APPENDIX G
ENVIRONMENTAL NOISE ASSESSMENT

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Blue Ridge Research and Consulting, LLC

August 2012 Final Report

Environmental Noise Assessment for the Proposed Foreign Affairs Security Training Center (FASTC) in Nottoway County, Virginia

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Executive Summary

The United States (U.S.) General Services Administration (GSA) is proposing to acquire land and develop a U.S. Department of State (DOS), Bureau of Diplomatic Security (DS) Foreign Affairs Security Training Center (FASTC) in Nottoway County, Virginia. The proposed location is near the town of Blackstone within and adjacent to the Army National Guard Maneuver Training Center Fort Pickett (Fort Pickett), which is operated by the Virginia Army National Guard (VAARNG). FASTC would be used to provide training for DS law enforcement and security personnel. Training would be conducted in the use of small caliber weapons, demolition, and evasive and tactical driving at planned facilities. These facilities, which would be fully operational in the year 2020, are expected to generate a mixture of continuous and impulsive noise.

The purpose of this study was to predict the noise environment that would result from implementing the Proposed Action, the development of FASTC in Nottoway County. This study also determines whether there would be a change in the existing noise environment that may adversely impact the community.

Noise results are provided for the three main types of FASTC activities: drive tracks and courses, demolition, and small caliber weapons training. Where applicable, these results are then compared and combined with the Baseline noise environment, defined as existing noise generated by Fort Pickett operations. The results are combined because under the proposed project the resulting noise environment would be both FASTC and Fort Pickett operations occurring simultaneously. Fort Pickett operations are mainly due to demolition and large caliber weapons. Weapons are classified as large caliber if the associated rounds are greater than .50 caliber; otherwise they are classified as small caliber. This analysis was accomplished using training operations data provided by the DS and standardized computer models and methods of assessment.

The study results show that, overall, the proposed FASTC training operations are predicted to generate limited additional noise exposure in the surrounding residential communities beyond the existing noise due to Fort Pickett. However, Blackstone residents are still likely to notice several changes to their noise environment if FASTC is implemented. First, there would be additional demolition operations, increasing the overall number of explosive events heard. But of these additional events, mainly the higher yield FASTC demolition operations (2 to 3 pound charges) would be noticed; the 3 pound demolition charges are expected to occur a total of 6 times per year during the daytime (and likewise the 2.23 pound charges are expected to occur 36 times per year during the daytime). These are much lower in number on an annual basis then existing Fort Pickett operations. For example, existing 105mm Howitzer firings occur 565 times per year during the daytime and 63 times per year during nighttime hours at just one gun site. Overall, Fort Pickett conducts a much larger number of firings by multiple high-caliber weapons. The higher yield FASTC demolition operations (2 to 3 pound charges) add up to 42 additional events per year. While the frequency of these proposed events is unknown, if they were spread out

evenly throughout the year, over a fifty week period, for example, then this would mean that Blackstone residents would be expected to hear about 1.2 additional demolition events per week with the Proposed Action.

The second noticeable difference is that peak noise levels would increase in the immediate vicinity of the northwest boundary of Fort Pickett as a result of these FASTC demolition charges. This is predicted to occur because the FASTC demolition pads would be located closer to the western boundary of Fort Pickett than the existing operations, even though the FASTC operations have a lower acoustic output compared to most of the high caliber Fort Pickett weapons. Despite this increase in peak levels, the infrequency of these events would result in a low risk that residents in the surrounding communities would complain.

Drive tracks and road courses

Drive tracks and road courses were assessed in terms of hourly average sound levels and maximum sound levels. Noise criteria were determined from a review of the noise ordinances of several local jurisdictions as well as from the Noise Abatement Criteria (NAC) of the Federal Highway Administration (FHWA). The FHWA criteria, which was used for average sound levels, are that a noise impact occurs when the hourly average A-weighted sound level is 66 decibels (dBA) or higher. The study results show there would no noise impact beyond 70 feet from the centerline of the loudest track as well as from the skid pad locations where skid pad and car ramming exercises would occur.

The local criteria used for maximum sound levels are that noise impacts occur when the maximum A-weighted sound level (L_{Amax}) is 65 dB or higher during the daytime or 55 dB or higher at night. The study results show there would be no noise impact beyond approximately 1,000 feet from the loudest track during the daytime, and 500 feet from the loudest track at night. Similarly for skid pad and car impact exercises, the study results show there would be no noise impact beyond 800 feet from the skid pads.

Because of the distances to the nearest residential community of Blackstone, about one mile northwest of the drive tracks, none of the driving exercises would generate noise levels in residential areas that exceed either criteria.

Demolition noise

Demolition noise was evaluated two ways: first from a land use planning perspective with regard to compatibility with residential, commercial, or other types of development; and second, to identify where noise complaints are likely to occur. The main observations, comparing the Proposed Action noise levels with the Baseline Fort Pickett levels (U.S. Army Public Health Command 2011)[1], are that (1) noise exposure from FASTC proposed operations is concentrated in the northwest part of Fort Pickett, including the 21/20 Parcel (where the demolition pads are located), LRA Parcels 9 and 10, Grid Parcel, and the Blackstone Army Airfield and (2) this additional FASTC noise exposure only increases the combined noise environment (Baseline + Proposed Action) above the Baseline in this one area. Examining the noise exposure outside Fort Pickett in terms of compatible land use, the only noticeable

difference, between the Baseline and the combined action (Baseline + Proposed Action) occurs for the 57 dB noise contour. In this analysis, average noise level contours define noise zones used to assess land use compatibility. The proposed addition of FASTC activities would generate a 57 dB contour that would extend just beyond the Fort Pickett boundary, directly north of the airfield, by approximately 650 feet. This would result in an extension of the Land Use Planning Zone (LUPZ) and Zone I, which are acceptable for noise sensitive land uses (e.g., housing, schools, and medical facilities). In addition, the area affected is mostly limited to the industrial zone, such that minimal additional incompatibilities in land use are expected to result with the introduction of FASTC operations. Noise exposure within Fort Pickett is also expected to increase with the most notable result being an increase in Noise Zone II (62-70 dB) extending over parts of Pickett Park, the 21/20 Parcel, Grid Parcel and the eastern part of LRA Parcel 9. There are a number of VAARNG buildings located east of Pickett Park and near the southern boundaries of LRA Parcel 9 and the Grid Parcel that would be located in Noise Zone II with the Proposed Action.

Peak noise levels would also increase with the addition of FASTC demolition activity, but the complaint risk areas determined indicate that there is still expected to be a low risk of complaints from residents in the surrounding communities. Blackstone would still be well outside of the Moderate Complaint Risk area. However, this complaint risk area would extend to include several commercial and residential properties located north of the airfield; these include the Virginia Polytechnic Institute Agricultural Research and Extension campus and a single residence located on Virginia Tech property. Still, these properties would be located in a Moderate Complaint Risk area. For locations within Fort Pickett, there would be an expansion of the Moderate Complaint Risk areas associated with LRA Parcels 9 and 10 and the Blackstone Army Airfield and an expansion of the High Complaint Risk areas associated with LRA Parcel 9 and the Grid Parcel. Although there are VAARNG buildings located east of LRA Parcel 9 and south of the Grid Parcel, these areas are typically used by base personnel therefore complaint risk is expected to be lower than it would be for the general population. Likewise, simulator activity in LRA Parcel 9 is expected to have a low risk of complaints associated with these same VAARNG buildings.

Small Caliber Weapons

Small caliber weapons noise was evaluated for outdoor and indoor ranges separately using peak sound levels. The single outdoor firing range (R05) is an existing range currently used by Fort Pickett. It is expected that FASTC training would use a similar mix of weapons as are currently being used by Fort Pickett; therefore, peak noise levels are not expected to change from the existing Baseline conditions. The indoor firing ranges include several different types of structures but design plans for these structures have not been finalized. For this analysis, a generic case was analyzed which assumed that the building construction of each indoor range is of the brick and mortar type, with a corresponding noise level reduction (NLR) value of 25 dB provided on the exterior of the building. For the proposed FASTC gun types, estimates were made of the exterior peak sound levels for two representative distances (328 feet and 656 feet) and three azimuths (0°, 90° and 180°) from the firing position. Per AR 200-1 (U.S. Army 2007)[2], small arms operations were analyzed using noise zone definitions, which define acceptable land uses. Estimates of the exterior peak sound levels (dBP) associated with the indoor ranges indicate

that all Zone II (87-104 dBP) and Zone III levels (> 104 dBP) are expected to remain within Fort Pickett. Additionally, the Zone III noise contour (> 104 dBP) is expected to remain relatively localized and within 328 feet of the weapon position for all types of weapons, whereas the Zone II contours (87-104 dBP) extend farther out from the weapon position (approximately 656 feet).

Occupational Noise Exposure

Noise levels within Fort Pickett are not expected to change much in areas where there are existing operations; however, levels would increase in areas where new facilities are planned, especially in areas located away from existing operational sites. A concern for personnel working or training at these new facilities is that certain noise events may be of high enough intensity to damage unprotected hearing. To address this concern, an assessment of occupational noise exposure was conducted for all FASTC facilities to identify areas where personnel would potentially be at risk. The Federal Occupational Safety and Health Administration (OSHA) (U.S. Department of Labor 1981)[3] has established decibel (dB) levels for hearing protection that include limits on "continuous" and "impulsive" noise exposure. For continuous noise, the 8-hour, time-weighted average level of 85 dBA was used, which corresponds to the limit for establishing a hearing conservation program. For impulsive noise, the OSHA criterion for unprotected occupational noise exposure is an unweighted peak level of 140 dB. OSHA noise evaluation of the driving exercises (which are treated as continuous sources) indicates that while the noise levels for individual car passes, skid pad exercises, and car ramming exercises would exceed 85 dBA at locations close to the tracks, because of the low number of proposed daily operations, the OSHA 8-hour TWA, in the vicinity of all tracks and courses, would be significantly less than the OSHA limit. Demolition training and small arms training (which are impulsive sound sources) are expected to generate peak noise levels that exceed the OSHA criteria of 140 dBP at certain distances from each demolition or firing event. This is also true for simulators and other smaller explosives. Predicted distances to the 140 dB peak contour for each weapon are specified in the report, thus estimating the extent of the hazardous noise zone. A single unprotected exposure to loud gunfire can result in temporary hearing loss; repeated exposure to impulsive firearm noise can result in permanent noise-induced hearing loss. To be in compliance with OSHA 1910.95[3], it is expected that operators of the FASTC demolition ranges and firing ranges would provide hearing protection to personnel working and training at these sites during live operations.

List of Acronyms and Abbreviations

ACUB	Army Compatible Use Buffer
AMSL	Above Mean Sea Level
AR	Army Regulation
AVG	Average
BNOISE2	Large Arms Noise Assessment Model
CDNL	C-Weighted Day-Night Average Sound Level
dB	Decibel
dBA	A-Weighted Sound Pressure Level
dBP	Peak Sound Pressure Level
DGAC	Dense-Graded Asphaltic Concrete
DNL	Day-Night Average Sound Level
DOD	Department Of Defense
DOS	Department of State
DS	Bureau of Diplomatic Security
FASTC	Foreign Affairs Security Training Center
FHWA	Federal Highway Administration
GSA	General Services Administration
HCA	Hearing Conservation Amendment
Hz	Hertz
IED	Improvised Explosive Device
LAeq1h	Hourly Average A-Weighted Sound Level
L_{AFMAX}	Maximum A-Weighted Fast-Response Sound Level
L_{Amax}	Maximum A-Weighted Sound Level
LUPZ	Land Use Planning Zone
MAX	Maximum
MIN	Minimum
mm	Millimeter
MPH	Miles per Hour
NAC	Noise Abatement Criteria
NEW	Net Explosive Weight
NLR	Noise Level Reduction
OGAC	Open-Graded Asphaltic Concrete
OSHA	Occupational Safety and Health Administration
PCC	Portland Cement Concrete
PEL	Permissible Exposure Limit
PK15	Peak Sound Level Exceeded 15 Percent of the Time
PK50	Peak Sound Level Exceeded 50 Percent of the Time
REMEL	Reference Energy Mean Emission Level
SARNAM	Small Arms Range Noise Assessment Model
SI	International System of Units
TNM	Federal Highway Administration's Traffic Noise Model
TWA	Time Weighted Average
USAPHC	U.S. Army Public Health Command
VAARNG	Virginia Army National Guard

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1 Introduction

1.1 Purpose

This noise analysis is one of the environmental studies being conducted to support the U.S. General Services Administration, Environmental Impact Statement for the Department of State, Bureau of Diplomatic Security (DS), Foreign Affairs Security Training Center (FASTC). The United States (U.S.) General Services Administration (GSA) is proposing to acquire land and develop a U.S. Department of State (DOS), Bureau of Diplomatic Security (DS) Foreign Affairs Security Training Center (FASTC) in Nottoway County, Virginia. The proposed location is near the town of Blackstone within and adjacent to the Army National Guard Maneuver Training Center Fort Pickett (Fort Pickett), which is operated by the Virginia Army National Guard (VAARNG). FASTC would be used to provide training for DS law enforcement and security personnel. This would involve training in the use of small arms weapons and demolition as well as driver training on paved tracks and off-road courses. The purpose of this study is to estimate the noise levels associated with these training activities to determine if the proposed siting of FASTC would adversely impact the communities surrounding Fort Pickett or personnel working or training at Fort Pickett.

FASTC training includes a variety of exercises and operational events which would combine to form a complex noise environment. For instance, driver training exercises on paved tracks would include multiple cars travelling at speeds of up to 100 mph on certain parts of the track. Other related driving exercises would involve controlled skidding and car ramming. On one of the urban drive tracks, flash bangs would be used to create an environment where simulated improvised explosive devices (IED) are used. These noise sources related to driver training have different characteristics; whereas the flash bangs are impulsive, high-amplitude events, car driving on the paved tracks is better classified as continuous noise, and car skidding and ramming tests are short duration events (i.e., neither impulsive nor continuous). Added to these driving exercises would be small arms training at both indoor and outdoor facilities and demolition training, which are impulsive, high-amplitude operations. All of these operations are expected to generate a varied and complex noise environment.

Because there is no single noise assessment methodology which combines impulsive and continuous noise sources, the various FASTC training exercises were modeled separately depending on whether the noise from these exercises is normally characterized as impulsive, high-amplitude (such as gun fire or demolition operations) or as continuous (car driving). Industry standard computer noise models were used to predict the noise exposure due to all FASTC training operations. Where applicable, the noise from FASTC operations were compared (and integrated) with the existing Fort Pickett Baseline noise environment recently estimated by the U.S. Army Public Health Command (USAPHC) (USAPHC 2011)[1]. The results are combined because under the proposed project the resulting noise environment would be both FASTC and Fort Pickett operations occurring simultaneously. To compare both results and determine the overall noise environment for the Proposed Action (Fort Pickett Baseline + proposed FASTC), the FASTC analysis uses noise assessment methodologies identical to those used by the USAPHC.

This report contains the following sections: a description of the noise metrics and models used (section 1), FASTC training facilities and operations (section 2), and noise evaluation for the drive tracks, demolition, and small caliber weapons operations (in sections 3-5, respectively). Section 6 provides an occupational noise exposure assessment for personnel who would be working or training at FASTC facilities.

1.2 Noise Environment and Metrics

Noise represents one of the most prominent environmental issues associated with military training operations. The noise environment at military installations, such as Fort Pickett, includes different types of noise sources that can either be classified as continuous noise (e.g., on-base vehicular traffic and aircraft operations), or impulsive noise (e.g., weapons firing or detonation of explosives). Not all of these noise sources are directly associated with military training, such as civilian vehicular traffic or building HVAC system noise. However, the noise environment on military bases is typically dominated by military training operations.

The noise environment at Fort Pickett is dominated by impulsive noise events ranging from demolition testing, large-caliber weapons firing, and small arms firing and, to a lesser extent, by continuous noise including vehicular traffic. Some of the loudest munitions used by Fort Pickett include mortars (up to 120 mm high explosive) and Howitzer firings (up to 155 mm high explosive). The proposed FASTC training facilities at Fort Pickett would also include demolition testing and small arms firing as well as driving exercises. The loudest FASTC training events would be 3 pound demolition charges which, in comparison to the loudest VAARNG operations, have a smaller net explosive weight (NEW) and acoustic output. The proposed FASTC demolition operations are also expected to be significantly lower in number than the existing VAARNG demolition and large caliber weapon operations.

Humans perceive and react differently to impulsive and continuous noise events depending on the level as measured in decibels (dB), frequency, and duration of the event. Also, the threshold of hearing damage for unprotected personnel is different for impulsive noise than it is for continuous noise. Because of the difference in human response to these types of noise events, military operational noise is assessed using several different noise metrics. The two most commonly used metrics are the Day-Night Average Sound Level (DNL) and the Peak Sound Pressure Level (dBP).

The DNL is a federally-recommended noise measure used for assessing cumulative sound levels that account for the exposure of all noise events in a 24-hour period. DNL is an average sound level, expressed in dB. DNL is related to compatible/incompatible land uses and does not directly relate to any singular sound event a person may hear; it includes a 10 dB penalty for nighttime noise events. Daytime is defined as the period from 7:00 a.m. to 10:00 p.m., and nighttime is the period from 10:00 p.m. to 7:00 a.m. the following morning. The 10 dB penalty accounts for the generally lower background sound levels and greater community sensitivity to noise during nighttime hours.

To accurately assess the impacts on humans to these different types of noise events, the DNL metric is used along with different weighting factors that emphasize certain parts of the audio frequency spectrum. The normal human ear detects sounds in the range from 20 hertz (Hz) to 20,000 Hz, but is most sensitive to sounds in the 1,000 to 4,000 Hz range; the hertz is the International System of Units (SI) unit of frequency defined as the number of cycles per second of a periodic phenomenon. Community noise is often assessed using a filter called an "A-weighting" filter that approximates the frequency response of the human ear, adjusting low and high frequencies to match the sensitivity of the ear. This "A-weighting" filter is used to assess most community noise sources, including vehicular traffic and aircraft noise. However, for community sounds that are impulsive and contain significant low frequency energy, such as large-caliber weapon firings or explosive detonations, a weighting filter called "C-weighting" is used, which includes more low frequency noise than does the A-weighting filter.

The dBP is the highest instantaneous, unweighted sound level over any given time period. It is also used to quantify impulsive, short duration events such as a large-caliber and small arms weapon firing and explosive detonation. High peak sound levels can generate complaints from people in the local community. Peak sound levels can vary significantly due to varying weather conditions. Therefore, computer models used to predict peak levels account for this variation by using the PK15 metric. PK15 is the peak sound level, factoring in the statistical variations caused by weather, that is likely to be exceeded only 15 percent of the time (i.e., 85 percent certainty that the sound would be within this range). For average weather conditions, without significant variations, the PK50 metric can be used. This metric is the peak sound level that is likely to be exceeded 50 percent of the time.

In this analysis, and to be compatible with USAPHC's recent Baseline noise analysis for Fort Pickett[1], range noise was assessed using the Department of Defense (DoD) recommended noise metrics for Army Installations. Small arms noise was assessed using the peak sound level PK15. Large caliber weapon (Fort Pickett Baseline) and demolition noise, which includes low frequency noise components, was assessed using the C-weighted DNL (CDNL) as well as the PK15 and PK50 metrics. Besides the small arms weapon firing and demolition activity, FASTC would generate community noise from the various driving exercises. These were evaluated using hourly average and maximum sound levels, expressed in dBA, along with acceptable criteria for residential land use.

1.3 Computerized Noise Exposure Models

BNOISE2 (U.S. Army Construction Engineering Research Laboratories 2009)[5] is the standard DoD model used in this analysis to compute the PK15, PK50 and CDNL metrics for large caliber weapons and demolition operations. Primary inputs to BNOISE2 are the range firing and target point coordinates, munitions type, and number of daytime and nighttime rounds or operations. BNOISE2 accounts for weather and the effects of any land-water boundaries.

The DoD standard model for assessing noise from small arms range operations is SARNAM (U.S. Army Construction Engineering Research Laboratories 2003)[6]. SARNAM was used in this analysis to compute

the peak sound level (PK15) based on the range design (geographic location, number of targets, and direction of fire), weapons and ammunition used.

The Federal Highway Administration's (FHWA) Traffic Noise Model (TNM) (Federal Highway Administration 2004)[4] and associated Reference Energy Mean Emission Level (REMEL) data were used to predict the sound levels for the driving exercises. Average and maximum A-weighted sound levels were estimated for the proposed car operations on each of the drive tracks and courses.

Based on the FASTC operations data obtained from study team members, these models were exercised to develop noise exposure contours for the metrics identified above. CDNL contours define noise zones used to assess land use compatibility; peak level contours similarly define noise zones used to assess complaint risk. These noise contours are shown in sections 3-5 of this report.

2 FASTC Training Facilities and Proposed Operations

This section provides a description of the proposed FASTC training facilities and operations that are the focus of this noise study, including an overview of the entire training complex and details about each facility such as its primary use and proposed operations. FASTC would become fully operational by the year 2020.

To model the noise environment for the FASTC training exercises, operations data were collected for each of the exercises, including: demolition training, munitions utilization at small arms ranges, and several types of driving exercises. Driver training would include high-speed driving on paved tracks and driving at lower speeds on urban and off-road courses. Driving exercises on the paved tracks would also include car skid and car impact (ramming) events. Urban driving at Explosives Simulation Alley would include simulators used at various points along the course.

All operations data were collected from project team members during the first few months of the study. These data were organized in a Data Validation Package (Blue Ridge Research and Consulting 2012)[7], which was reviewed by project team members and finalized prior to starting the noise analysis.

The following sections provide a description of the study area and the FASTC training operations that are expected to occur when each facility is fully operational.

2.1 FASTC Site Plans

The proposed site of the FASTC training complex is located on the Fort Pickett, Virginia Army National Guard Maneuver Training Center (Fort Pickett) and on Pickett Park, in Nottoway County, Virginia, approximately 60 miles southwest of Richmond. Figure 1 depicts the Fort Pickett installation and surrounding areas, which consist primarily of rural land. The town of Blackstone, Virginia is the closest population center, located less than two miles west of Fort Pickett (Figure 2). All figures indicate the Fort Pickett boundary using either a grey border (as in Figure 1) or a blue border (Figure 2). The Proposed Action would locate the FASTC training facilities on four parcels of land (Figure 1), LRA 9 & 10, Grid Parcel, and 21/20 (EIS Alternatives 1 and 2 2012)[8]. Facilities are located in these parcels such that a buffer is provided between the expected noisiest training activities, occurring in the 21/20 Parcel, and the nearby town of Blackstone.

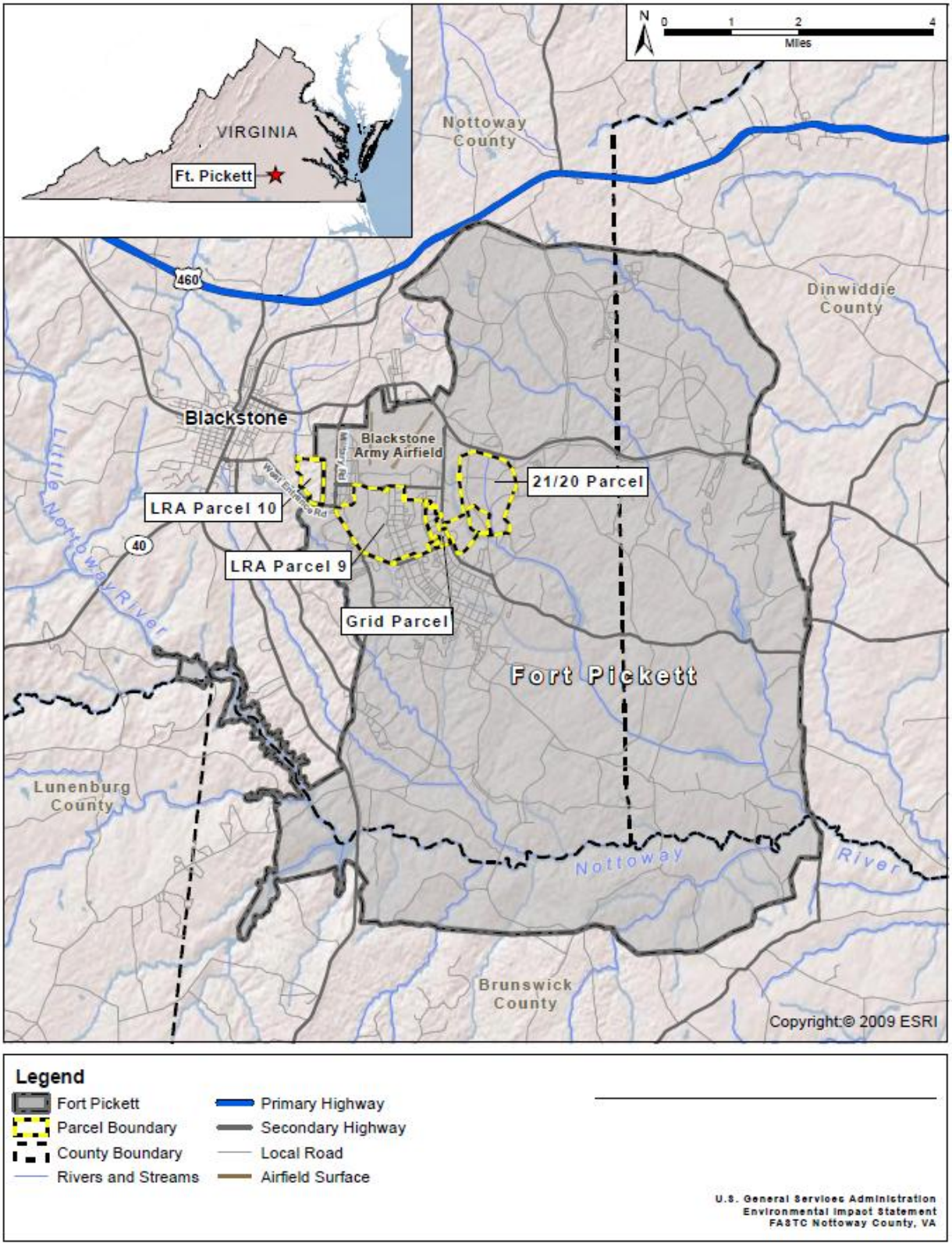

Figure 1. Fort Pickett Site Map with Proposed FASTC Land Parcels.

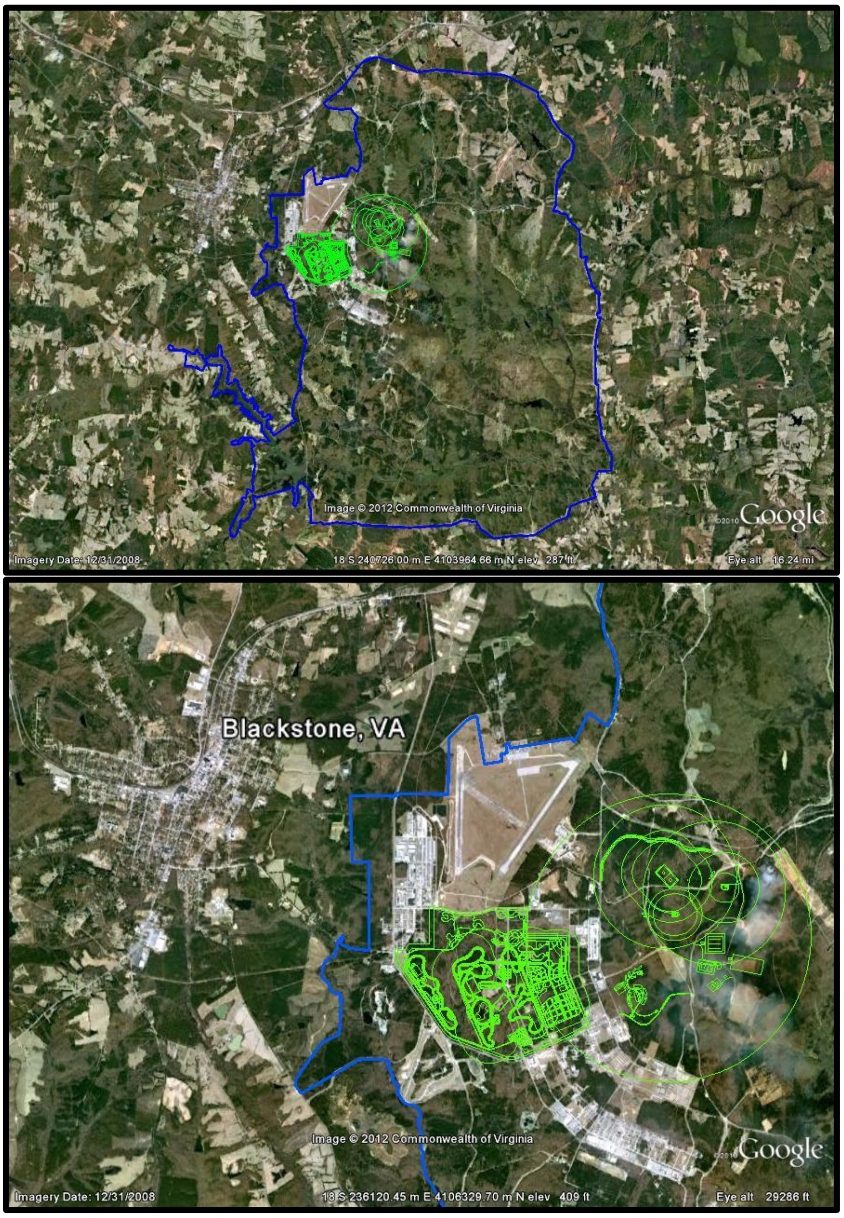

Figure 2. Proposed FASTC and Town of Blackstone, Virginia.

This analysis considers two build alternatives for the FASTC complex, referred to as Alternative 1 and Alternative 2. Build Alternative 1 is shown in Figure 3 with the different types of facilities identified using colored labels; blue (drive tracks and courses), red (demolition areas) and orange (firing ranges). Build Alternative 2 is similar to Alternative 1 with the exception that demolition facilities E02, E04, E05b and E05c/d and driving facilities D03 and T02 are relocated as indicated in Figure 4; this change in the range layout is the only major difference between the two alternatives' noise source locations. Facility operations, which are described in the following sections, are identical for both alternatives.

Figure 3. FASTC Build Alternative 1 Facility locations.

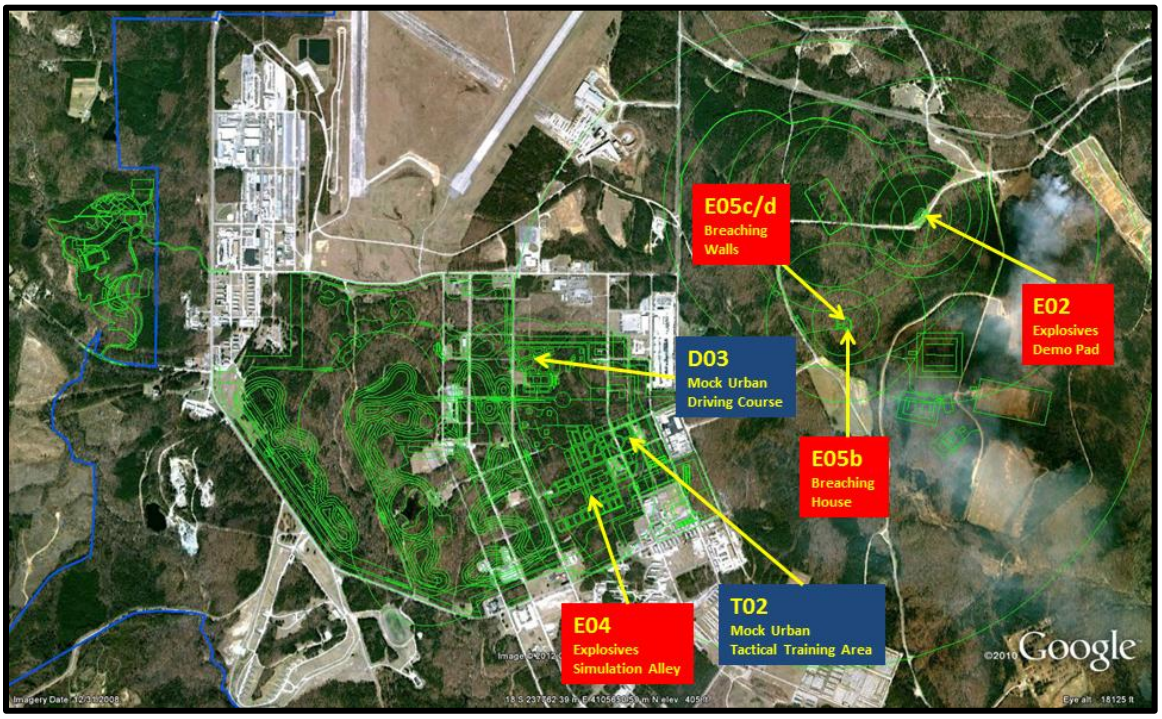

Figure 4. FASTC Build Alternative 2 (same as Alternative 1 but with E02, E04, E05b, E05c/d, D03 and T02 relocated).

2.2 Drive Tracks

2.2.1 High-Speed Driving Exercises

There are three High-Speed Anti-Terrorism Drive tracks as indicated in Figure 3. For training purposes, each track is divided into several sections where individual maneuvers are performed. The vehicle counts provided for each track in Table 1 are indicative of the number of trips around the track necessary to impart skills for protective security driving, attacks on principal, etc. The maximum number of cars on any track at one time is 9 and each car is estimated to make 30 trips around the track on the average day; this is a total of 270 trips around each track (or vehicle passes) per day[7]. Vehicle speeds would vary but can be up to 100 mph. No nighttime activities are proposed.

Table 1. High-Speed Driving Exercises

Driver Training Exercise	Vehicle Location	Speed (mph)			Average Daily Vehicle Count	
		Avg	Min	Max	Day (0700-2200)	Night (2200-0700)
D02 High-Speed Anti-Terrorism Driving (Track 1)	Continuous around track	50	25	100	270	0
D02 High-Speed Anti-Terrorism Driving (Track 2)	Continuous around track	50	25	100	270	0
D02 High-Speed Anti-Terrorism Driving (Track 3)	Continuous around track	50	25	100	270	0

Three other types of training events occur as part of the high-speed driving exercises; artillery simulator (flash bang) detonations, controlled car skids and car impacts or ramming of other cars. The proposed annual operations for these events are shown in Table 2 through Table 4, along with the event locations near each track, and the daytime and nighttime percentage of operations.

Table 2. Flash Bang (Artillery Simulator) Events

Flash Bang Events	Flash Bang Locations		Explosive Type	Total Events Forecast Year	Daytime % 0700-2200	Nighttime % 2200-0700
	Latitude (° N)	Longitude (° W)				
D02 (Track 1) Western	37.05477	77.96599	CTS 7290 Mini-Bang Pyrotechnic	200	100	0
D02 (Track 2) Center	37.05248	77.95759	CTS 7290 Mini-Bang Pyrotechnic	200	100	0
D02 (Track 3) Eastern	37.05751	77.95597	CTS 7290 Mini-Bang Pyrotechnic	200	100	0

Table 3. Skid Pad Exercises (controlled car skids)

Skid Pad Exercises	Skid Pad Location			Total Events Forecast Year	Daytime % 0700-2200	Nighttime % 2200-0700
	Latitude (° N)	Longitude (° W)				
D02 Skid Pad (Track 1)	37.05681	77.96789		300	100	0
D02 Skid Pad (Track 2)	37.05758	77.95868		300	100	0
D02 Skid Pad (Track 3)	37.05739	77.95744		300	100	0

Table 4. Car Impact Exercises

Car Impact Events	Car Impact Locations			Total Events Forecast Year	Daytime % 0700-2200	Nighttime % 2200-0700
	Latitude (° N)	Longitude (° W)				
D02 (Track 1) Skid Pad	37.05681	77.96789		150	100	0
D02 (Track 2) Skid Pad	37.05758	77.95867		150	100	0
D02 (Track 3) Skid Pad	37.05740	77.95744		150	100	0

All of the operations listed in Table 1 through Table 4 are associated with the high-speed drive tracks and therefore were grouped together. But these operations do not all generate similar types of noise and their assessment requires the use of different metrics. For example, noise from high-speed cars were treated as steady state and assessed using A-weighted levels (maximum and average), whereas simulator noise, which is impulsive, was assessed using peak levels. Sections 3-5 describe the methods of noise assessment used for each type of training exercise.

2.2.2 Mock Urban Tactical Training

Several types of car driving exercises are conducted in simulated urban areas. Table 5 shows the operations associated with Mock Urban Drive Tracks (T02 and D03 in Figure 3) and the Simulation Alley Drive Track (E04 Urban); operations are also indicated for the nearby Rural Drive Course (E04 Rural). Average daily operations for tracks T02 and D03 are based on 6 cars per exercise, each traveling through the course, and estimating a maximum of 6 exercises per day (36 total)[7]. For both the Simulation Alley Track (E04 Urban) and the rural course (E04 Rural), there would be an estimated two exercises per day, each with 6 cars traveling through the course. For all of these tracks, vehicle speeds are estimated to range from 15 to 50 mph[7]. No nighttime activities are proposed.

Table 5. Mock Urban and Rural Drive Course Exercises

Driver Training Exercise	Vehicle Location	Speed (mph)			Average Daily Vehicle Count	
		Avg	Min	Max	Day (0700-2200)	Night (2200-0700)
T02 Mock Urban Tactical Training Area (Driving)	Continuous around track	35	20	50	36	0
D03 Mock Urban Driving Track	Continuous around track	35	20	50	36	0
E04 Urban Driving Track	Continuous around track	25	15	40	12	0
E04 Rural Drive Course	Continuous around track	35	20	50	12	0

2.2.3 Off-Road and Unimproved Road Driving Exercises

Table 6 shows the operations associated with the off-road (DO5) and unimproved road (DO4) courses. Vehicle speeds are estimated to range from 20 to 50 mph. Twenty-five percent of the total daily operations on these courses are nighttime operations[7].

Table 6. Off-road and Unimproved Road Driving Exercises

Driver Training Exercise	Vehicle Location	Speed (mph)			Average Daily Vehicle Count	
		Avg	Min	Max	Day (0700-2200)	Night (2200-0700)
D05 Off-Road Driving Course	Continuous around track	35	20	50	12	4
D04 Unimproved Road Driving Course	Continuous around track	35	20	50	12	4

2.3 Demolition Facilities

Five demolition training facilities are proposed, including the Explosives Demo Range (E02), Post Blast Training Range (E03), Explosives Simulation Alley (E04), Explosives Breaching House (E05b) and Explosives Breaching Walls (E05c/d). These facilities accommodate explosives ranging in size from flash bangs (4.5 grams) up to 3 pound charges[7]. The primary modeling parameters are the number of operations by type of munitions and the geographic location of each facility, shown in Tables 7 and 8.

For each explosives range, Table 7 lists the explosive type, number of annual rounds and the percentage of daytime and nighttime operations. The higher-weight explosives (1-3 pound charges) would be used on ranges E03 and E05c/d, whereas the lower-weight explosives (less than 1 pound charge) would be used on ranges E02, E04, and E05b. Table 8 shows the demolition range locations in Latitude and Longitude coordinates. Explosives Simulation Alley (E04) has three locations defined where flash bangs would be used. Ranges E02, E03 and E04 would have explosives detonated on a pad, at ground level, whereas the detonation points for the Explosive Breaching House and Walls (E05b and E05c/d) are expected to be located on building elements (i.e., doors or walls) at a height estimated at 3.3 feet (1 meter) above ground. Sites E02, E05b and E05c/d would be relocated for Alternative 2.

Table 7. Demolition Operations

Type of Explosives	Total Annual FASTC Rounds	Daytime 0700-2200 %	Nightime 0700-2200 %	Total Annual Rounds Distributed By Explosives Training Area				
				EO2	EO3	EO4	EO5b	EO5c/d
Black Powder, 2 oz	312	100	0	312	0	0	0	0
C4 / C2 Detasheet, 1 / 10 lb	156	100	0	156	0	0	0	0
C4 / C2 Detasheet, 1 / 8 lb	433	100	0	433	0	0	0	0
C4 / C2 Detasheet, 1 / 7 lb	156	100	0	156	0	0	0	0
C4 / C2 Detasheet, 1 / 5 lb	18	100	0	18	0	0	0	0
C4 / C2 Detasheet, 1 / 4 lb	424	100	0	424	0	0	0	0
C4 / C2 Detasheet, 1 / 3 lb	238	100	0	238	0	0	0	0
Cast Booster, 1 / 2 lb	493	100	0	493	0	0	0	0
C4 / C2 Detasheet, 1 lb	54	100	0	0	54	0	0	0
C4 / C2 Detasheet, 1 1 / 4 lb	30	100	0	0	30	0	0	0
C4 / C2 Detasheet, 1 1 / 2 lb	9	100	0	0	3	0	0	6
C4 / C2 Detasheet, 3 lb	6	100	0	0	6	0	0	0
C6 (0.25 in), 2.23 lb	36	100	0	0	0	0	0	36
C6 (0.25 in), total of 0.62 lb	60	100	0	0	0	0	60	0
Flash Bangs (4.5 grams)	400	100	0	0	0	400	0	0
FASTC Annual Total	2825							

Table 8. Demolition Range Geographic Coordinates

Explosives Range	Alternative	Description	Range Coordinates		
			Latitude (° N)	Longitude (° W)	Height (feet)
EO2	1	Explosives Demo Range	37.06403	77.93287	0
EO3	1 & 2	Post Blast Training Range.	37.06773	77.93399	0
EO4	1 & 2	Explosives Simulation Alley	37.06012	77.95224	0
	1 & 2		37.06027	77.95454	0
	1 & 2		37.06028	77.95060	0
EO5b	1	Explosives Breaching House	37.06709	77.92608	3.3
EO5c/d	1	Explosives Breaching Walls	37.06686	77.92608	3.3
EO2	2	Explosives Demo Range	37.06758	77.92853	0
EO5b	2	Explosives Breaching House	37.06232	77.93330	3.3
EO5c/d	2	Explosives Breaching Walls	37.06256	77.93329	3.3

2.4 Firing Ranges

There are five small arms ranges proposed which include one existing outdoor range (R05) and four indoor ranges (R02, R03a, R03b and R04). These ranges accommodate small-caliber weapons such as shotguns, rifles, and pistols. Table 9 indicates the daytime operations by gun type that would occur on each range; no nighttime operations are proposed[7].

Table 9. Firing Range Operations

	SMALL ARMS (Munitions Utilization)				
Range/Facility	Weapon Type		Total Annual Rounds	Daytime 0700-2200 %	Nighttime 2200-0700 %
R02 - Indoor Firing Ranges	Handgun	.357 magnum	190,000	100	0
	Handgun	9 mm	190,000	100	0
	Handgun	.40 cal	190,000	100	0
	Rifle	5.56 mm	190,000	100	0
	Sub-machine gun	9 mm	190,000	100	0
	Sub-machine gun	.40 cal	190,000	100	0
	Sub-machine gun	.45 cal	190,000	100	0
	Shotgun	12 gauge	190,000	100	0
R03a - Live Fire Shoot House (1 story)	Handgun	.357 magnum	190,000	100	0
	Handgun	9 mm	190,000	100	0
	Handgun	.40 cal	190,000	100	0
	Rifle	5.56 mm	190000	100	0
R03b - Live Fire Shoot House (2 story)	Handgun	.357 magnum	190,000	100	0
	Handgun	9 mm	190,000	100	0
	Handgun	.40 cal	190,000	100	0
	Rifle	5.56 mm	190000	100	0
R04 - Baffled Indoor Tactical Combat Range	Handgun	.357 magnum	190,000	100	0
	Handgun	9 mm	190,000	100	0
	Handgun	.40 cal	190,000	100	0
	Rifle	5.56 mm	190,000	100	0
	Sub-machine gun	9 mm	190,000	100	0
	Sub-machine gun	.40 cal	190,000	100	0
	Sub-machine gun	.45 cal	190,000	100	0
	Shotgun	12 gauge	190,000	100	0
R05 - Existing Outdoor Rifle Range	Handgun	.357 magnum	190,000	100	0
	Handgun	9 mm	190,000	100	0
	Handgun	.40 cal	190,000	100	0
	Rifle	5.56 mm	190,000	100	0
	Sub-machine gun	9 mm	190,000	100	0
	Sub-machine gun	.40 cal	190,000	100	0
	Sub-machine gun	.45 cal	190,000	100	0
	Shotgun	12 gauge	190,000	100	0

The small arms range-modeling parameters, used to define the range's geographic location, dimensions, and orientation, are shown in Table 10. Included for each range are the firing location (latitude, longitude and height above ground), azimuth from the first firing point to the target point, distance between firing and target points, number of firing lanes, and lane spacing.

Table 10. Firing Range Modeling Parameters

	SMALL ARMS (Range Coordinates/Parameters)						
Range/Facility	Firing Location (leftmost firing point)			Azimuth from 1st Firing Point to 1st Target Point (° clockwise from North)	Distance Firing Point to Target Point (feet)	Firing Lanes #	Lane Spacing (feet)
	Latitude (° N)	Longitude (° W)	Height (feet)				
R02 - Indoor Firing Range (4 Ranges Total)	37.05818	77.92956	3.3	10.9	164	100	1.6
R03a - Live Fire Shoot House (1 story)	37.05598	77.92779	3.3	360	82	6	16
R03b - Live Fire Shoot House (2 story)	37.05639	77.92727	3.3	360	98	9	16
R04 - Baffled Indoor Tactical Combat Range (3 Ranges Total)	37.06159	77.92832	3.3	90	492	90	1.6
R05 - Existing Outdoor Rifle Range	37.05920	77.92457	3.3	101	985	33	16

The munitions operations and range modeling parameters in Tables 9 and 10 are part of the noise model inputs for SARNAM. In Section 5, small arms noise is assessed using different methodologies for outdoor and indoor ranges. SARNAM is normally used to model outdoor ranges. For indoor ranges, estimates were made of the exterior noise levels using common structural noise reduction values and the methodology recommended by the USAPHC.

3 Drive Track Noise Evaluation

This section describes the noise analysis conducted for automobile operations on the FASTC drive tracks and road courses. The modeling parameters for these tracks and courses were defined in detail in section 2. To summarize, this project has nine separate tracks and courses including three High-Speed Anti-Terrorism Driving Tracks (DO2 tracks 1, 2, and 3), Mock Urban Tactical Training Area Drive Track (T02), Mock Urban Driving Track (D03), Urban Driving Track (E04), Rural Driving Track (E04), Unimproved Road Course (D04) and Off-Road Course (D05). Only common street automobiles would use each track and course. This analysis follows guidelines recommended by FHWA and uses noise criteria from local jurisdictions. Maximum and hourly average sound levels are estimated for all driving exercises.

3.1 Noise Level Criteria

The project is located near the town of Blackstone, Virginia. Although there is a noise ordinance in this jurisdiction, that ordinance is what is commonly referred to as a "nuisance" ordinance in that it does not provide numerical noise level limits. In order to provide reference points for commonly-accepted criteria in environmental noise, a survey of nearby ordinances was undertaken. The following nearby jurisdictions also have nuisance-type ordinances:

- Altavista
- Amherst County
- Bedford County
- Blackstone
- Brunswick County
- Chesterfield County
- Franklin
- Lawrenceville
- South Boston
- South Hill
- Suffolk

The following is a summary of the noise level limits for many jurisdictions near Blackstone which have numerical limits. All of these limits are in terms of the maximum A-weighted sound level, although the response time might vary between slow and fast, depending on specific conditions listed in the ordinance. The land near Fort Pickett appears to be mostly agriculturally zoned with some residential areas. Some of the noise ordinances only have requirements for residential zones, while others have the same requirements for both residential and agricultural zones. Most of the ordinances limit noise levels anywhere on residential zones while some limit noise levels inside residences as well. Each ordinance that lists different requirements for different zoning classifications has the strictest limit for residential zones.

For brevity, only the residential limit is presented.

	Daytime definition	Daytime (nighttime) residential limit
Accomack County	7:01 am to 9:00 pm	65 dB outdoors (55 at night)
Emporia	7 am to 10 pm	65 dB indoors (55 at night)
Franklin County	7 am to 11:30 pm	67 dB outdoors (62 at night)
Petersburg	7 am to 10 pm	65 dB outdoors (55 at night)
	(am Weekends and Holidays) to 10 pm	65 dB outdoors (55 at night)
Richmond	7 am to 11 pm	65 dB indoors, 75 dB outdoors (55 indoors & 65 outdoors at night)

The strictest of the daytime noise ordinance limits in residential zones are maximum A-weighted sound levels of 65 dB during the day and 55 dB at night outdoors. These criteria were used in the analysis of maximum sound levels.

Another common set of criteria for automobile noise are the Noise Abatement Criteria (NAC) of the FHWA (Federal Highway Administration 1982)[9]. While these criteria are not binding for this project, they form a useful reference. The criterion for residential land uses is that when the hourly average A-weighted sound level (LAeq1h) approaches or exceeds 67 dB a noise impact occurs. State departments of transportation implement the criteria and most states define "approach or exceed" to mean that a noise impact exists when the hourly average A-weighted sound level is 66 dB or higher. This criterion was used in the analysis of hourly average sound levels.

3.2 Drive Track Operations Summary

Operations on the nine tracks and courses used for noise modeling purposes are summarized in Table 11. The speeds listed below are the minimum, average, and maximum speeds estimated for the tracks and courses.

Table 11. Summary of Drive Track and Course Operations

Track / Course	Cars / day (0700-2200)	Max Cars / Hr	Cars at a time	Speeds (mph)
D02 Track 1	270	72	9	25,50,100
D02 Track 2	270	72	9	25,50,100
D02 Track 3	270	72	9	25,50,100
T02	36	12	6	20,35,50
D03	36	12	6	20,35,50
E04 Urban	12	6	6	15,25,40
E04 Rural	12	6	6	20,35,50
D05 Off-Road	12 (plus 4 night)	6 day, 4 night	9 (4 at night)	20,35,50
D04 Unimproved	12 (plus 4 night)	6 day, 4 night	9 (4 at night)	20,35,50

3.3 Analysis Methodology

The FHWA developed TNM[4] over many years. This is a computerized noise model which predicts average sound levels due to roadway traffic. During the development of this model, vehicle noise levels were measured at a distance of 50 feet from the centerline of the lane of travel. From these data, the Reference Energy Mean Emission Levels (REMEL) (Federal Highway Administration 1995)[10] were developed. The REMEL values can be taken as the maximum sound levels which would be measured as a vehicle passes by with a sound level meter set on fast response (eight samples per second integration rate). This sound level meter setting produces slightly higher sound levels than does the slow response (one sample per second integration rate). Although not all noise ordinances specify the fast response setting, it is conservative to use this setting, and it is straightforward to use the REMEL data in calculations.

The FHWA document which describes the development of the REMEL data[10] provides equations to determine REMELs as a function of vehicle type, pavement type, vehicle speed, and sound frequency using one-third octave frequency bands. Since automobiles would predominantly be used on the FASTC tracks and courses, as opposed to other vehicle types, the REMEL data for automobiles were used in this analysis. The pavement types included in the REMEL data are Portland Cement Concrete (PCC), Dense-Graded Asphaltic Concrete (DGAC), an average of PCC and DGAC, and Open-Graded Asphaltic Concrete (OGAC). It was assumed that the paved roads for this project would have asphaltic concrete. Since data are not available for dirt roads, the most common form of asphaltic concrete pavement, DGAC pavement, was used in the analysis for unimproved and off road tracks. To provide supplemental information, sound levels were also calculated for PCC pavement. Each of the speeds listed in Table 11 were considered in the analysis. In the calculation of maximum sound levels, it was assumed that all of the cars operating at once would be approximately in the same location. This assumption is the maximum scenario because in reality not all cars would be the same distance from the evaluation point. Also, it was assumed that sounds from other tracks, which might be in use at that instant, are negligible. The REMELs were calculated for each one-third octave frequency band. Based on these values, octave band sound levels were determined.

When modeling sound propagation it is useful to know the height at which the noise is generated. Based on the REMEL document[10], for modeling sound propagation from automobiles the sound can be assumed to be radiating from a combination of 0 and 1.5 meters (5 feet) above the ground. The ratio of the sound energy at each of these heights is a function of vehicle type and speed. To be conservative, and for simplicity, it was assumed in this analysis that all sound is generated 5 feet above the ground.

In order to predict sound levels in the community the Sound Propagation Model for Outdoor Sources (Power Acoustics 2002) SPM9613 Version 2.0 was used. This computer program takes octave band sound power levels as the input and outputs the octave band and A-weighted sound pressure levels. The sound power level is the total amount of sound energy emitted by a sound source in all directions, and the sound pressure level is simply the sound level at a specific location. Sound power levels were inferred from the REMEL data. This computer model is directly based on the standard: ISO 9613-2:1996

"Acoustics – Attenuation of sound during propagation outdoors – Part 2: General Method of Calculation (International Standards Organization 1996)[12]." The procedures contained in this standard are the most widely used method for predicting sound propagation outdoors in computer models. ISO 9613 predicts the long-term average downwind sound level during conditions favorable to sound propagation, including mild temperature inversions. In this way, the noise model is somewhat conservative with respect to atmospheric conditions. This model also factors in whether the ground is acoustically reflective (hard) or sound-absorptive (soft). For this analysis, the ground at the automobile (pavement) was modeled as hard, while the ground at all community locations (grass or field) was modeled as soft. Also, topography was not modeled in this analysis (i.e., the ground was assumed to be flat); the ground elevation in the study area was examined and the changes in elevation indicate that this is a reasonable assumption. Neither do these estimates include the potential moderating effects of vegetation on sound propagation.

3.4 Driving Exercise Hourly Average Noise Levels

In this section hourly average noise levels are computed for the drive track, skid pad and car impact operations. In section 3.5, maximum A-weighted noise levels are computed for these same operations.

<u>Drive Track Hourly Average Noise Levels</u>

The tracks and courses would not have many cars traveling each hour. As such, the analysis methodology for average sound levels was simplified. As indicated in Table 11, the worst conceivable (though quite unlikely to occur) case is when the following car operations occur during the same hour:

- 72 cars traveling 100 mph on each of the D02 tracks (1-3)
- 12 cars traveling 50 mph on tracks T02 and D03
- 6 cars traveling 50 mph on D04, D05 and the E04 rural course
- 6 cars traveling 40 mph on the E04 urban course

To illustrate what the average sound level would be from all of these operations occurring at once, on tracks located side-by-side, a simple case was created using the FHWA TNM model[4]. Three roads were created, one with 216 cars traveling 100 mph, one with 42 cars traveling 50 mph, and one with 6 cars traveling 40 mph. To simplify the analysis, each road was 500 feet long, with centerlines just 20 feet apart. Each road was 12-feet wide with DGAC pavement. Receivers were set up along a row extending out from the midpoint of the roads (i.e., 250 feet from one end), spaced 10 feet apart. The road with cars traveling 100 mph was closest to the receivers, while the other roads were parallel to that road on the side opposite the receivers. The receiver height was 5 feet. The default ground type was lawn. The result was that the hourly average sound level was 66 dBA at a distance of 70 feet from the road for this unlikely worst case condition. No noise impact is expected to occur outside the Fort Pickett boundary.

Skid Pad and Car Impact Hourly Average Noise Levels

Hourly average sound levels for the skid pad and car impact exercises were not computed because of the low number of expected operations. Hourly average sound levels for these exercises would be lower than the levels estimated above for the worst case drive track operations (66 dBA at a distance of 70 feet from the source).

Summary of Hourly Average Noise Levels for All Car Exercises

Figure 5 shows the hourly average A-weighted sound levels (LAeq1h) estimated for all driving operations for Alternative 1; contours for the car ramming and skid pad exercises are conservatively shown using the same LAeq1h value as was determined for the drive tracks (66 dBA at 70 feet); although it was mentioned that the LAeq1h value for these exercises is expected to be much lower. In Figure 5, the 66 dBA hourly average sound level contour is shown extending around the perimeter of all drive tracks and courses approximately 70 feet outward from each track or course. Three circular contours representing the car ramming and skid pad exercises are shown extending 70 feet from the center of each skid pad. Figure 6 shows the 66 dBA hourly average sound level contour estimated for all driving operations for Alternative 2; the primary difference for Alternative 2 being that the 66 dBA contour extends about 150 feet further south and 550 feet further east than does the same contour for Alternative 1, reflecting the differences in the site layouts. This analysis of hourly average sound levels indicates that noise due to FASTC driver training exercises would be contained entirely within the Fort Pickett boundary and would not exceed the FHWA NAC levels for residential land use. No impacts are expected outside LRA Parcel 9.

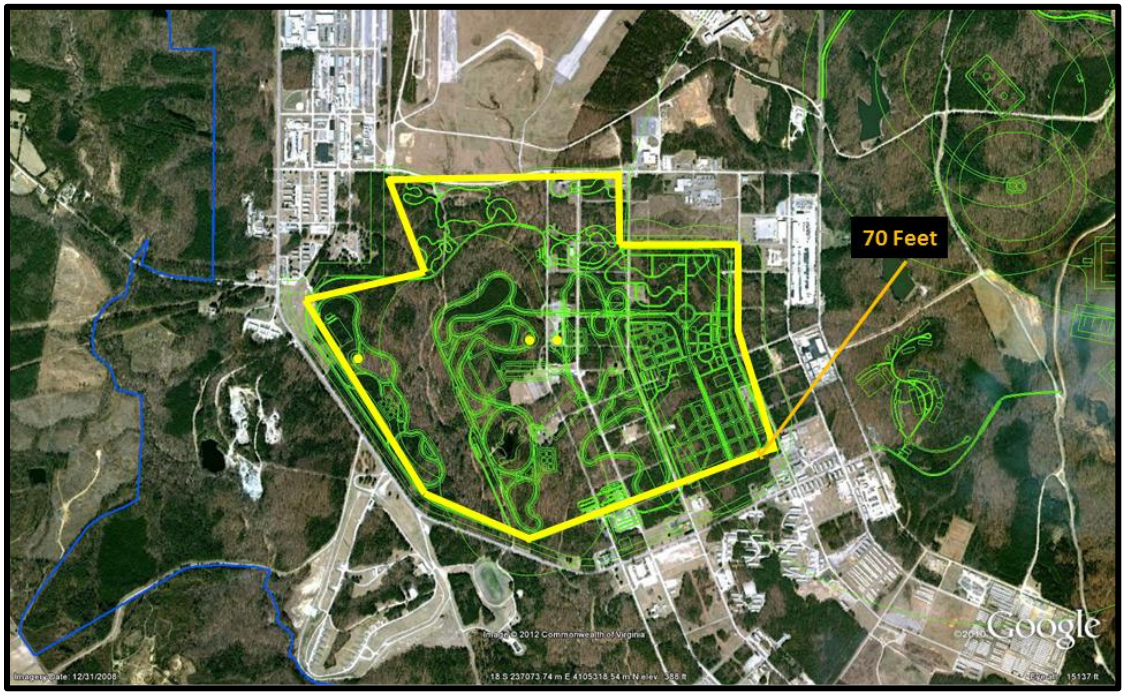

Figure 5. Drive Track Noise Level Envelope for Alternative 1 (66 dBA Hourly Average Sound Level).

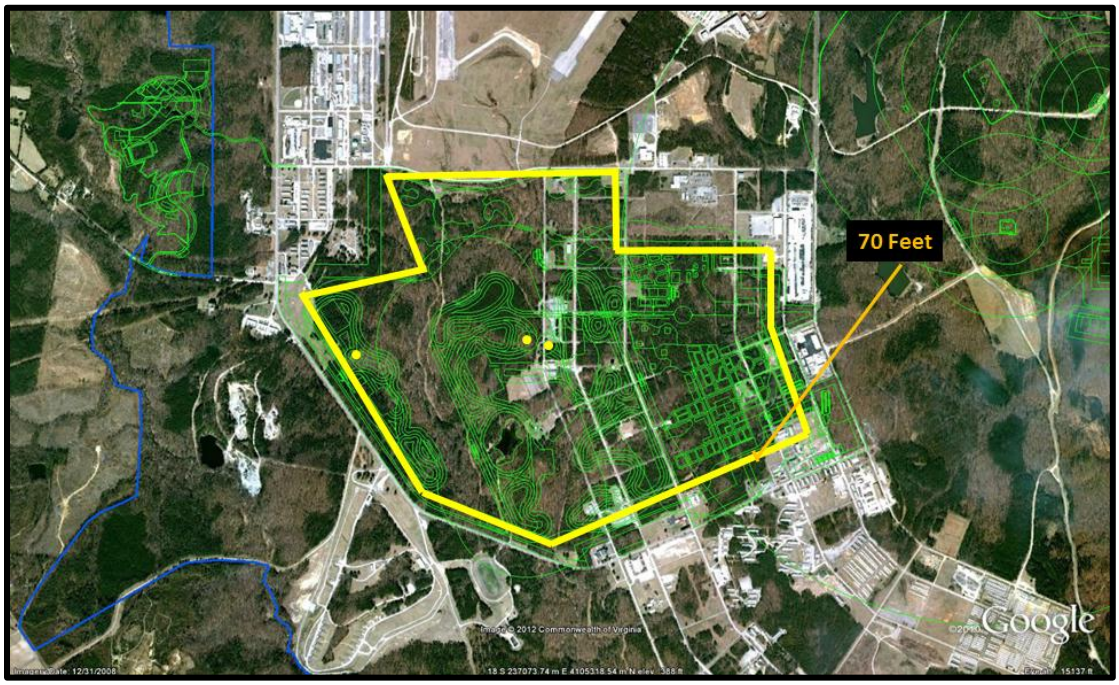

Figure 6. Drive Track Noise Level Envelope for Alternative 2 (66 dBA Hourly Average Sound Level).

3.5 Driving Exercise Maximum Noise Levels

<u>Drive Track Maximum Noise Levels</u>

The first step in this analysis was to extrapolate sound power levels based on the octave band sound pressure levels for each vehicle speed. Next, evaluation locations were set up at varying distances from the vehicle. These locations were used to determine where the maximum A-weighted sound level reaches 55 dB at night and 65 dB during the day.

Based on the REMEL data as outlined above, the maximum A-weighted fast-response sound levels (L_{AFMAX}) at a distance of 50 feet, due to a single car traveling on DGAC pavement, are shown in Table 12; for reference, the levels are also shown for PCC pavement. Unless noted otherwise in this report, the pavement was assumed to be DGAC.

Table 12. Car Pass Maximum A-Weighted Sound Levels

Car Speed (mph)	L_{AFMAX} (dBA)	
	DGAC Pavement	PCC Pavement
15	51.8	54.4
20	55.0	58.4
25	58.4	62.2
35	64.1	68.3
40	66.5	70.8
50	70.6	75.0
60	74.0	78.5
80	79.4	84.2
100	83.7	88.7

During the course of this project, sound level measurements were made (Shen Milsom & Wilke 2011)[13] of car passes at various speeds. Because these measurements were made available for use on this project, a comparison was made with the REMEL data. The following are the maximum fast-response A-weighted sound levels measured for cars on smooth, wet, asphaltic concrete pavement: an average of 81.5 dB for two events at a distance of 35 feet with a speed of 60 mph, and an average of 86.8 dB for four events at a distance of 22 feet and a speed of 80 mph. In order to compare these data to the REMEL data presented above, these sound levels were extrapolated for distance. For simplicity, the car was treated as a point source of sound, and assumed that sound levels drop off at a rate of 6 dB per doubling of distance. Using this simple relationship, the maximum A-weighted sound levels at 50 feet are 80.4 dB at 60 mph and 79.7 at 80 mph. These compare reasonably well to the REMEL data sound levels presented above for DGAC pavement. For the remainder of this analysis, to evaluate other FASTC vehicle speeds, A-weighted sound levels determined from the REMEL data were used.

For each of the FASTC tracks and modeled operations, Table 13 shows the distances from the centerline of the track or course at which the maximum A-weighted sound level is 65 dB. Similarly, the distances at which the sound level is 55 dB (for nighttime assessment) are presented in Table 14.

Table 13. Distances from Track or Course to 65 dB Contour - Daytime

Track / Course	Cars at a time	Min Speed	Avg Speed	Max Speed
D02 Tracks 1-3	9	68 feet at 25 mph	256 feet at 50 mph	994 feet at 100 mph
T02, D03, E04 Rural	6	39 feet at 20 mph	106 feet at 35 mph	213 feet at 50 mph
E04 Urban	6	26 feet at 15 mph	56 feet at 25 mph	136 feet at 40 mph
D05, D04	9	48 feet at 20 mph	128 feet at 35 mph	256 feet at 50 mph

Table 14. Distances from Track or Course to 55 dB Contour - Nighttime

Track / Course	Cars at a time	Min Speed	Avg Speed	Max Speed
D05, D04	4	103 feet at 20 mph	256 feet at 35 mph	505 feet at 50 mph

For daytime operations the data in Table 13 indicate that the 65 dB maximum A-weighted contour would extend out as far as approximately 1,000 feet (994 feet) from the high-speed drive tracks for the straightaway track segments where vehicle speeds approach 100 mph. On the high-speed track turn sections, and on all other courses, vehicle speeds are expected to be lower (50 mph or less); therefore the 65 dB contour would extend outward from the track approximately 250 feet or less. For nighttime operations on the unimproved road course (D04) and the off-road course (D05) the 55 dB maximum A-weighted contour would extend outward from each course as much as approximately 500 feet.

Skid Pad and Car Impact Maximum Noise Levels

Controlled car skids and car ramming exercises are expected to be conducted on the skid pads associated with each high-speed drive track. To assess the noise from these operations, measurement data (Shen Milsom & Wilke 2011)[14] were used in this analysis. Shen, Milsom & Wilke had previously conducted field measurements of various Department of State driver training exercises. The measurements included recordings of car ramming events and tire squeal events (due to acceleration burnout rather than from hard braking).

Based on the data provided, the maximum A-weighted sound levels for these two types of events were compared with the 65 dB criteria for daytime events; proposed operations indicate that neither of these exercises would be conducted at night. A summary of the measured data is provided:

- Tire Squeal, 5 events measured at a distance of 10-15 feet, L_{Amax}(dBA) = 100.2 (maximum), 98.8 (minimum) and 99.4 (average),
- Car Ramming, 23 events measured at location 1 at a distance of 35-50 feet, L_{Amax}(dBA) = 99.2 (maximum) , 84.6 (minimum) and 89.3 (average) and
- Car Ramming, 23 events measured at location 2 at a distance of 20-30 feet, L_{Amax}(dBA) = 98.0 (maximum), 83.5 (minimum) and 92.3 (average).

The tire squeal measurements are highly consistent whereas the car impact measurements show a wide variation in measured levels. This variation seen for the impact events is likely due to these exercises being conducted with different drivers and different car orientations when the impacts occurred.

To simplify the noise assessment for FASTC, a representative maximum A-weighted sound level of 100 dBA was used to represent the tire squeal events at a reference distance of 15 feet; likewise, a maximum A-weighted sound level of 89 dBA was used to represent the car ramming events at a reference distance of 50 feet. These reference levels are close to the average levels determined from the measurement data. By propagating these levels outward from the source, taking into account spherical spreading (i.e., sound levels drop off at a rate of 6 dB per doubling of distance) and atmospheric absorption, computed for 15-degrees Celsius and 70% relative humidity, both representative sources generate 65 dBA at a distance of approximately 800 feet from their source locations.

Summary of Maximum Noise Levels for All Car Exercises

Figure 7 shows the maximum A-weighted noise levels (L_{Amax}) estimated for all driving operations for Alternative 1 including the car ramming and skid pad exercises. The 65 dBA maximum sound level contour is shown extending around the perimeter of all drive tracks and courses; approximately 1,000 feet from the most western high-speed track straightaway and 250 feet, from the nearest drive track or course, around the remaining parts of the complex. These distances were determined from the data provided in Table 13. Generally, the distance to the 65 dBA contour was computed using the maximum speed indicated for each track or course. In the case of the high-speed tracks, this methodology was used only for the long straight segment associated with the most western track (where vehicle speeds can be up to 100 mph); speeds on the turn segments, such as those which occur at the south end of the complex, were estimated to be 50 mph (Table 13 indicates that the distance to the 65 dBA contour is about 250 feet in this case). The 65 dBA maximum sound level contours are also shown for the skid pad and car impact exercises, indicated by the three circles which extend outward approximately 800 feet from the center of each skid pad. For all driving exercises considered, the 65 dBA contour does not extend outside the Fort Pickett boundary and, therefore, would not impact any of the surrounding residential communities. For the limited nighttime driving expected to occur on the unimproved road (D04) and off-road (D05) courses, the 55 dB maximum A-weighted noise contour would be located approximately 505 feet from these two courses. This contour is not shown in Figure 7, however it is entirely within the Fort Pickett boundary; no impact of residential properties is expected. Further, there are expected to be low numbers of vehicle operations per day (4 each) on D04 and D05.

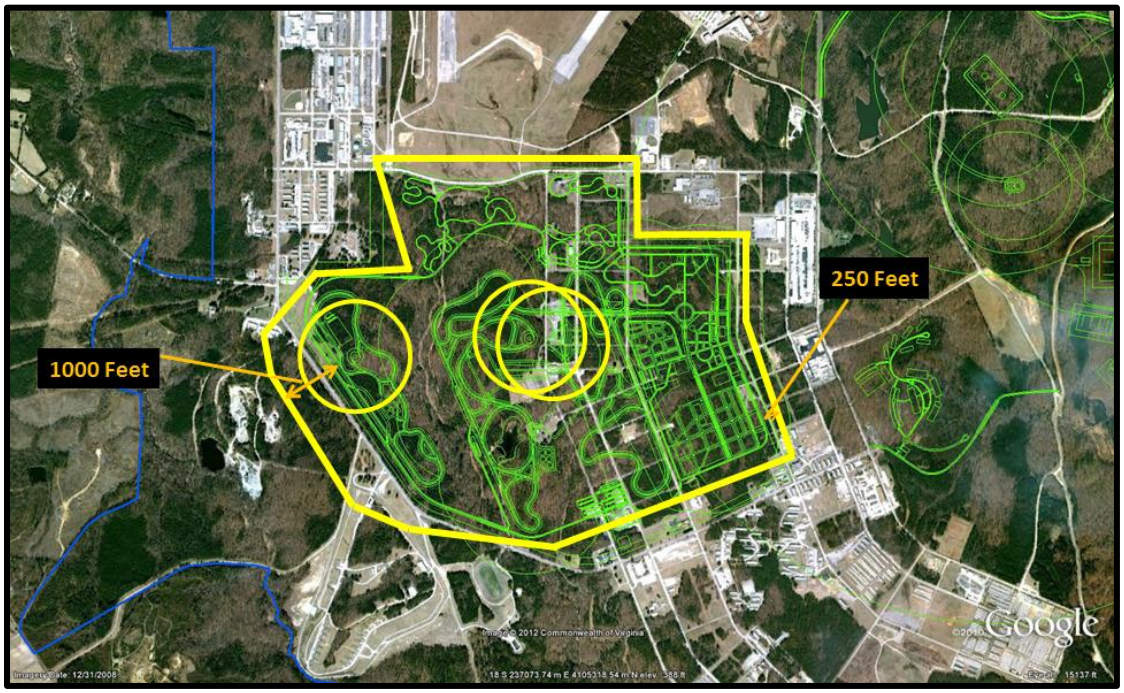

Figure 7. Drive Track Noise Level Envelope for Alternative 1 (65 dB Maximum A-weighted Sound Level).

Figure 8 shows the maximum A-weighted noise levels (L_{Amax}) estimated for all driving operations for Alternative 2. The 65 dBA maximum sound level contour extends around the perimeter of all drive tracks and courses at the same distances from the drive tracks that were estimated for Alternative 1; approximately 1,000 feet from the most western high-speed track straightaway and 250 feet, from the nearest drive track or course, around the remaining parts of the complex. Comparing this Alternative 2 result with Alternative 1, the main difference is that the 65 dBA contour extends approximately 200 feet further south and 750 feet further east than does the same contour for Alternative 1.

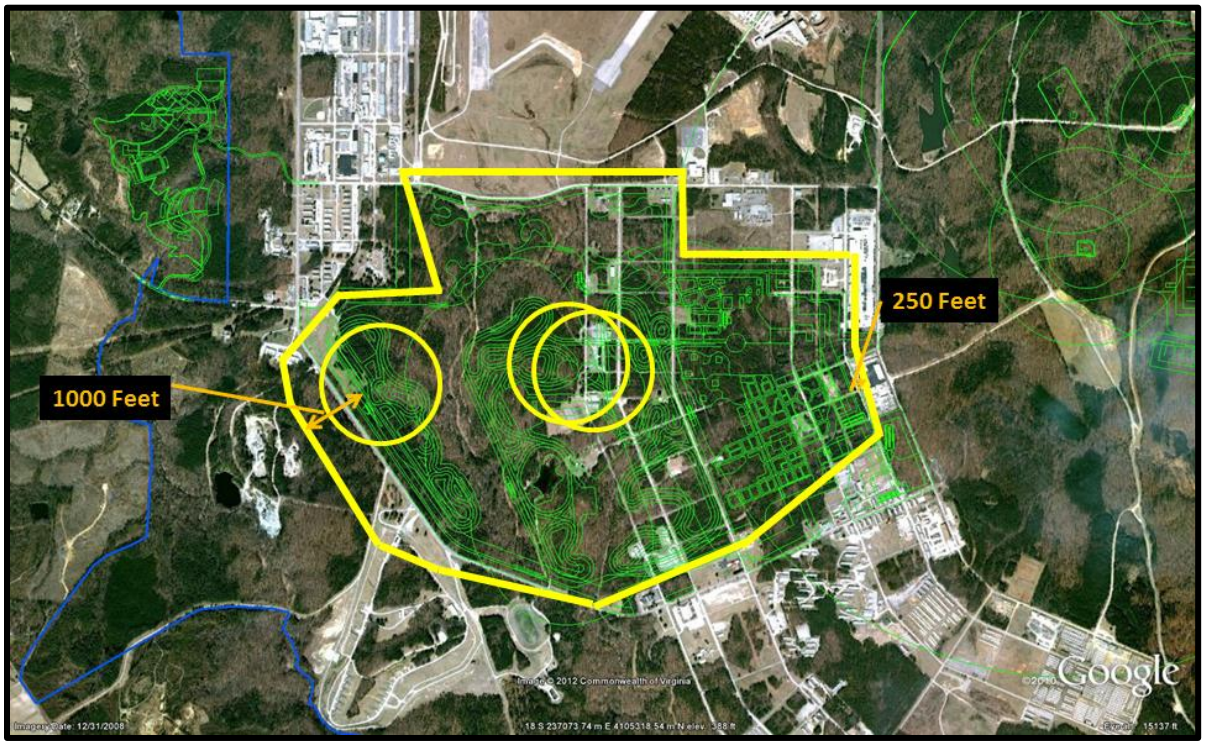

Figure 8. Drive Track Noise Level Envelope for Alternative 2 (65 dB Maximum A-weighted Sound Level).

4 Demolition Noise Evaluation

There are five demolition training ranges planned for FASTC which include the Explosives Demo Range (E02), Post Blast Training Range (E03), Explosives Simulation Alley (E04), Explosives Breaching House (E05b) and Explosives Breaching Walls (E05c/d). These ranges, which were shown on the site map in Figure 3, are all located in the northeast section of the FASTC complex, except the Explosives Simulation Alley, which is more centrally located near the Urban Drive Course. All of these ranges are within the Fort Pickett boundary, and their noise contribution would be additive to the existing Fort Pickett noise exposure. To properly compare the FASTC demolition noise with the existing Fort Pickett demolition and large caliber weapons noise, the same metrics that were used in the Fort Pickett Baseline study[1] were used in this analysis for FASTC. The use of similar metrics is also required to determine the noise exposure for both activities combined. It should be noted that while the Fort Pickett Baseline operations and noise contours were finalized at the end of 2011, the proposed FASTC activity is not expected to be fully operational until 2020. Phase I, which includes most hard skills (explosive ranges etc.), is operational in 2017.

The Proposed Action and the Baseline were evaluated two ways: the first method examines the noise exposure from a land use planning perspective to identify areas, in specific noise zones, which are compatible with residential, commercial or other types of development; second, noise exposure is evaluated in terms of complaint risk areas to identify where noise complaints are likely to occur due to these operations. The next two sections cover these methods of analysis. Lastly, noise levels are evaluated separately for simulators (flash bangs) because these devices have significantly lower net explosive weight (NEW), compared with the other explosives and weapons analyzed.

4.1 Land Use Planning

<u>Noise Zones</u>

Army Regulation (AR) 200-1[2] lists housing, schools, and medical facilities as examples of noise-sensitive land uses. The AR defines four noise zones that are used to evaluate land use compatibility which were used in this analysis to determine the significance of noise impacts associated with the Proposed Action:

- Noise-sensitive land uses are not recommended in Zone III.
- Although local conditions such as availability of developable land or cost may require noise-sensitive land uses in Zone II, this type of land use is strongly discouraged on the installation and in surrounding communities. All viable alternatives should be considered to limit development in Zone II to non-sensitive activities such as industry, manufacturing, transportation, and agriculture.
- Noise-sensitive land uses are generally acceptable within Zone I. However, though an area may only receive Zone I levels, military operations may be loud enough to be heard or even judged

loud on occasion. Zone I is not one of the contours shown on the map; rather it is the entire area outside of the Zone II contour.

- The *Land Use Planning Zone (LUPZ)* is a subdivision of Zone I. The LUPZ is 5 decibels (dB) lower than the Zone II. Within this area, noise-sensitive land uses are generally acceptable. However, communities and individuals often have different views regarding what level of noise is acceptable or desirable. To address this, some local governments have implemented land use planning measures out beyond the Zone II limits. Additionally, implementing planning controls within the LUPZ can develop a buffer to avert the possibility of future noise conflicts.

Table 15 describes the noise zones in relation to the CDNL noise contours provided in this document.

Table 15. Noise Zone Definitions

Noise Zone	Noise Limits, (dB)	
	Large Caliber, Demolitions, Etc. (CDNL)	Small Arms PK15(met)
LUPZ	57 to 62	
Zone I	<62	<87
Zone II	62 to 70	87 to 104
Zone III	>70	>104

LUPZ is a land-use planning zone
PK15(met) is the peak sound level exceeded 15 percent of the time (unfavorable weather conditions)

Three C-weighted Day-Night average sound Level (CDNL) contour results are presented in Figures 9 through 11 to evaluate land use compatibility for demolition and large caliber weapon operations. The assessment period used to create the CDNL contours was 104 days, reflecting the number of National Guard operating days per year and for consistency with the Fort Pickett Baseline analysis. In order, the scenarios are the Fort Pickett Baseline, Baseline plus Proposed Action Alternative 1, and the Baseline plus Proposed Action Alternative 2. The legend in each figure identifies the CDNL contour levels described in Table 15, shown overlaid on a map of Fort Pickett and vicinity. Of note in the figures are the Fort Pickett boundary and Army Compatible Use Buffer (ACUB) which serves as a land use planning buffer zone between base operations and the surrounding communities.

<u>Baseline</u>

The Fort Pickett Baseline was taken from USAPHC, "Operational Noise Consultation No. 52-EN-0FNT-12 Operational Noise Contours Fort Pickett, Virginia, 28 November 2011[1]. The Baseline CDNL noise contours are shown in Figure 9. The Baseline LUPZ (57 dB CDNL) extends beyond the base boundary in most directions but generally does not extend beyond the ACUB. The Zone II (62 dB CDNL) extends beyond the western and southern boundaries 1,000 and 2,300 feet respectively and it extends beyond the eastern boundary up to 5,250 feet. The Zone III (70 dB CDNL) extends beyond the boundary less than 1,300 feet from the activity at firing point series 33 and 53[1]. Based on available imagery, the Zone II

and III areas extending outside the Fort Pickett boundaries are primarily undeveloped rural land. There are several rural residential properties located in Zone II.

Proposed Action

Comparing the FASTC Proposed Action cases (Alternative 1 in Figure 10 and Alternative 2 in Figure 11) with the Baseline case, two of the main observations are that (1) noise exposure from FASTC proposed operations is concentrated in the northwest part of Fort Pickett, including the 21/20 Parcel (where the demolition pads are located), LRA Parcels 9 and 10, Grid Parcel and the Blackstone Army Airfield and (2) this additional FASTC noise exposure only increases the combined noise environment (Baseline + Proposed Action) above the Baseline in this one area.

Comparing existing and proposed noise exposure, the only noticeable difference between the Baseline and the combined contours (Baseline + Proposed Action) occurs for the 57 dB CDNL contour which, due to the addition of FASTC, would extend beyond the Fort Pickett boundary, directly north of the airfield, by approximately 650 feet. This would result in an extension of the LUPZ and Zone I which are acceptable for noise sensitive land uses. In addition, the area affected is mostly within the industrial zone, such that no additional incompatibilities in land use are expected to result due to the introduction of FASTC operations.

Noise exposure within Fort Pickett is expected to increase, with the Proposed Action, in areas directly east and south-east of Blackstone Army Airfield. These areas include parts of Nottoway County Pickett Park, the 21/20 Parcel and the eastern part of LRA Parcel 9. As shown in Figures 10 and 11, while the Proposed Action LUPZ extends further north, primarily over the airfield, Noise Zone II (62-70 CDNL) extends over these areas mentioned. In general, land use within Noise Zone II should be limited to non-sensitive activities such as industry, manufacturing, etc. There are a number of VAARNG buildings located near the eastern airfield boundary, eastern boundary of Pickett Park and the southern boundary of the Grid Parcel which would be located within Noise Zone II with the Proposed Action. Noise Zone III would expand to cover the northern half of the 21/20 Parcel; this is where the demolition pads are located, primarily in an undeveloped area suitable for demolition operations.

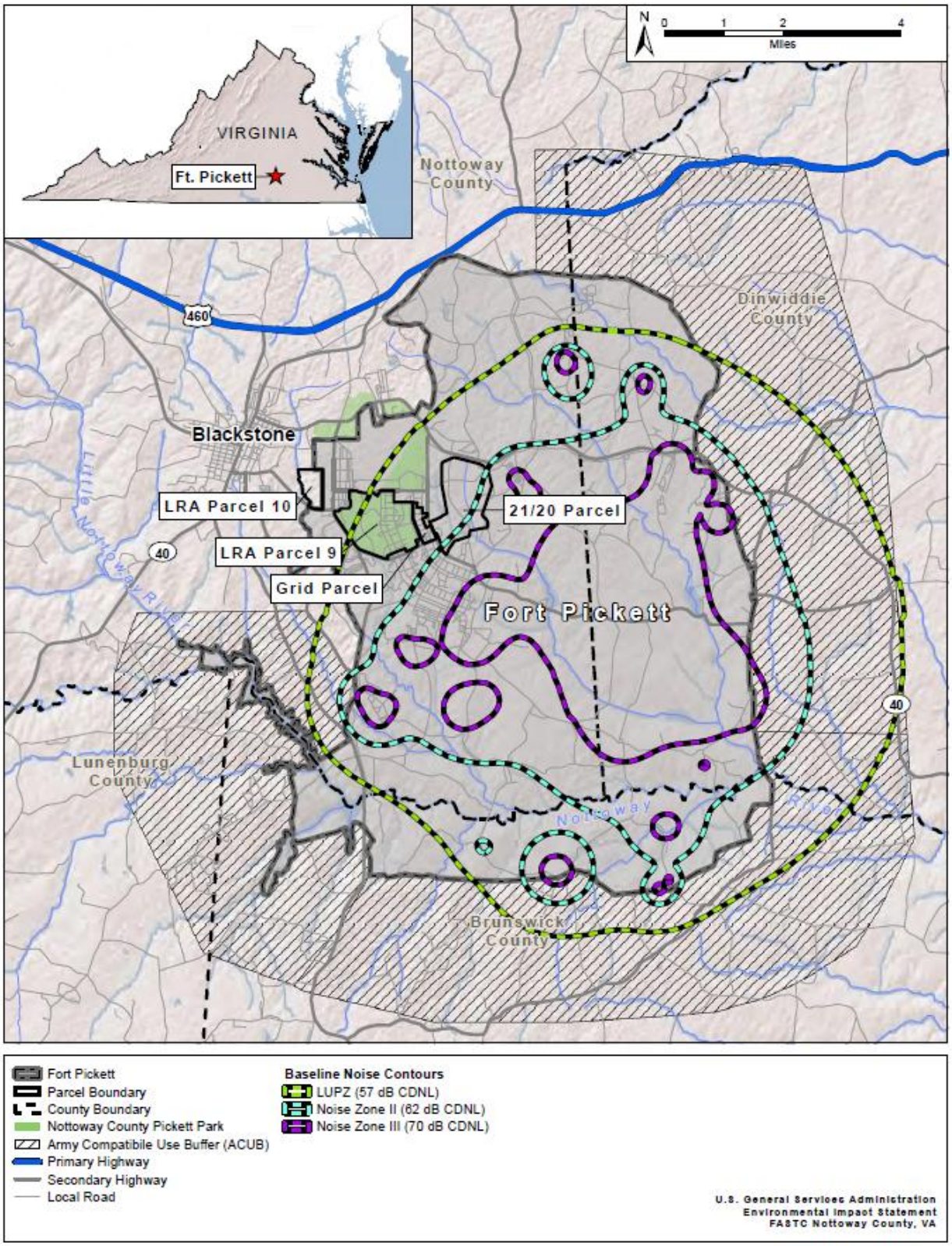

Figure 9. Demolition and Large Caliber Operations Noise Contours (Fort Pickett Baseline).

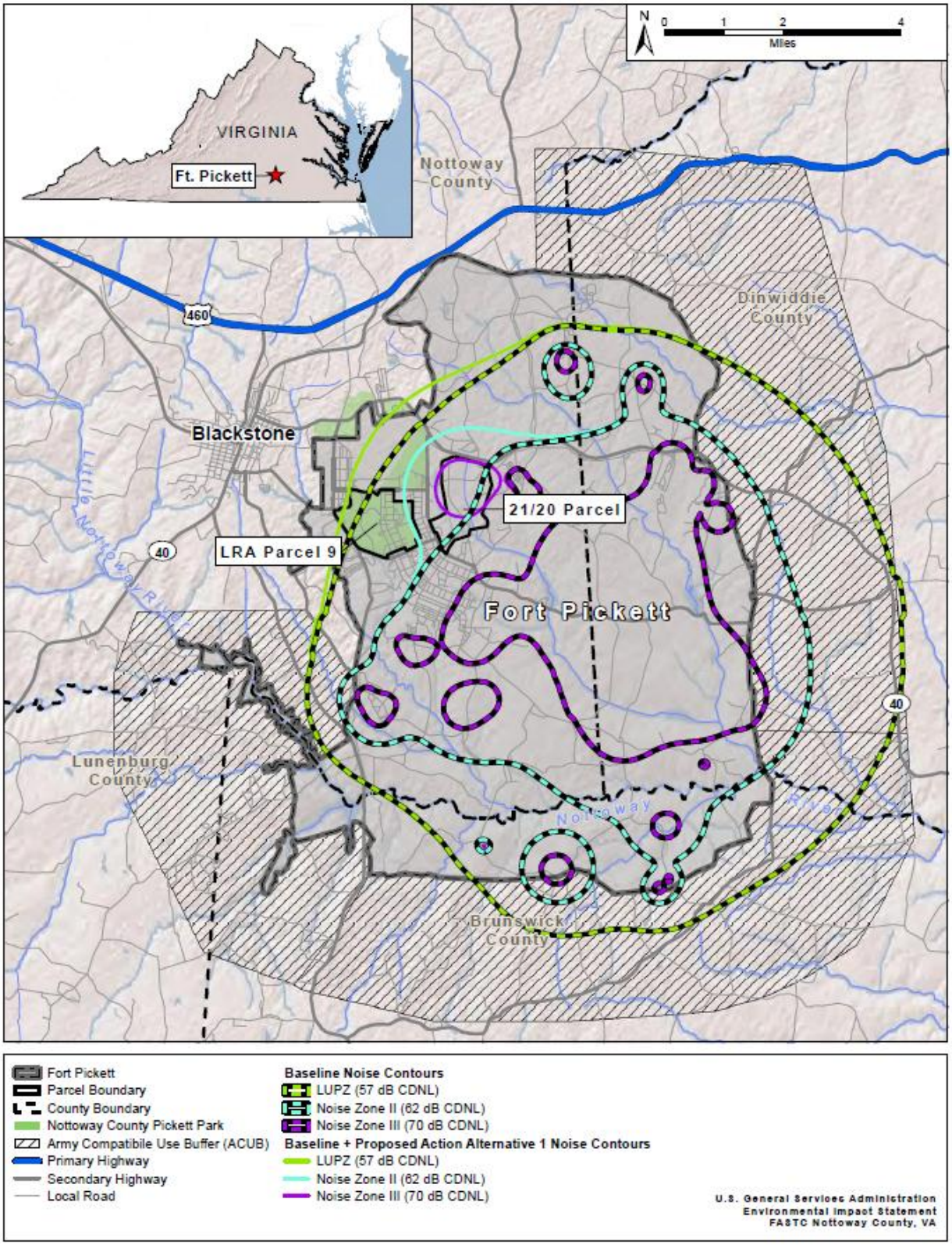

Figure 10. Demolition and Large Caliber Operations Noise Contours (Baseline + Alternative 1).

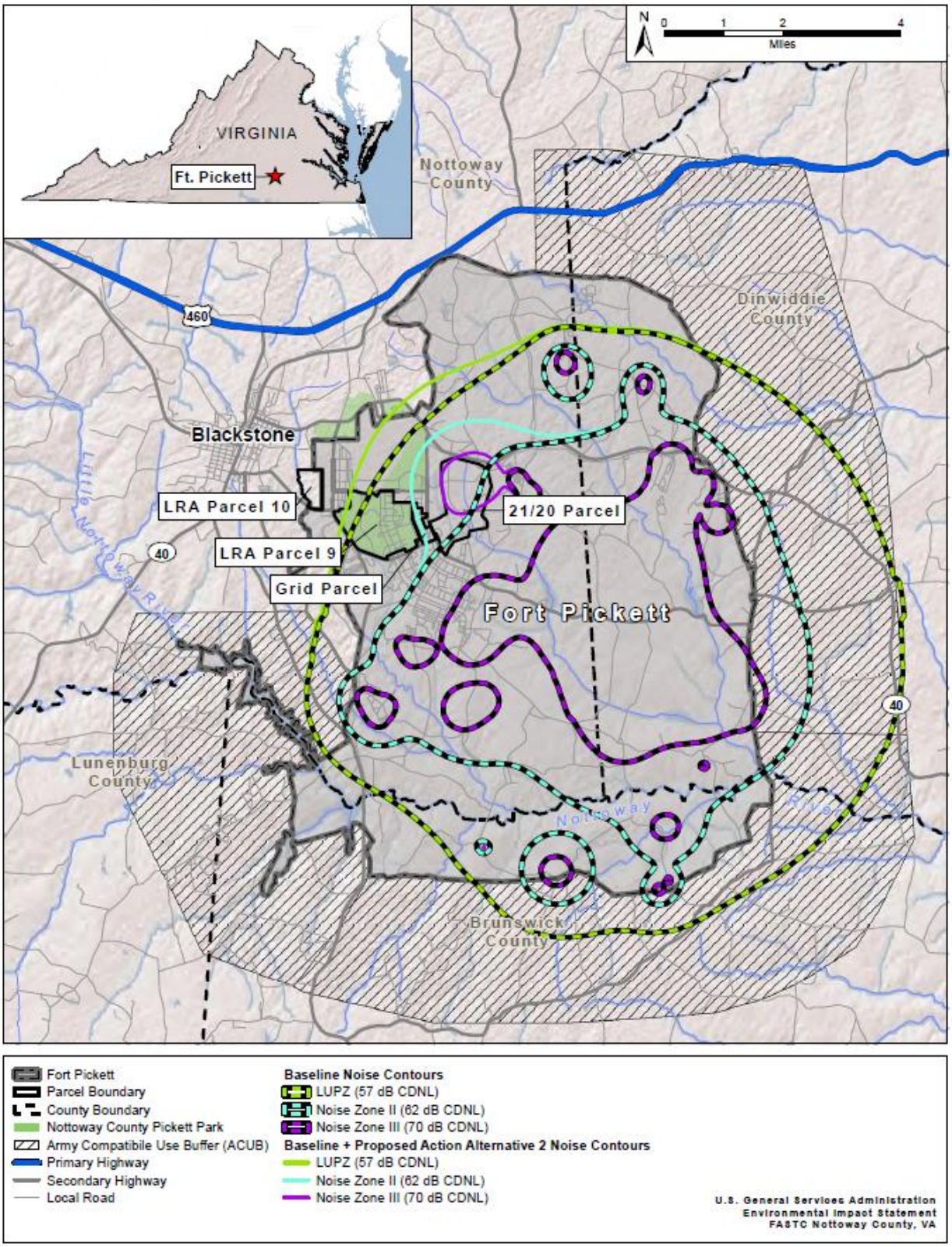

Figure 11. Demolition and Large Caliber Operations Noise Contours (Baseline + Alternative 2).

4.2 Complaint Risk Areas

Annual average noise levels (i.e., CDNL) were evaluated to determine the significance of the noise impacts. However, complaints are more attributed to single specific events rather than annual average noise levels. Peak levels are appropriate for estimating the risk of receiving a noise complaint because they correlate with the receiver's perception of the single event noise level. Table 16 indicates the risk of receiving noise complaints with increasing levels of impulsive noise from large weapons and demolition.

Table 16. Complaint Risk Guidelines for Impulsive Noise

Perceptability	Large Weapon Noise Limit (dB) PK 15(met)	Risk of Receiving Noise Complaints
Audible	<115	Low
Noticeable, Distinct	115 to 130	Moderate
Loud, May Startle	130 to 140	High
Intense, at or above Threshold of Pain and Discomfort	>140	Risk of Physiological damage to unprotected human ears and structural damage claims

The risk of receiving noise complaints due to demolition and large caliber weapons was evaluated for three scenarios, including the Fort Pickett Baseline and the Baseline combined with each of the two Proposed Action alternatives. This was conducted using BNOISE2 to generate peak noise contours (representing the loudest single event at each range or firing location). But because peak noise levels can vary significantly with different atmospheric conditions, two sets of contours were computed:

- Unfavorable Weather Conditions: The PK15(met) is the peak sound pressure level, factoring in statistical variations caused by weather, that is likely to be exceeded only 15 percent of the time. The PK15(met) levels would occur under conditions that enhance sound propagation such as a temperature inversion; that is, warmer air above colder ground surfaces.
- Neutral Weather Conditions: The PK50(met) is the peak sound pressure level that would be expected 50 percent of the time and under neutral weather conditions.

<u>Baseline</u>

The complaint risk areas for demolition and large caliber weapons operations are shown using PK15(met) contours in Figure 12 for the Baseline condition, as provided by USAPHC. Figure 15 shows the results for the PK50(met) contours. The following results were determined for demolition and large caliber weapons operations in the Fort Pickett Baseline Study[1]:

Under enhanced propagation conditions (Figure 12), the High Complaint Risk area (130 to 140 dB PK15(met)) extends beyond the boundary less than 2,950 feet (0.6 miles) at Ranges 15 and 16 and from the artillery firing points near the boundary. The Moderate Complaint Risk area (115 to 130 dB PK15(met)) extends beyond the boundary in most directions up to 7,220 feet (1.4 miles).

Under neutral propagation conditions (Figure 15), the High Complaint Risk area (130 to 140 dB PK50(met)) remains within Fort Pickett except for small areas near Ranges 15 and 16 and from the artillery firing points near the boundary. The Moderate Complaint Risk area (115 to 130 dB PK50(met)) extends beyond the boundary less than 4,250 feet (0.8 miles). Though the complaint risk guidelines would indicate a moderate to high risk of complaints, these areas are primarily undeveloped and as such the risk of complaints would be low for the Baseline scenario. Although these Baseline contours do extend outside Fort Pickett in certain areas they do not extend beyond the ACUB.

Proposed Action

In comparison to the Baseline scenario, the primary difference in the peak contours representing the Baseline plus Proposed Action cases occurs in the northwest area containing the 21/20 Parcel, LRA Parcels 9 and 10, Grid Parcel and the Blackstone Army Airfield. Under enhanced propagation conditions, PK15(met), Figure 13 shows the Complaint Risk areas for the combined activities Baseline plus Proposed Action Alternative 1 and Figure 14 shows the same areas for the combined activity with Alternative 2. The result of adding the FASTC activity is to expand the complaint risk areas to the northwest, over the proposed FASTC complex. The Moderate Complaint Risk area (115 to 130 dB PK15(met)) would extend outside Fort Pickett in the area directly north of the airfield; this projected new area includes commercial buildings associated with the Virginia Polytechnic Institute and at least one residence, located north of the Virginia Tech campus. The High Complaint Risk area (130 to 140 dB PK15(met)) would be further extended to the northwest, but still remain entirely within Fort Pickett; although some existing VAARNG buildings, which are now located in a Moderate Complaint Risk area, would then be located in a High Complaint Risk area.

The Proposed Action Alternatives under neutral propagation (Figures 16 and 17) show a similar change where the complaint risk areas are identical to the Baseline case except for their expansion to the northwest. For neutral propagation, the High Complaint Risk area (130 to 140 dB PK50(met)) to the northwest is larger than it is for the Baseline case, but it remains entirely within Fort Pickett and mainly within the 21/20 Parcel; the Moderate Complaint Risk area (115 to 130 dB PK50(met)) also extends further to the northwest but not outside Fort Pickett. Under neutral propagation parts of the Blackstone Army Airfield, LRA Parcel 9 and the Grid Parcel would now be in a Moderate Complaint Risk area with the Proposed Action.

The purpose of this peak level analysis was to determine how the Complaint Risk areas change from the existing Fort Pickett Baseline case to the combined cases which include proposed FASTC operations. Under enhanced sound propagation conditions, there would be an increase in Moderate Complaint Risk for the area outside Fort Pickett north of the airfield; several commercial buildings including those belonging to Virginia Polytechnic Institute and at least one residence would potentially be at a higher complaint risk. For locations within Fort Pickett, there would be an increase in the Moderate and High Complaint Risk areas associated with Pickett Park and the 21/20 Parcel. These areas are typically used by base personnel therefore complaint risk is expected to be lower than if the affected areas were in the surrounding community.

Blackstone residents are likely to notice a couple of changes to their noise environment if FASTC is implemented.

First, there would be additional demolition operations, increasing the overall number of explosive events heard. But of these additional events, mainly the higher yield FASTC demolition operations (2 to 3 pound charges) would be noticed. There are expected to be only six 3 pound charges and thirty-six 2.23 pound charges detonated annually under the Proposed Action. These are much lower in number on an annual basis then existing VAARNG operations which include thousands of rounds fired (many by 105mm and 155mm Howitzers and 120mm Tank guns). The higher yield FASTC demolition operations (2 to 3 pound charges) add up to 42 additional events per year. While the frequency of these proposed events is unknown, if they were spread out evenly throughout the year, over a fifty week period, for example, then this would mean that Blackstone residents would be expected to hear about 1.2 additional demolition events per week due to the Proposed Action.

Second, peak noise levels would increase as a result of these FASTC demolition charges. This is projected to occur because the FASTC demolition events would be located closer to Blackstone, even though they have lower acoustic output compared to most of the high caliber VAARNG operations. However, the projected Complaint Risk Areas indicate that there is still expected to be a low risk of complaints from Blackstone residents, i.e., Blackstone is still located well outside of the moderate complaint risk area.

On post, in addition to the higher yield FASTC demolition charges, some of the lower yield charges may also be noticed, depending on the observer's location with respect to the demolition pads. Considering the FASTC demolition operations, there is expected to be a much higher annual number of these lower yield charges including black powder 2 ounces (312), flash bangs 4.5 grams (400) and C2/C4 Detasheet ¼ pound (424). These may be noticed at times by personnel within Fort Pickett, but these are considered minor events compared with the greater number of higher yield Fort Pickett demolition and high caliber weapons operations.

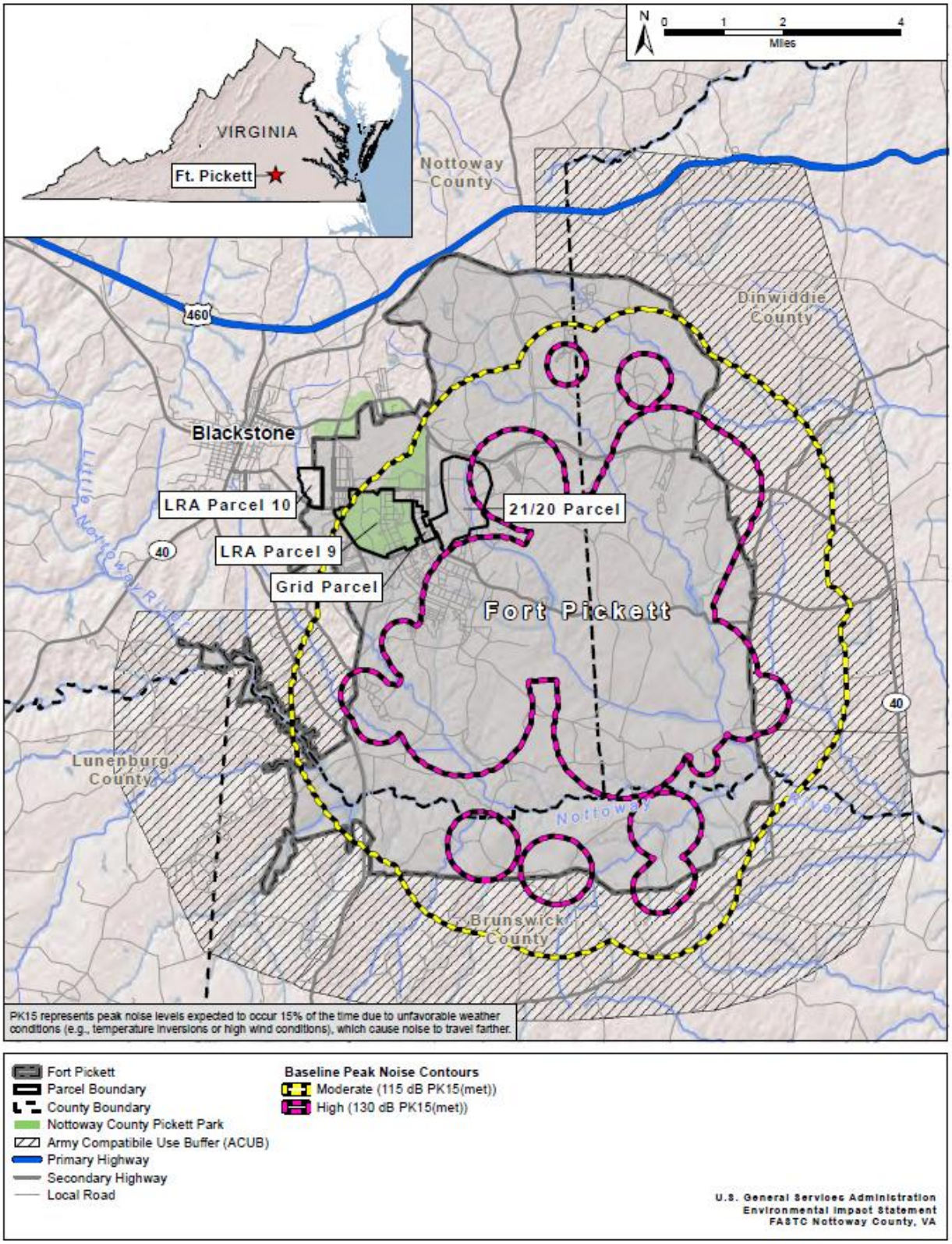

Figure 12. Demolition and Large Caliber Operations Complaint Risk Areas, PK15(met), (Fort Pickett Baseline).

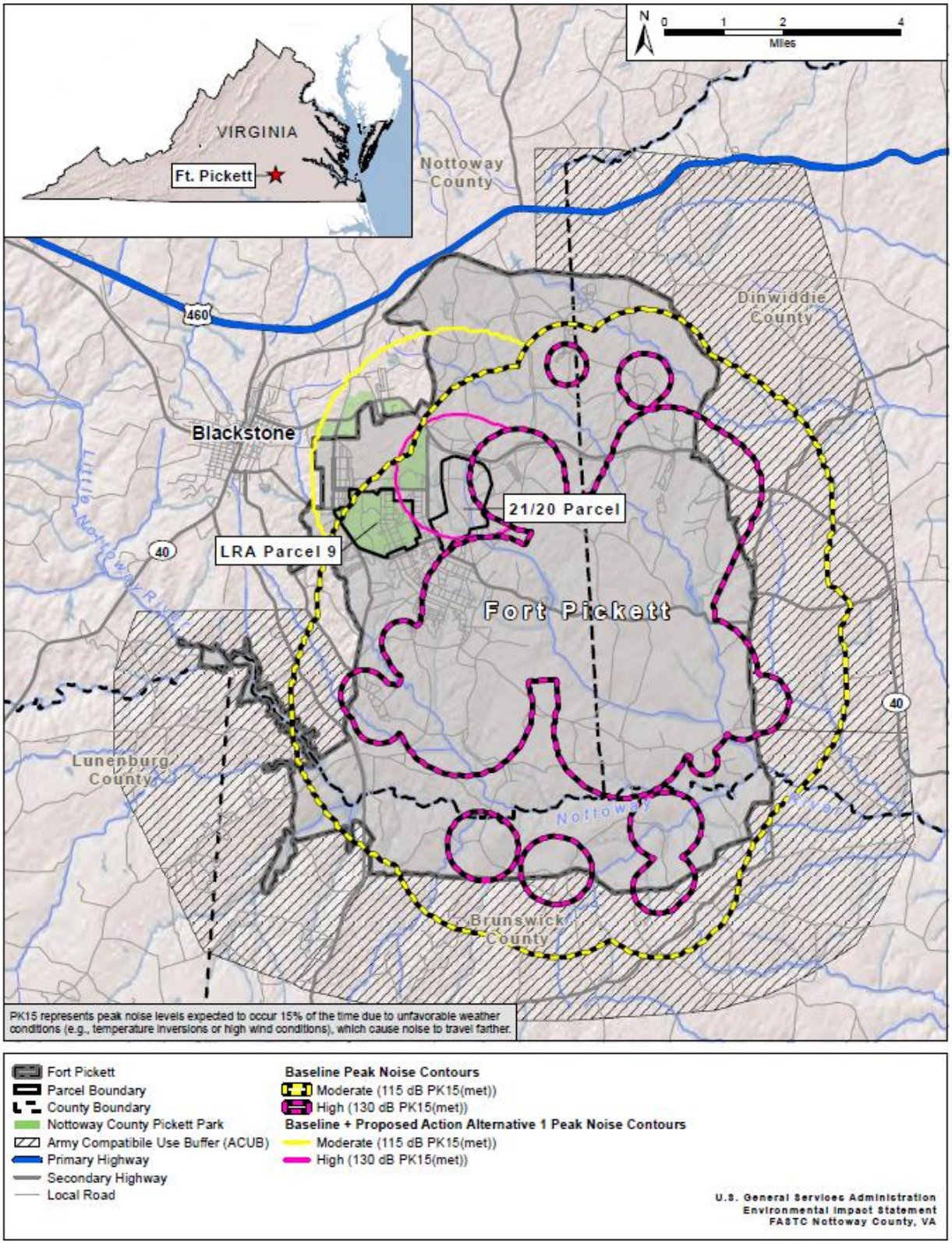

Figure 13. Demolition and Large Caliber Operations Complaint Risk Areas, PK15(met), (Baseline + Alternative 1).

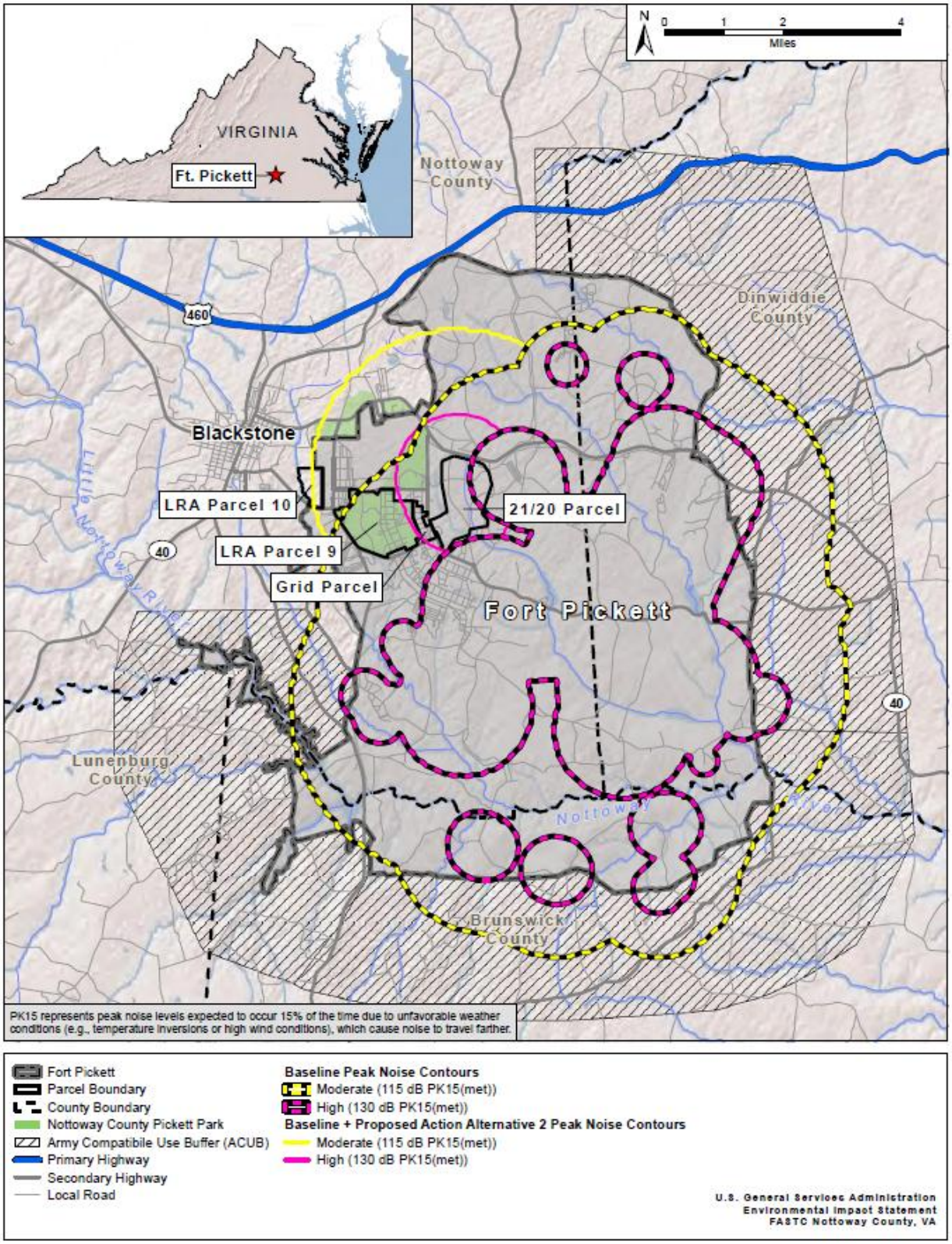

Figure 14. Demolition and Large Caliber Operations Complaint Risk Areas, PK15(met), (Baseline + Alternative 2).

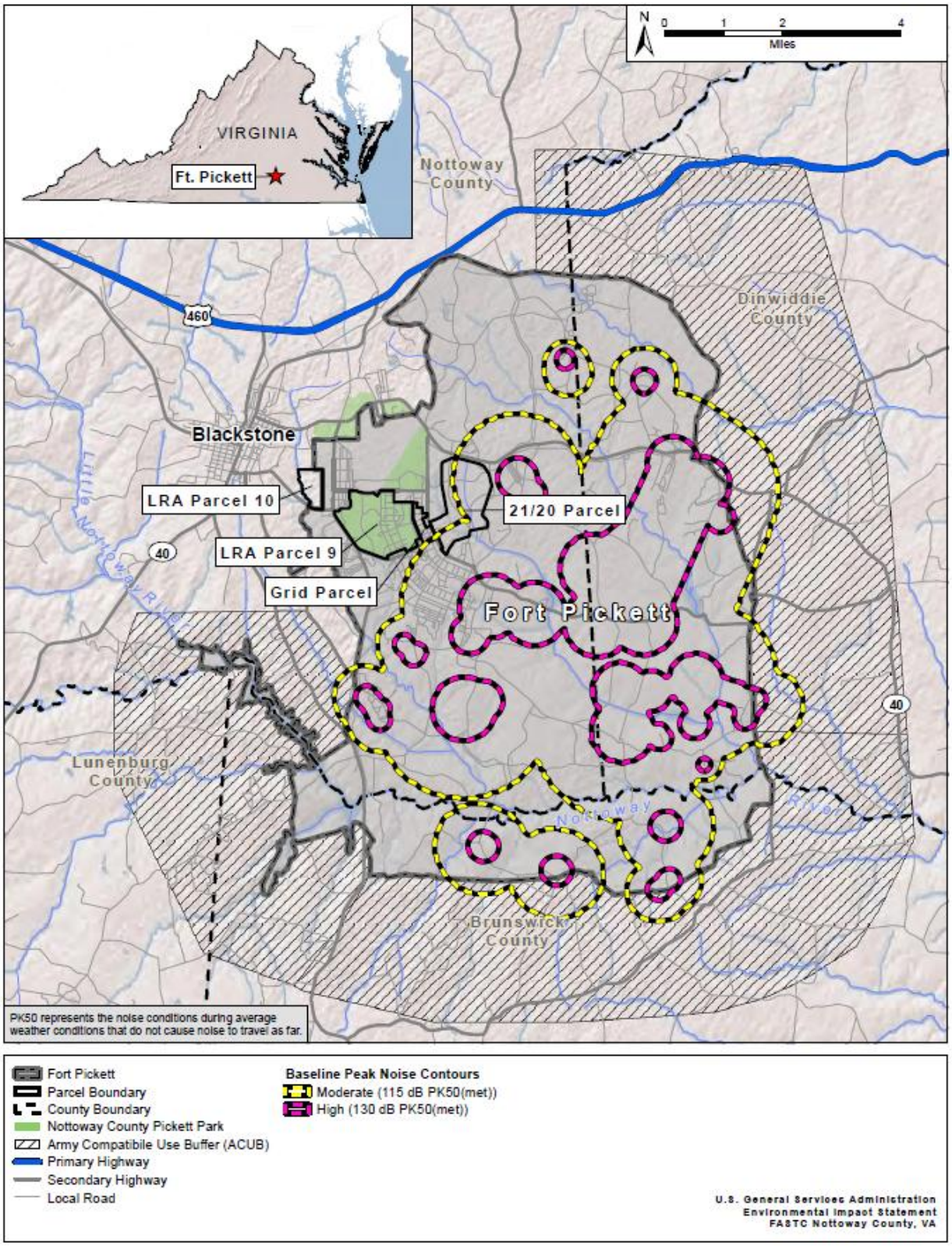

Figure 15. Demolition and Large Caliber Operations Complaint Risk Areas, PK50(met), (Fort Pickett Baseline).

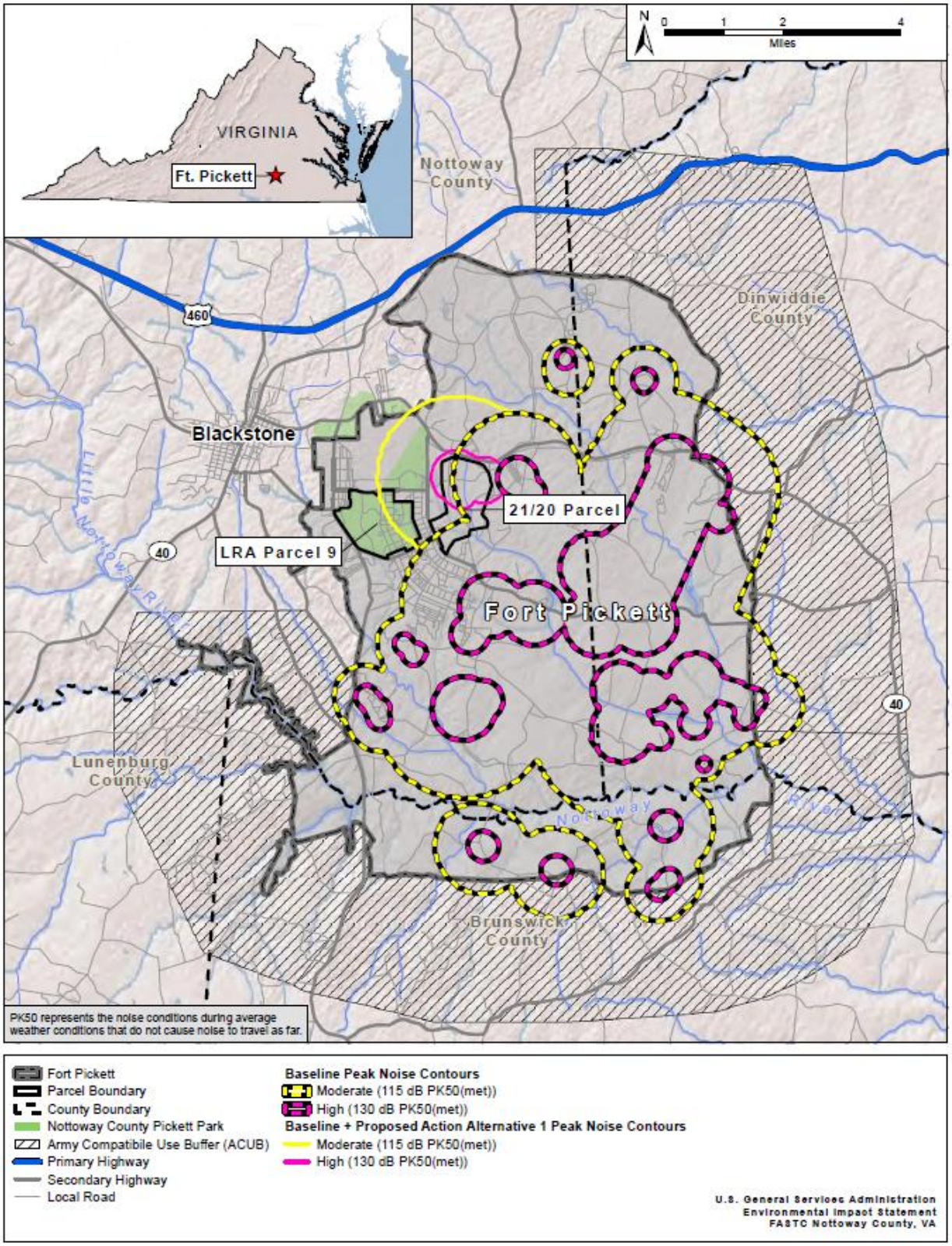

Figure 16. Demolition and Large Caliber Operations Complaint Risk Areas, PK50(met), (Baseline + Alternative 1).

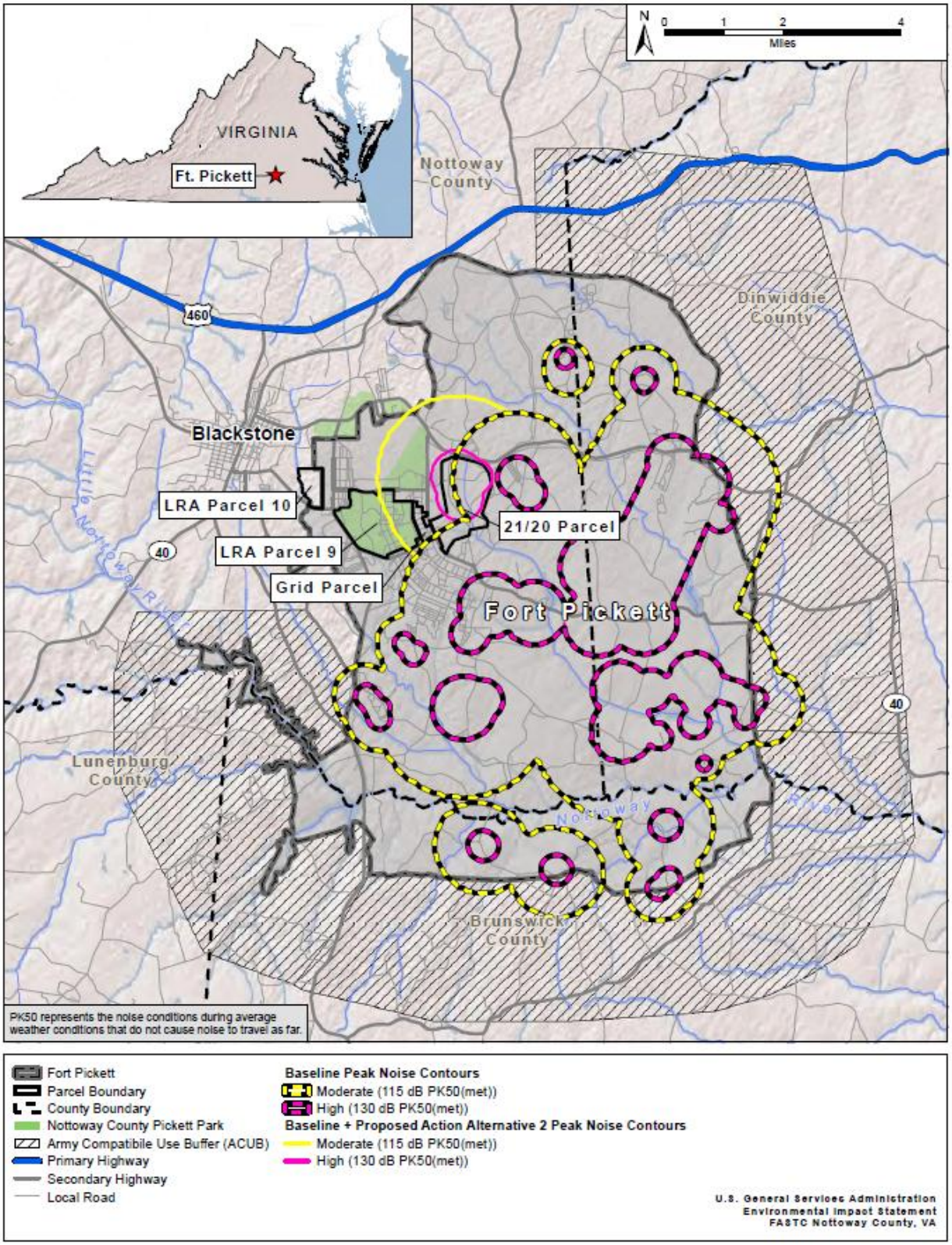

Figure 17. Demolition and Large Caliber Operations Complaint Risk Areas, PK50(met), (Baseline + Alternative 2).

4.3 Predicted Peak Noise Levels for Simulators

Simulators (flash bangs) are an explosive proposed for use in certain FASTC driver training exercises. Part of the Urban Drive Course (E04) is the Explosives Simulation Alley where it is proposed that approximately 400 simulator events would occur on an annual basis. This number of simulators is below the threshold used in BNOISE2 to compute annual average noise levels. However, BNOISE2 was used to compute peak noise levels to evaluate the risk of complaints from these events.

Simulator noise levels would vary depending on the type (artillery, ground burst and grenade) but the variation is limited to a few decibels[1]. Table 17 provides an estimate of the distances from the source of a simulator event to the peak noise contours used to define the Moderate (115 to 130 dBP) and High (130 to 140 dBP) complaint risk areas for both unfavorable (PK15(met)) and average (PK50(met)) weather conditions. These guidelines for impulsive noise were indicated previously in Table 16.

Table 17. Predicted Peak Noise Levels for Simulators

Metric	Weather Conditions	Noise Guideline (dBP)	Complaint Risk	Distance from Source (feet)
PK15(met)	Unfavorable	115 to 130	Moderate	2577 feet to 115 dBP
PK15(met)	Unfavorable	130 to 140	High	656 feet to 130 dBP
PK50(met)	Average	115 to 130	Moderate	1462 feet to 115 dBP
PK50(met)	Average	130 to 140	High	520 feet to 130 dBP

The peak levels and complaint risk areas used to describe simulator noise are analogous to those used for demolition and large caliber operations (Figures 12 through 17). Simulator activity is assessed here, in terms of peak levels, for the Baseline and Proposed Action conditions.

Baseline

For the Baseline condition, Figures 12 and 15 respectively indicate moderate to low complaint risk in the area proposed for E04 due to Fort Pickett demolition and large caliber weapons operations. Currently, no simulator activity occurs in this area planned for E04.

Proposed Action

For Proposed Action Alternative 1, range E04 is located in the northeast part of LRA Parcel 9 (see Figure 3). Simulator activity at E04 is expected to generate peak noise levels above 130 dB within 656 feet from the source for unfavorable weather conditions (PK15(met)) and within 520 feet from the source for average weather conditions (PK50(met)). These levels, which correspond to high complaint risk, are not expected to extend beyond the eastern boundary of LRA Parcel 9 and therefore existing VAARNG buildings located near this boundary would be in a Moderate Complaint Risk Area when simulators are used. Peak levels above 130 dB may extend beyond the northern boundary of LRA Parcel 9, depending on simulator location, but are not expected to impact existing buildings which are located more than 650 feet from this northern boundary.

For Proposed Action Alternative 2, E04 is located in the southeast part of LRA Parcel 9 (see Figure 4). In this case, simulator peak levels above 130 dB generally would not extend beyond the LRA Parcel 9 boundary unless simulators were used in the most south-eastern part of E04 (within about 650 feet from the existing VAARNG MEDCOM or classroom buildings). Therefore operating simulators more than 650 feet away from these buildings would ensure they were located in a Moderate Complaint Risk Area, rather than in a High Complaint Risk Area. The Officer's Club, another prominent existing building located approximately 1,500 feet southwest of E04, is expected to be located in a Low to Moderate Complaint Risk Area when simulators are used.

5 Small Caliber Weapon Noise Evaluation

Five firing ranges are to be used by FASTC personnel for small arms weapons training, including the Indoor Firing Range (R02), Live fire Shoot House, 1-Story (R03a), Live fire Shoot House, 2-Story (R03b), Baffled Indoor Tactical Combat Range (R04) and the Existing Outdoor Rifle Range (R05). The first four are planned indoor ranges whereas the outdoor range is currently being used by Fort Pickett for training.

In this analysis, the same methods were used to assess small arms noise for FASTC operations as were used by the USAPHC to assess the Fort Pickett Baseline operations[1]. The FASTC operations data used were identified in section 2.4. It is important to note that the small arms noise assessment was conducted using different methods for outdoor and indoor ranges. The SARNAM model was used for all outdoor ranges, including those in the Baseline assessment, where the primary output is peak sound level contours. But for indoor ranges, there is no model that takes into account all of the structural and acoustical characteristics of an enclosed range, such as interior sound field characteristics or detailed building noise reduction. To assess indoor ranges, the USAPHC estimates the exterior peak levels using common structural noise reduction values and limits these estimates to several distances and azimuths from each weapon being analyzed. The following sections describe both types of noise analysis conducted for outdoor and indoor ranges.

5.1 Outdoor Firing Ranges

Baseline

Per AR 200-1 (U.S. Army 2007)[2], small arms operations for the Baseline case were analyzed using PK15(met). The noise zone definitions were provided in Table 15.

Since the contours are based on peak levels rather than a cumulative or average level, the size of the contours would not change if the number of rounds fired increases or decreases.

The small caliber weapons noise contours for the Fort Pickett Baseline case, which were developed by the USAPHC[1], are shown in Figure 18. Along the eastern boundary, Zone II [87 dB PK15(met)] extends less than 5,900 feet (1.1 miles) into the community and Zone III [104 dB PK15(met)] extends less than 820 feet into the community. Based on available imagery, the Zone II and III areas outside Fort Pickett are primarily undeveloped. There may be scattered residential properties within Zone II.

These contours were generated using SARNAM which requires specific firing point and target point locations entered into the model. At several of Fort Pickett training areas and ranges, there are no set firing points or target point locations and firing can occur at multiple locations and in multiple directions. The USAPHC addressed this by estimating the peak levels for specific types of munitions and determining at what distances noise levels would approach Zone II limits [PK15(met) 87 decibels (dB)]. Although the USAPHC did this for several types of munitions, the loudest in the group is the .50 caliber blank activity for which Zone II levels would extend out approximately 2,625 feet. For the .50 caliber and all other munitions analyzed, noise levels approaching Zone II limits [PK15(met) 87 dB] would either be

contained within the small caliber noise zones shown in Figure 18 or would not extend beyond the Fort Pickett boundary.

Proposed Action

The preceding analysis of small caliber weapons noise refers to the Fort Pickett Baseline operations conducted at existing outdoor ranges. The only outdoor firing range associated with the proposed FASTC operations is R05 which has the same activity and layout as existing Range 8, used by Fort Pickett. Because this analysis was conducted using peak sound levels, the additional activity associated with R05 would not change the Baseline peak sound level contours (or noise zones) depicted in Figure 18.

The remaining four FASTC firing ranges are indoor ranges. The noise assessment for these ranges is presented in the following section.

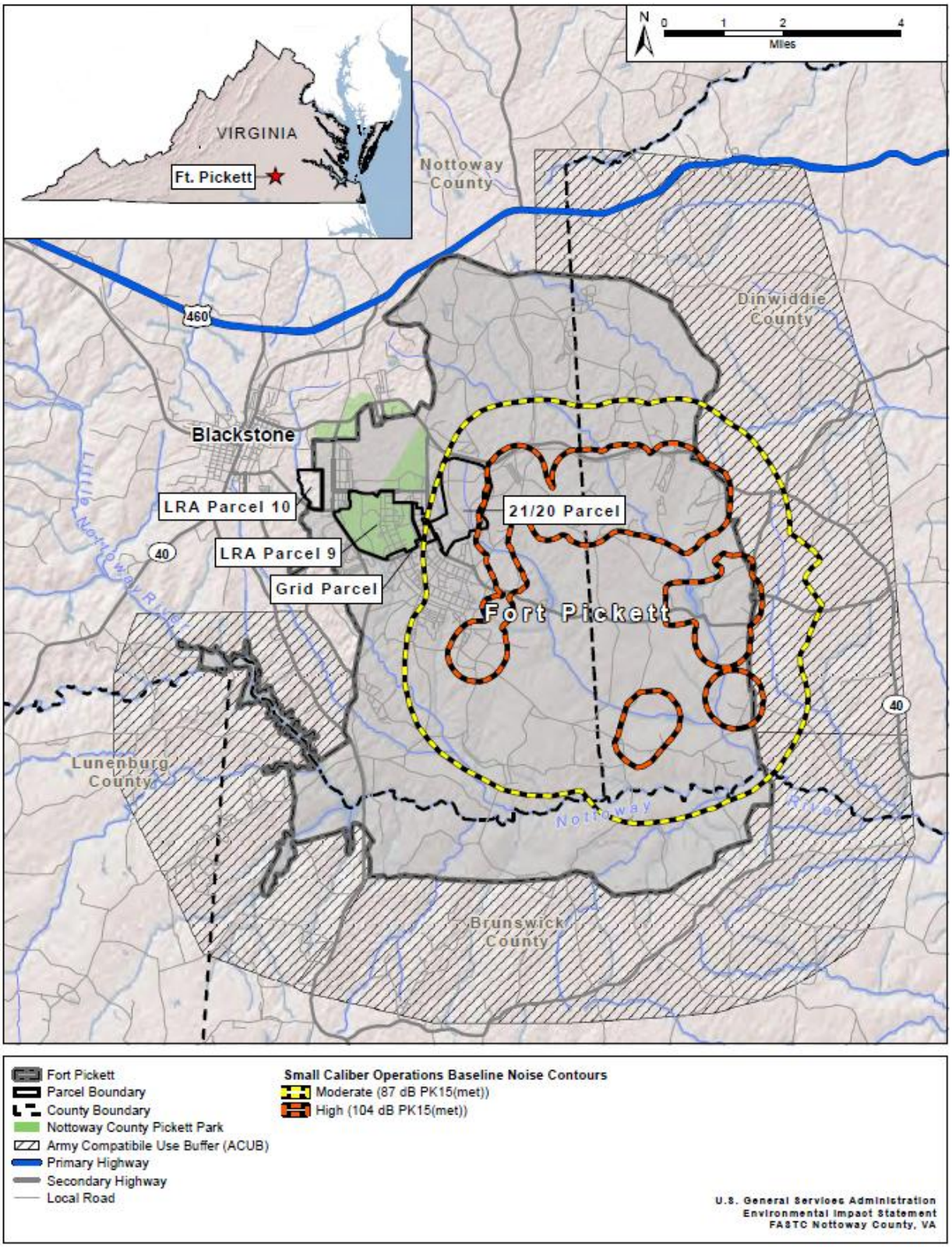

Figure 18. Small Caliber Operations Noise Contours (Fort Pickett Baseline).

5.2 Indoor Firing Ranges

Baseline

All firing ranges at Fort Pickett are outdoor ranges; therefore, the Fort Pickett Baseline does not include indoor firing ranges.

Proposed Action

The proposed FASTC indoor ranges include the Indoor Firing Range (R02), One-Story Live Fire Shoot House (R03a), Two-Story Live Fire Shoot House (R03b) and the Baffled Indoor Tactical Combat Range (R04). Weapons to be fired in these ranges include handguns (.357 magnum, 9mm, and .40 caliber), M16 Rifle (5.56mm), Shotgun (12 gauge), and Machine Guns (9mm, 0.40 caliber, and 0.45 caliber), with operations distributed on each range as indicated in Table 9.

Modeling the activity for indoor ranges was done making some assumptions about the building type because the designs for these ranges are not final. The indoor ranges are expected to be fully enclosed, however no firing range noise model currently available can account for a full or partial structure. Preliminary plans for these indoor ranges have indicated different types of structures, some with interior sound absorption to make the facility as 'sound proof' as possible. Generally, the exterior noise level of an enclosed small arms range is of little concern due to the attenuation effects of the structure itself.

To estimate the exterior noise levels for an indoor range, the building construction Noise Level Reduction (NLR) is used. For example, if the building construction of the indoor ranges was the common brick and mortar type, a typical NLR value of 25 dB would be used to represent this type of construction. If the brick and mortar structure also had interior sound absorption or other noise mitigation, the NLR would be expected to be higher (30 dB or more). Or, If the construction was wood exterior, the NLR would be expected to be lower (15 dB).

Since there are several different types of structures proposed for the indoor ranges, and the design plans for these structures have not been finalized, a generic case is presented here. In this example, it is assumed that the building construction of each indoor range is the brick and mortar type, with a corresponding NLR value of 25 dB provided on the exterior of the building.

Using the SARNAM[6] noise model program, combined with the building NLR value of 25 dB, an estimate of the exterior peak sound levels can be made for a generic indoor range utilizing the proposed FASTC operations. Table 18 shows the results of this exercise where the exterior peak sound levels are estimated for each FASTC weapon type and live round for two representative distances (328 feet and 656 feet) and three azimuths (0°, 90° and 180°) from the firing position. In this case, 0° is directly in front of the weapon and 180° is directly behind the weapon.

Table 18 shows a range of peak noise levels for each distance and azimuth from the firing position. For each range of levels, the lower number represents the level exceeded 85 percent of the time (mean-1σ)

and the higher number represents the level exceeded 15 percent of the time (mean +1σ). This bounds the range of exterior peak noise levels accounting for statistical variation in meteorological conditions.

Table 18. Predicted Exterior Peak Sound Levels for Indoor Range Operations

Weapon Type and Round		Predicted Exterior Peak Sound Level, dBP					
		Distance = 328 feet			Distance = 656 feet		
		Azimuth			Azimuth		
		0°	90°	180°	0°	90°	180°
Handgun	.357 magnum	93-103	87-97	86-96	86-96	80-90	78-88
Handgun	9 mm	83-93	78-88	74-84	77-87	71-81	68-78
Handgun	.40 cal	83-93	80-90	80-90	77-87	73-83	73-83
Rifle	5.56 mm	93-103	86-96	76-86	86-96	79-89	69-79
Sub-machine gun	9 mm	83-93	78-88	74-84	77-87	71-81	68-78
Sub-machine gun	.40 cal	83-93	80-90	80-90	77-87	73-83	73-83
Sub-machine gun	.45 cal	83-93	80-90	80-90	77-87	73-83	73-83
Shotgun	12 guage	92-102	80-90	81-91	85-95	73-93	75-85

Notes: the 0° is directly in front of the weapon and the 180° azimuth is directly behind the weapon.
NLR estimated at 25 dB.

For example, the Shotgun (12 gauge) is one of the loudest weapons where the exterior peak levels, at 328 feet (100 meters) from the firing position, are predicted to be within a range of 92-102 dBP in front of the weapon or in the firing direction. To the side of the weapon, the exterior peak levels are predicted to be within a range of 80-90 dBP and behind the weapon, 81-91 dBP.

With brick and mortar construction and estimated building attenuation of 25 dB, the Zone III noise contour (> 104 dBP) is expected to remain relatively localized and within 328 feet to the front of the weapon position for all weapons indicated in Table 18. In comparison, the Zone II contours (87-104 dBP) extend further covering a larger area around the firing range. Noise approaching or within Zone II levels (87-104 dBP) would extend out approximately 656 feet in front of the weapon position for all weapons indicated in the table. Due to noise directivity, levels to the side and behind the weapon are reduced when compared to levels in front; this is normally true for a weapon fired in open space. Depending on the structure and interior acoustics of an indoor range, this directivity pattern can potentially change. Therefore, the levels presented in Table 18 are estimates which use the noise directivity patterns of each weapon, without accounting for any filtering of the range structure.

Zone II noise levels estimated for all FASTC firing range operations are expected to remain within the Fort Pickett boundary. The noise levels in Table 18 can be used to estimate the location of the Zone II and Zone III contours for a building NLR of 25 decibels. The results for using a different building NLR value can be determined by adding (or subtracting) decibels to the levels in Table 18. For example, if the NLR was 15 dB, 10 dB would be added to the levels in Table 18 whereas if the NLR was 30 dB, 5 dB would be subtracted from the levels in the table. It is expected that firing range buildings would be designed to ensure noise levels at adjacent facilities are within acceptable levels.

6 Occupational Noise Exposure

The proposed FASTC training operations are estimated to have limited additional noise exposure on the surrounding residential communities beyond the existing Baseline noise at Fort Pickett. However, FASTC training operations are expected to increase noise levels within Fort Pickett where new facilities are to be located. One concern for personnel working or training at these facilities is that some noise events may be of high enough intensity to damage unprotected hearing.

The various training events are expected to generate different types of noise ranging from the continuous sound of cars on the drive tracks to impulsive sounds of gun fire and demolition activity on the ranges. A person's cumulative noise exposure to continuous noise is determined from the constantly varying noise levels and the duration of exposure to each level. The evaluation of continuous noise uses the A-weighting filter adjustment which corresponds well to human hearing sensitivity, reducing the contribution of lower frequency noises. A person's exposure to impulsive noise is typically quantified using the unweighted peak noise metric since the unweighted or 'flat' response better approximates human hearing sensitivity to loud sounds.

The federal Occupational Safety and Health Administration (OSHA)[3] has established decibel (dB) levels for hearing protection that include limits on "continuous" and "impulsive" noise exposure. For continuous noise, the OSHA criterion level or permissible exposure limit (PEL) is 90 decibels (A-weighted), as an 8-hour, time-weighted average level (TWA). This standard specifies a 5 dB exchange rate and slow response measurement. Using this criterion, individuals may be exposed to a noise level of 90 dBA for no longer than 8 hours before a temporary threshold shift is expected. Higher levels are permitted for shorter durations. For example, a TWA level of 95 dBA reduces the time for an individual to receive a maximum dose from 8 hours to 4 hours. Similarly, for a TWA level of 85 dBA, the permissible exposure time is increased by a factor of two. The OSHA hearing protection criterion limits the maximum A-weighted sound level (for unprotected personnel) to 115 dBA (for 15 minutes); the threshold level for dose computations is 80 dBA.

Although the permissible noise exposure limit is defined as 90 dBA for 8 hours, OSHA also published a hearing conservation amendment (HCA) which specifies that employers must administer a continuing, effective hearing conservation program whenever employee noise exposures are at or above an 8-hour TWA of 85 dBA. For evaluation of continuous noise at the FASTC facilities, the 85 dBA level was used to identify areas where personnel could potentially be at risk.

For impulsive noise, the OSHA criterion for unprotected occupational noise exposure is an unweighted peak level of 140 dB. The OSHA procedure for determining occupational noise exposure is to evaluate both continuous and impulsive noise separately using their respective criteria. If, in either case, noise levels exceed the stated criteria then OSHA requires a reduction in noise exposure via implementing a hearing conservation program.

For each of the FASTC facilities, the proposed operations and associated noise levels determined previously were evaluated using the appropriate OSHA criterion. Table 19 identifies the FASTC training

facility operations and indicates whether either of the OSHA criteria, for peak sound pressure level or the 8-hour TWA level, are expected to be exceeded at the facility. It should be noted that each type of facility and operations are evaluated using only one of the two OSHA criteria, depending on whether the noise source is considered impulsive or continuous.

Table 19. OSHA Occupational Noise Exposure Evaluation for FASTC Facilities

FASTC Training Facilities/Operations	OSHA Occupational Noise Exposure Standard 1910.95	
	Impulsive Sound	Continuous Sound
	Peak SPL Exceeds 140 dBP	8-hr TWA Exceeds 90 dBA
High-Speed Anti-Terrorism Driving, D02 (Tracks 1-3)	N/A	No
Skid Pad Exercises at D02 (Tracks 1-3)	N/A	No
Car Impact Events at D02 (Tracks 1-3)	N/A	No
Mock Urban and Rural Drive Courses T02, D03 and E04	N/A	No
Off-Road (D05) and Unimproved Road (D04) Drive Courses	N/A	No
Indoor Firing Ranges (R02, R03a, R03b and R04)	Range Interior Locations	N/A
Outdoor Firing Range R05	Range Interior Locations	N/A
Demolition Ranges (E02, E03, E04, E05b and E05c/d)		
C4/C2 Detasheet, 1/10 LB	< 492 feet	N/A
C4/C2 Detasheet, 1/3 LB	< 656 feet	N/A
C4/C2 Detasheet, 1 LB	< 984 feet	N/A
C4/C2 Detasheet, 3 LB	< 1148 feet	N/A
Simulators (flash bangs) at D02 and E04	< 328 feet	N/A

The driving operations (high-speed tracks, urban, rural and off-road/unimproved courses) are more accurately characterized as continuous noise sources, rather than impulsive, although noise generated at these tracks would be intermittent because cars would be dispersed on the tracks. Based on model predictions and measured data[14], none of the individual car passes (with speeds of up to 100 mph) or group of cars would exceed 85 dB(A) at distances greater than about 100 feet from the track. Since there are a limited number of operations per day on each track (far lower than would be considered continuous for eight hours) the OSHA 8-hour TWA for each track would be significantly less than the 85 dBA criteria.

The skid pad exercises and the car impact events were also evaluated using the criteria for continuous noise, although these events are of short duration. Measurements conducted for the skid pad and car impact exercises[14] show that the maximum A-weighted levels recorded for each did not exceed 100 dBA at distances of approximately 15 feet from the test track. Considering the proposed number of events per day, it is estimated that the skid pad exercises and car impact events would not exceed the OSHA 8-hour TWA criteria of 85 dBA at any locations in the vicinity of the drive tracks.

While the car operations on the drive tracks and courses are not expected to exceed the TWA limits for continuous noise, operations associated with firing ranges, demolition ranges and simulators are expected to exceed the peak sound level criteria at certain distances from the source, depending on the type of munitions used. These high-intensity, impulsive noise sources are expected to create a hazardous noise environment for people working and training at these facilities.

For this analysis, all of these operations are considered short duration, impulsive noise sources; although, at firing ranges, in cases where shooters on the firing line are exposed to noise from multiple guns being fired, then this could, at times, be considered a continuous noise source.

It is well known that high-powered guns generate peak noise levels that often exceed the OSHA 140 dB peak limit, for unprotected personnel, at the shooter's location. The area where peak levels are 140 dB or higher would potentially extend farther from the shooter's location, depending on the design of the range (i.e., size, type of enclosure and interior acoustic characteristics). A single unprotected exposure to loud gunfire can result in a temporary hearing loss. However, repeated exposure to impulsive firearm noise can result in permanent noise-induced hearing loss.

Due to both the high intensity of firearm noise and the preliminary nature of the FASTC range designs, all indoor and outdoor firing ranges are identified in Table 19 as areas where the OSHA 140 dB limit would likely be exceeded; and potentially at large areas surrounding the firing line. This is a typical result since all firing ranges generate these types of impulsive sound levels, requiring anyone located within the range to wear hearing protection. To be in compliance with the OSHA Occupational Noise Exposure Standard 1910.95[3], operators of the FASTC firing ranges are expected to provide hearing protection to personnel working and training inside these ranges during shooting practice.

FASTC demolition training would use explosives with higher power than ordinary firearms, yet lower power than some of the high explosive munitions used by Fort Pickett. Originally shown in Table 7, these explosives range in weight from 2 ounces black powder up to 3 pounds of C4/C2 Detasheet. In Table 19 several explosive weights, within this range, were evaluated for noise exposure, including C4/C2 Detasheet (1/10, 1/3, 1 and 3 pounds). BNOISE2 was used to determine the approximate distance to the 140 dBP contour (measured along an azimuth of 0° from the blast location). Table 19 indicates the estimated distances from each demolition event where the peak levels would be equal to or higher than 140 dBP; locations within these distances are considered to be in a hazardous noise zone during live operations. For safety purposes, fragmentation guidelines are expected to be more stringent than the noise distance guidelines shown in Table 19. In any case, hearing protection would be required to be used by personnel working or training in any of the FASTC demolition ranges during live operations.

Simulators are expected to be used at several locations near drive tracks 1-3 (D02) and Explosives Simulation Alley (E04). Peak noise levels for simulators were reported in section 4.3 to be 134-136 dBP at a distance of 328 feet from the blast. In Table 19, 328 feet is listed conservatively as the distance within which the OSHA 140 dBP limit would be exceeded.

OSHA criteria were evaluated above for noise associated only with the proposed FASTC facilities. However, noise from Fort Pickett operations, especially peak levels from demolition and large caliber weapon operations, should also be a concern to any personnel on base. Since Fort Pickett operations are well established, it is expected that hearing protection is already used by personnel in the vicinity of the Fort Pickett demolition ranges and large caliber operations.

7 References

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12. ISO 9613-2:1996 "Acoustics – Attenuation of sound during propagation outdoors – Part 2: General Method of Calculation."
13. Pollock, C., "Summary of Car Driving Noise at Creeds Training Facility, Virginia Beach, VA," Shen Milsom & Wilke, LLC, December 2011.

14. Excel data file, Car Ramming and Tire Squeal Noise Summary.xls, Shen Milsom & Wilke, LLC, provided October 2011.

15. FASTC EIS Traffic Study, Timmons Group, 2012.

Appendix A: Project Assumptions

1. Noise analysis was conducted to predict the noise environment that would result from implementing the development of FASTC at Fort Pickett, Virginia.

2. The locations of the facilities for Build Alternatives 1 and 2 were based on FASTC Master Plan concepts dated May 15, 2012 (Alternative 1) and July 27, 2012 (Alternative 2).

3. Operations data for all FASTC driving exercises, small arms range activity and demolition exercises were initially obtained from the previous Shen, Milsom & Wilke report (SM&W #09250) on the proposed FASTC site in St. Mary's County, Maryland. These data were assembled by BRRC into a data validation package for approval by GSA/DOS. The operations data used in this analysis were from the data validation package dated May 2012.

4. FASTC noise analysis was conducted for three main types of exercises; car driving exercises, small arms range activity and demolition exercises. Where applicable these exercises were combined with similar existing Fort Pickett exercises; primarily this meant combining FASTC demolition operations with Fort Pickett demolition and large caliber operations.

5. Industry standard noise models were used for all FASTC noise analysis except to predict noise levels from car ramming and tire squeal exercises. Large arms modeling was conducted using the BNOISE2 Large Arms Noise Assessment Model (version 1.3 2003 -07-03), small arms modeling was conducted using the SARNAM2 Small Arms Range Noise Assessment Model (version 2.6 2003-06-06), and drive track/course noise levels were determined using the Federal Highway Administration's Traffic Noise Model (FHWA TNM) version 2.5, February 2004 and associated reference noise (REMEL) data.

6. Noise metrics and reporting methodology, for the large and small arms noise analysis, were the same as those used by the Army PHC (USAPHC) in their recent (2011) Baseline noise analysis for Fort Pickett. This allowed a direct comparison with the Fort Pickett Baseline, and because the metrics and methodology used by the USAPHC are considered to be the industry standard.

7. Noise measurements for several FASTC driving activities had previously been recorded by Shen, Milsom & Wilke and these were considered for use on this project. The measurements found suitable for use in this analysis were for tire squeal and car ramming exercises; these measured data were used in this analysis to predict noise levels for these two exercises. Noise levels for all other driving exercises were estimated using TNM and the associated REMEL data.

8. Several modeling assumptions are noted: (1) the 3 pound demolition charge, which is the highest yield charge proposed for FASTC use, was modeled in BNOISE2 using the 3.5 pound surrogate because data for a 3 pound charge is not available. Contours generated by the available options (3.5 pound and 2.6 pound) indicated that there was not much of a difference between these two; therefore, modeling the 3.5 pound charge in the study was appropriate (i.e., using the 2.6 pound charge would not have affected the results significantly.; (2) the unimproved road and off-road courses were modeled using pavement as the road surface rather

than dirt; this was done because there is no noise data available for car driving on dirt roads. With reasonable approximation, pavement can be considered as 'best available' data. It should also be noted that the driving operations on the unimproved road and off-road courses are significantly less than those on the other FASTC high speed driving tracks and therefore noise levels generated by these courses are lower than the noise levels generated by the other tracks.

9. For the demolition and large caliber noise analysis, the metrics used were CDNL to assess land use compatibility and PK15 and PK50 to assess complaint risk. PK15 represents the peak noise level that is exceeded only 15 percent of the time, based on unfavorable weather conditions; this is a commonly used metric for this type of analysis but it does assume that these unfavorable weather conditions occur 15 percent of the time. Actual Fort Pickett weather data may indicate something different.

10. Detailed architectural designs for the FASTC small arms ranges were not available at the time of this noise analysis; therefore, to estimate exterior noise levels a general case was presented assuming a common brick and mortar structure. This analysis of exterior noise levels was presented in such a way that, once detailed estimates of building noise reductions become available, these noise reductions could be used to recalculate the exterior noise levels, using a simple procedure, if desired.

11. The analysis of simulators was based on project layouts for Alternative 1 dated May 15, 2012 and Alternative 2 dated July 27, 2012 and operations listed in the Data Validation Package dated May 2012. The Master Plan will continue to evolve and the location and operations of simulator detonations may change from that analyzed in this report. Any potentially significant change to the future noise environment presented in this report would be monitored and additional impact analysis performed if required.