25 lb				4	1	1	0
MACHINE GUN	40mm Grenade High Explosive	700				175	175	0
MOUT LFX SHOOTHOUSE	Demolition, Block C4 1.25 lb	11			2	3	3	0
	Demolition, Shaped 15 lb		24			6	6	0
OAK SPRINGS	155mm Howitzer High Explosive	200				50	50	0
PAIUTE	155mm Howitzer High Explosive			6		2	2	0
PINYON HILL	155mm Howitzer High Explosive	72				18	18	0
UTE	105mm Howitzer High Explosive	34	467		20	130	130	0
	155mm Howitzer Inert			29		7	7	0
	155mm Howitzer High Explosive	30	137	73		60	60	0
WEST DIGGING AREA	105mm Howitzer High Explosive	624	308		42	244	244	0
	155mm Howitzer High Explosive	253		72		81	81	0

Notes:
Artillery firing points are summarized in their respective training areas.
Expenditure maybe rounded to prevent fractional rounds.
Inert is defined as any round that does not explode upon impact (i.e., illum, practice, smoke, etc…)

Table C-3. Secondary Assessment Single Event Peak Contour Noise Model Inputs

Shown In	Facility	Nomenclature
Figure 6-6	14 PEAKS	155mm Howitzer High Explosive
	100 FIR PT	105mm Howitzer High Explosive
		155mm Howitzer High Explosive
	300 FIR PT	105mm Howitzer High Explosive
		155mm Howitzer High Explosive
	400 SERIES	155mm Howitzer Inert
		105mm Howitzer High Explosive
		155mm Howitzer High Explosive
		155mm Howitzer Inert
	500 SERIES	105mm Howitzer High Explosive
		155mm Howitzer High Explosive
		155mm Howitzer Inert
	AFGHAN VILLAGE	Demolition, Block C4 1.25 lb
	BEEF HOLLOW EAST	155mm Howitzer High Explosive
	BLUFFDALE MEADOW	155mm Howitzer High Explosive
	BLUFFDALE SOUTH	155mm Howitzer High Explosive
	EAST DIGGING AREA	155mm Howitzer High Explosive
	EQA #1 PAD	Demolition, Block C4 1.25 lb
		Demolition, Cratering 40 lb
	EQA #2 PAD	Demolition, Block C4 1.25 lb
		Demolition, Cratering 40 lb
	EQA #3 PAD	40mm Grenade High Explosive
		60mm Mortar High Explosive
		81mm Mortar High Explosive
		AT-4 Rocket High Explosive
		Demolition Kit, Bangalore M1A2
		Demolition Kit, C4 16 @ 1.25 lb
		Demolition, Block C4 1.25 lb
		Demolition, Cratering 40 lb
		Mine, Claymore M18A1
	GOSHUTE	155mm Howitzer High Explosive
	GRENADE LAUNCHER	40mm Grenade High Explosive
	HAND GRENADE	Hand Grenade M33/M67
	HST LANE-SEARCH HOUSE-COP/HST LANE-WOOD HOLLOW HST	Demolition, Block C4 1.25 lb
		Demolition, Block TNT 0.25 lb

Table C-3. Secondary Assessment Single Event Peak Contour Noise Model Inputs, cont'd

Shown In	Facility	Nomenclature
Figure 6-6	ISBC	155mm Howitzer High Explosive
	LIVE-FIRE-SHOOTHOUSE-USASOC	Demolition, Block C4 1.25 lb
	MACHINE GUN	40mm Grenade High Explosive
	MOUT LFX SHOOTHOUSE	Demolition, Block C4 1.25 lb
		Demolition, Shaped 15 lb
	OAK SPRINGS	155mm Howitzer High Explosive
	PAIUTE	155mm Howitzer High Explosive
	PINYON HILL	155mm Howitzer High Explosive
	POW HIGH	155mm Howitzer High Explosive
	POW LZ	155mm Howitzer High Explosive
	SHOSHOONI HIGH	155mm Howitzer High Explosive
	SHOSHOONI INTERSECTION	155mm Howitzer High Explosive
	UTE	105mm Howitzer High Explosive
		155mm Howitzer Inert
		155mm Howitzer High Explosive
	WATER TOWERS	155mm Howitzer High Explosive
	WEST DIGGING AREA	105mm Howitzer High Explosive
		155mm Howitzer High Explosive
Figure 6-9	EQA #2 PAD	Demolition, 320 lb NEW
Figure 6-10	EQA #3 PAD	Demolition, 105 lbs NEW
Figure 6-8	LIGHT DEMO RANGE	Demolition, 40 lb NEW

D REFERENCES

Crocker, M. J., editor. 1998. *Handbook of acoustics*. John Wiley and Sons, Inc., New York, New York, USA.

DOD, 2020. Department of Defense Instruction (DODI) 4715.13, DoD Operational Noise Program, January 2020.

DOD, 2004. DODI 3030.3, Joint Land Use Study (JLUS) Program.

Federal Highway Administration, 1965, Standard Land Use Coding Manual: A Standard System for Identifying and Coding Land Use Activities.

International Organization for Standardization (ISO), 1996. ISO 9613-2:1996, *Acoustics- Attenuation of Sound During Propagation Outdoors- Part 2: General Method of Calculation*.

Lewis, 1991. "Military Applications of Barriers," Presented at the 122nd meeting of the Acoustical Society of America, November 1991.

Luz, 1990. "The Acoustics of Guns," Presented at the US Army Europe and Africa Noise Management Workshop.

Northwestern University, 1981. Center for the Interdisciplinary Study of Science and Technology Report, Social, Economic and Legal Consequences of Blasting in Strip Mines and Quarries.

National Guard Bureau, 2018. National Guard Supplement 1 to Army Regulation 95-1, Flight Regulations.

Pater, 1976. "Noise Abatement Program for Explosive Operations at NSWC/DL," Presented at the 17th Explosives Safety Seminar of the DOD Explosives Safety Board.

Pater, 1981. Gun Blast Far Field Peak Overpressure Contours. NSWC TR 79-442, Dahlgren, Va., March 1981.

REPI, 2017. Readiness and Environmental Protection Integration (REPI) Program Project

Rylander, R, S Sorensen, and K Berglund, 1974. Re-analysis of aircraft noise annoyance data against the dB(A) peak concept. *Journal of Sound and Vibration* 36(3):399–406.

Rylander, Bjorkman, and Ahrlin, 1980. Aircraft Noise Annoyance Contours: Importance of Overflight Frequency and Noise Level. *Journal of Sound and Vibration* 69(4): 583–595.

Rylander and Bjorkman, 1988. Maximum Noise Levels As Indicators of Biological Effects. *Journal of Sound and Vibration* 127(3): 555–563.

Siskind, 1989. “Vibrations and Airblast Impacts on Structures from Munitions Disposal Blasts,” Proceedings, Inter-Noise 89, G. C. Maling, JR., editor, pages 573-576.

Schomer, P.D. and Luz, G. A. 1978. “Statistics of amplitude and spectrum of blasts propagated in the atmosphere.” *Journal of the Acoustical Society of America*, 63(5), 1431-1443, May 1978.

University of Utah, 1958. Explosives Research Group Report No. 12, Measurement of Air and Ground Shock Disturbances Arising from Demolition Activities at Letterkenny Ordnance Depot.
US Air Force, 1978. Air Force Manual 19-10, Planning in the Noise Environment.

U.S. Air Force, 2005. SELcalc2 Noise Model, Wright-Patterson Air Force Base, OH.

U.S. Air Force, 2019, Noisemap 7.366 – Advanced Acoustical Model (AAM), Wright-Patterson Air Force Base, OH.

U.S. Army 1983. USAEHA Environmental Noise Assessment No. 52-34-0415-83, Noise Levels from Machine Guns, Grenade and Artillery simulators from Training at Sudbury Annex, Fort Devens, MA, 23-24 March 1983.

U.S. Army, 1984. Army Environmental Hygiene Agency, Environmental Noise Assessment No. 52-34-0442-84, Noise Measurement Study, Camp Bullis, Texas, 27 February – 2 March 1984.

U.S. Army 1989. USAEHA Environmental Noise Assessment No. 52-34-0447-89, Results of Monitoring Edgewood Area Field Training Exercise Site, Aberdeen Proving Ground, MD, June 1989.

U.S. Army, 1999. Center for Health Promotion and Preventive Medicine, Health Hazard Assessment Report on the 40mm XM1001 Canister Cartridge for the MK-19 Mod 3 Grenade Machine Gun, No. 69-37-2735-00, November 1999.

U.S. Army, 2007. Army Regulation 200-1, Environmental Protection and Enhancement, Chapter 14 Operational Noise.

U.S. Army, 2009. U.S. Army Construction Engineering Research Laboratories, BNOISE2 Computer Model, Version 1.3 2009-11. 30.

U.S. Army, 2015. U.S. Army Engineer Research and Development Center, SARNAM Computer Model, Version 2015-07-27

U.S. Census Bureau, 2023. Homepage and Quick facts. URL: http://www. census.gov

Utah National Guard, 2022. Utah National Guard Regulation (UTNRG) 385-63-1. Camp W.G. Williams Range Safety, January 2022.