DECOMMISSIONING PLAN FOR LICENSE SUB-1435

JEFFERSON PROVING GROUND

MADISON, INDIANA

U.S. Department of the Army
Soldier and Biological Chemical Command
5183 Blackhawk Road
Aberdeen Proving Ground, MD 21010-5424

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Final

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MADISON, INDIANA

Submitted to:

Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards
Washington, D.C.

Prepared by:

U.S. Department of Army
Soldier and Biological Chemical Command
Aberdeen Proving Ground, Maryland

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ACRONYMS AND ABBREVIATIONS

ACHP	Advisory Council on Historic Preservation
ADA	Americans with Disabilities Act of 1990
ALARA	as low as reasonably achievable
Am	americium
ANG	Air National Guard
ANSI	American National Standards Institute, Inc.
AR	Army Regulation
ARPA	Archeological Resources Protection Act
BGS	below ground surface
BLM	Bureau of Land Management
Bq	becquerel
Bq/kg	becquerel per kilogram
BRAC	Base Realignment and Closure Act of 1988
°C	degrees Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CERFA	Community Environmental Response Facilitation Act of 1992
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
cm	centimeter
cm/sec	centimeters per second
cm^2	square centimeter
COC	chemical of concern
cpm	counts per minute
Cs	cesium
DCGL	Derived Concentration Guideline Limit
DEIS	Draft Environmental Impact Statement
DOE	U.S. Department of Energy
DP	Decommissioning Plan
dpm/cm^2	disintegrations per minute per square centimeter
dpm/g	disintegrations per minute per gram
DU	depleted uranium
E	Endangered
EIS	Environmental Impact Statement
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ER	Environmental Report
ERM	Environmental Radiation Monitoring
°F	degrees Fahrenheit
FE	Federally Endangered
FONSI	Finding of No Significant Impact

ACRONYMS AND ABBREVIATIONS (Continued)

FS	Feasibility Study
FT	Federally Threatened
ft	foot or feet
ft^3	cubic feet
FWS	U.S. Fish and Wildlife Service
GDP	Gaseous Diffusion Plant
GPR	ground-penetrating radar
HE	high explosive
HPP	Health Physics Program
IANG	Indiana Air National Guard
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
ISDH	Indiana State Department of Health
in.	inch
INEEL	Idaho Engineering and Environmental Laboratory
INSC	Indiana Special Concern
IRP	Installation Restoration Program
JPG	Jefferson Proving Ground
kBq/kg	thousand becquerel per kilogram
keV	kiloelectron volt
kg	kilogram
km	kilometer
km^2	square kilometers
KSNPC	Kentucky State Nature Preserves Commission
KYE	Kentucky Endangered
KYSC	Kentucky Special Concern
LANL	Los Alamos National Laboratory
m	meter
m^3	cubic meters
m^3/sec	cubic meters per second
meV	megaelectron volt
MMI	Modified Mercalli Intensity
MOA	Memorandum of Agreement
mrem/yr	millirem per year
MW	Monitoring Well
MWH	Montgomery Watson Harza
MWS	Missile Warning System
NA	not applicable
NAGPRA	Native American Graves Protection and Repatriation Act of 1990

ACRONYMS AND ABBREVIATIONS (Continued)

NaI	sodium iodide
NCDC	National Climatic Data Center
NCSHPO	National Conference of State Historic Preservation Officers
NE	Northeast
NHPA	National Historic Preservation Act of 1966
NIST	National Institute of Standards and Technology
NMSS	Office of Nuclear Material Safety and Safeguards
NOI	Notice of Intent
Np	neptunium
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NW	Northwest
NWR	National Wildlife Refuge
Pa	protactinium
pCi/g	picocuries per gram
pCi/L	picocuries per liter
ppb	parts per billion
ppm	parts per million
Pu	plutonium
R	Rare
RAB	Restoration Advisory Board
RAI	request for additional information
RCCCD	Radiologic, Classic, and Clinical Chemistry Division
RESRAD	Residual Radiation
RI/FS	Remedial Investigation and Feasibility Study
ROD	Record of Decision
RSO	Radiation Safety Officer
Rust E&I	Rust Environment and Infrastructure
S	South
SAIC	Science Applications International Corporation
SARA	Superfund Amendments and Reauthorization Act of 1986
SBCCOM	Soldier and Biological Chemical Command
SEG	Scientific Ecology Group
SER	Safety Evaluation Report
SHPO	State Historic Preservation Officer
SRP	Standard Review Plan
STOLS	Surface Towed Ordnance Locater System
STV	Save the Valley

ACRONYMS AND ABBREVIATIONS (Continued)

SVOC	semivolatile organic compound
T	Threatened
TACOM	Tank-Automotive and Armaments Command
Tc	technetium
TEDE	total effective dose equivalent
Th	thorium
TRU	transuranic
U	Uranium
UNEP	United Nations Environmental Programme
USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAEC	U.S. Army Environmental Center
USAF	U.S. Air Force
USATSDR	U.S. Agency for Toxic Substances and Disease Registry
USDA	U.S. Department of Agriculture
USDHHS	U.S. Department of Health and Human Services
USGS	U.S. Geological Survey
UXO	unexploded ordnance
VOC	volatile organic compound
WHO	World Health Organization
WL	watch list
µm	micrometer
µR/hr	microroentgen per hour
µrad/hr	microrad per hour

1.0 INTRODUCTION

This Decommissioning Plan (DP) presents the U.S. Army's request for termination of its license SUB-1435 for possession of depleted uranium (DU) at the Jefferson Proving Ground (JPG) under restricted conditions and is a revision of the DP submitted on June 30, 2001, in response to Nuclear Regulatory Commission (NRC) comments received via letter dated September 27, 2001 (NRC 2001). U.S. Army Soldier and Biological Chemical Command (SBCCOM), Aberdeen Proving Ground, Maryland, is the organization responsible for this license. This DP presents background information, assessments, and commitments to support this license termination request.

Section 1.1 of this introduction describes the site. Sections 1.2 to 1.3 highlight the licensed activities and nature and extent of contamination. The decommissioning objective is presented in Section 1.4. A summary of the dose assessment and as low as reasonably achievable (ALARA) analysis (Sections 1.5 and 1.6) provides the basis for the restrictions used to limit doses (Section 1.7). Public participation activities (Section 1.8) also are summarized. Finally, the proposed initiation and completion dates and request for license termination are stated in Sections 1.9 and 1.10. Section 1.11 identifies the organization of this DP.

1.1 SITE DESCRIPTION

JPG was established in 1941 as a proving ground for the test firing of a wide variety of ordnance. The facility is approximately 55,264 acres [224 square kilometers (km^2)] and is located in Jefferson, Jennings, and Ripley Counties in southeastern Indiana. A firing line with 268 gun positions used for testing ordnance separates JPG into two areas: a 4,000-acre (16.1-km^2) southern portion and a 51,000-acre (206-km^2) northern portion [Science Applications International Corporation (SAIC) 1997a].

The U.S. Army used JPG as a proving ground from 1941 to 1994. During this time, more than 24 million rounds of conventional explosive ammunition were fired. Approximately 1.5 million rounds did not detonate upon impact, remaining as high explosive (HE) unexploded ordnance (UXO) either on or beneath the ground surface. In addition, the Army estimates that 7 million inert filled rounds with live detonators, primers, or fuzes did not function properly. This remaining UXO and its hazard has been a major factor in decisions about managing the area north of the firing line (SAIC 1997a).

1.2 SUMMARY OF LICENSED ACTIVITIES

As part of its munitions testing program, the JPG test fired DU projectiles. The DU test firings were conducted under a license issued by the NRC (License SUB-1435, Docket 040-08838) [Appendix B]. The test firing of DU projectiles occurred between 1983 and 1994.

The DU projectiles were fired from three fixed-gun positions on the firing line at soft (cloth) targets placed at intervals of 3,280 feet (ft) [1,000 meters (m)], starting at 3,280 ft (1,000 m) from the gun position and continuing to 13,123 ft (4,000 m). Because of the type of testing performed, the DU projectiles would impact in approximately the same location each time on their respective line of fire. This firing protocol, with repeated impacts in the same area, resulted in the formation of a trench approximately 3.4 ft (1 m) deep by 16.4 to 26.3 ft (5 to 8 m) wide extending for approximately 3,937 ft (1,200 m) at the most frequently used gun position [Scientific Ecology Group (SEG) 1996].

The primary impact location was the trench. Secondary impact locations developed when the projectile skipped, either whole or in fragments. A similar pattern was repeated at each of the other two firing

positions but to a lesser extent because a smaller quantity of DU was fired from each of these locations (SEG 1996).

Approximately 220,462 pounds [100,000 kilograms (kg)] of DU projectiles were fired at soft targets in a 2,080-acre (8.4-km^2) DU Impact Area. This surface recovery occurred semiannually when the installation was operational and resulted in removal of most of the DU projectiles located on the ground surface. Approximately 66,139 pounds (30,000 kg) of DU projectiles and projectile fragments were recovered. Approximately 154,323 pounds (70,000 kg) of DU remain in the DU Impact Area (SEG 1995, 1996). Removal of the remaining DU would be extremely difficult, posing high risks to workers and costing $45 million to $1.6 billion because of the necessity to complete surface and subsurface remediation in the presence of UXO (see Section 7.0).

The JPG was closed in September 1995 under the Defense Authorization Amendments and Base Realignment and Closure Act of 1988 (BRAC). At this time, the area south of the firing line, where DU was stored, was surveyed to determine the extent of DU contamination. Any contaminated areas were decontaminated, and the total area south of the firing line was released for unrestricted use in 1996. The NRC license for the area north of the firing line was amended for possession of DU only in May 1996.

1.3 NATURE AND EXTENT OF CONTAMINATION

There is an estimated 154,323 pounds (70,000 kg) of DU in the DU Impact Area. The distribution of this DU is non-homogeneous because of the variability in the projectile trajectory and projectile fragmentation. The initial non-homogeneous deposition of DU as metal remains non-homogeneous as the DU metal oxidizes with time. The highest concentrations of DU in the soil have been from samples taken directly under projectiles or projectile fragments. In these cases, the DU concentration in the soil in the top 5.9 inches (in.) [15 centimeters (cm)] under a penetrator or penetrator fragment can be thousands of picocuries per gram (pCi/g). The DU concentrations decrease with depth, and at depths greater than about 2 ft (61 cm), DU concentrations are comparable to background (SEG 1995, 1996).

Site surveys that have measured DU contamination without disturbing the surface have indicated that most of the contamination is along the firing lines. This surface characterization effort has identified an area of about a hundred acres that would require remediation if the DU Impact Area were to meet the criteria for license termination without restrictions. In actuality, a larger area would have to be investigated and remediated because of the uncertainty about the distribution of the DU projectiles and fragments (SEG 1995, 1996).

Random soil sampling programs have shown that the soil concentration typically is near background (about 2 pCi/g) with a few locations being 10 or 100 times background. No, or only minimal, DU contamination has been detected from environmental sampling of surface and groundwater, stream sediment, vegetation, and wildlife (Ebinger and Hansen 1996; SEG 1995, 1996).

Based on this understanding of the nature and extent of contamination, the radionuclides of concern, as a result of licensed activities, are the DU. Other potential radiological contaminants, such as plutonium, technetium, or americium, are negligible contributors to overall dose (see Appendix C for additional detail). DU is distributed non-homogeneously. The highest DU concentrations are in locations where projectiles or projectile fragments came to rest and are now corroding at an unknown rate. Additional characterization to understand the physical distribution of the DU would require UXO detection and removal and pose an imminent personnel safety hazard. The size of the area requiring UXO removal before a complete assessment of the nature and extent of DU contamination could be 200 to 400 acres (0.81 to 1.6 km^2).

1.4 SELECTED DECOMMISSIONING OBJECTIVE

The selected decommissioning objective is license termination with restrictions in compliance with the requirements of 10 *Code of Federal Regulations* (*CFR*) 20.1403. The selection of this objective for decommissioning and license termination was made after considering decontamination and license termination without restrictions (10 *CFR* 20.1402), as well as the selected decommissioning objective. The license termination with restrictions was selected for the following reasons:

- It is compatible with current use plans for the JPG property, specifically the maintenance of the Big Oaks National Wildlife Refuge (NWR) and the use of portions of the JPG property for bombing practice by the Indiana Air National Guard (IANG).

- The Army has institutional controls in place that define access and land use restrictions for the area North of the Firing Line, in general, because of the UXO hazard. Additional access and land use restrictions for the DU Impact Area (Section 16.0).also are defined. These institutional controls currently are the responsibility of the U.S. Fish and Wildlife Service (FWS) and U.S. Air Force (USAF) through the IANG (hereafter referred to as USAF/IANG) in accordance with a Memorandum of Agreement (MOA) [U.S. Army 2000a, b, and c]. If the MOA expires or one or more of these parties terminates the agreement, the U.S. Army, as the holder of the deed title, would be responsible for the institutional controls (see Appendix A).

- The Army has committed to request the necessary annual funding for the maintenance and implementation of institutional controls necessary to support license termination under restricted conditions (Section 15.0).

- The proposed institutional controls are legally enforceable and provide reasonable assurance that the total effective dose equivalent (TEDE) from residual DU radioactivity distinguishable from background to the average member of the critical group will not exceed 25 millirem per year (mrem/yr) if the institutional controls remain in place (Section 5.0).

- Residual radioactivity at the site is such that if institutional controls were no longer in effect, there is reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group is ALARA and would not exceed 100 mrem/yr (Section 5.0).

- The residual DU activity is consistent with ALARA because of the high costs of UXO and DU detection, removal, and disposal and the small benefit that would result from the cleanup of an approximately 2,080-acre (8.4-km^2) area inside the 51,000-acre (206-km^2) portion of JPG where UXO is present and is used for bombing practice. The ALARA analysis also indicates that decontamination of the DU Impact Area to meet the criteria for unrestricted use likely would result in "net public or environmental harm" (Section 7.0).

1.5 SUMMARY OF DOSE ANALYSIS

To assess compliance with the criteria for license termination with restrictions, two sets of exposure scenarios were developed and analyzed based on the estimated DU concentration in the environment. The first set of exposure scenarios is for the situation where institutional controls function as intended. These scenarios address members of the public at off-site locations, members of the public who use the Big Oaks NWR, and the FWS, USAF/ IANG, and U.S. Army workers at the site. The second set of exposure scenarios addresses the possible situation where institutional controls were no longer in effect.

This second set of scenarios includes a very conservative resident farmer. The exposure scenarios consider (1) information on the nature and distribution of DU contamination, (2) site-specific parameters for DU environmental transport processes, and (3), for the first set of scenarios, the proposed institutional controls.

For the scenarios where institutional controls are in place, the limiting average member of the critical group is an off-site industrial worker. The peak of the mean TEDE for this individual is calculated to be 16.6 mrem/yr using a high (conservative) average DU soil concentration of 225 pCi/g. This is below the limit of 25 mrem/yr TEDE. These results are summarized in Section 5.0 of this Decommissioning Plan (DP). Details of the associated calculations are presented in Appendix C. The population dose that will result based on institutional controls to limit public exposure also is estimated.

The scenarios for the situation where institutional controls are not in place also were analyzed. Because of uncertainty over the DU distribution, different combinations of DU concentrations in soil and different soil properties were evaluated. The resident farmer scenario without irrigation was identified as the limiting average member of the critical group. The peak of the mean TEDE for this individual is calculated to be 37 mrem/yr using a high (conservative) average DU soil concentration of 225 pCi/g. This is below the limit of 100 mrem/yr. These results are also summarized in Section 5.0 of this DP. Details of the associated calculations are presented in Appendix C.

1.6 SUMMARY OF ALARA ANALYSIS

An ALARA analysis was conducted according to the principles identified in the Office of Nuclear Material Safety and Safeguard's (NMSS's) Decommissioning Standard Review Plan (NRC 2000). This analysis identified and quantified, to the extent practical, the benefits and costs of decontaminating the DU Impact Area to meet license termination criteria for unrestricted use. The analysis indicated that small benefits would accrue from UXO and DU removal. Given that there is a potential for UXO to be present throughout the area North of the Firing Line, the remediated area would be surrounded by UXO and continue to pose risks to visitors or workers in the area.

The costs of UXO and DU detection and removal from the DU Impact Area also were estimated. The uncertainty associated with these costs is attributable to remediation technology limitations and insufficient knowledge of the depth and location of DU projectiles and fragments. These uncertainties are recognized in the ALARA analysis.

Based on the ALARA analysis, it was determined that the cost of decontamination is much larger than the benefits; therefore, the existing DU concentrations are consistent with ALARA. The analysis also indicates that decontamination of the DU Impact Area would result in net public and environmental harm.

1.7 RESTRICTIONS USED TO LIMIT DOSES

The U.S. Army will retain title to the property and impose access and land use restrictions to ensure that doses to the average member of the critical group are less than 25 mrem/yr. The Army has and will grant permits to other Federal agencies for use of the portion of the JPG North of the Firing Line when uses are consistent with the Army's commitments to the NRC.

At the present time, the Army has issued permits to the FWS for establishment and management of the Big Oaks NWR (~50,000 acres) and to the USAF (~1,087 acres, which are not part of the Big Oaks NWR) for use as a bombing range. These permits are presented in Appendix A of this DP. The Army will monitor these agencies for compliance with the terms of these permits.

This DP includes the U.S. Army's Statement of Intent to request the funds necessary for the maintenance and implementation of the institutional controls necessary to meet the criteria for license termination with restrictions.

1.8 SUMMARY OF PUBLIC PARTICIPATION ACTIVITIES

The Army has an ongoing public involvement program at JPG (SAIC 1997b). In support of this program, a Restoration Advisory Board (RAB) was established. The RAB is an advisory organization composed of local citizens and staff from involved federal and state agencies. The RAB is used as a forum for providing the community with an opportunity to identify concerns and participate in the Army's decision-making process. Numerous RAB meetings have been held since 1994, when the RAB was established, to discuss the installation closure and environmental restoration issues, including plans for management of the DU Impact Area.

The major issue raised by the public during these meetings has been the uncertainty about future doses to off-site individuals if the license were terminated and institutional controls were used to limit public exposure to DU contamination. The dose analysis, presented in Appendix C, addresses this issue.

1.9 PROPOSED INITIATION AND COMPLETION DATES

The U.S. Army proposes that the license be terminated upon NRC approval of this DP. The DP process for JPG, anticipated to be completed over the next 6 years, will involve the following major steps:

- **Acceptance Review** - The objective of the NRC's acceptance review is to verify that JPG's application is complete before an in-depth technical review is initiated. In addition, a limited technical review is conducted to identify significant technical deficiencies at an early stage, thereby precluding a detailed technical review of a technically incomplete submittal. At the conclusion of the acceptance review, JPG's DP will either be accepted for detailed technical review or rejected and returned to the licensee with the deficiencies identified. This phase of the process is approximately 60 days in duration.
- **Technical Review** – The NRC review of the JPG DP for license termination under restricted release conditions will be conducted in two phases. The first phase of the review will focus on the financial assurance and institutional control provisions of the DP. The review of the remainder of the DP will be initiated only after NRC is satisfied that the U.S. Army's proposed financial assurance and institutional control provisions will comply with the requirements of the License Termination Rule (10 *CFR* 20, Subpart E). The applicable portions of NUREG-1727 will be used to guide this phase of the review. Phase II of the review addresses all other sections of the technical review under NUREG-1727 and includes the development of an environmental impact statement (EIS). Therefore, one of the first steps in Phase II is the NRC's publication of a Notice of Intent (NOI) to develop an EIS. The basic EIS development steps that the NRC will implement include:
  - NOI;
  - public scoping meeting and scoping report;
  - preparation and publication of the draft EIS (DEIS);
  - public comment period on the DEIS, including a public meeting;
  - preparation and publication of the final EIS; and
  - preparation and publication of the Record of Decision (ROD).

  In parallel with the development of the EIS, the NRC will develop a draft and final Safety Evaluation Report (SER). The development of the draft SER will be coordinated with the development of the

DEIS so that any requests for additional information (RAIs) can be consolidated. This phase of the DP process is approximately 2 years in duration.

- **License Termination** - The DP process includes a step to complete decommissioning. For this license termination under restricted release conditions, decommissioning of the site is not planned. The U.S. Army's existing radiological surveys are proposed to fulfill NRC's required surveys. Furthermore, the U.S. Army demonstrates that the premises are suitable for release under restricted release criteria using the dose analysis presented in this plan. Once the NRC is satisfied that all decommissioning requirements are fulfilled, the license will be terminated by written notice to the U.S. Army when NRC determines that the information presented in this plan demonstrates that the DU Impact Area is suitable for release in accordance with the License Termination Rule.

1.10 REQUEST FOR LICENSE AMENDMENT

The U.S. Army requests that license SUB-1435 be terminated, subject to the commitments for institutional controls identified in this DP.

1.11 ORGANIZATION OF THIS DP

This DP includes the following sections:

- **Section 1.0. Introduction** – Provides an overview of the installation and operating history, and results of analyses; also states the U.S. Army's request for license termination with restrictions.
- **Section 2.0. Facility Operating History** – Describes the facility's operating history, including the licensed activities.
- **Section 3.0. Facility Description** – Details the site location, land use, socioeconomics, and existing environmental conditions.
- **Section 4.0. Radiological Status of the Facility** – Describes the radiological status of the facility, with emphasis on the DU Impact Area.
- **Section 5.0. Dose Modeling Evaluations** – Details and summarizes the dose modeling evaluations that are based on the risk analysis presented in Appendix C.
- **Section 6.0. Alternatives Considered and Rationale for the Chosen Alternative** – Presents the alternatives for license termination and the rationale for the selected alternative.
- **Section 7.0. ALARA Analysis** – Presents the ALARA analysis and includes the benefits and costs of decontamination of the DU Impact Area.
- **Section 8.0. Planned Decommissioning Activities** – Addresses any planned decommissioning activities.
- **Section 9.0. Project Management and Organization** – Describes the project management and organization, including the role and responsibilities of key organizations and personnel.
- **Section 10.0. Radiation Safety and Health Program During License Termination** – Describes the radiation safety and health program during license termination.
- **Section 11.0. Environmental Monitoring and Control Program** – Addresses the environmental monitoring and control program.

- **Section 12.0. Radioactive Waste Management Program** – Identifies the radioactive waste management program.
- **Section 13.0. Quality Assurance Program** – Describes the quality assurance program.
- **Section 14.0. DU Impact Area Radiation Surveys** – Specifies surveys to characterize the DU Impact Area.
- **Section 15.0. Financial Assurance** – Provides the U.S. Army's plan to ensure funding is available to support implementation of institutional controls.
- **Section 16.0. Restricted Use** – Provides the rationale and basis for license termination under restricted conditions under the provisions of 10 *CFR* 20.1402.
- **Section 17.0. References** – Details the references cited in this DP.
- **Appendices** – Four appendices support this DP and are noted below:

  Appendix A. Permits and Memorandum of Agreement

  Appendix B. NRC License SUB 1435

  Appendix C. Risk Analysis

  Appendix D. Statement of Intent

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2.0 FACILITY OPERATING HISTORY

In this section an overview of the facility's operational history is provided (Section 2.1). The license and operating history, with respect to DU operations, are summarized in Sections 2.2 and 2.3, respectively.

2.1 OVERVIEW

The Army's mission at JPG was to perform production and post-production tests of conventional ammunition components and other ordnance items and to conduct tests of propellant ammunition/ weapons systems and components. The base was closed in September 1995 under the BRAC.

The installation, located in southeastern Indiana (Figure 2-1), is divided into two areas separated by a firing line consisting of 268 gun positions formerly used for testing ordnance. An east–west fence, which is 7 ft (2.1 m), chain linked, and topped with V-shaped, three-strand barbed wire, separates the area north of the firing line from the cantonment area. The firing line demarcates the ordnance impact area to the north from the cantonment area to the south. The cantonment area houses the support facilities that were used for administrative ammunition assembly and testing, vehicle maintenance, and residential housing. The area north of the firing line consists of 51,000 acres (206 km^2) of undeveloped and heavily wooded land and contains the NRC-licensed area (SAIC 1997a). The DU Impact Area is located in the south-central portion of this area, as shown on Figure 2-2.

JPG was used as a proving ground from 1941 to 1994. During this time, more than 24 million rounds of conventional explosive ammunition were fired. Approximately 1.5 million rounds did not detonate upon impact, remaining as UXO either on or beneath the ground surface (U.S. Army 1995a). In addition, it is estimated that 7 million inert filled rounds with live detonators, primers, or fuzes did not function properly.

2.2 LICENSE HISTORY

Under NRC license SUB-1435, the Army tested DU projectiles and munitions from 1983 to 1994 (NRC 1996a). This testing was conducted in approximately a 2,080-acre (8.4-km^2) area located in the south–central portion of the installation, referred to as the DU Impact Area (Figure 2-1). During its 10-year use, more than 220,462 pounds (100,000 kg) of DU projectiles were fired into the DU Impact Area. Approximately 30,000 kg of DU have been removed. Approximately 154,323 pounds (70,000 kg) of DU remain in the DU Impact Area, which also contains one of the largest concentrations of UXO (SEG 1995, 1996; U.S. Army 1995a).

NRC license SUB-1435 was amended for possession of DU only in May 1996 (NRC 1996a) until license termination. Amendment 10 currently is in effect. NRC License No. 13-12416-01, for the use of scandium-46, was terminated in 1993. Other radionuclides were used under a general Army-wide license.

2.3 DU OPERATIONS

The DU projectiles (i.e., 105 and 120 mm DU rounds) were fired from three fixed gun positions on the firing line at soft (cloth) targets placed at intervals of 3,280 ft (1,000 m), starting at 3,280 ft (1,000 m) from the gun position and continuing to 13,123 ft (4,000 m). Because of the type of testing performed, the DU projectiles would impact approximately in the same location each time on their respective lines-of-

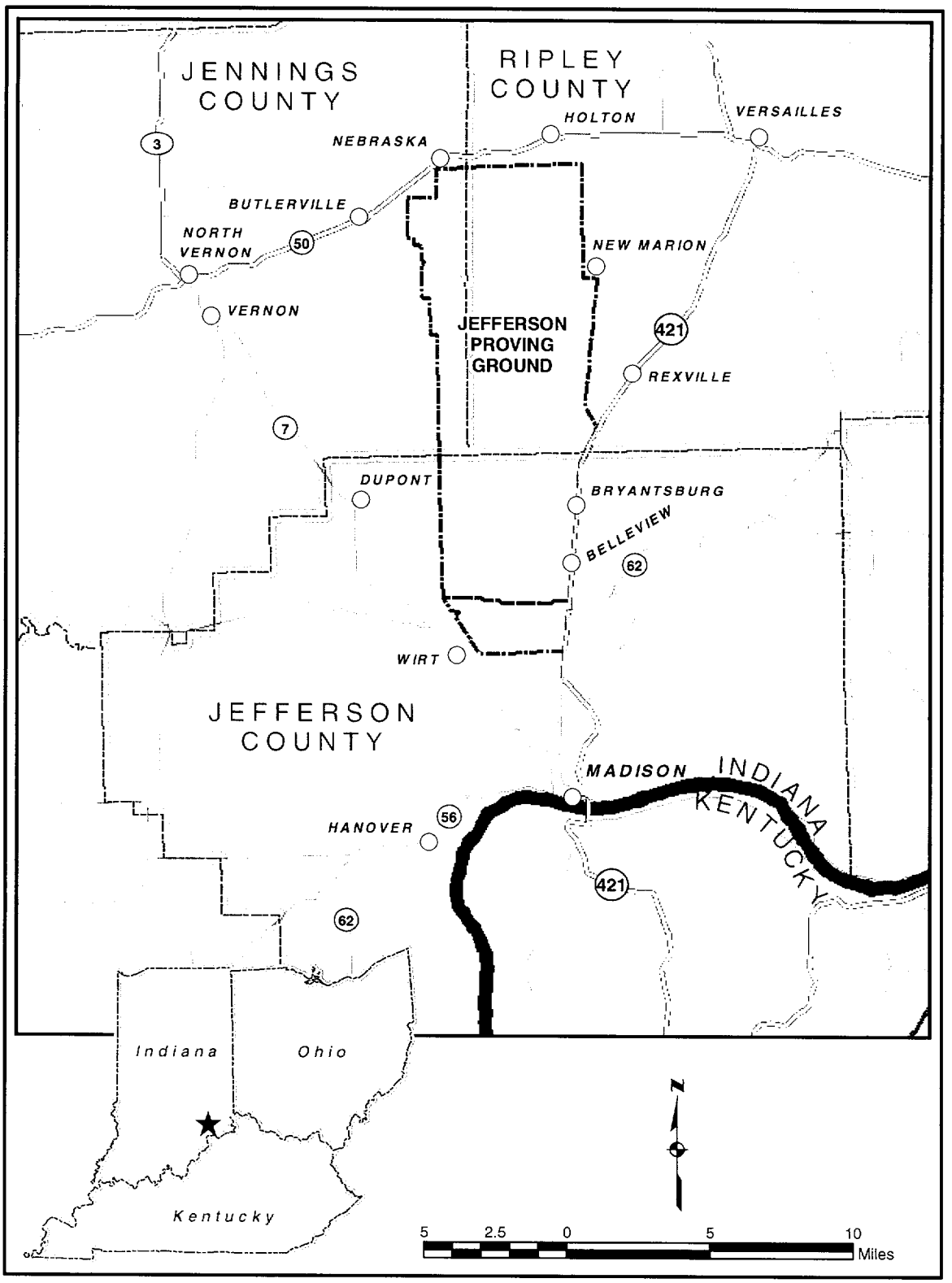

Figure 2-1. Regional Location of Jefferson Proving Ground

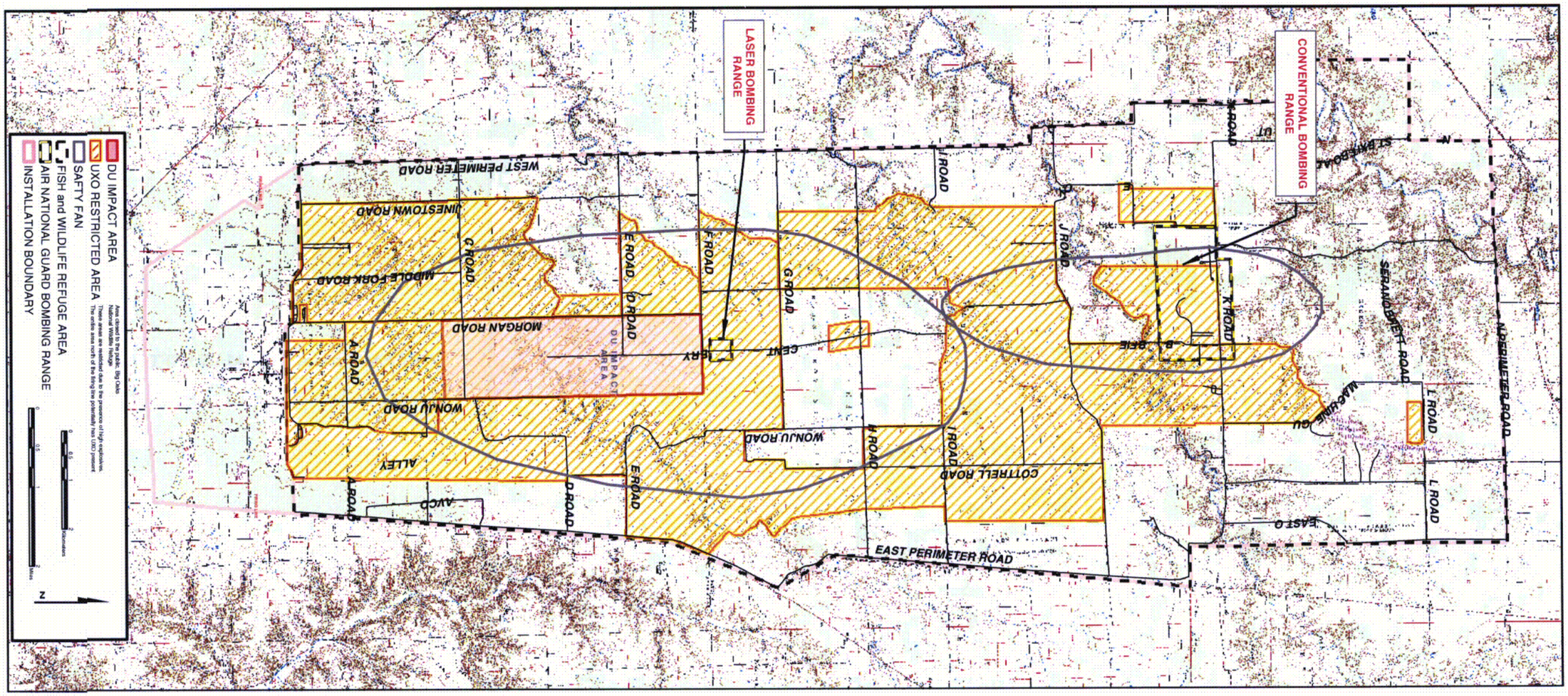

Figure 2-2. Jefferson Proving Ground, Indiana

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fire (SEG 1996). This firing protocol, with repeated impacts in the same area, resulted in the formation of a trench approximately 3.4 ft (1 m) deep by 16.4 to 26.3 ft (5 to 8 m) wide extending for approximately 3,937 ft (1,200 m) at the most frequently used gun position.

The primary impact location was the trench. Secondary impact locations developed when the projectile skipped, either whole or in fragments. A similar pattern was repeated at each of the other two firing positions but to a lesser extent and magnitude because a smaller quantity of DU was fired from each of these locations (SEG 1996).

The DU varies in size from microscopic particles to complete projectiles (SEG 1996). Other NRC-licensed activities at JPG included the storage of DU in buildings located in the cantonment area (Figure 2-3) of the installation (Buildings 186, 205, 216, 223, and 227). This portion of the site was released for unrestricted use by NRC action in 1996 to amend license SUB-1435. The Indiana State Department of Health, Division of Indoor and Radiological Health, concurred with the findings and recommendations for release of this latter area (NRC 1996b).

There is no historical or anecdotal evidence of spills, uncontrolled releases, or on-site burial of licensed material in the DU Impact Area.

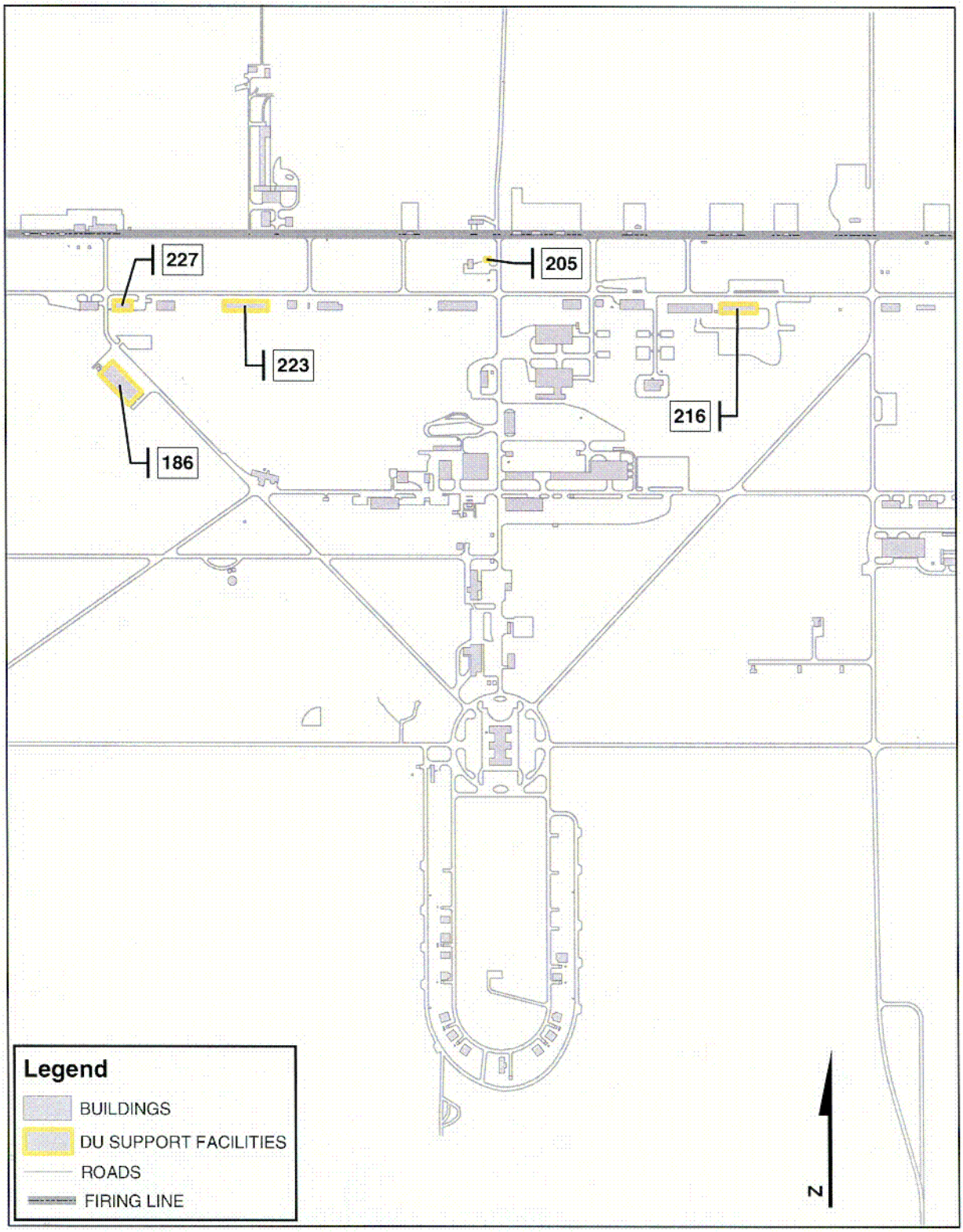


Figure 2-3. Location of DU Support Facilities in the Cantonment Area

C02

3.0 FACILITY DESCRIPTION

The description of the facility presented in this section is based primarily on information contained in the 1995 Final Environmental Impact Statement (EIS) that evaluated disposition and reuse of JPG (U.S. Army 1995a), the remedial investigation/feasibility study (RI/FS) [Rust Environment and Infrastructure (E&I) 1994, 1998; Montgomery Watson Harza (MWH) 2002], and information obtained through internet searches. The discussion of land use north of the firing line is based on information from the Memorandum of Agreement (MOA) [see Appendix A] between the U.S. Army, USAF, and the FWS (U.S. Army 2000).

The site location and description are provided in Section 3.1. Information on the population distribution and current and future land uses is detailed in Sections 3.2 and 3.3. The remaining sections address meteorology and climatology (Section 3.4), geology and seismology (Section 3.5), surface water and groundwater hydrology (Sections 3.6 and 3.7), natural resources (Section 3.8), and ecology/endangered species (Section 3.9).

3.1 SITE LOCATION AND DESCRIPTION

JPG occupies approximately 55,264 acres (224 km^2) within parts of north-central Jefferson, southwestern Ripley, and southeastern Jennings counties in the southeastern portion of the state of Indiana. The firing line divides the JPG into two portions, approximately 51,000 acres (206 km^2) north of the firing line and 4,000 acres (16.1 km^2) south of the firing line. The DU Impact Area, consisting of approximately 2,080 acres (8.4 km^2), is located within the 51,000-acre (206-km^2) area north of the firing line. The DU Impact Area is approximately 17,280 ft (5,270 m) long and 5,240 ft (1,600 m) wide. The southern boundary of the DU Impact Area is slightly south of C Road while the northern boundary is at F Road. The western and eastern boundaries are at Morgan and Wonju Roads, respectively.

The nearest population center is the City of Madison, Indiana, which has a population of 12,004 (U.S. Census Bureau 2000), approximately one-third of the population of Jefferson County. The location of the site and nearby communities is shown in Figure 2-1. Major metropolitan areas include Louisville, Kentucky, approximately 60 miles (96 km) southwest; Cincinnati, Ohio, approximately 75 miles (121 km) northeast; and Indianapolis, Indiana, approximately 100 miles (161 km) north–northwest. The JPG is located 8 miles (13 km) north of the Indiana-Kentucky border (SAIC 1997a).

The natural topography of the site is rolling wooded and grassy areas with elevations ranging from 850 ft (260 m) to 930 ft (285 m). Most relief is due to stream incision. In addition to the natural features, there are several munitions-excavated trenches. There is an interior road system suitable for off-road vehicles. A fence system (i.e., a 7-ft (1.8-m) chain-linked fence topped with V-shaped, 3-strand barbed wire) is maintained around the perimeter of the area north of the firing line. A barricade system (high-security locks with swing gates) is maintained for all roads providing direct access to the DU Impact Area. Several historic structures stand north of the firing line: Oakdale Schoolhouse, Old Timbers Lodge, and four stone-arch bridges (SAIC 1997a). A diagram of the site is presented in Figure 2-2.

The property surrounding the site is predominantly farmlands, woodlands, and rural residential areas (SAIC 2002a). Public water from a municipal system, or deep wells, is used by nearby communities or individuals. Well depths range from 50 ft (15 m) to 300 ft (90 m) and are completed in limestone formations underlying the site (Rust E&I 1994, 1998; MWH 2002).

Prominent water pathways on-site are Big Creek, Graham Creek, Otter Creek, Harberts Creek, and several smaller creeks that are sub-basins of the Muscatatuck River, White River, and the Ohio River. Surface water drainage is generally from the northeast to the west and southwest. Old Timbers Lake, a man-made lake from the impoundment of Little Otter Creek, is the primary lake. Old Timber's Lake runs generally north to south and is located in the northeast portion of JPG. Krueger Lake, located in the southeastern corner of JPG, is a result of the impoundment of Harbert's Creek. Several smaller ponds are on the site. The Ohio River is located 8 miles (13 km) south of the site.

3.2 POPULATION DISTRIBUTION

The DU Impact Area is located in Jefferson County, which has a population of approximately 31,705 people. The county has undergone approximately 6.4 percent growth from 1990 to 2000, based on 1990 and 2000 census data (U.S. Census Bureau 2000). The nearest population center is the city of Madison, Indiana, which has a population of 12,004 people, approximately one-third of the Jefferson County population. The 2000 census data indicate that approximately 85,782 people live in Jefferson, Jennings, and Ripley Counties combined, covering a radius of more than 15 miles (24 km) from the DU Impact Area. The population in Jefferson, Jennings, and Ripley Counties is projected to increase an average of 2.8, 5.0, and 4.1 percent, respectively, every 5 years to the year 2020, based on the 1990 census data (U.S. Census Bureau 2000). The nearest residences are in Buildings 205 and 241, which are due north of the family housing area in the Cantonment Area along the firing line fence. These structures are about 0.5 miles (.81 km) closer to the DU Impact Area than the family housing; therefore, the closest residence is about 2 miles (3.2 km) from the southern boundary of the DU Impact Area (Knouf 2002). The family housing area is approximately 2.5 miles (4.0 km) from the southern border of the DU Impact Area. Approximately 100 farmhouses and other dwellings are located within 1 mile (1.61 km) of JPG's southern border or almost 4 miles (6.4 km) from the southern border of the DU Impact Area (MWH 2002). Table 3-1 indicates the population trends in the vicinity of JPG.

The average minority population in the State of Indiana is 12.5 percent. The minority population within Jefferson, Jennings, and Ripley Counties averages approximately 2.7 percent of the total population in these counties as shown in Table 3-1. The minority population within the immediate area [i.e., a 6.4-km (4-mile) radius of the installation] is less than 0.3 percent of the population living within that radius. The highest median income of $36,854 occurs in Ripley County. The lowest median income of $32,121 occurs in Jennings County. Approximately 12 percent of people residing in Jefferson County have incomes below poverty level [U.S. Department of Agriculture (USDA) 1997], defined as an income of $17,650 for a family of four [U.S. Department of Health and Human Services (USDHHS) 2001].

3.3 CURRENT/FUTURE LAND USE

The majority of land surrounding JPG is rural agricultural. The adjacent land use has changed little since establishment of the installation in the 1940s and has been used predominantly for small family farms since the early 1800s. JPG is surrounded by several small rural towns. Approximately 100 farmhouses and other dwellings are located within 1 mile (1.6 km) of JPG's southern border (Rust E&I 1998; MWH 2002). The major local crops are tobacco, corn, and soybeans.

The FWS established the Big Oaks NWR in the area north of the firing line in June 2000. Under a negotiated MOA (Appendix A) between the U.S. Army, USAF, and the FWS, the Army will retain ownership of the land and the FWS will operate the Big Oaks NWR on a 25-year lease with 10-year renewal options. The Big Oaks NWR encompasses more than 50,000 acres (202 km^2) of grasslands, woodlands, and forests, including the DU Impact Area. The FWS restricts access to approximately 24,000 acres (97 km^2) of land within the refuge because of the occurrence of both UXO and DU.

Table 3-1. Population Trends Near Jefferson Proving Ground

Location	Compass Vector	Population			Population by Race				Household Income				
		2000 Population	% Change (1990–2000)	2020 Projected Population[c]	% White	% Black	% Asian	% Other	Median Income	% Under Poverty Level[d]	% Under $50K	% $50–$100K	% Over $100K
State of Indiana[a]	NA	6,080,485	9.7	6,481,489	87.5	8.4	1.0	3:1	$37,909	9.9	NA	NA	NA
Jefferson County[a]	NA	31,705	6.4	35,340	96.2	1.5	0.6	1.7	$33,630	11.6	NA	NA	NA
City of Madison[a]	S	12,004	NA	NA	94.6	2.4	0.8	2.2	$37,651	NA	68.6	25.9	5.6
Jennings County[a]	NW	27,554	16.5	33,404	97.5	0.7	0.3	1.5	$32,121	9.8	NA	NA	NA
City of North Vernon[b]	NW	20,144	NA	NA	98.3	1.1	0.3	0.2	$37,013	NA	70.1	24.9	5
Ripley County[a]	NNE	26,523	7.7	30,983	98.3	0	0.4	1.3	$36,854	9.7	NA	NA	NA
City of Versailles[b]	NE	4,145	NA	NA	99.5	0	0.3	0.2	$34,242	NA	71.3	22.9	5.8
4-Mile (6.4-km) Radius of DU Impact Area[e]	NA	6,943	NA	NA	99.7	0.2	0	0.1	NA	NA	NA	NA	NA

[a]Source: U.S. Census Bureau 2000.
[b]Source: CACI 2000.
[c]Calculated from 1990 census data (U.S. Census Bureau 2000).
[d]Source: U.S. Department of Agriculture (USDA) 1997.
[e]Number biased high (overestimates the actual population) because the census block groups used in the analysis cover an area of 282.9 mi^2 (732.8 km^2) instead of 50.3 mi^2 (130 km^2) [the area within a 4-mile (6.4-km) radius].
NA = Not applicable.

The Indiana ANG also operates a bombing range north of the firing line. The bombing range includes an approximately 50-acre (0.2-km^2), precision-guided munitions range, an approximately 983-acre (4-km^2) conventional bombing range, and approximately 5 acres (0.02 km^2) associated with the Old Timbers Lodge (Figure 2-2). These areas are excluded from the real estate permit for the refuge. When in use, the bombing ranges have large safety fans. FWS personnel and visitors are excluded from the bombing ranges (inclusive of the safety fan) during flight operations involving training munitions or laser energy (U.S. Army 2000).

To date, approximately 1,469 acres (6 km^2) located south of the firing line have been transferred for private, recreational, or commercial use. In addition, approximately 2,400 acres (9.8 km^2) south of the firing line are being leased to a local businessman. This property is used for light industrial, commercial, agricultural, and residential purposes. The fee title will be transferred as the parcel is remediated of ordnance and other contamination. Disposition of an additional approximately 300-acre (1.2-km^2) parcel south of the firing line and west of the airfield area (west of Tokyo Road and south of Woodfill Road) has not yet been determined.

3.4 METEOROLOGY AND CLIMATOLOGY

The climate at JPG is mid-continental with frequent changes in temperature and humidity because of the low- and high-pressure systems that routinely pass through the area and the occasional influx of warm, humid air from the Gulf of Mexico. During the summer, the temperatures average from the mid-70 to the mid-80 degrees Fahrenheit (°F) [21 to 27 degrees Celsius (°C)]. On average, the temperature exceeds 90°F (32.2°C) for 39 days a year. Winter temperatures generally range from 22 to 35°F (−5.6 to 1.7°C) [MWH 2002].

Thunderstorms with high rainfall intensities and damaging winds are common during the spring and summer months. Heavy fog, reducing prevailing visibility to ¼-mile (0.4 km) or less, occurs an average of 18 days a year. The prevailing wind direction is to the south with an average velocity of less than 10 miles (16 km) per hour (MWH 2002). The total annual precipitation is approximately 42 to 44 in. (107 to 112 cm), with nearly 50 percent occurring during the growing season from May to October. Precipitation is greater than or equal to 0.5 in. (1.3 cm) approximately 28 days per year. Table 3-2 presents climatological data for southern Indiana.

There are four weather stations located in Jefferson County, three of which are active (COOP ID 122184 and 125237 and WBAN 53814). These stations collect limited data (e.g., minimum/maximum temperature, precipitation, etc.) that may be accessed from the National Climatic Data Center (NCDC) [see http://www.ncdc.noaa.gov/]. Information on wind speed and direction at all heights is not available in this region. The closest location where related data are collected is Wilmington, Ohio [National Weather Service (NWS) 2002]. Wind speed and direction data may be obtained from Indianapolis, Indiana, and Louisville, Kentucky. Data for the 30-year period ending in 1990 from the Louisville International Airport are provided in Table 3-3 (NWS 2002). These values are consistent with those data reported in MWH (2002).

The FWS installed and began operation of a weather monitoring station within the Big Oaks NWR in April 2002. Typical data collected include rain, wind, temperature, and relative humidity. Seasonal or trend data are not available given the short duration the station has been operational.

Air monitoring stations are located at six locations in Jefferson County (Wilson Road, Bacon Ridge Road, K Road, Graham Road, Kent Hall-State Hospital, and Sunrise Golf course), which at various points in time were used to monitor for total suspended particulates, sulfur dioxide, nitrogen dioxide, and/or nitrous oxides. The Wilson Road station was the only active station in 2001, which monitored sulfur dioxide. This information is based on the U.S. Environmental Protection Agency's (EPA's) air pollution database, AIRS.

Table 3-2. Climatology of Jefferson Proving Ground

Month	Temperature[b]					Precipitation[c]				
				2 Years in 10 Will Have			2 Years in 10 Will Have			
	Average[a] (°F)	Average Maximum[a] (°F)	Average Minimum[a] (°F)	Maximum Higher Than[a] (°F)	Minimum Lower Than[a] (°F)	Average[a] (Inches)	Less Than[a] (Inches)	More Than[a] (Inches)	Average # of Days with 0.10 Inch or More[a]	Average Snowfall[a] (Inches)
January	33.0	42.0	24.0	67	-3	3.21	1.8	4.36	7.36	5.4
February	36.7	46.7	26.7	69	1	3.34	1.52	4.82	7	2.3
March	44.5	55.4	33.7	80	14	4.48	2.48	6.1	9	2.9
April	55.8	68.4	43.5	86	25	4.03	2.02	5.66	9	0.1
May	65.2	77.5	52.8	93	33	4.48	2.59	6.01	8	0
June	73.8	85.3	62.2	97	45	4.01	2.36	5.46	7	0
July	77.0	88.1	65.9	98	51	3.76	2.18	5.03	7	0
August	75.8	87.3	64.2	98	50	2.61	1.18	3.78	5	0
September	70.1	82.3	57.9	97	40	3.15	1.49	4.49	6	0
October	59.0	71.4	46.5	88	27	2.6	1.27	3.68	5	0
November	46.4	56.3	36.5	79	14	3.25	1.78	4.44	6	0.6
December	35.7	44.7	26.8	70	2	3.05	1.54	4.29	6	1.8
Average	56.1	67.1	45.1	—	—	—	—	—	6.8	1.09
Extreme	—	—	—	102	-5	—	—	—	—	—
Total	—	—	—	—	—	41.97	35.46	48.16	82	13.1

[a]Source: MWH 2002 (data recorded in the period 1951–1976 at Madison, Indiana).
[b]To convert from Fahrenheit to Celsius, subtract 32 and multiply by 5/9.
[c]To convert from inches to centimeters, multiply by 2.54.

Table 3-3. Average Monthly Wind Speed and Direction from 1960–1990, Louisville International Airport

Month	Wind Speed (miles per hour)[a]	Direction (Degrees)
January	9.6	290
February	9.6	300
March	10.1	310
April	9.8	180
May	8.0	180
June	7.4	180
July	6.9	180
August	6.4	180
September	6.8	180
October	7.2	180
November	9.0	180
December	9.1	180
Average	8.3	180

Source: NWS 2002.
[a]To convert from miles/hour to km/hour, multiply by 1.61.

The JPG region also is subject to tornadoes, which are most common in southeastern Indiana from May through July. A tornado occurred at JPG in 1998. The tornado path traversed the area north of the firing line, entering the installation north of F Road and exiting the installation at approximately H Road (see Figure 2-2). If the tornado followed a straight path, it would have touched down approximately 2.5 miles (4 km) north of the DU Impact Area. According to the NCDC, for the period from 1950 to 1995, an annual average of 20 tornadoes per year occurred in the State of Indiana. The annual average number of strong–violent tornadoes (F2–F5 on the Fujita scale) in Indiana is 7 (NCDC 2001).

The State of Indiana's ambient air quality standards are identical to the National Ambient Air Quality Standards. Air quality monitoring is conducted under the Indiana Department of Environmental Management's (IDEM's) Office of Air Management. JPG is located in a region that complies with both State of Indiana and Federal ambient air quality standards (IDEM 2001). During operation, JPG was not classified as a major source contributor to air pollution (U.S. Army 1995a). No emission sources are associated with the DU Impact Area.

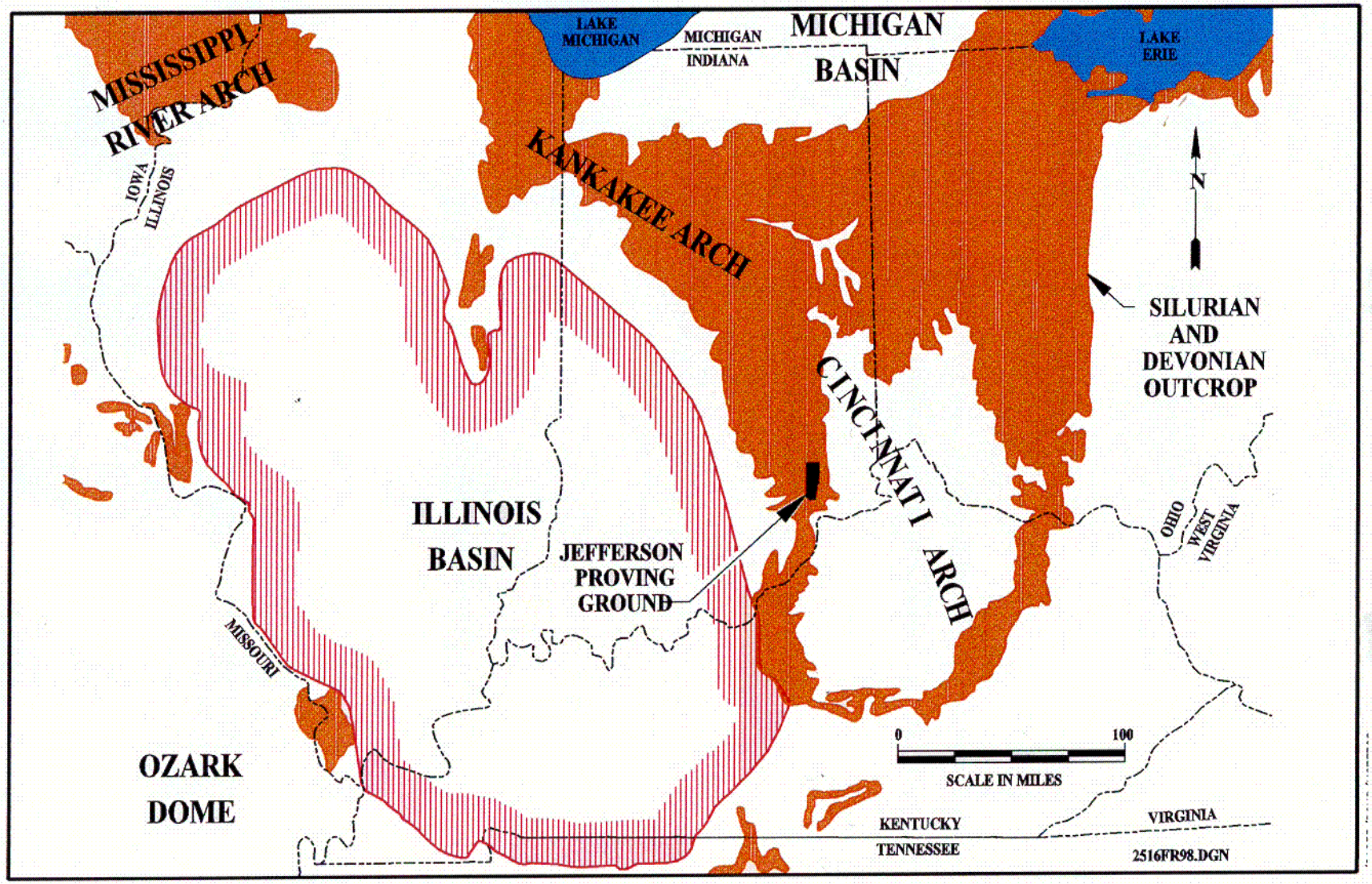
3.5 GEOLOGY, SOILS, AND SEISMOLOGY

Information on JPG's bedrock and glacial geology, soils, and seismology is provided in Sections 3.5.1, 3.5.2, and 3.5.3, respectively.

3.5.1 Geology

JPG is located on the western flank of the Cincinnati Arch, a broad structural feature that separates the Illinois and Appalachian Basins (Figure 3-1). Most of the installation is covered by a layer of Pleistocene glacial deposits that overlies Paleozoic bedrock. These deposits average about 25 ft (7.6 m) in thickness, and range in thickness from 3.5 to 45 ft (1.1 to 13.7 m) [Figure 3-2]. The underlying bedrock consists of interbedded limestone, dolomite, and shale.

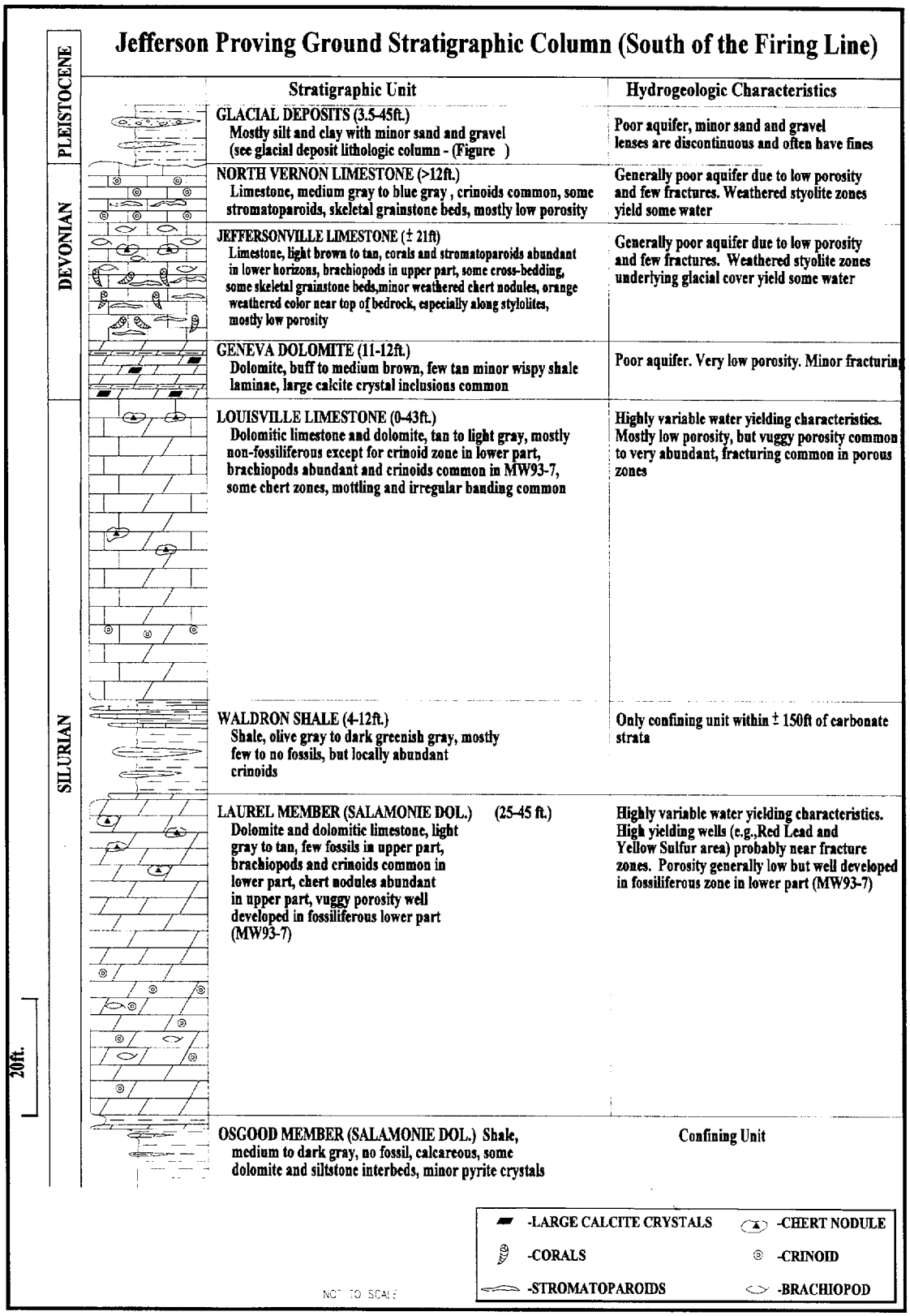
The bedrock thickness encountered in wells drilled south of the firing line has varied from approximately 10 to 65 ft (3 to 20 m) [MWH 2002]. The thickness of the underlying bedrock formations is variable, as shown on the cross-section of the cantonment area in Figure 3-3, reflecting the installation's location on the Cincinnati Arch. For example, the Louisville Limestone has a thickness of approximately 50 ft (15.2 m) on the western edge of the installation but pinches out to the east (Figure 3-3) [MWH 2002].



Source: MWH 2002.

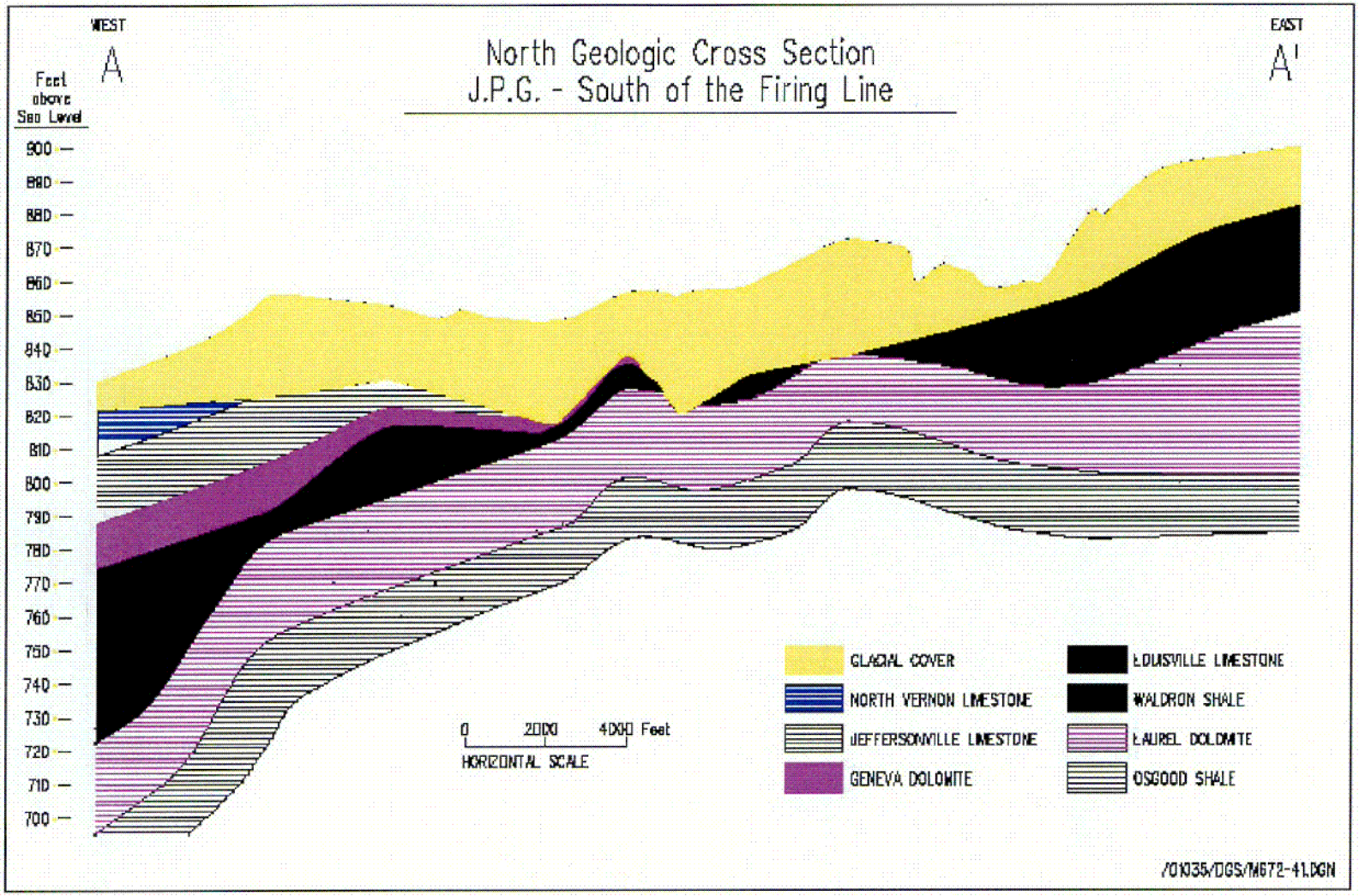
Figure 3-1. Regional Structural Setting of Jefferson Proving Ground

C03



Source: MWH 2002.

Figure 3-2. Stratigraphic Column for Jefferson Proving Ground



Source: MWH 2002.

Figure 3-3. West-East Cross-Section Across the Cantonment Area at Jefferson Proving Ground

C04

Within the DU Impact Area, the depth to bedrock ranges from 2 to more than 19 ft (0.6 to more than 5.8 m) based on the stratigraphy in the groundwater monitoring wells in this area. The bedrock in this area is described as fine-grained, light-to-medium gray limestone with shale streaks.

The overlying glacial deposits south of the firing line consist of interbedded silts and clays, and silts with gravel, based on a review of borehole logs from wells drilled on the installation. Closer to the bedrock contact, the glacial deposits contain chert, dolomite, and limestone rock fragments overlain by silt and clay layers that contain discontinuous gravel lenses (MWH 2002).

Within the DU Impact Area, the glacial deposits are described as brown, silty clay containing some black gravel/rock fragments and some chalky white rock fragments. From the ground surface to a depth of 1 to 1.5 ft (0.3 to 0.5 m) below ground surface (BGS) has been disturbed from detonation.

3.5.2 Soils

Soils at JPG developed from glacially derived parent material. There are two major soil associations present on the installation: Cobbsfork-Avonburg and Cincinnati-Rossmoyne Hickory (Figure 3-4). The Cobbsfork-Avonburg soils are present on upland glacial drift plains characterized by smooth topography with slopes ranging from 0 to 4 percent. The nearly level Cobbsfork soils have a seasonal high water table and are located on tabular divides. Typically, these soils have surface and subsurface layers composed of grayish-brown silt loam; both layers are about 6 in. (0.15 m) thick. The Avonburg soils also have a seasonal high water table and are located in relatively broad tabular divides and upper back slopes. These soils have a low-permeability fragipan in the subsoil. These soils have a brown silt loam surface layer about 10 in. (0.25 m) thick (MWH 2002).

The nearly level and gently sloping, moderately drained Rossmoyne soils are located on summits, shoulder slopes, and upper back slopes and have a low-permeability fragipan in the subsoil. Typically, these soils have a dark brown silt loam surface layer about 8 in. (0.23 m) thick. The gently sloping to moderately sloping, well-drained Cincinnati soils are located on summits, shoulder slopes, and back slopes, and have a low-permeability fragipan in the subsoil. The dark brown surface layer is about 6 in. thick (MWH 2002).

Soils within the DU Impact Area vary depending on the location. Six different types of soils occur either on or adjacent to stream beds. These soils are described as silt loam, loam, and silty clay loam. At more inland locations, the soil type is generally deep and moderately well drained, with slopes of 0 to 35 percent, occurring mainly on the ridge tops, breaks, and hillsides. Further inland, the soil type is generally nearly level to gently sloping, somewhat poorly drained, and located on tabular divides (U.S. Army 1995a).

3.5.3 Seismology

The U. S. Geological Survey (USGS) maps of seismic hazards published in 1997, for Central and Eastern United States (CEUS) [USGS 2001a] and historical earthquakes (USGS 2002a) were reviewed to determine the potential seismic hazard for the JPG site (USGS 2001a). The number of earthquakes within a radii of 100 and 200 miles (161 and 322 km) of Modified Mercalli Intensity (MMI) IV (note that an earthquake of Richter Magnitude 4 ~ 5 is comparable to an earthquake with MMI IV ~ V) or greater over the last 100 years are listed in Tables 3-4 and 3-5. A total of 24 earthquakes of MMI IV have occurred within 200 miles of the site since 1901. No earthquakes of MMI IV have occurred within 50 miles (80 km) of the site over the last 100 years. The largest magnitude earthquake recorded was magnitude 5.5 in November 1968 at a distance of approximately 172 miles (276 km) from the site.

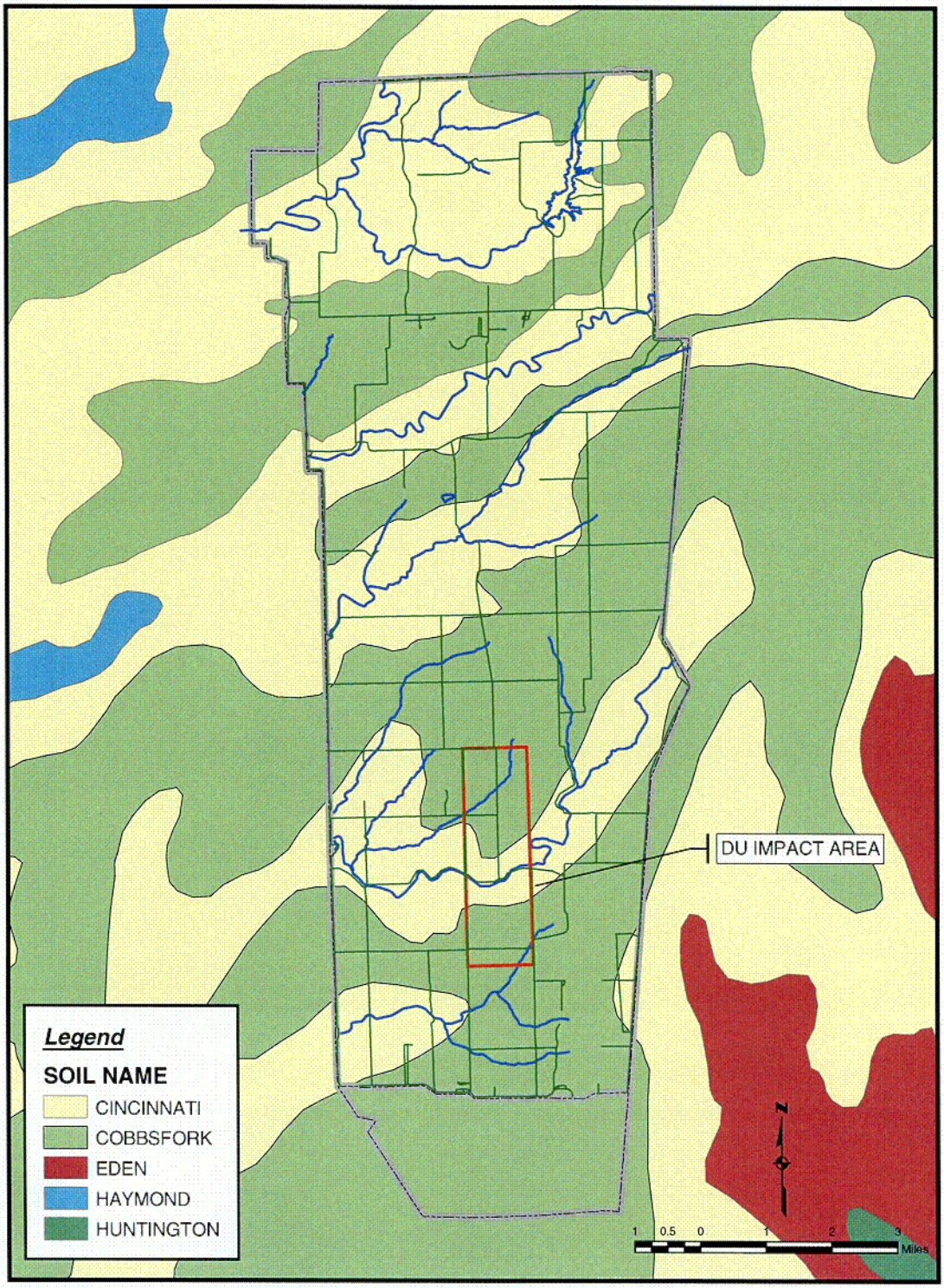


Figure 3-4. Major Soil Associations Present at Jefferson Proving Ground

C05

Table 3-4. Historical Earthquakes within 200 Miles (332 km) of Jefferson Proving Ground, Madison, Indiana

Date	Location		Depth (km)[a]	Magnitude	Distance (km)[a]
	Latitude (degrees)	Longitude (degrees)			
May 17, 1901	38.75	–83.00	NR[b]	4.2	210
September 27, 1909	39.80	–87.20	NR	5.1	189
March 14, 1921	39.50	–87.50	NR	4.4	196
November 27, 1922	37.80	–88.50	NR	4.8	291
April 27, 1925	38.20	–87.80	NR	4.8	217
September 2, 1925	37.80	–87.50	NR	4.6	212
November 5, 1926	39.10	–82.10	NR	3.8	289
September 30, 1930	40.30	–84.30	NR	4.2	192
September 20, 1931	40.43	–84.27	5	4.7	206
March 2, 1937	40.49	–84.27	2	5.0	211
March 9, 1937	40.47	–84.28	3	5.4	209
June 20, 1952	39.64	–82.02	9	4.0	307
January 2, 1954	36.60	–83.70	NR	4.3	286
September 7, 1956	36.44	–83.79	5	4.1	297
November 8, 1958	38.44	–88.01	5	4.4	229
November 9, 1968	37.91	–88.37	21	5.5	276
April 3, 1974	38.55	–88.07	14	4.7	232
January 19, 1976	36.87	–83.86	1	4.0	254
June 17, 1977	40.71	–84.71	1	3.2	220
July 27, 1980	38.19	–83.89	6	5.1	148
June 29, 1984	37.70	–88.47	2	4.1	293
July 12, 1986	40.54	–84.37	10	4.6	213
June 10, 1987	38.71	–87.95	10	5.2	220
September 7, 1988	38.14	–83.88	10	4.6	152

Source: USGS 2002a.
[a]To convert from km to miles, multiply by 0.621.
[b]NR = Not reported.
km = kilometer.

Table 3-5. Historical Earthquakes within 100 Miles (161 km) of Jefferson Proving Ground, Madison, Indiana

Date	Location		Depth (km)[a]	Magnitude	Distance (km)[a]
	Latitude (degrees)	Longitude (degrees)			
April 12, 1791	37.40	–85.00	NR[b]	NR	159
July 27, 1980	38.19	–83.19	6	5.1	148
September 7, 1988	38.14	–83.88	10	4.6	152

Source: USGS 2002a.
[a]To convert from km to miles, multiply by 0.621.
[b]NR = Not reported.
km = kilometer.

A review of the seismicity in this area reveals that the greatest threat at the site could result from the so-called New Madrid Seismic Zone (NMSZ). The peak acceleration map for the National Earthquake Hazard Reduction Program (NEHRP) B-C Boundary, indicating seismic hazard as percent of the acceleration of gravity (g) [i.e., 9 percent g] with a probability of 5 percent of exceedance in 50 years, is shown in Figure 3-5. The Peak Ground Acceleration (PGA) hazard parameters (based on USGS 2002a) for the JPG Site are shown in Table 3-6. From this table, it is evident that earthquakes with a thousand years return period could result into a PGA of approximately 0.047g at the JPG site.

3.6 SURFACE WATER HYDROLOGY

Surface water features are abundant at the installation and include ponds, lakes, streams, and wetland areas, along with numerous ephemeral streams, ponding sites, and wet areas. Seven streams and their tributaries drain the JPG area, generally flowing from northeast to southwest, and include Otter Creek, Graham Creek, Little Graham Creek, Marble Creek, Big Creek, Middle Fork Creek, and Harberts Creek (Figure 3-6). JPG lies within the White River Drainage Basin (a sub-basin of the Wabash River Basin, which is a sub-basin of the Ohio River Basin) [U.S. Army 1995a]. Peak flow rates for surface water at JPG generally are in the spring. Typical flow rates range from 25 to 50 cubic feet per second (cfs) [0.7 to 1.4 cubic meters per second (m^3/s)].

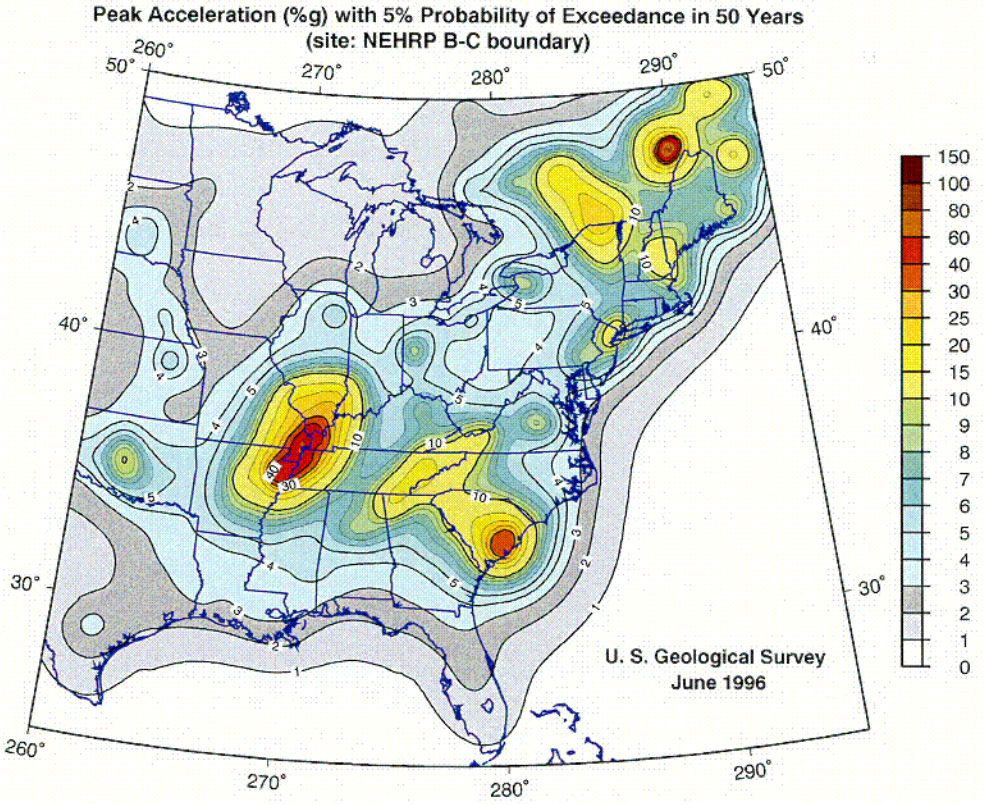
JPG is located in the Muscatatuck watershed of the White River Drainage Basin. EPA's Index of Watershed Indicators (IWI) rates the condition and vulnerability of aquatic systems in the United States. The overall IWI score for this watershed is 3, which indicates "Less Serious Water Quality Problems - Low Vulnerability to stressors such as pollutant loadings" (see http://cfpub.epa.gov/surf/huc.cfm?huc_code=05120207). Additional information is provided in the White River Basin Study (USGS 2001b).

Big Creek bisects the DU Impact Area, and Middle Fork Creek crosses the southeastern DU Impact Area boundary, as shown in Figure 3-6. Big Creek originates off-site and flows 9.2 stream miles across JPG. It is fed by numerous unnamed, intermittent tributaries and has a sandy/gravelly substrate. Middle Fork Creek originates on JPG and is fed by several unnamed intermittent tributaries. It has a gravel substrate and meanders 4.5 miles (7.2 km) across the facility, draining 6,520 acres. Information on the other five streams is provided in the Final EIS for Disposal and Reuse of the JPG (U.S. Army 1995a).

Surface water is not used as a domestic drinking water supply in the vicinity of JPG; its primary use is for recreation and livestock watering (MWH 2002). Within the Big Oaks NWR, fishing is permitted only at the 165-acre Old Timbers Lake (FWS 2001b). The streams have no segments listed in the Nationwide Rivers inventory, nor are they a part of the National Wild and Scenic Rivers System (Mason and Hanger 1992). All surface water bodies at JPG are classified as "warm-water aquatic and full-body contact" by the State of Indiana water quality standards (Clark 1993).

Flooding is common in southeastern Indiana because of the proximity to the Ohio River. One major flood has occurred along the Ohio River in southeastern Indiana since 1998. Heavy rains also may cause the tributaries of the Ohio River that cross JPG (i.e., Big Creek) to swell (MWH 2002).

At least 10 ponds or lakes that vary in size from less than 1 acre to 165 acres (0.004 to 0.7 km^2) are located on the installation. No ponds or lakes are located in the DU Impact Area. The impoundment of Little Otter Creek by little Otter Dam formed Old Timber's Lake, and a dam on Harbert's Creek formed Krueger Lake. Both lakes are used for recreational purposes. There is no significant commercial value associated with the water bodies. Old Timbers Lake in the northeast corner of the site has an area of 165 acres. Krueger Lake is in the southeast portion of the site and has an area of 8 acres. No other



Source: USGS 2001a.

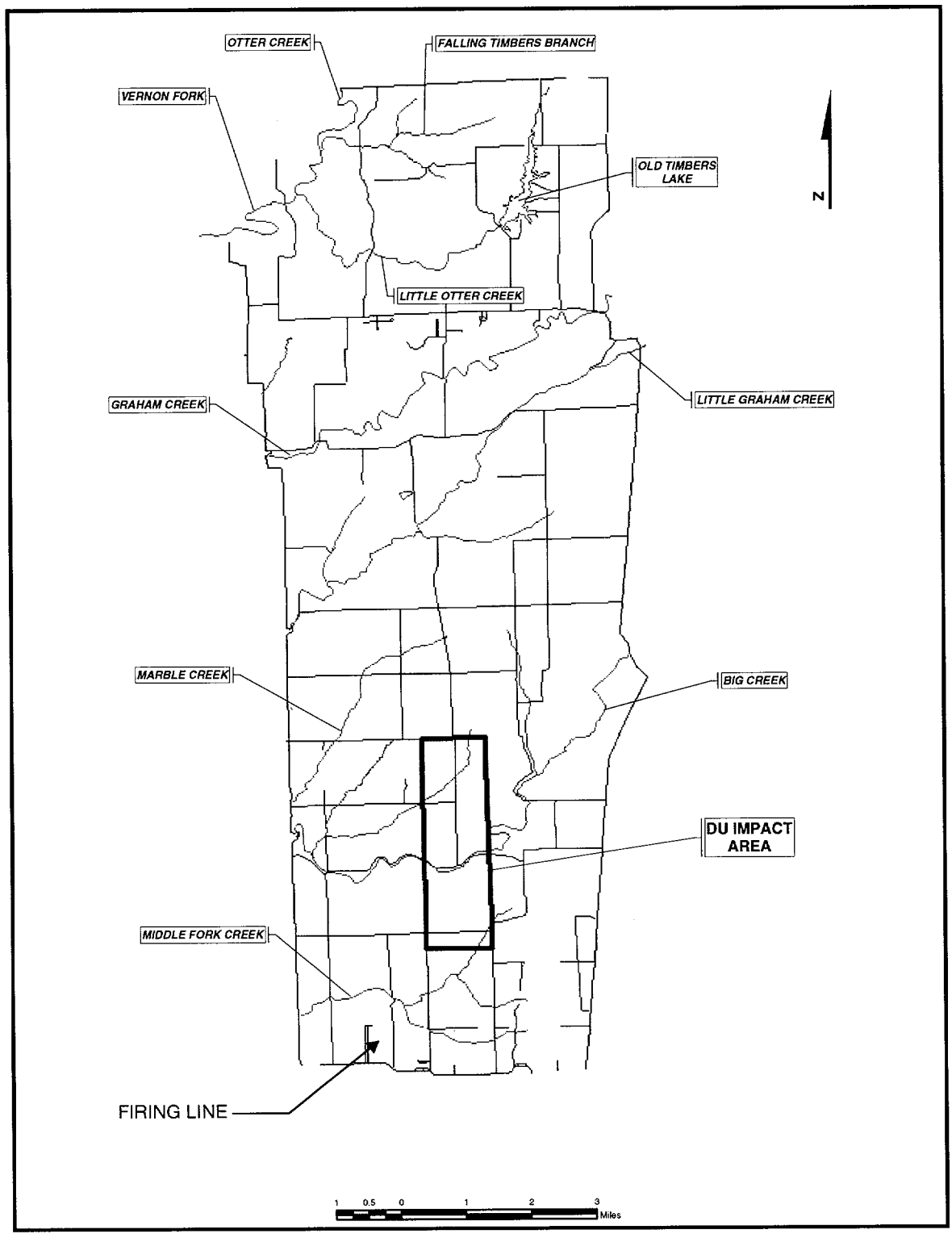
Figure 3-5. Peak Acceleration With a Probability of 5 Percent of Exceedance in 50 Years

Table 3-6. Seismic Hazard Curve for Jefferson Proving Ground, Madison, Indiana

Acceleration (%g)	Frequency of Exceedance (dimensionless)
0.0050	2.456×10^{-2}
0.0070	1.688×10^{-2}
0.0098	1.121×10^{-2}
0.0137	7.226×10^{-3}
0.0192	4.510×10^{-3}
0.0269	2.736×10^{-3}
0.0376	1.612×10^{-3}
0.0527	9.083×10^{-4}
0.0738	4.880×10^{-4}
0.1030	2.497×10^{-4}
0.1450	1.189×10^{-4}
0.2030	5.523×10^{-5}
0.2840	2.539×10^{-5}
0.3970	1.182×10^{-5}
0.5560	5.535×10^{-6}
0.7780	2.568×10^{-6}
1.0900	1.139×10^{-6}
1.5200	4.782×10^{-7}
2.1300	1.818×10^{-7}

Source: Based on USGS 2002a.
g = Gravity.

C06



Source: MWH (2002).

Figure 3-6. Surface Water Drainage at Jefferson Proving Ground, Madison, Indiana

man-made water control structures are anticipated for the site. It has been noted that a growing beaver population has led to the creation of significant acreage of ponds and marsh areas, some within the DU Impact Area.

Water quality, biological, and physical data available on EPA's STORET (short for STOrage and RETrieval) do not include any of the streams on JPG. Surface water sampling data involving total uranium concentrations are available for Big Creek and Middle Fork Creek and are discussed in Section 4.3 of this report. There are no surface water or subsurface uses (e.g., withdrawals, consumption, or returns) currently within the installation boundaries. There is no evidence of past, current, or future pollutant sources with discharges to water in the area north of the firing line, which includes the DU Impact Area (U.S. Army 1995a; Mason and Hanger 1992). Detailed flow information on these streams (e.g., historic monthly flow information, drought stages and discharges by month, and short-duration flow fluctuations) is not available for the JPG streams. Current Federal Emergency Management Agency data (see http://www.fema.gov/mit/tsd) indicate that JPG is not located within a floodplain.

3.7 GROUNDWATER HYDROLOGY

In this section the hydrostatic units are described (Section 3.71). Groundwater use and off-site groundwater wells are identified in Sections 3.7.2 and 3.7.3, respectively.

3.7.1 Hydrostatic Units

Three hydrostratigraphic units are located in the JPG area. The unconsolidated glacial deposits underlying the site form one unit. The Paleozoic limestones and dolomites that underlie the unconsolidated glacial deposits form a second unit. The third hydrostratigraphic unit consists of the alluvial deposits in the Ohio River Valley south of the installation.

Unconsolidated Glacial Deposits

The unconsolidated glacial deposits range in thickness from 4 to 43 ft (1.2 to 13.1 m) south of the firing line and are composed predominantly of glacial till (MWH 2002). The hydraulic conductivity of the till ranges from 1.1×10^{-5} to 3.3×10^{-5} in./sec [2.9×10^{-5} to 8.4×10^{-5} centimeters per second (cm/sec)] based on slug tests in wells (Rust E&I 1998; MWH 2002). The direction of groundwater flow is roughly the same as the surface water drainage, which is to the west–southwest over most of the installation. The matrix hydraulic conductivity of the tills at JPG ranges from 1.3×10^{-5} to 3.9×10^{-5} in./sec (3.4×10^{-8} cm/sec to 9.8×10^{-8} cm/sec) [MWH 2002]. Small-scale fractures and sand lenses within the till contribute to the higher hydraulic conductivity measured by the slug tests.

Silurian and Devonian Limestones and Dolomites

The shallow bedrock groundwater in the vicinity of JPG is stored primarily in the bedrock hydrostratigraphic unit comprised of Silurian and Devonian limestones and dolomites members. The aquifer is unconfined to semi-confined and is recharged by infiltration of precipitation to the bedrock aquifer concentrated along fractures within the glacial till and in areas where the creek channels are losing water to the groundwater system. Groundwater in the bedrock shows a direct and rapid response to changing climatic conditions (MWH 2002).

Groundwater flow in the bedrock aquifer is controlled primarily by fractures. The bedrock aquifer is unconfined and recharged by surface water flow. In areas where the overlying till is not fractured, the groundwater in the bedrock aquifer appears to be confined. Cores of limestone bedrock from the site contained fractures 3.94×10^{-3} in. (100 μm) or larger and showed evidence of solutioning (MWH 2002).

Karst features, such as sinkholes, have been recognized along the Otter Creek and Big Graham Creek drainages a few miles west of JPG; however, no karst features have been mapped at JPG (MWH 2002).

A karst study to identify caves was conducted at the installation from 1994 to 1997 along five creeks: Big Creek, Middle Fork Creek, Graham Creek, Little Graham Creek, and Otter Creek (Sheldon 1997). During this inventory, 32 caves with 52 entrances were identified. The cave lengths ranged from approximately 26 ft (7.9 m) to the longest cave length of 1,507 ft (459 m). Nineteen caves were identified along Big Creek, with an average cave length of approximately 162 ft (49.4 m).

The water-level elevations of wells screened in bedrock loosely conform to the configuration of the surface topography. The direction of groundwater flow in bedrock generally is to the west–southwest. The water level elevations measured in the DU Impact Area are variable, ranging from a minimum of 3 ft below the surface in monitoring well (MW)-10 to a maximum of 32 ft (9.8 m) below the surface in MW-09 (refer to Figure 3-2 for well locations) [U.S. Army 2001]. The variability in the depth to groundwater may reflect the occurrence of fractures in bedrock. Table 3-7 provides data for the DU Impact Area groundwater monitoring wells (SEC Donahue, Inc. 1992). Figure 3-7 shows the potentiometric contours based on these data. The wells are too widely spaced to interpret the potentiometric surface or identify preferred flow paths. It appears, however, that in the vicinity of incised surface drainages, the potentiometric surface slopes toward the streams at roughly the same gradient as the surface topography. Therefore, on a local scale, the bedrock groundwater tends to discharge to surface streams (SEC Donahue, Inc. 1992).

Slug and pump tests were completed on 51 wells located south of the firing line screened in the bedrock aquifer. The hydraulic conductivity of the bedrock aquifer computed from slug tests ranges from 0.67×10^{-5} to 2.3×10^{-4} in./sec (1.7×10^{-5} to 5.8×10^{-4} cm/sec) [MWH 2002]. The pumping test results indicate hydraulic conductivities ranging from 0.55×10^{-4} to 2.4×10^{-3} (1.4×10^{-4} cm/sec to 6×10^{-3} cm/sec) [MWH 2002].

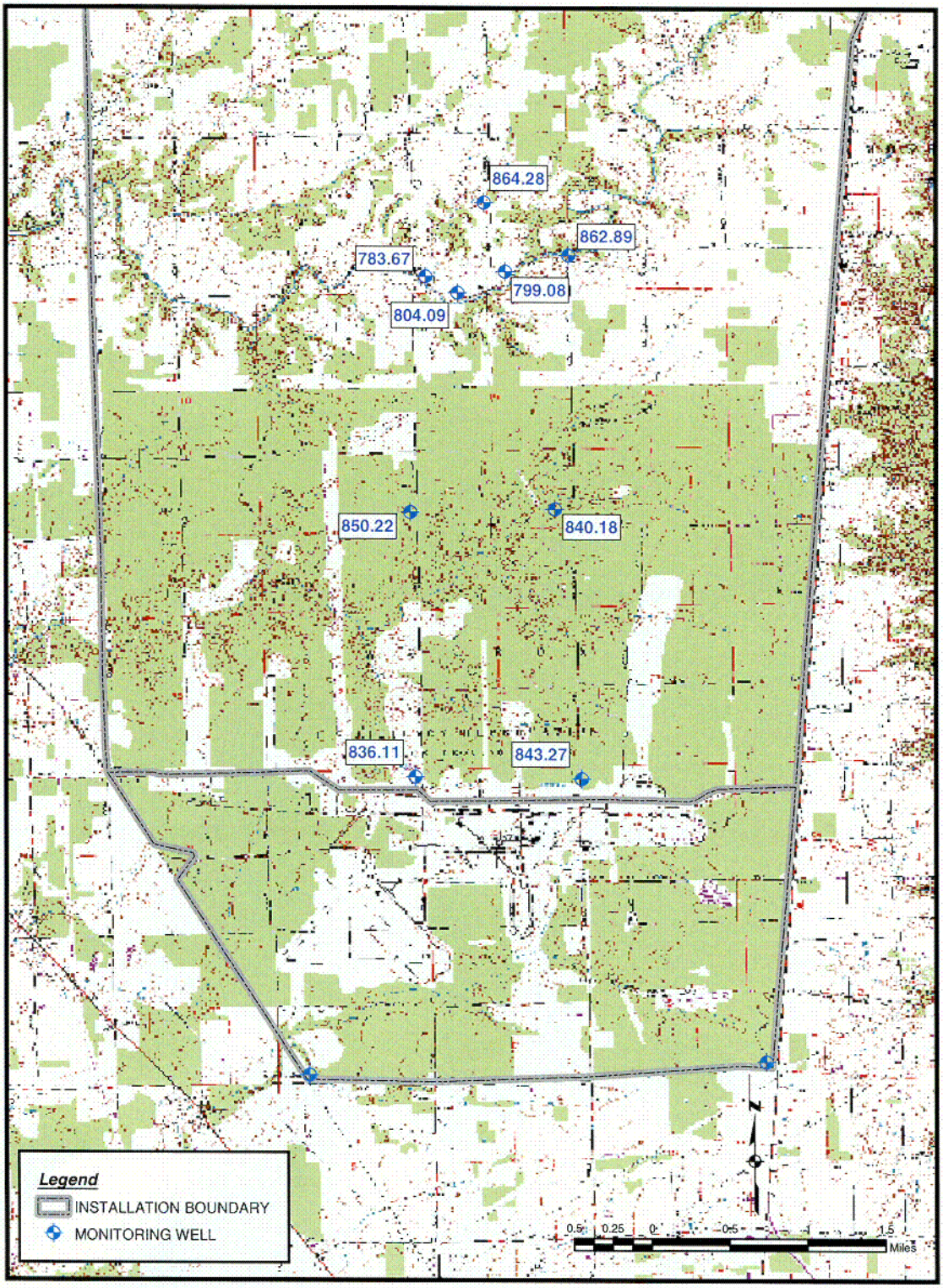
Ohio River Alluvial Deposits

The third hydrostratigraphic unit, the Ohio River Valley alluvium, does not underlie the site and is significant because it is the only major source of groundwater in the region that is available for domestic use (MWH 2002). However, the closest location of this unit is approximately 5 miles (8 km) south of JPG. Because the bedrock groundwater flow direction at JPG generally is to the southwest, and the north–south stream drainages are located west of JPG, it is unlikely that potential contamination present at JPG could reach the Ohio River alluvial aquifers. The southwest groundwater flow direction at JPG is in agreement with the regional groundwater flow direction documented in the USGS Open File Report 90-151 (see Figure 3-8) [Bugliosi 1990].

Table 3-7. DU Impact Area – Groundwater Monitoring Wells

Well No.	Date Completed	Total Depth (ft)[a]	Depth to Bedrock (ft)[a]	Water Level Depth[b] (ft Below Ground Surface)	Comment
1	12/6/83	33.2	4.5	10	1.5 feet (ft) disturbed by detonation. Fire-granted gray limestone. Loss of recirculation water near 8 ft.
2	12/13/83	23.7	7	10	1.5 ft disturbed by detonation. Fractured gray to brownish-gray limestone. Loss of recirculation water near 14.8 ft. Large solution cavities and shaley-clay-filled voids.
3	12/13/83	4.3	18.5	8	1.5 ft disturbed by detonation.
4	12/14/83	28.5	10	3	
5	12/7/83	33.4	20.3	5.6	1 ft disturbed by detonation.
6	12/17/83	40	NA	18.25	1.5 ft disturbed by detonation. No bedrock encountered.
7	12/8/83	53.7	26.5	8.8	
8	12/9/83	28.2	14.5	23	Loss of recirculation water at 20 ft.
9	9/18/88	38.2	3.7	32	
10	9/18/88	41.3	NA	3	No bedrock encountered. Borehole encountered glacial till.
11	9/19/88	41.9	2	6.8	Limestone with horizontal solution features. Solution cavities filled with sediment.

Source: SEC Donahue, Inc. 1992.
[a]To convert feet to meters, multiply by 0.3.
[b]Groundwater levels from borehole drilling logs.
NA = Not applicable.



Source: SEC Donahue, Inc. 1992.

Figure 3-7. Groundwater Contours of the DU Impact Area

C07

Source: Bugliosi 1990.

Figure 3-8. Regional Groundwater Flow Direction for the Cincinnati Arch

C08

3.7.2 Groundwater Use

There are no sole source aquifers on or in the vicinity of JPG based on a review of EPA Region 5's sole source aquifer designations (EPA 2002). A sole source aquifer is an aquifer designated by EPA as the sole, or principal, source of drinking water for a given area (i.e., an aquifer that supplies 50 percent or more of the area), and for which there is no reasonable alternative should the aquifer become contaminated.

The groundwater under JPG generally is of poor quality and is not used for drinking purposes or for other purposes in any significant capacity. The drinking water at JPG is obtained from the City of Madison Municipal Supply Systems and the Canaan Deposits in the Ohio River Valley, approximately 5 miles (8 km) from JPG (MWH 2002).

3.7.3 Off-site Groundwater Wells

A review of the State of Indiana records of groundwater wells drilled off-site in a downgradient direction indicated that nine groundwater wells completed in bedrock had been drilled from 1945 to 1966 for domestic and stock use. Table 3-8 summarizes water wells identified by an online search of the Indiana Department of Natural Resources (IDNR) well data files. It is unknown if these wells currently are operational. The closest well location is approximately 4 miles (6.4 km) southwest of the DU Impact Area. The Draft Final RI provides additional information on wells in Jennings, Ripley, and Jefferson Counties (MWH 2002).

3.8 NATURAL RESOURCES

The primary natural resources occurring at or near the site are timber from the wooded area of the site. The JPG is 75 percent forested, primarily with hardwoods, and, to a lesser extent, coniferous trees. The species of potential commercial value are white oak and black walnut. Groundwater at the site is considered non-potable because the water has high total dissolved solids and is of poor quality and low productivity (MWH 2002). Water used at the site is supplied by the Madison, Indiana, municipal water supply system for areas south of the firing line and by other municipal water supply system(s) [i.e., Canaan Water Company] for areas off of the facility but north of the firing line. No drinking water wells, or municipally supplied water, are available north of the firing line on the facility. Canaan Water Company supplies potable water for Old Timbers Lodge when it is operational.

3.9 ECOLOGY/ENDANGERED SPECIES

JPG provides quality habitat for a variety of terrestrial and aquatic species. Forty-one species of fish, 8 species of freshwater mussels, 24 species of amphibians, and 18 species of reptiles have been found on the installation. Mammal species include white-tail deer, raccoon, coyote, opossum, gray and fox squirrel, skunk, beaver, red fox, weasel, and mink. Large populations of small mammals, including mice and moles, attract significant numbers of reptiles and raptors. JPG is approximately 80 percent reforested, and the unbroken stands of mature and young trees are used by migrating neo-tropical birds. More than 100 breeding birds have been recorded at the installation. The American Bird Conservancy has listed the Big Oaks NWR as a Globally Important Bird Area because of its importance to grassland birds (e.g., Henslow's sparrow) and forest birds (e.g., cerulean warbler). The FWS and the Institute for Bird Populations are conducting ongoing census surveys of wildlife at the installation. Wildlife management continues even with the JPG's closure in September 1995. Twenty-five river otters were released in January 1996 at the Old Timbers Lake in support of Indiana's Otter Restoration Program (SAIC 1997a). Six additional otters were released into Otter Creek at Blue Hole on January 31, 1999 (SAIC 2002b).

Table 3-8. Groundwater Wells Located Outside of the JPG boundaries and Downgradient of the DU Impact Area

Township	Range	Section	Reference Number	Well Depth (ft)[a]	Depth to Bedrock (ft)[a]	Formation	Static Water Level (ft)[a]	Well Use	Install Date	Status
5N	9E	10	220845	189	Unknown	Unknown	11	Home	Unknown	Unknown
5N	9E	10	220850	78	Unknown	Limestone	11	Home	1945	Unknown
5N	9E	11	220873	85	20	Limestone	10	Home	1960	Unknown
5N	9E	11	220878	80	10	Grey and Blue Limestone	Unknown	Home	1960	Unknown
5N	9E	15	220868	111	17	Limestone	17	Home	1966	Unknown
5N	9E	23	220843	60	35	Hard Blue Limestone	15	Stock	1960	Unknown
5N	9E	34	220811	78	15	Blue Shale and White Lime	27	Home	1966	Unknown
5N	9E	34	220816	96	15	Blue Stone or Soapstone	14	Home	1964	Unknown
5N	9E	34	220821	285	16	Limestone	Unknown	Home	1963	Unknown

Source: IDNR 2001a.
[a]To convert from feet to meters, multiply by 0.3.

JPG provides habitat for a wide variety of game animals and fish that are harvested on the installation. Until the early 1990s, there was some stocking of game birds, fish, and other creatures to maintain stable populations of some species. Hunting is allowed on approximately 27,700 acres (112 km^2). The remaining area, approximately 27,300 acres (110 km^2), provides habitat for small game; however, this land is closed to hunters because of the presence and hazards of UXO and DU. The staff of the Big Oaks NWR manage the hunting program at JPG (FWS 2001b).

White-tailed deer and wild turkey hunting is permitted in designated areas administered by the FWS as part of the Big Oaks NWR (FWS 2001b). Mammals and fowl harvested on JPG include white-tail deer, fox squirrel, eastern gray squirrel, eastern cottontail rabbit, and wild turkey. Approximately 400 to 500 whitetail deer are harvested annually (FWS 2001b). The wild turkey harvest averages 50 birds per year (MWH 2002). Permit-drawn hunts for the general public have been conducted for deer since the 1960s and for turkey since 1984. Fish harvested on JPG include bass, bluegill, sunfish, crappie, and catfish.

There are 11 federally endangered animals (3 birds, 1 mammal, and 7 mollusks) that may occur within the boundaries of JPG. The three bird species are transients that may be present during migration, including the Piping plover (*Charadrius melodus*), Kirtland's warbler (*Dendroica kirtlandi*), and interior least tern (*Sterna antillarum athalassos*). The Indiana bat (*Myotis sodalis*) also has been documented at JPG (Rust E&I 1998). The white catspaw (*Epioblasma obliquata perobliqua*), northern riffleshell (*Epioblasma torulosa rangiana*), tubercled blossom (*Epioblasma torulosa torulosa*), pink mucket (*Lampsilis abrupta*), ring pink (*Obovaria refusa*), orange-foot pimpleback (*Plethobasus cooperianus*), and fat pocketbook (*Potamilus capax*) are all federally endangered mollusks. The bald eagle (*Haliaeetus leucocephalus*) is the only federally threatened animal (IDNR 2001b). Table 3-9 identifies Federal, State of Indiana, and Carroll and Trimble Counties, Kentucky, endangered species.

In addition to the 11 federally endangered species, 9 State of Indiana-endangered species (6 birds, 2 mammals, and 1 reptile) and 2 Carroll and Trimble County, Kentucky, endangered species (2 mollusks) also have been identified. Additionally, Henslow's sparrow (*Ammodramus henslowii*) has been identified as a breeding species at JPG. Ten species in Indiana and five species in Kentucky are listed as species of special concern [IDNR 2001b; Kentucky State Nature Preserves Commission (KSNPC) 2001].

Table 3-9. Federal and State Endangered Species

Species Type	Species Name	Common Name	Status
Bird	*Charadrius melodus*	Piping plover	FE
Bird	*Dendroica kirtlandii*	Kirtland's warbler	FE
Bird	*Sterna antillarum athalassos*	Interior least tern	FE, INE
Mollusk	*Epioblasma obliquata perobliqua*	White catspaw	FE
Mollusk	*Epioblasma torulosa rangiana*	Northern riffleshell	FE
Mollusk	*Epioblasma torulosa torulosa*	Tubercled blossom	FE
Mollusk	*Lampsilis abrupta*	Pink mucket	FE, KYE
Mollusk	*Obovaria retusa*	Ring pink	FE, KYE
Mollusk	*Plethobasus cooperianus*	Orangefoot pimpleback	FE, KYE
Mollusk	*Potamilus capax*	Fat pocketbook	FE, INE
Mammal	*Myotis sodalis*	Indiana bat	FE, INE
Bird	*Haliaeetus leucocephalus*	Bald eagle	FT

Table 3-9. Federal and State Endangered Species (Continued)

Species Type	Species Name	Common Name	Status
Bird	*Aimophila aestivalis*	Bachman's sparrow	INE
Bird	*Ammodramus henslowii*	Henslow's sparrow	INE
Bird	*Asio flammeus*	Short-eared owl	INE
Bird	*Circus cyaneus*	Northern harrier	INE
Bird	*Falco peregrinus*	Peregrine falcon	INE
Bird	*Tyto alba*	Barn owl	INE, KYSC
Mammal	*Lutra Canadensis*	River otter	INE
Mammal	*Lynx rufus*	Bobcat	INE
Mammal	*Nycticeius humeralis*	Evening bat	INE
Mammal	*Taxidea taxus*	American badger	INE
Reptile	*Clonophis kirtlandii*	Kirtland's snake	INE
Mollusk	*Lampsilis ovata*	Pocketbook	KYE
Mollusk	*Pleurobema pyramindatum*	Pyramid pigtoe	KYE
Bird	*Ixobrychus exilis*	Least bittern	KYT
Mollusk	*Simpsonaias ambigua*	Salamander mussel	KYT
Amphibian	*Necturus maculosus*	Mudpuppy	INSC
Bird	*Accipiter striatus*	Sharp-shinned hawk	INSC
Bird	*Buteo lineatus*	Red-shouldered hawk	INSC
Bird	*Buteo platypterus*	Broad-winged hawk	INSC
Bird	*Dendroica cerulea*	Cerulean warbler	INSC
Bird	*Helmitheros vermivorus*	Worm-eating warbler	INSC
Bird	*Mniotilta varia*	Black-and-white warbler	INSC
Bird	*Wilsonia citrina*	Hooded warbler	INSC
Mammal	*Condylura cristata*	Star-nosed mole	INSC
Mammal	*Mustela nivalis*	Least weasel	INSC
Amphibian	*Rana Pipiens*	Northern Leopard Frog	KYSC
Bird	*Ardea herodias*	Great Blue Heron	KYSC
Bird	*Riparia riparia*	Bank swallow	KYSC
Mollusk	*Plethobasus cyphyus*	Sheepnose	KYSC

Sources: IDNR 2001a and KSNPC 2001.
FE = Federally Endangered.
FT = Federally Threatened.
INE = Indiana Endangered.
INSC = Indiana Special Concern.
KYE = Carroll and/or Trimble County, Kentucky Endangered.
KYSC = Carroll and/or Trimble County, Kentucky Special Concern.

4.0 RADIOLOGICAL STATUS OF THE FACILITY

The radiological status of the DU Impact Area at JPG has been determined from historical records, a radiological scoping survey conducted in 1994 (SEG 1995a,b), and a radiological characterization survey conducted in 1995 (SEG 1996). Section 4.1 presents a summary of historical information relevant to radiological characterization of the JPG and a description of the methods, procedures, and results of a final status survey of facilities and grounds located south of the firing line. Section 4.2 describes the methods and procedures used in scoping and characterization studies that determined the radiological status of the DU Impact Area. Section 4.3 summarizes the results of the radiological characterization of the DU Impact Area. A summary of the facility's radiological status is presented in Section 4.4.

4.1 HISTORICAL SITE ASSESSMENT

Historical information relevant to termination of the current license includes the facility operating history, characterization of radioactive material used at the facility, characterization of support facilities, and monitoring of radioactive material in the environment. The following paragraphs summarize these sources of information. The facility operating history is described in more detail in Section 2.0 of this DP.

4.1.1 Summary of Facility Operating History

Testing of conventional explosives was conducted at JPG between 1941 and 1994. NRC-licensed activities, including handling and test firing of tank penetrator rounds containing DU, were conducted between 1984 and 1994. All firings of DU were conducted from three gun positions designated as Firing Points J, 500 Center, and K, and were directed toward the DU Impact Area. Adjacent firing points and their northward-oriented firing lines are separated by a distance of approximately 394 ft (120 m). Masses of DU fired from Firing Points J, 500 Center, and K were 14,550, 196,886, and 8,572 lbs [6,600, 89,306, and 3,888 kg], respectively. During active testing of DU munitions, explosives ordnance personnel periodically would sweep the range area surrounding the DU target area to recover DU. The recovered projectiles and fragments were weighed and the recovered weights subtracted from the fired projectile weights to determine the total DU material weight remaining in the range. The mass of DU remaining in the DU Impact Area is estimated as 154,323 lbs (70,000 kg).

DU projectiles were fired from tank guns at high velocities against soft cloth targets. Upon impact, the projectiles penetrated into the earth, ricocheted, or broke into two or more pieces rather than shattering into small particles (Mason and Hanger 1992). Firing of DU projectiles against metal target plates, which could contribute to minute particle fragmentation or aerosolization of DU rods and particle burning, was not conducted.

4.1.2 Characterization of Radioactive Materials

Radioactive materials utilized at JPG were in the form of DU penetrators contained in 105 or 120 millimeter (mm) antitank cartridges. The penetrators themselves were long, thin cylinders of DU alloyed with titanium (0.75 percent) and contained no explosive materials. Original masses of the penetrators were approximately 8.5 and 10.7 lbs (3.9 and 4.9 kg) while nominal diameters and lengths were 1.2 and 12.6 in. (3 and 32 cm), respectively. In addition to use in performance testing, DU munitions were used in combat in the Gulf war (1991) and in the Balkans conflict (1999). The penetrators contain the naturally occurring isotopes of uranium and low concentrations of transuranic (TRU) elements and fission products derived from use of recycled uranium in the gaseous diffusion plants (GDPs) that produced enriched uranium and DU. Concentrations of the uranium (U) isotopes U-234, U-235, U-236, and U-238 in DU used by the U.S. Department of Defense (DoD) have been reported as 0.0006, 0.2,

0.0003, and 99.8 percent, respectively [Center for Health Promotion and Prevention Medicine (USACHPPM) 2000]. At these concentrations, total specific activity is 3.8×10^{-7} curies per gram (Ci/g). Further information on radiological characterization of the penetrators is available from several sources:

- specifications developed during operation of the GDPs,
- review of the flow of recycled uranium through the DOE complex,
- analysis of billets used in the production of armor containing DU, and
- analysis of penetrators used in the Balkans conflict.

The following discussion summarizes data and results from these information sources.

The presence of TRU elements in the Paducah, Kentucky, GDP was recognized as early as 1953 and confirmed in 1957 (DOE 2000a). At this plant, a neptunium (Np) recovery project was begun in 1958, and a technetium (Tc) recovery program was operated from 1960 to 1963. As early as 1953, plant documents identified a plutonium concentration of 10 parts per billion (ppb) of uranium as acceptable feed material. Plant documents, dated 1966, specified the maximum level of alpha activity from reactor fuel elements as 150 disintegrations per minute per gram (dpm/g) of uranium. This level was interpreted as equivalent to concentrations of 0.0004, 1.0, or 0.3 ppb of uranium for plutonium-238 (Pu-238), Pu-239, or Pu-240, respectively. A 1957 plant document indicates that this maximum specification was increased to 1,500 dpm/g of uranium in 1967, and the Neptunium-237 (Np-237) limit became 1 part per million (ppm) uranium basis. Between 1986 and 1989, the feed specification for plutonium was 10 ppb of uranium. After 1989, the feed specification for plutonium and neptunium combined became 200 dpm/g of uranium. This limited feed concentrations to 1.4 and 125 ppb of uranium for Pu-239 and Np-237, respectively.

As part of an effort to assess the health risks for workers at the Paducah GDP, the U.S. Department of Energy (DOE) completed a study of the mass flows and radiological characteristics of recycled uranium processed within the DOE complex (DOE 2000b). While the flow of recycled material within the complex was complicated, the study estimated that as much as 143,298 short tons (130,000 metric tons) of recycled uranium were produced in separation plants and that blending and other operations increased the quantity of uranium containing recycled material to 275,572 short tons (250,000). Based on measurement data and the results of mass balance projects conducted for the GDPs, DOE estimated the contaminant levels summarized in Table 4-1. Measurements of contaminant levels in DU processed in the Specific Manufacturing Facility at the Idaho National Engineering and Environmental Laboratory (INEEL) are summarized in Table 4-2.

The Tank-Automotive and Armaments Command (TACOM) of the U.S. Army has an NRC license governing management and use of DU in armor. To fully describe in the license the radiological characteristics of the DU armor, TACOM, at the request of the NRC, performed a sampling and laboratory analysis to establish concentrations of Tc and TRU elements in DU used in the armor. TACOM analyzed random samples from three generations, or populations, of finished billets (Bhat 2000). The first population was drawn from billets comprising an original shipment of DU. The second population comprises billets cast from scrap material of the first population, while the third population comprises billets cast from scrap material of the second population. Samples were collected by drilling approximately 0.088 lb (40 g) of shavings from each of 20 billets of the first population, 30 billets of the second population, and 10 billets of the third population. The samples were dissolved in nitric acid and analyzed for TRU elements using alpha and mass spectroscopy. A set of duplicate samples was selected and analyzed independently for quality assurance (QA) purposes. The results of the analysis are summarized in Table 4-3. The nuclides Pu-236, Pu-242, and Americium-243 (Am-243) were not present above the minimum detectable concentration of 0.2 pCi/g of uranium. In addition to the above analyses, gamma spectroscopy was to investigate the presence of fission products other than Tc. The analysis identified no gamma peaks other than those due to progeny of uranium.

Table 4-1. Summary of Constituents in Product and Tails Streams at the GDPs

Site	Radionuclide	Concentration (ppb)	
		Enriched Product	Depleted Tails
Oak Ridge	Pu	< 0.05	< 0.01
	Np	< 5	< 5
	Tc	< 1,000	< 10
Portsmouth	Pu	< 0.037	< 0.007
	Np	< 3.19	< 0.6
	Tc	< 690	< 0.4
Paducah	Pu	< 0.01	< 0.01
	Np	< 5	< 5
	Tc	< 20,000 (?)	< 10

Source: DOE 2000a.
GDP = gaseous diffusion plant.
Np = Neptunium.
ppb = parts per billion.
Pu = Plutonium.
Tc = Technetium.

Table 4-2. Representative Sampling of Contaminants in DU at INEEL

Nuclide	Concentration (ppb)		
	Maximum	Minimum	Average
Np-237	5.29	1.62	2.58
Pu-238	1.2×10^{-4}	0	1.59×10^{-5}
Pu-239/240	0.0428	0	6.55×10^{-3}
Am-241	5.61×10^{-3}	0	8.1×10^{-4}
Tc-99	31.6	3.78	9.06

Source: DOE 2000b.
DU = depleted uranium.
INEEL = Idaho National Engineering and Environmental Laboratory.
Np = Neptunium.
ppb = parts per billion.
Pu = Plutonium.
Tc = Technetium.

Table 4-3. Concentrations of Contaminants in Billets of DU Armor

Nuclide	Concentration, ±1 sigma (pCi/g armor)					
	Population No. 1		Population No. 2		Population No. 3	
	Lowest Value	Highest Value	Lowest Value	Highest Value	Lowest Value	Highest Value
Am-241	–0.8 ±1.3	4.4 ±5.5	–1.7 ±2.8	19 ±5.8	1.2 ±1.8	5.3 ±2.2
Np-237	< 1.3	3.7 ±0.92	< 1.1	2.2	1.2	< 3.6
Pu-238	–0.03 ±0.06	2.0 ±0.53	0.01 ±0.01	0.80 ±0.14	0.17 ±0.06	0.86 ±0.23
Pu-239/240	–1.2 ±1.9	2.7 ±0.88	0.12 ±0.17	1.0 ±0.16	0.24 ±0.06	0.86 ±0.14
Tc-99	< 73	240 ±47	64	540 ±32	83	400 ±26

Source: Bhat 2000.
Am = Americium.
Np = Neptunium.
pCi/g = picocuries per gram.
Pu = Plutonium.
Tc = Technetium.

Following termination of hostile actions in the Balkans during the early 1990s, a United Nations Environmental Programme (UNEP) conducted an assessment of the impact of the Kosovo conflict on the environment and human settlements. As an element of this program, soil, water and other samples were collected from 11 sites where DU had reportedly been used in the conflict (UNEP 2001). Analysis of environmental samples showed low levels of contamination but identified U-236 at concentrations in the range of 61,000 to 71,000 becquerels per kilogram (Bq/kg). Identification of U-236 indicated the presence of recycled DU, motivating further analysis for TRU elements. The results of the analysis of four penetrator samples are summarized in Table 4-4.

Table 4-4. Studies on Penetrators from the Kosovo Conflict

Sample Number/ Found At	Concentration (Bq/kg) [Ci/g]				
	U-238	U-235	U-234	U-236	Pu-239/-240
ZA/R-00-505-01 Ceja Mountain	$12.37 \times 10^{+6}$ 3.34×10^{-7}	$1.60 \times 10^{+5}$ 4.32×10^{-9}	$1.16 \times 10^{+6}$ 3.14×10^{-8}	$6.10 \times 10^{+4}$ 1.65×10^{-9}	< 0.8 $< 2.16 \times 10^{-14}$
ZA/R-00-505-02 Ceja Mountain	$12.37 \times 10^{+6}$ 3.34×10^{-7}	$1.61 \times 10^{+5}$ 4.35×10^{-9}	$1.51 \times 10^{+6}$ 4.08×10^{-8}	$6.15 \times 10^{+4}$ 1.66×10^{-9}	2 5.41×10^{-14}
Kokovce	$12.70 \times 10^{+6}$ 4.43×10^{-7}	$2.00 \times 10^{+5}$ 5.41×10^{-9}	$1.55 \times 10^{+6}$ 4.19×10^{-8}	$5.72 \times 10^{+4}$ 1.55×10^{-9}	< 0.8 $< 2.16 \times 10^{-14}$
Ceja Mountain	NR	NR	NR	NR	12.9 3.49×10^{-13}

Source: UNEP 2001.
Bq/kg = becquerel per kilogram.
Ci/g = curies per gram.
NR = Data not reported. Note to Author: What does blank in Ceja Mountain mean for the isotopes of U?
Pu = Plutonium.
U = Uranium.

4.1.3 Final Status Survey of Support Facilities

Support facilities used in licensed activities at JPG included 17 buildings and storage facilities (magazines) located south of the firing points (the firing line) and the three firing points. A final survey of these support facilities was conducted in late 1994 and early 1995 in conjunction with decontamination of these facilities (SEG 1995a,b). The results of the survey supported release with no restrictions of the buildings and magazines from the JPG license. Criteria applicable at the time included limits on surface contamination of beta and alpha emitters, exposure rate, and uranium concentration in soil (NRC 1987).

Based on historical site information, facilities were grouped as "affected" or "unaffected." The survey identified three structures (Building 610, Building 611, and the Portable Magazine) containing eight areas where direct DU surface contamination exceeded applicable NRC requirements. Prior to decontamination, the maximum measured surface contamination ranged from 28,000 disintegrations per minute (dpm)/100 square centimeters (cm^2) to 158,000 dpm/100 cm^2. The applicable NRC requirement is 15,000 dpm/100 cm^2 for maximum surface contamination from uranium or beta emitters. The DU contamination in these eight areas was attributable to the storage of DU penetrators retrieved from the firing range. Remediation of all measured contaminated surfaces in the eight areas was accomplished by a combination of scabbling, jack hammering, and using a needle-gun to remove contaminated material. This remediation process resulted in the generation of six 55-gallon drums of waste equivalent to a total waste volume of 1.3 cubic meters (m^3) [45 ft^3], which were sealed, surveyed, and placed in temporary storage pending disposal. The remaining 14 buildings and the 3 firing points were classed as unaffected.

After remediation, a final survey of both affected and unaffected facilities was performed to demonstrate that all surfaces met the NRC requirements of 15,000 dpm/100 cm^2 and 5,000 dpm/100 cm^2 for maximum and average uranium or beta contamination. Differing approaches were used for affected and unaffected facilities. For affected facilities, 100 percent of all areas were grided and scanned, and 5 points within each grid were surveyed for beta-gamma contamination. For unaffected facilities, 10 percent of all areas were scanned, and a minimum of 30 randomly selected locations were surveyed for total and removable activity. A total of 6,426 swabs and beta surface measurements were made on surfaces for all the previously identified structures. The highest maximum measured value for any area was 3,901 dpm/100 cm^2, which is well below (74 percent) the associated NRC limit of 15,000 dpm/100 cm^2. The highest average measurement for any area was 805 dpm/100 cm^2, which is also well below (84 percent) the associated NRC limit of 5,000 dpm/100 cm^2. In addition, 10 soil samples were collected and analyzed for uranium isotopic distribution for each firing point. The average total uranium concentrations in soil were 1.5, 11.8, and 1.3 pCi/g for Firing Points J, 500 Center, and K, respectively.

A total of 1,040 gamma dose rate measurements in previously contaminated structures were made after remediation, with the highest structure individual measured values being 14.0 microroentgen per hour (14.0 µR/hr) for an average measured value, and 20.8 µR/hr for a maximum measured value. Both of these values were well below (< 10 percent of the limit) their respective NRC limits of 200 microrad per hour (µrad/hr) for average dose rate and 1,000 µrad/hr for maximum dose rate.

For the measurement of building and soil DU contamination, a Ludlum Model 2350 Data Logger™ was used with one of the following three detectors: (1) 15.5 square inch ($in.^2$) [100 cm^2] gas-flow proportional detector (Ludlum Model 43-68™) for direct beta measurement and scanning; (2) 1-in. by 1-in. (2.54-cm by 2.54-cm) sodium iodide (NaI) NaI(Tl) high-energy gamma scintillation detector (Ludlum Model 44-2™) for gamma exposure rate measurements; and (3) Geiger-Muller (G-M) detector (Ludlum Model 44-40™), with the proportional detector, for contamination smear measurements.

All instruments were calibrated in accordance with American National Standards Institute, Inc. (ANSI) N323-1988 and ANSI N42.17A-1989 using sources traceable to the National Institute of Standards and

Technology (NIST). The proportional and G-M detectors were calibrated twice daily with a Tc-99 source, while the NaI detector was calibrated twice daily with a cesium-137 (Cs-137) source. All detectors were calibrated so that they were determined to be within ±20 percent of the actual source. Appropriate SEG quality assurance and quality control (QA/QC) procedures were used for the survey.

4.1.4 Environmental Radiation Monitoring Program

An environmental monitoring program, termed the Environmental Radiation Monitoring (ERM) Program, has been implemented at JPG from 1983 to the present. For the period from 1983 to 1994, samples located on a judgmental basis have been collected for up to 58 soil, 11 groundwater, and 11 surface water and sediment locations. In addition, results from analysis of 17 vegetation and approximately 25 wildlife samples have been reported (Ebinger and Hanson 1996).

Under the current ERM Program, 4 soil, 11 groundwater, and 8 surface water and sediment locations are sampled (U.S. Army 2002). The four soil locations are at the corners of the DU Impact Area. Groundwater samples are collected at the same locations as those of the scoping and characterization surveys (Figures 4-1 and 4-2). Four surface water samples are collected on Big Creek, three in the DU Impact Area and one at the west perimeter fence. Four surface water samples are collected on Middle Fork Creek, one at the southeast corner of the DU Impact Area, two in the Firing Line area, and one at the west perimeter fence. Sediment samples are collected at the same locations as the surface water samples.

4.2 METHODS AND PROCEDURES FOR SURVEYS OF THE DU IMPACT AREA

The methods and procedures used in the scoping and characterization surveys of the DU Impact Area are described in Sections 4.2.1 and 4.2.2, respectively. These descriptions are based on the SEG reports (SEG 1995a,b; SEG 1996). Results of the surveys are presented in Section 4.3.

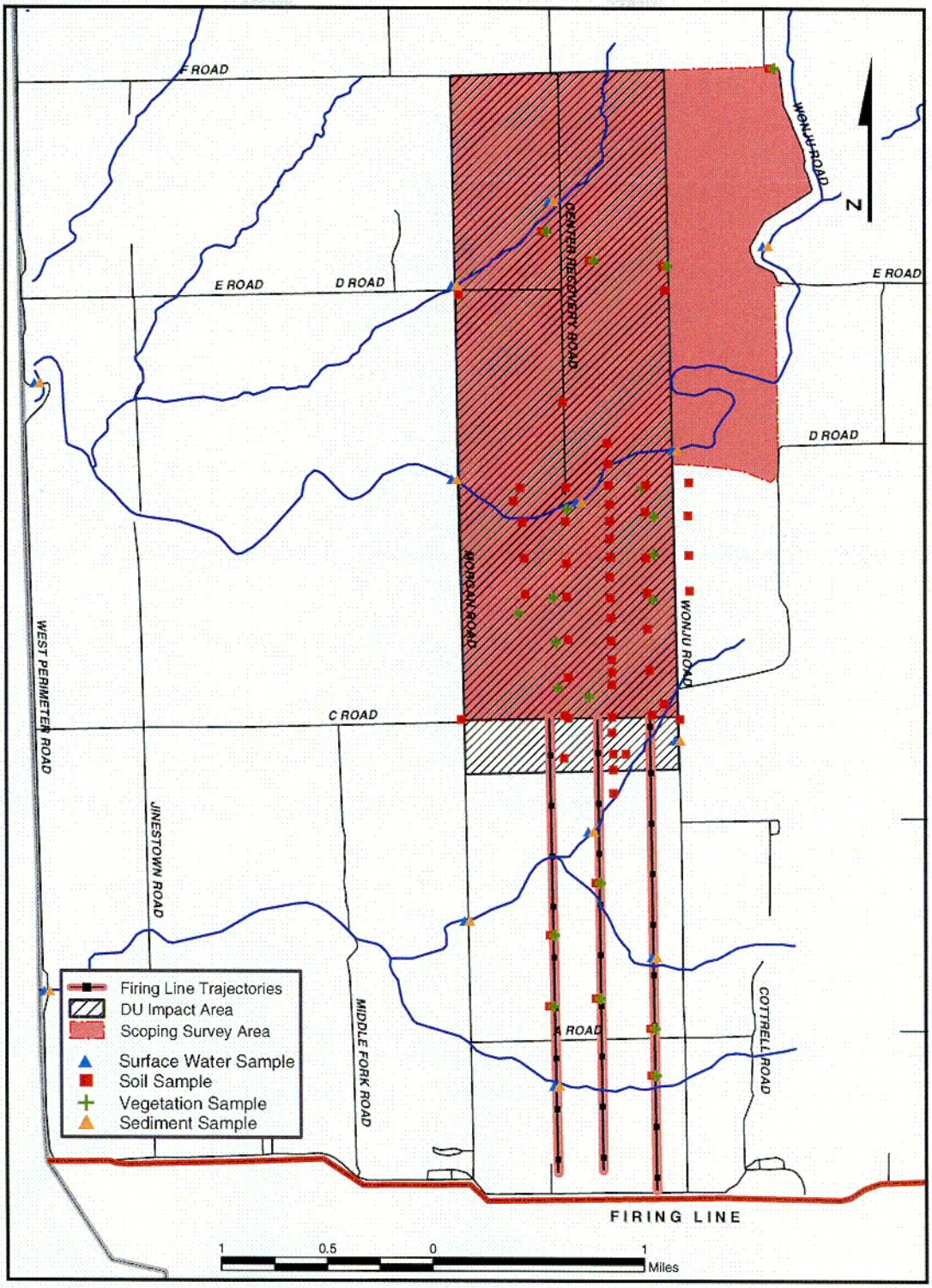
4.2.1 Scoping Survey

Areas potentially affected by facility operations include the firing lines and the DU Impact Area. A radiological scoping survey of these areas was conducted between October 8 and December 23, 1994. The objective of the study was to confirm and document areas affected by DU projectiles and to identify areas to be included in further studies (SEG 1995a).

The survey was conducted according to a site-specific plan and procedures. The procedures included identification of instrumentation requirements and development of data quality objectives (DQOs) and methods for sample collection and measurement and data reduction and evaluation. The approach to data collection involved measurement of exposure rates at grid locations and collection of soil, groundwater, surface water, sediment, and vegetation samples at locations referenced to a similar grid.

For exposure rate measurements in the DU Impact Area, grid lines were established at separations of 164 ft (50 m) in the north-south direction, and measurements were taken 3.3 ft (1 m) above the ground at 33-ft (10-m) intervals along each grid line. For the exposure rate measurements in the firing line area, three north-south grid lines were established for each of the three firing lines. A central grid line was located along the firing line, and two additional grid lines were located 164 ft (50 m) to the east and west of the central line. Exposure rate measurements were taken 3.3 ft (1 m) above ground level at an interval of 33 ft (10 m) along each grid line.

Soil, groundwater, surface water, sediment, and vegetation samples were collected on a judgmental basis determined, in part, by locations used in the environmental monitoring program. A total of 62 soil, 11 groundwater, 14 surface water, 13 sediment, and 20 vegetation locations were sampled. Sampling locations are summarized in Figure 4-1.



Source: SEG 1995.

Figure 4-1. Scoping Survey Sample Locations
Jefferson Proving Ground, Indiana (Scoping area survey color and area on map?)

C09

Exposure rates were measured using a Ludlum Model 44-2™ (1-in. by 1-in.) NaI detector in conjunction with a Ludlum Model 2350 Data Logger™. Detectors and data loggers were calibrated using NIST-traceable sources and calibration equipment. Calibration checks were conducted at the beginning and end of each workday. Environmental samples were packaged, surveyed, and shipped to an approved vendor for alpha spectroscopy isotopic analysis. A chain-of-custody (COC) record was completed for each shipment. Minimum detectable concentrations less than 0.3, 0.07, and 0.06 pCi/g and 0.5 picocuries per liter (pCi/L) were reported for soil, sediment and vegetation, and water samples, respectively (SEG 1995a).

Prior to performance of exposure measurements in the DU Impact Area, a background study was performed. Thirty-five locations south of the firing line were measured to determine an average background exposure rate of 12 μR/hr. The result is consistent with results of the site environmental monitoring program.

4.2.2 Characterization Survey

The scoping survey conducted in late 1994 confirmed classification of the DU Impact Area as a radiologically affected area. Additional information on residual contamination in the DU Impact Area was collected in a characterization study conducted in mid-1995. The purpose of the characterization survey was to confirm and document the contamination in a 1,300-acre (5.3-km^2) portion of the DU Impact Area and to estimate costs and techniques for decontamination of the area.

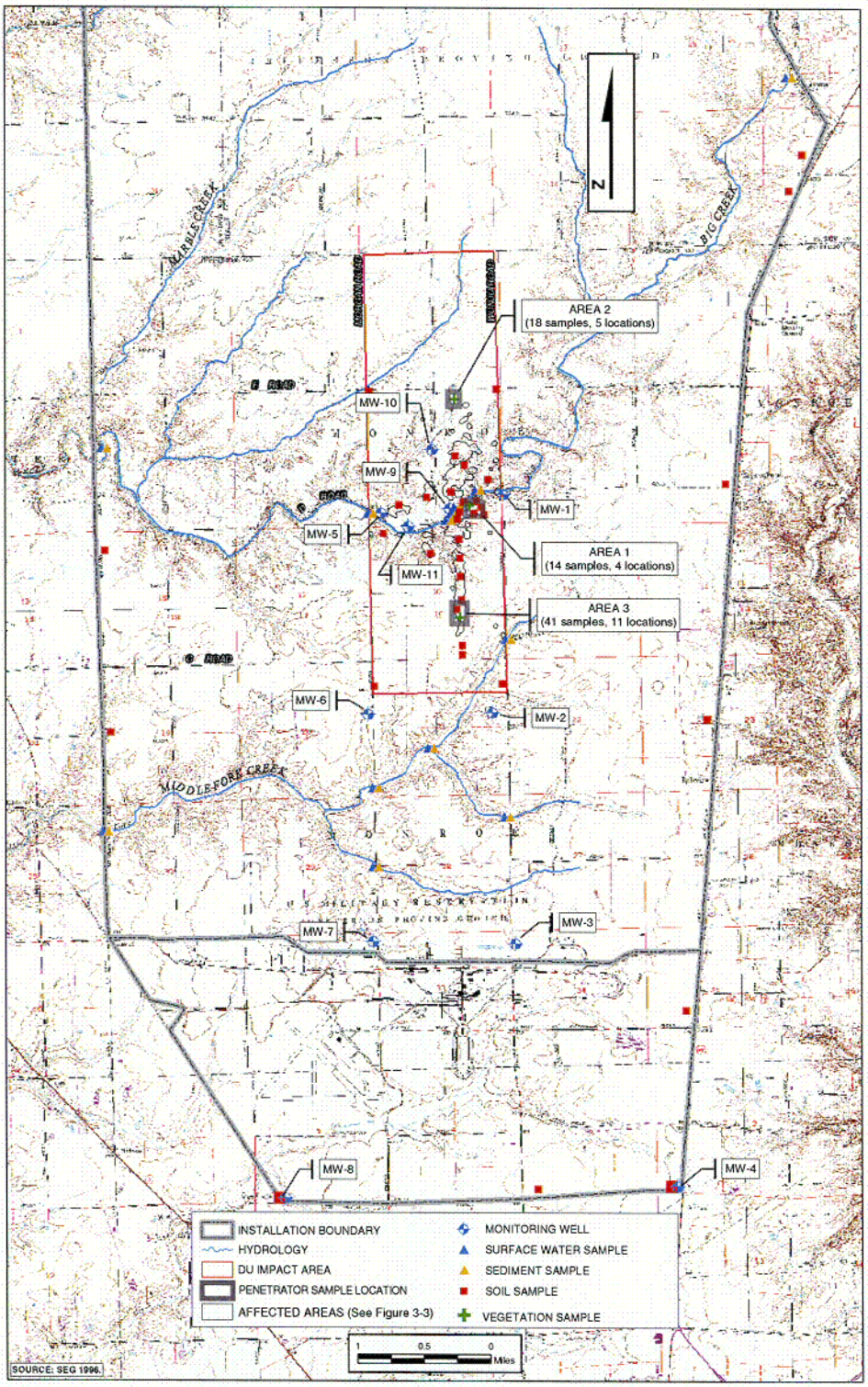
The survey design utilized a combination of random- and judgment-selected locations to estimate the size of the affected area and the volume of contaminated soil and to confirm prior results of environmental sampling. Estimation of the volume of contaminated soil involved establishing the depth profile of contamination and development of a correlation between level of contamination in soil and exposure rate. Locations selected based on best judgment included:

- Background soil samples: 10 locations to match the environmental baseline;
- Penetrator soil samples: 20 locations beneath DU penetrators;
- 500 Center trench exposure rate measurements: 10 locations in 33-ft by 33-ft (10-m by 10-m) grids traversing west to east across the 500 Center trench;
- Vegetation samples: 10 locations within 3 ft of the first 10 penetrator soil samples;
- Groundwater samples: 11 locations of completed wells;
- Surface water: 10 locations determined by configuration of existing streams;
- Sediment samples: 10 locations to match surface water sampling locations; and
- Biological samples: clams, fish, turtle, and deer at locations of convenience.

Locations randomly selected included:

- 20 soil locations in the DU Impact Area, and
- 20 exposure rate/gamma spectroscopy measurements of 33-ft by 33-ft (10-m by 10-m) grids.

Sampling locations for the characterization survey are summarized in Figure 4-2. In the case of background, random, and judgmental locations for soil, samples were collected at three depths: 0 to 5.9 in., 5.9 to 11.8 in., and 11.8 to 17.7 in. (0 to 15 cm, 15 to 30 cm, and 30 to 45 cm). Samples of soil, groundwater, surface water, sediment, fish, freshwater clams, and turtle were analyzed using alpha spectroscopy to determine concentrations of U-234, U-235, U-238, and the ratio of concentration of U-234 to U-238.



Source: SEG 1996.

Figure 4-2. Characterization Survey Sample Locations
Jefferson Proving Ground, Indiana

C10

Integrated exposure rate measurements and in situ gamma spectroscopy was performed for the thirty 33-ft by 33-ft (10-m by 10-m) square grids. Two exposure rate measurements were made at each location: 120-second integrated count while walking over the 33-ft by 33-ft (10-m by 10-m) grid and a 60-second integrated count at the same location where soil samples were taken. The Ludlum Model 2350™ was used with a 1-in. by 1-in. (2.44-cm by 2.44-cm) NaI detector. Exposure rate data were downloaded from the Ludlum Data Logger™ to a personal computer for storage and comparison.

In situ gamma spectroscopy, using the Canberra System, includes a 2-in. by 2-in. (5.08-cm by 5.08-cm) high-purity germanium crystal with a 5-day-duration liquid nitrogen coolant supply, an IBM "Thinkpad" notebook computer, and a laboratory-grade, multi-channel analyzer for real-time radionuclide concentration analysis.

To measure DU concentrations, two U-238 radionuclide decay products were evaluated as effective indicators because they are both in equilibrium with U-238, the major constituent of DU: thorium-234 (Th-234) and protactinium (Pa-234m). Although the yield for Th-234 is greater than that of Pa-234m, the gamma ray emitted by Th-234 [0.093 megaelectron volt (MeV)] is much smaller than that of Pa-234m (1.08 MeV). The low gamma energy of Th-234 makes it much more difficult to detect especially when considering attenuation from soil, whereas the approximately ten times higher gamma rays from Pa-234m enable it to be detected. Therefore, the measurement of Pa-234m was used to determine U-238 and DU concentration.

To determine whether the measured uranium present was due to DU or natural uranium, the U-238/U-234 ratio was determined by measuring the concentration of each of these isotopes. A U-238/U-234 ratio of two or less is representative of natural uranium, whereas higher ratios are indicative of DU. This difference in ratio is due to the fact that the relative abundance of U-238 in DU has been significantly increased after U-235 has been removed from natural uranium since much of the U-234 has been concentrated with the U-235. In addition, the much smaller half-life of U-234, as compared to U-238, results in a much higher specific activity of U-234 even though its natural abundance in uranium is only approximately 0.005 percent as compared to U-238 at > 99 percent. Four other independent studies of the U-238/U-234 ratio in soil and water resulted in measured ratio values of 0.8 to 2.0 for soil and 0.025 to 2.0 for water (Fujikawa et al. 2000; Gilkeson and Cowart 1987; Goldstein et al. 1997; Osmond and Cowart 1976).

It is important to note that no areas or surfaces within the 1,300-acre (5.3-km^2) JPG DU Impact Area were inaccessible for this survey. Due to the potential presence of UXO, suitable precautions were taken in the field to prevent the occurrence of any accidents involving such UXO. The only other hazard present, which did not hinder the conduct of the survey, was the presence of sometimes rugged and steep terrain.

The characterization survey used three principal instruments at the JPG site: Ludlum Model 2350 Data Logger™, Ludlum Model 44-2 Sodium Iodide NaI(Tl)™ detector, and Canberra InSpector™ gamma spectroscopy system. The two Ludlum instruments were used to measure and record exposure rates while the Canberra system was used on-site to measure gamma ray-emitting radionuclide concentrations in soil samples. An off-site lab was used for alpha spectroscopy. All instruments were calibrated semi-annually by Ludlum Measurements, Inc., using NIST-traceable sources and calibration equipment. At the beginning and end of each workday, daily calibration checks were conducted with all instrumentation.

This survey was conducted under the controls and protocols of the SEG QA/QC Programs and Procedures. The calibration, maintenance, accountability, operation, and QC of radiation detection instruments were performed in accordance with procedures that implement the guidelines in ANSI N323-1978 and ANSI N42.17A-1989. Each survey measurement was handled and documented using appropriate and unique identifying numbers. Off-site sample shipments were accompanied by a COC

record to track each sample. Replicate laboratory analysis was performed by Lockheed Analytical Services on selected samples. Method blanks were analyzed at a frequency of 5 percent per batch. Each batch of up to 20 samples had an independent laboratory control sample (LCS) prepared and included. One duplicate sample was prepared for each ten samples in a batch.

Analysis of the measurement methodology, instrumentation, and data provides ample evidence of the adequacy of the survey for the following reasons: (1) The Ludlum instrumentation used was specifically designed for this application, has the appropriate sensitivity for gamma radiation energy in the range of interest for Th-234 and Pa-234m, and has an acceptable manufacturer-designated accuracy of ±10 percent; (2) the Canberra instrumentation has been extensively used for in situ radionuclide concentration measurement in soils and has been validated by the Monte Carlo N-Particle (MCNP) radiation transport digital computer code to substantiate an accuracy of ±10 percent for in situ soil measurements in the gamma energy range of 60 to 3,000 kiloelectron volts (keV) [Th-234 emits 93 keV gammas, and Pa-234m emits 1,080 keV gamma rays]; and (3) the average background rate of 12 microrad per hour and the > 35 pCi/gm DU exposure rate of 14.4 microrad per hour each provide sufficient counting statistics with the Ludlum instrumentation to acceptably measure these different dose rates because the Ludlum instrument has a sensitivity of 175 counts per minute (cpm) for one microrad per hour (2,100 cpm for 12 microrads per hour vs. 2,520 cpm for 14.4 microrads per hour).

4.3 RADIOLOGICAL CONTAMINATION STATUS

In this section, radiological contamination is documented for structures (Section 4.3.1), systems and equipment (Section 4.3.2), surface and subsurface soil (Sections 4.3.3 and 4.3.4), surface water and sediment (Section 4.3.5), groundwater (Section 4.3.6), and vegetation and biological resources (Section 4.3.7).

4.3.1 Structures

There are no radiologically contaminated structures within the JPG site. Facilities that were contaminated with DU were subject to a survey, remediation, and confirmatory survey after the remediation to verify that all remaining contamination is below NRC guideline levels (SEG 1995a). The only remaining residual contamination at JPG is the DU penetrators, which were fired into a target area of approximately 1,300 acres (5.3 km^2). No structures exist on the site that were used in conjunction with these DU penetrators. No structures are present in the DU Impact Area. Since the DU was only handled while loading one of three guns and fired into the impact area, there was no means of contaminating any structures on JPG.

4.3.2 Systems and Equipment

There are no radiologically contaminated systems and equipment within the JPG site. The only residual contamination at JPG is the DU penetrators, which were fired into a DU target area of 1,300 acres (5.3 km^2). No systems and equipment exist on the site that were used in conjunction with these DU penetrators. No systems and equipment are present in the DU Impact Area. Since the DU was only handled while loading one of three guns and fired into the impact area, there was no means of contaminating any systems and equipment on the JPG site.

4.3.3 Surface Soil

Residual contamination of surface soil has been investigated in the scoping and characterization surveys and in the ERM Program. Techniques used include measurement of exposure rates one meter above the ground surface in the scoping and characterization surveys and sample collection and laboratory analysis

in all three programs. The following paragraphs summarize the results of these programs (SEG 1995; SEG 1996; Ebinger and Hanson 1996).

4.3.3.1 Exposure Rate Measurements

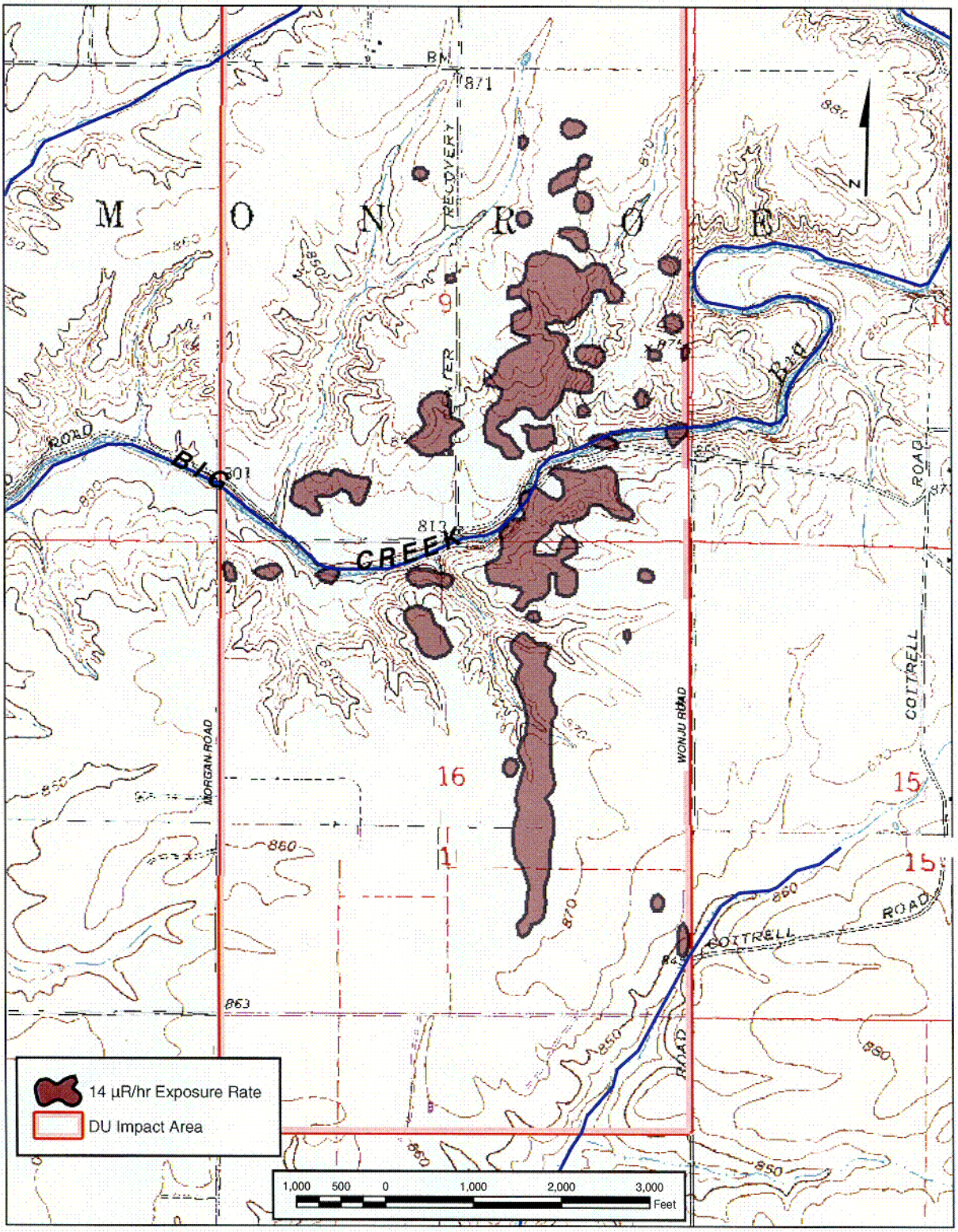
The scoping survey included measurement of exposure rates in an area south of the firing line and in the DU Impact Area. The background study was performed in 1995 prior to conducting measurements in the DU Impact Area. Thirty-five background measurements were taken south of the firing line in an unaffected area. An average background value of 12 μR/hr was established for this area consistent with background levels determined in 1983. Background values ranged from 6 to 8 μR/hr on roads and in creek beds to a high of 10 to 12 μR/hr in open fields and wooded areas (SEG 1995b). For approximately 25,000 measurements of exposure rate in the DU Impact Area, the majority (> 95 percent) of measurements were at background levels, but strong indications of the presence of DU were found near the trenches for each firing line. In these areas, exposure rates as high as approximately 3,300 μR/hr were observed.

During the characterization survey, a combination of exposure rate measurements, in situ gamma spectroscopy, and soil sampling was used to further define the affected area. The relationship between the average concentration of DU in the ground and exposure rate was analyzed to determine the isotopic concentration from the in situ gamma spectroscopy data. These measurements were obtained using the same instrument used in the scoping survey (SEG 1995b).

At each location, a single in situ gamma spectroscopy measurement yielded the total inventory of activity for each nuclide presented as an area of activity concentration at the surface. Using these results, the concentrations of Th-234 and Pa-234m were calculated for depth ranges of 0 to 5.9 in. (0 to 15 cm) 5.9 to 11.8 in. (15 to 30 cm), and 11.8 to 17.7 in. (30 to 45 cm) BGS. The specific assumptions used to determine this relationship are discussed in SEG (1996). Statistical analysis of the belowground soil uranium measurements (from Pa-234m data) resulted in a calculated average depth of contamination of 4.3 in. (11 cm) in the affected area. This value of 4.3 in. (11 cm) corresponds to a 95th percentile, that is, there is only a 5 percent chance that contamination would exist below 4.3 in. (11 cm). The exposure rate corresponding to a DU concentration of 35 pCi/g is 14.4 μR/hr based on a linear regression analysis of measured data. The contour map showing areas with an exposure rate greater than 14.4 μR/hr is shown in Figure 4-3.

4.3.3.2 Soil Samples

Sixty-two soil samples were collected during the scoping survey. Fifty samples were collected from within the DU Impact Area, and 12 samples were collected along the three trajectories between the firing line and C Road (Figure 4-1). The soil sampling program was unbiased and based on a 492-ft (150-m) grid system. Samples were collected along the 500 center firing position, along lines parallel to and 984 ft (300 m) east and west of the 500 center firing position, and along lines 1,968 ft (600 m) east and west, respectively, of the 500 center firing position.



Source: SEG 1996.

Figure 4-3. Exposure Rate of 14 µR/hr from Soil at Jefferson Proving Ground

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The results of this sampling indicated that the highest uranium concentrations were detected south of Big Creek within the DU Impact Area. Total uranium concentrations ranged from < 1.3 to 201 pCi/g, with an average concentration of 12.9 pCi/g. Soil samples collected along the trajectories south of the DU Impact Area had concentrations ranging from 1.4 to1.8 pCi/g total uranium.

Soil samples were analyzed for concentrations of the three major uranium isotopes: U-234, U-235, and U-238. The U-238 to U-234 activity ratio (unitless) was reviewed to determine whether the uranium is naturally occurring or includes DU. In samples containing naturally occurring uranium, the activity ratio of U-238 to U-234 is approximately 1 (0.5 to 1.3). The activity ratio for DU is 5.5 to 9 based on a review of isotopic analysis of penetrators collected from the field within the DU Impact Area (SEG 1995b). Therefore, environmental measurements with U-238 to U-234 activity ratios greater than two are indicative of DU contamination.

The scoping survey soil samples indicated evidence of DU contamination primarily along the central and eastern trajectories within the DU Impact Area.

As part of the characterization survey, background surface and subsurface soil samples were collected from 10 sites in areas not impacted by the DU testing. The background locations were selected to ensure that these locations were representative of the different types of soils in the impact area and consistent with those locations sampled in 1983 as part of the baseline environmental impact survey. Background soil samples were collected from three depths at each location: 0 to 5.9 in. (0 to 15 cm), 5.9 to 11.8 in. (15 to 30 cm), and 11.8 to 17.7 in. (30 to 45 cm) BGS. Total uranium concentrations ranged from 1.33 to 2.76 pCi/g in the background soil samples as shown in Table 4-5. The U-238 to U-234 activity ratio in the background soil samples ranged from 0.5 to 1.3.

Table 4-5. Summary of Soil Sample Results for the Characterization Survey

Depth (cm) BGS	Number of Samples	Range in Total Uranium Concentration (pCi/g)	Average (pCi/g)
Background			
0–15	10	1.52–2.53	1.97
15–30	10	1.33–2.59	1.84
30–45	10	1.33–2.76	1.95
Penetrator Soil Samples			
0–15	20	2.9–12,318	2,881
15–30	20	1.5–547	79.5
30–45	20	1.8–63	12.7
45–60	13	1.4–11.5	4.50
Random Soil Samples			
0–15	20	1.46–4.73	2.60
15–30	20	1.51–6.91	2.40
30–45	20	1.34–4.21	2.00

Source: Compiled from SEG (1996).
To convert from centimeters to inches, divide by 2.54.
BGS = below ground surface.
cm = centimeter.
pCi/g = picocurie per gram.

To correlate measured soil uranium concentration with measured gamma dose rate, 26 measurements of dose rate for locations in and around a previously identified DU projectile impact trench in the affected area were made. The measured dose rates ranged from 10.0 μR/hr to 35.6 μR/hr with the resulting data analysis, using linear regression, correlating a 35 pCi/g DU concentration to a measured gamma dose rate of 14.4 μR/hr.

Analysis of surface soil samples collected in the ERM Program provides results consistent with the more detailed surveys. Most measurements show low levels of residual contamination, but high levels are found near the firing line trenches. Representative results are presented in Table 4-6.

Table 4-6. Representative Results for Soil Samples from the ERM Program

Sample Location	Concentration of Total Uranium (pCi/g)	
	Average	Range
6	45.0	0.8 to 225.1
8	172.2	0.78 to 3,857.0
10	15.5	0.03 to 106.7
12	5.7	0.03 to 37.1
26	1.3	0.3 to 1.8
32	1.3	0.2 to 1.9
43	1.0	ND to 1.0
44	1.4	ND to 2.1
45	8.8	0.3 to 63.0
46	3.1	0.1 to 5.2
47	1.0	0.1 to 1.6
48	4.9	0.14 to 40.9
53	1.2	0.23 to 1.6
56	3.0	0.23 to 15.0

Source: Ebinger and Hanson 1996.
ERM = Environmental Radiation Monitoring.
pCi/g = picocuries per gram.
ND = non-detect.

4.3.4 Subsurface Soil

Samples of subsurface soil were collected at 10 background, 20 randomly selected, and 20 penetrator locations during the characterization survey (SEG 1996). Sampling locations are summarized in Figure 4-2. In each case, samples were collected at depths of 0 to 15, 15 to 30, and 30 to 45 cm. For 13 of the penetrator locations, an additional sample was collected at a depth of 45 to 60 cm.

For the background sample locations, concentrations of total uranium ranged from 1.33 to 2.76 pCi/g and averaged 1.92 pCi/g. For the depth from 0 to 15 cm, the concentration of total uranium ranged from 1.52 to 2.53 pCi/g and averaged 1.97 pCi/g. For the depth from 15 to 30 cm, the concentration of total uranium ranged from 1.33 to 2.59 pCi/g and averaged 1.84 pCi/g. For the depth from 30 to 45 cm, the concentration of total uranium ranged from 1.33 to 2.76 pCi/g and averaged 1.95 pCi/g. The ratio of concentration of U-238 to U-234 ranged from 0.7 to 1.3. Trends of concentration or ratios of concentrations with location or depth are not evident.

For the randomly selected soil locations, the total uranium concentrations ranged from 1.34 to 6.91 pCi/g, with an average concentration of 2.33 pCi/g. None of the samples was from trenches within the DU Impact Area, and most samples were at background concentrations. The U-238 to U-234 activity ratio in the random soil samples indicated that 95% of the samples had uranium isotopic ratios within the range of natural variability (i.e., 0.5 to 2.0).

For penetrator locations, samples were collected at four depths. Concentrations of total uranium ranged from 1 to 12,318 pCi/g. The ratio of concentration of U-238 to U-234 ranged from 1.1 to 8.4. Results of the measurements are summarized in Table 4-7. Concentrations decreased with depth but indicated the presence of contamination and downward movement at all depths.

Table 4-7. Summary of Results of Surface and Subsurface Soil Analysis for Penetrator Locations

Depth	Concentration of Total Uranium (pCi/g)		
	Average	Range	
		Minimum	Maximum
0 to 15 cm	2,882	3	12,318
15 to 30 cm	80	2	547
30 to 45 cm	10	2	63
45 to 60 cm	5	1	12

Source: SEG 1996.
To convert from centimeters to inches, divide by 2.54.
BGS = below ground surface.
cm = centimeter.
pCi/g = picocurie per gram.

4.3.5 Surface Water and Sediment

Surface water and sediment samples have been collected as part of the scoping and characterization surveys and in the ERM Program. Results for each of these programs are presented in the following paragraphs.

4.3.5.1 Scoping Survey

For the scoping survey (SEG 1995a), concentrations in surface water were measured for samples collected at 14 locations. Concentrations of total uranium ranged from 0.21 to 4.11 pCi/L, and reported ratios of the concentrations of U-234 to U-238 were near unity. The data are summarized by location in Table 4-8. Concentrations are at background levels and show no trend with location.

Thirteen sediment samples were collected during the scoping survey. Four samples were collected from within the DU Impact Area, two samples were collected from Big Creek on the border of and east of the DU Impact Area border, five samples were obtained from the firing line trajectories south of the DU Impact Area, and two samples were collected on the western edge of the JPG where Big Creek and Middle Fork Creek exit the property. Samples collected upgradient of (2) and within (4) the DU Impact Area averaged 0.64 and 1.36 pCi/g of total uranium, respectively. Samples collected within the Firing Line Area (5) averaged 1.99 pCi/g of total uranium. Samples collected on the western perimeter averaged 1.46 pCi/g of total uranium. The maximum reported concentration was 3.08 pCi/g of total uranium for a location within the Firing Line Area. All concentrations and isotopic ratios are similar to background conditions.

Table 4-8. Average Concentrations of Total Uranium Measured in Surface Water in the Scoping Survey

Location	Concentration of Total Uranium (pCi/L)
Big Creek-Upgradient (2 locations)	0.27
Big Creek (4 locations)	1.53
North Tributary of Big Creek (2 locations)	0.75
Middle Fork Creek (4 locations)	0.46
South Tributary of Middle Fork Creek (2 locations)	0.58

Source: SEG 1995a.
pCi/L = picocuries per liter.

4.3.5.2 Characterization Survey

Surface water and sediment samples were collected from 10 locations during the characterization survey. Six samples were collected in Big Creek at locations upstream (1), within (4), and downstream (1) of the DU Impact Area. Four samples were collected in Middle Fork Creek at locations within (3) and downstream (1) of the Firing Line Area.

In the surface water of Big Creek, upstream of the DU Impact Area, the total uranium concentration was measured at 0.62 pCi/L; at locations within the DU Impact Area, the total uranium concentration in surface water ranged from 0.77 to 25.02 pCi/L. At the sample locations on the western boundary of the installation, the total uranium concentration in surface water averaged 0.89 pCi/L. The concentrations of total uranium in surface water samples collected from Middle Fork Creek ranged from 0.63 to 1.80 pCi/L. Concentrations of total uranium in sediment had the same trend as concentrations in surface water. The data are summarized in Table 4-9.

Table 4-9. Concentrations of Total Uranium in Surface Water and Sediment Measured in the Characterization Survey

Location Number	Location	Concentration of Total Uranium	
		Surface Water (pCi/L)	Sediment (pCi/g)
1	Big Creek, east boundary of JPG	0.62	0.78
2	Big Creek, DU Impact Area	25.0	6.20
3	Big Creek, DU Impact Area	2.92	3.83
4	Big Creek, DU Impact Area	0.77	2.18
5	Big Creek, DU Impact Area	1.08	0.75
6	Middle Fork Creek, Firing Line Area	1.04	3.10
7	Middle Fork Creek, Firing Line Area	0.73	2.23
8	Middle Fork Creek, Firing Line Area	1.80	3.46
9	Big Creek, west perimeter of JPG	0.89	0.75
10	Middle Fork Creek, west perimeter of JPG	0.63	1.81

Source: SEG 1996.
DU = depleted uranium.
JPG = Jefferson Proving Ground.
pCi/L = picocuries per liter.
pCi/g = picocuries per gram.

All samples were at, or near, background except for two sampling locations within the DU Impact Area. The surface water samples from the DU Impact Area that had higher total uranium concentrations were collected from static pools of water. The U-238 to U-234 activity ratios in the samples from static pools of water were 4.4 and 7.3, indicating the presence of DU contamination. Uranium isotopic ratios were within the range of natural variability for 7 of the 10 surface water samples.

4.3.5.3 Environmental Radiation Monitoring Program

Data for concentrations of uranium isotopes in surface water and sediment are reported for eight locations along Big Creek and Middle Fork Creek. Results are similar and are represented by the data summarized in Table 4-10 for sampling points located on Big Creek at the west edge of the DU Impact Area and Middle Fork Creek at the west edge of the Firing Line Area. High concentrations are reported for the year 1991 but are not repeated for following years, implying a handling, measurement, or reporting error. Ratios of the concentrations of U-234 to U-238 are within the naturally occurring range for all measurements.

Table 4-10. Concentrations of Total Uranium in Surface Water and Sediment Reported for the ERM Program

Year	Average Concentration of Total Uranium			
	Big Creek		Middle Fork Creek	
	Surface Water (pCi/L)	Sediment (pCi/g)	Surface Water (pCi/L)	Sediment (pCi/g)
1984	0.18	0.23	0.02	0.94
1985	0.24	–1	0.07	–
1986	0.58	0.61	0.29	–
1987	0.48	0.18	0.47	1.14
1988	0.50	0.23	0.37	1.67
1989	0.30	0.08	0.0	0.59
1990	3.32	0.33	2.45	0.40
1991	17.73	0.62	4.75	3.09
1992	1.33	0.14	0.09	0.39
1993	0.49	0.28	0.0	0.84
1994	0.33	4.55	0.0	1.87

Source: Ebinger and Hansen 1996.
– = no data.
ERM = Environmental Radiation Monitoring.
pCi/g = picocuries per gram.
pCi/L = picocuries per liter.

4.3.6 Groundwater

Concentrations of uranium isotopes in groundwater have been measured at 11 wells in the scoping and characterization surveys and in the ERM Program. As reported in the introduction to this section, the scoping and characterization survey samples were collected in 1994 and 1995. A summary of the results of these measurements is presented in Table 4-11. The total uranium concentration in groundwater samples collected in the surveys ranges from 0.33 to 5.09 pCi/L at background levels at the site. The U-238 to U-234 activity ratio in groundwater samples indicates that the uranium is naturally occurring.

Table 4-11. Summary of Concentrations of Uranium in Groundwater Samples from the Scoping and Characterization surveys

Sample Location	Concentration of Total Uranium (pCi/L)	
	Scoping Survey	Characterization Survey
MW-01	0.43	0.33
MW-02	1.25	1.20
MW-03	0.76	1.67
MW-04	2.40	3.34
MW-05	0.46	3.74
MW-06	3.61	5.09
MW-07	1.99	0.80
MW-08	1.23	1.10
MW-09	2.26	1.50
MW-10	3.38	1.34
MW-11	<1.28	2.04

Source: SEG 1995a and 1996.
MW = monitoring well.
pCi/L = picocuries per liter

The 11 wells discussed above are also sampled as part of the ERM Program. Two of the monitoring wells (MW-3 and MW-7) are located near the firing line approximately 1.9 miles (3 km) south of the DU Impact Area. Seven of the wells are located in the vicinity of Big Creek, and results of measurements have been reported for these wells.

For well MW-11, located near Big Creek at the west of the DU Impact Area, concentrations of total uranium were below approximately 5 pCi/L for the years 1988 through 1993. For well MW-5, located near Big Creek at the west of the DU Impact Area, concentrations of total uranium approached 15 pCi/L for the year 1990 and were below approximately 5 pCi/L for the years 1990 through 1993. For well MW-9, located near Big Creek at the center of the DU Impact Area, concentrations of total uranium ranged from 5 to 15 pCi/L for the years 1988 through 1993. For well MW-1, located near Big Creek at the east side of the DU Impact Area, concentrations of total uranium were approximately 5 pCi/L for years 1988, 1989, 1990, 1992, and 1993 but rose to approximately 35 pCi/L in 1991. Behavior similar to that of well MW-1 is reported for well MW-10, except that the peak in concentration of total uranium of approximately 80 pCi/L occurred in 1992. The results indicate that groundwater conditions may be affected by DU. The accuracy of these high values for the years 1991 and 1992 is in doubt due to QA issues at the analytic laboratory. Deletion of the high values is supported by review of trends of the data and analysis of duplicate samples (see appendix C and Ebinger and Hanson 1996).

4.3.7 Vegetation and Biological Resources

Sampling data for vegetation and biological specimens are summarized in Sections 4.3.7.1 and 4.3.7.2, respectively.

4.3.7.1 Vegetation Samples

During the scoping survey, 20 vegetation samples were collected. Fourteen samples were obtained from within the DU Impact Area, and six samples were obtained along the firing line trajectories. The total uranium concentration in vegetation samples was less than 0.7 pCi/g in all samples. Two lichen samples

from the south-central portion of the DU Impact Area had U-238 to U-234 activity ratios of 2.3 and 2.6, which indicate DU contamination.

During the characterization survey, 10 vegetation samples of lichens, leaves, or grasses were collected from the affected area trenches. Samples were collected from the three penetrator fragment areas shown on Figure 4-2. Five vegetation samples were collected from Area 1, four samples from Area 2, and one sample from Area 3 and were analyzed for total uranium. Samples were washed with deionized water prior to analysis, and the wash water was analyzed separately from the vegetation sample to determine the amount of uranium on the surface of, and in, the sample. The total uranium concentration in vegetation samples ranged from 0.75 to 3,447 pCi/g, with an average concentration of 627.5 pCi/g. The total uranium concentration in the root wash samples ranged from 46.1 to 14,258 pCi/g, with an average concentration of 2,869 pCi/g. The U-238 to U-234 activity ratio ranged from 6.1 to 8.4, indicating the presence of DU contamination.

As part of the ERM Program, analyses of eight lichen samples and seven leaf samples have been reported. For 16 of the samples concentrations of total uranium were less than 2 pCi/g but were at 91 pCi/g for the final sample (lichen). The results indicate that uranium can concentrate in vegetation but that this has not occurred on a widespread basis.

4.3.7.2 Biological Samples

During the characterization survey, a total of eight biological samples were collected from deer, freshwater clams, fish, and a soft-shelled turtle. For three deer samples, concentrations of total uranium ranged from 0.09 to 0.42 pCi/g. For two samples of freshwater clams, concentrations of total uranium were 0.33 and 0.77 pCi/g. Concentrations of total uranium in fish and turtle were below 0.25 pCi/g. The U-238 to U-234 activity ratio ranged from 0.4 to 1.2 and does not indicate the presence of DU contamination.

Data on concentrations of uranium in deer are reported for the ERM Program for the years 1984, 1987, 1992, and 1993. Concentrations of total uranium are low, less than 0.4 pCi/g, and do not indicate an impact from DU.

4.4 SUMMARY

In 1994 and 1995 characterization studies, remediation and final survey of radiological status were completed for facilities and grounds located south of the firing line. The characterization activities identified several facilities in which DU contamination from handling DU projectiles was greater than allowable NRC limits. After remediation, a final survey confirmed that these facilities were decontaminated to the extent that any measured radioactivity was well below applicable NRC limits for uranium, beta emitters, and gamma radiation. In addition, the survey confirmed that the three gun-firing positions themselves were not contaminated with DU in excess of that allowed under NRC regulations and limits applicable at that time.

In 1994 and 1995, SEG conducted a radiological scoping survey and a radiological characterization survey of the DU Impact Area of the JPG that was affected by the firing of about 220,462 lbs (100,000 kg) of DU projectiles between 1983 and 1994. The primary result of the scoping survey of the DU Impact Area was identification of the affected area within the larger firing range. The affected area of about 125 acres (12.5 km^2) was determined by measurements of DU concentrations in the soil in excess of the level of 35 pCi/g of uranium.

The characterization survey was performed to obtain more detailed information regarding the location and extent of DU contamination in the affected area of 125 acres (12.5 km^2), which was previously identified by the scoping survey. A total of 235 environmental samples, including soil, surface water, groundwater, sediment, vegetation, and animals, were obtained and measured for DU concentration. Soil samples included depths of up to 17.7 in. (45 cm), as well as samples from the affected DU trajectory area including soil directly under extant DU penetrators. Uranium isotope concentrations were measured, and the U-238/U-234 activity ratio was calculated for each measurement. Together, the magnitude of uranium concentration and the U-238/U-234 ratio constitute a determination of the extent and nature of any uranium contamination.

Using the correlation of 14.4 μR/hr as the indicator of greater than 35 pCi/g DU soil contamination, the characterization survey identified specific regions within the affected area that are in excess of this concentration. Only two affected area surface water measurements, for stagnant water pools, exceeded guidelines proposed for uranium in water. In addition, surface water samples collected from Big Creek and Middle Fork Creek on a monthly basis for the year 2001 by the Indiana State Department of Health (ISDH 2002) indicate the presence of only background levels of radioactivity. Concentrations of uranium were high for soil in and around actual DU penetrator locations in the affected area. The characterization survey also identified that the top 4.3 in. (11 cm) of soil in the affected area would exceed the 35 pCi/g of uranium concentration level based on a 95th percentile analysis of the measurements of DU in soil at different depths. Another result of the characterization survey was that, with the exception of vegetation, all biological samples obtained from the DU affected area (i.e., animals) showed no radiological evidence of DU contamination by virtue of both the magnitude of uranium concentration and the U-238/U-234 activity ratio.

In summary, the radiological scoping and characterization surveys identified the specific areas within the JPG that are contaminated with DU above 35 pCi/g and provided information on the extent of movement of uranium through the environment. The scoping survey identified a 125-acre (12.5-km^2) area within the potentially affected area as being DU contaminated. A common result of the scoping and characterization surveys is that soil samples collected in the immediate vicinity of, or immediately below, penetrators contain relatively high levels of DU and that soil samples collected in locations not in the immediate vicinity of penetrators contain low or background levels of uranium. In addition, surface water and wildlife samples contain background levels of radioactivity. These results indicate that residual contamination at the JPG is concentrated in a heterogeneous manner in trenches located along the three firing lines and that movement of DU through the environment has been confined to the immediate vicinity of the penetrators.

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5.0 DOSE ANALYSIS

Residual radiological contamination at JPG is in the form of DU penetrators and their degradation products concentrated in a heterogeneous manner in and around trenches oriented along three northward-directed firing lines. A large amount of UXO is co-located with the residual contamination, posing an immediate risk to life in addition to the lesser, long-term stochastic risk posed by the residual radiological contamination.

The operating history and radiological status of the facility are discussed in greater detail in Sections 2.0 and 4.0 of this DP. As described in Section 6.0 of this DP, the proposed action is license termination under restricted conditions. The objective of this section is to describe dose analysis that provides reasonable assurance that the dose criteria of 10 *CFR* 20.1403(b) and (e) will not be exceeded. The dose analysis demonstrates that if institutional controls remain in effect, dose to the average member of the critical group (AMCG) will not exceed 25 mrem/yr, and if institutional controls are not in effect, dose to the AMCG will not exceed 100 mrem/yr.

The dose analysis follows the first approach of Section 5.0 of the NMSS Decommissioning SRP (NRC 2000), i.e., the analysis uses projections of the final concentrations of residual contamination to demonstrate compliance with the dose criteria. Given the proposed approach to license termination (Section 6.0), values for DCGLs are not calculated. Compliance with the ALARA, financial assurance, and public participation requirements of 10 *CFR* 20.1403 are presented in Sections 7.0, 15.0 and 16.0 of this DP. The balance of this section, sub-sections 5.1 through 5.8, describes the technical approach, conceptual site model (CSM), source term, transport pathways, receptors, exposure scenarios, analysis techniques, and results and findings of the dose analysis.

5.1 TECHNICAL APPROACH TO DOSE ANALYSIS

The technical approach to dose analysis is development and analysis of exposure scenarios. A scenario is a combination of source conditions, environmental transport pathways, and receptor locations and behavior that constitute a hazard to health. The starting point for development of scenarios is review of current conditions of the site, plans for future use or development of the site, and regulatory guidance on dose analysis.

Source conditions include the characteristics of the residual contamination and environmental conditions that facilitate, or cause, release of the material to the environment. Environmental conditions include physical and chemical characteristics of environmental media; that is, soil, groundwater, surface water, and the meteorological, hydrologic, and geomorphologic processes that transport radioactive material to receptors. Environmental and radiological status of the site is described in Sections 3.0 and 4.0 of this DP. Plans for future use of the site are described in Section 6.0, and the primary source of regulatory guidance for dose analysis was Appendix C of the SRP for license termination (NRC 2000).

The approach to the dose analysis is represented schematically in Figure 5-1. The figure represents only estimations of dose and findings on compliance with dose criteria. Additional requirements of the framework for license termination are described in NRC (2000); ALARA analysis, financial assurances, and public participation are discussed in Sections 7.0, 15.0 and 16.0 of this DP. The following sub-sections describe the elements of the procedure for estimation of dose and the findings on compliance with dose criteria.

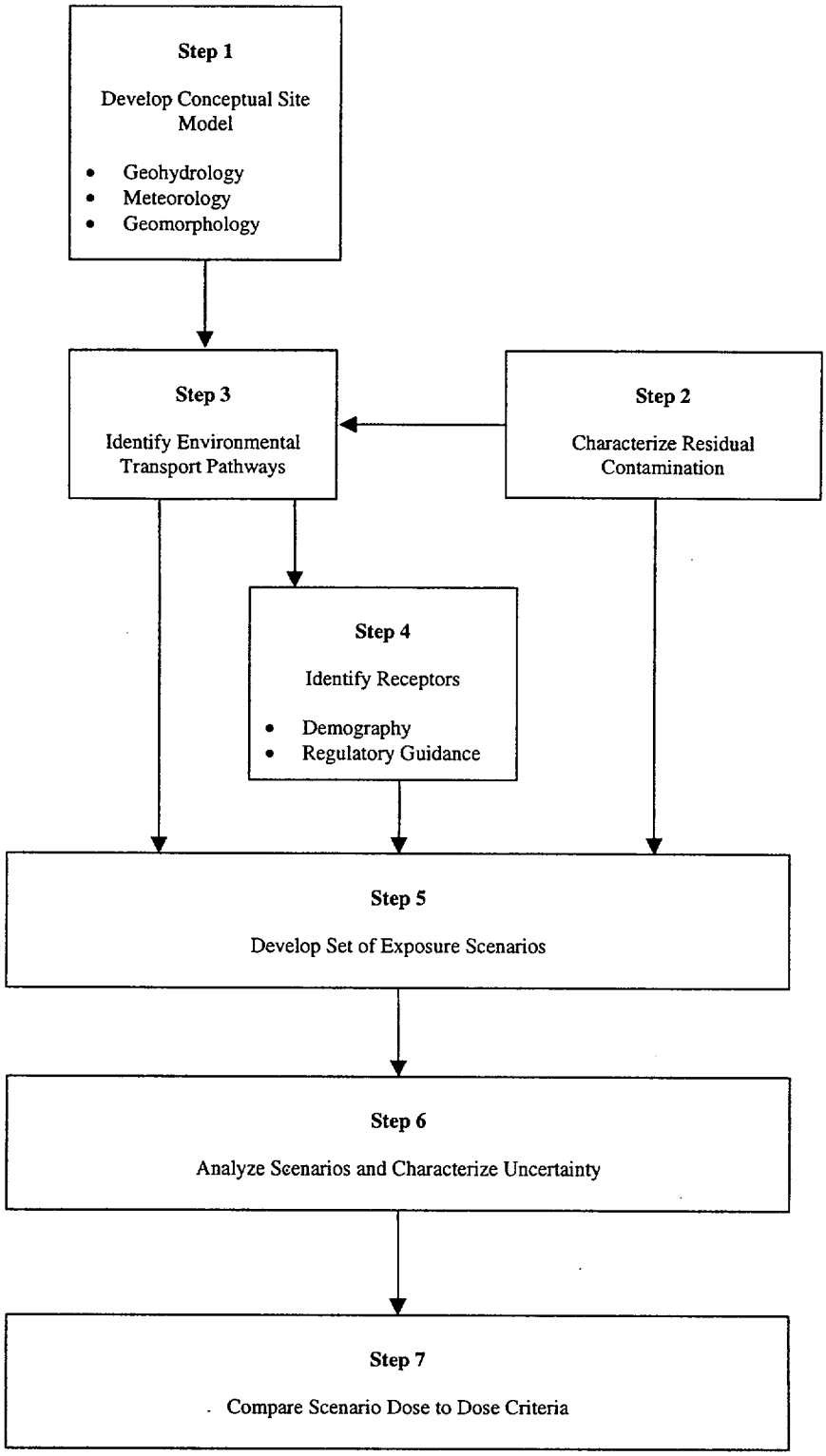

Figure 5-1. Schematic Representation of Procedure for Estimation of Dose

5.2 CONCEPTUAL SITE MODEL

The CSM is an abstraction from the observed physical conditions and processes of the site that provides a basis for estimation of rates of mobilization and movement through the environment of residual contamination. Details of the basis for development of the CSM for JPG are presented in Section 3.0 of this DP and in an EIS prepared for the decision on disposition of JPG (U.S. Army 1991). The primary elements of the CSM are abstractions of the meteorological, geologic, hydrologic, and geomorphological processes affecting the site. The following paragraphs discuss each of these elements of the model.

Climatic conditions in the vicinity of the JPG are moderate with winter temperatures ranging from 22 to 35°F (–6 to 2°C) during the winter and 75 to 85°F (21 to 27°C) during the summer. Annual precipitation is approximately 43 in. (109 cm), and annual average wind speed is approximately 8 mi/hr (4 m/s). Tornadoes occur in the vicinity of the JPG but because of the absence of contaminated buildings, the dispersed nature of the residual soil contamination, and the extreme mixing characteristic of tornadoes, tornadoes are not included in the CSM.

Geohydrologic conditions at the site include physical properties of soils and groundwater and surface water flow characteristics. In addition, rates of erosion related to precipitation and run-off are included in the CSM. Stratigraphy at JPG is represented as comprising two layers, glacial till overlying limestone bedrock. Thickness of the till is approximately 20 ft (6 m), and the texture is that of a silt loam. Hydraulic conductivity for this type of soil ranges from 0.1 to 980 m/yr (0.3 to 3,200 ft/yr) with an average of approximately 30 m/yr (100 ft/yr) [Meyer and Gee 1999]. Results of a limited number of slug test measurements of hydraulic conductivity of glacial till at JPG are consistent with the average values for silt loam. Thus, the average hydrologic properties for silt loam were adopted as representative of JPG conditions for the contaminated unsaturated and saturated zones.

Depth to the water table for on-site wells is reported as approximately 3 m (10 ft). The limestone bedrock underlying the site contains fractures and solution cavities. Wells completed in the bedrock formation are productive and serve as a source of domestic/household water for some residents in the vicinity of JPG. In general, well water is not used for irrigation in the vicinity of the site. Well depths range from 13 to 60 m (40 to 200 ft) [IDNR 2001].

The primary source of drinking water for residents in the vicinity of JPG is municipal water drawn from the Ohio River. Average flow rate for the Ohio River near the JPG is 1.44×10^5 ft^3/s (1.29×10^{11} m^3/yr). Drainage of surface water from the JPG is toward the west (toward the East Fork of the White River). Annual average flow for this river near Bedford, Indiana, is 4,184 ft^3/s (3.74×10^9 m^3/yr) [USGS 2002].

The risk of earthquake at JPG is dominated by events at the NMZ. Peak ground acceleration at JPG due to an earthquake with a 1,000-year return period is estimated as 0.047% g. An event of this magnitude is not expected to disturb near-surface soils or hydraulic conditions in the bedrock aquifer; therefore, earthquakes are not included in the CSM.

The portion of the JPG containing residual contamination, the DU Impact Area, is drained by Big Creek. Measurements of flow rate and loading of suspended sediment have not been conducted for this stream. Estimates of run-off to Big Creek and erosion rates for the Big Creek basin are based on hydrologic and geomorphologic modeling. Base data included a digital elevation model of the basin and rainfall amounts for storms of 2-, 10-, 25-, 50- and 100-year return periods. The HEC-1 (Hydrologic Engineering Center) [i.e., a Hycomputer code developed by the U.S. Army Corps of Engineers (USACE)] and the TR-55 computer code developed by the Soil Conservation Service (SCS) were used to simulate surface water flow hydrographs and run-off quantities, respectively. Analysis of sediment loading for a similar basin,

Brush Creek, Indiana, was used to estimate sediment yield for the Big Creek basin. Annual average flow and sediment yield for Big Creek near the western boundary of JPG were estimated as 124×10^6 ft^3/yr (3.52×10^6 m^3/yr) and 2,320 lbs/acre/yr (2.60 MT/ha/yr), respectively. The procedure for estimation of these quantities is discussed in detail in Attachment 1 to Appendix C of this DP. The sediment yield corresponds to a basin averaged erosion rate of 0.0005 ft/yr (0.016 cm/yr).

5.3 CHARACTERIZATION OF SOURCE TERM

The objective of this section is to conceptualize the source term based on site characterization and regulatory guidance. This source term serves as a reasonably conservative basis for estimation of impacts. This conceptualization uses current conditions but is not intended to represent these conditions.

The original form of residual contamination at JPG is DU metal penetrators shaped as long, narrow rods. During firing, the penetrators struck the ground and, in some cases, broke into pieces before lodging in place. The angles of fire are such that most of the penetrators are thought to be located near the surface. Mass balance based on inventory control and recovery programs indicates that approximately 154,000 lbs (70,000 kg) of DU remain in the DU Impact Area. Primary constituents of the penetrators are the uranium isotopes U-234 and U-238 with a specific activity of 3.8×10^{-7} Ci/g. Trace contaminants include Pu-238/239/240 and technetium-99 (Tc-99) at concentrations less than 5 and 540 pCi/g, respectively.

The residual contamination is concentrated in and around trenches oriented along three lines of fire. The area of significant contamination is estimated as approximately 125 acres (5×10^5 m^2) although the range of estimates extends to approximately 250 acres (1×10^6 m^2). A schematic of the contaminated area is presented in Figure 4-3. Although intact penetrators and fragments of penetrators are visible, analysis of soil collected in the immediate vicinity of penetrators shows high levels of uranium, indicating that degradation is occurring. This finding is consistent with studies of corrosion of DU (Royal Society 2002), indicating that penetrators in intimate contact undergo complete degradation on the order of decades.

A final element used for identification of source characteristics is regulatory guidance (NRC 2000) recommending mixing of surface as may occur when the site is prepared for construction or plowed for agricultural purposes. The recommended mixing depth that maximizes concentration is 6 in. (15 cm).

Based on the concentration levels and potential for degradation described above, two cases of source characteristics are developed. In the first case, uranium at a concentration of 225 pCi/g is distributed over an area of 124 acres (5×10^5 m^2) to a depth of 6 in. (15 cm). In the second case, uranium at a concentration of 94 pCi/g is distributed over an area of 247 acres (1×10^6 m^2) to a depth of 6 in. (15 cm).

5.4 IDENTIFICATION OF ENVIRONMENTAL TRANSPORT PATHWAYS

Environmental pathways of potential significance at JPG include direct transport of energetic particles or electromagnetic radiation; atmospheric dispersion of resuspended soil particles; transport in groundwater or surface water; and accumulation in plants, domestic animals, or wildlife. Each of these seven processes may occur in the near field, affecting receptors in the immediate vicinity of the residual contamination or may occur over greater distances. At JPG, atmospheric dispersion and transport in groundwater and surface water occur over both short and long distances while the remaining processes occur only over the short distances.

Because residual contamination is not in gaseous form, atmospheric transport involves resuspension and dispersion of soil particles. Because of the near-surface nature of residual contamination at JPG, redistribution of contamination by insects or burrowing animals is not important. In addition to the seven

environmental transport pathways, a human activity-mediated pathway, direct contact, is considered. Thus, a total of eight major pathways for movement of residual contamination to receptors are identified for exposure scenario development. Sub-pathways may be identified for some or all of the identified pathways but are omitted from the discussion to facilitate presentation of key concepts. Sub-pathways entering each of the scenarios are described in Appendix C.

5.5 SELECTION OF RECEPTORS

Selection of receptors for dose analysis involves consideration of site conditions and regulatory guidance. Because the proposal for JPG is license termination with restriction, two cases are considered. In the first case institutional controls are assumed effective, while in the second case institutional controls are assumed to fail.

To bound and provide perspective on potential impacts, a set of receptors is constructed for each case. For the case where institutional controls remain in effect, the activities and locations of the set of candidate receptors (i.e., actual residents and individuals) are constrained by institutional controls. For the case in which institutional controls fail, the set of candidate receptors is expanded to include hypothetical individuals whose locations and activities are not possible currently. Consistent with regulatory requirements, each candidate receptor is a member of the group of individuals reasonably expected to receive the greatest exposure to residual contamination. Location and behavior are factors defining this individual, termed the AMCG. For each of the two institutional control cases, identification of the AMCG involves consideration of the:

- condition and location of residual contamination,
- proposed activities for the site,
- release mechanisms and environmental transport pathways significant to the site,
- current distribution of nearby residences and the surrounding population, and
- regulatory guidance.

The following sections discuss selection of on-site and off-site receptors for the two cases.

5.5.1 Institutional Controls in Effect

The proposed action for JPG involves transfer of control of the site to the FWS and the USAF for the foreseeable future. Under this proposed action, the USAF will use a portion of the JPG as a bombing range and will prohibit public access to the site. The mission of the FWS is to manage lands for the conservation of fish, wildlife, and plants. In this mission, the FWS plans to provide limited/restricted public access for fishing, hunting, and wildlife observation to certain areas north of the firing line (see Appendix A to this DP). Because of the hazard of UXO at the site, access to these activities will be controlled, and these controls are incorporated into the process for identification of candidate AMCGs where institutional controls remain in effect.

Controls include limitation of fishing to Old Timbers Lake and of wildlife observation to locations north of K Road. Because these locations are upgradient and removed for the area of residual contamination, these individuals are removed from consideration as an AMCG. The FWS plans to allow hunters access to portions of the JPG near but not on the area having residual contamination for two time periods each year. Proximity of the hunters and access of the wildlife to the DU Impact Area introduces the potential for exposure to residual contamination. Thus, a hunter of deer and turkey is selected as an AMCG for on-

site receptors. In addition to members of the public, FWS and USAF/INAG personnel may be in close proximity to the DU Impact Area. This proximity introduces the potential for exposure to residual contamination; therefore, an on-site worker frequenting the vicinity of the DU Impact Area is selected as an AMCG.

For the case where institutional controls remain in effect, selection of AMCGs located off-site is based on consideration of the location of nearby individuals and population centers in relation to the residual contamination and environmental transport mechanisms and pathways. The release mechanism of residual contamination and environmental transport pathways at JPG is atmospheric dispersion of resuspended soil, dissolution and movement in groundwater, and suspension in run-off and surface water. Although nearby residents currently do not use Big Creek as a source of domestic water, transport of sediment in surface water may influence these residents; therefore, these individuals are selected as an AMCG. Because light industrial activity occurs in the vicinity of JPG, an off-site worker is selected as an AMCG. Surface water draining from the DU Impact Area flows to the west, with the East Fork of the White River as the nearest significant location for public use. Residents of the town of Bedford, Indiana, located near this river, are selected as AMCGs for population exposures based on these considerations.

5.5.2 Institutional Controls Failed

If institutional controls fail, individuals would continue to use the JPG for hunting, fishing, and recreation. In addition, these individuals could perform these activities in the DU Impact Area or, in an extreme case, establish a residence and farm. These on-site activities are unlikely because of the presence of UXO; however, this case is assessed to bound the potential impacts. Locations and activities of the individuals where institutional controls fail are selected on the basis of the current residential activity and regulatory guidance.

Given the potential for fishing in the vicinity of Big Creek, an on-site fisherman is selected as an AMCG but conditions remain the same as in the case of intact institutional controls. Similar to the case where institutional controls remain in effect, an on-site hunter is selected as an AMCG; however, in this case, the hunter is permitted to enter the DU Impact Area. Consistent with local farming activities and regulatory guidance, a residential farmer located in the DU Impact Area is selected as an AMCG. Behavioral variations of this case are considered, farming with and without the use of irrigation water and domestic residency on full- and part-time basis.

For off-site receptors, failure of institutional controls does not affect residual contamination, release mechanisms, environmental transport pathways, or receptor locations and activities. Therefore, the off-site individual resident and off-site worker located near the site and the individual located near Bedford, Indiana, also are identified as AMCGs when institutional controls fail.

5.6 SELECTION OF EXPOSURE SCENARIOS

Development of exposure scenarios involves combining source conditions, transport pathways, and receptor locations and activities for the cases of effective and ineffective institutional controls. The discussions of Sections 5.3, 5.4 and 5.5 identified source conditions (2), transport pathways (8), and receptors (5 or 6) for the two institutional control cases. Combining these elements produces 64 and 80 scenarios for the cases of effective and ineffective institutional controls, respectively.

The sets of scenarios are screened to avoid unnecessary complexity and focus attention on important issues. Screening based on the location and activity of receptors described in the selection of receptors (Section 5.5) reduces the sets of scenarios to 14 and 24 for the cases of effective and ineffective institutional controls, respectively. Screening based on bounding of impacts and perspective of pathways

is used to remove the off-site industrial worker for whom impacts are bounded by both off-site and on-site scenarios. No additional pathways are introduced for this off-site industrial worker.

Finally, the list of scenarios is reduced by combination of single pathway scenarios affecting a common receptor into single multi-pathway scenarios. This screening process resulted in the final set of scenarios. These scenarios include: six scenarios for effective institutional controls and five scenarios for the case of ineffective institutional controls. Conditions for the final set of scenarios are summarized in Tables 5-1 and 5-2 for the cases of effective and ineffective institutional controls, respectively.

Table 5-1. Summary of Exposure Scenarios, Effective Institutional Controls

Receptor	Location	Transport Pathway[a]
Hunter	On-site	Wildlife
Worker	On-site	Direct Atmospheric Dispersion
Fisherman	Off-site	Surface water
Residential farmer	Off-site	Surface water
Industrial worker	Off-site	Groundwater
Population	Off-site	Surface water

[a]Pathways listed are primary pathways and may invoke a further set of sub-pathways.

Table 5-2. Summary of Exposure Scenarios, Institutional Controls Ineffective

Receptor	Location	Transport Pathway[a]
Hunter	On-site	Wildlife Direct Atmospheric Dispersion
Fisher	On-site	Surface water
Residential farmer (four versions)	On-site	Direct Atmospheric Dispersion Groundwater Plants Domestic Animals Contact
Residential farmer	Off-site	Surface water
Population	Off-site	Surface water

[a]Pathways listed are primary and may invoke sub-pathways. For example, primary pathways for on-site residential farmer are sub-pathways for off-site residential farmer.

5.7 ANALYSIS OF EXPOSURE SCENARIOS

Analysis of exposure scenarios developed for JPG requires estimation of release rate to and transport through environmental pathways, as well as evaluation of impacts attributable to a variety of receptor behavior-dependent exposure modes. This section describes the calculation techniques, including analysis of sensitivity and uncertainty, used for evaluation of JPG scenarios.

5.7.1 Techniques for Estimation of Dose

Doses for JPG scenarios were estimated using a combination of the RESRAD (LePoire et al. 2000) computer model and hand calculations. Version 6.1 of RESRAD was used to simulate hunter, worker, and residential farmer scenarios. Detailed discussion and a listing of parameter values are presented in Appendix C for RESRAD analyses. Values of the most important parameters are presented below in the discussion of sensitivity and uncertainty analysis.

The hand calculations were used to simulate doses due to potential contamination of surface water by erosion of the DU Impact Area. Drinking water dose was calculated as the product of concentration of uranium in water, water intake rate (510 L/yr), and dose conversion factor for ingestion (2.6×10^5 rem/Ci). Dose due to ingestion of fish was calculated as the product of concentration of uranium in water, bioaccumulation factor for uranium in fish [(10 pCi/kg)/(pCi/L)], fish consumption rate (15 kg/yr), and dose conversion factor for ingestion. Using the value of erosion rate of 2,320 lbs/acre/yr (2.60 MT/ha/yr) discussed above in Section 5.2, a value of 0.036 Ci/yr was estimated for the release rate of uranium to Big Creek due to erosion.

5.7.2 Sensitivity and Uncertainty Analysis

Doses predicted using environmental transport and exposure mode models depend, in a complex manner, on future societal conditions, changes in human behavior and environmental conditions and processes, the nature of the models, and the values of parameters used in the models. Changes in societal conditions and human behavior cannot be estimated accurately. This uncertainty is accounted for by using a reasonably conservative set of exposure scenarios. Evaluation of uncertainty related to model structure is not currently possible and is addressed by use of simple models whose performance is based on reasonably conservative understanding of transport and exposure processes. Evaluation of the uncertainty related to values of the parameters is addressed using deterministic sensitivity analysis and Monte Carlo simulation based on available data on parameter distributions.

Sensitive parameters in the JPG dose analysis were identified by calculation of single point sensitivity coefficients using repeated runs of the RESRAD computer code. This analysis identified the distribution coefficient for uranium in contaminated zone soil, mass loading factor, and drinking water ingestion rate as the most sensitive parameters. Uncertainty analysis using the RESRAD code was then performed for residential farmer and hunter scenarios using parameter distributions based on literature and regulatory guidance. For the distribution coefficient of uranium in contaminated zone soil, a triangular distribution was selected. The minimum, median, and maximum values were 5, 50, and 60 mL/g, respectively. For mass loading factor, a uniform distribution with minimum and maximum values of 6.3×10^{-9} and 6.2×10^{-8} lb/ft^3 (0.0001 and 0.001 g/m^3) was selected. A uniform distribution was also selected for drinking water ingestion rate with minimum and maximum values of 116 and 174 gal/yr (440 and 660 L/yr).

5.8 RESULTS OF DOSE ANALYSIS

Doses estimated for the case where institutional controls remain in effect and based on a source concentration of 225 pCi of uranium per gram of soil are presented in Table 5-3. The largest peak dose (6.4 mrem/yr) is estimated for the off-site worker, with the majority of impact due to ingestion of drinking water. For the off-site residential farmer, the peak dose from external exposure and inhalation also is observed in the early years, but lower doses from ingestion of water and consumption of crops appear in later years (i.e., after year 200). In all scenarios, doses are below the 25 mrem/yr criterion of 10 *CFR*

Table 5-3. Doses for Scenarios with Institutional Controls in Effect[a]

Receptor	Location	Dose (mrem/yr)	Method
Hunter	On-site	2.0	RESRAD
Worker	On-site	2.9	RESRAD
Fisherman	Off-site	0.81	Hand Calculation
Residential farmer	Off-site	0.2	RESRAD
Industrial worker	Off-site	6.4	RESRAD
Population	Off-site	0.003	Hand Calculation

[a]Doses for RESRAD simulations are peak-of-the mean estimates from probabilistic calculations. Doses for hand calculations are deterministic values.

20.1403(b). Estimated doses scaled linearly with source concentration. Therefore, the dose due to the source at 94 pCi/g was reduced relative to the dose for the case of source at 225 pCi/g in proportion to the ratio of source concentration. Dose due to fish consumption on Big Creek was estimated as approximately 0.81 mrem/yr. The population dose from the consumption of drinking water by the population of Bedford, Indiana, is 0.04 person-rem/yr.

Doses estimated where institutional controls fail and based on a source concentration of 225 pCi of uranium per gram of soil are presented in Table 5-4. No credit is taken for a period during which institutional controls are maintained. The largest peak dose (37 mrem/yr) is estimated for the on-site residential farmer, with the majority of dose from external exposure and inhalation occurring soon after the controls fail. Slightly lower doses from drinking water and crop ingestion occur approximately 200 years after failure of institutional controls. In all cases, doses are below the 100 mrem/yr criteria of 10 *CFR* 20.1403(e). Sensitivity analysis of the on-site residential farmer scenario indicated that the presence of trace contaminants, Pu-238/239/240 and Tc-99 would increase dose by approximately 0.15 mrem/yr, less than 0.5 % of the dose due to uranium for that scenario.

Table 5-4. Doses for Scenarios with Failure of Institutional Controls[a]

Receptor	Location	Dose (mrem/yr)	Method
Hunter	On-site	3.6	RESRAD
Fisherman	On-site	0.81	Hand calculation
Residential farmer	On-site	37.0	RESRAD
Residential farmer	Off-site	0.2	RESRAD
Population	Off-site	0.003	Hand Calculation

[a]Doses for RESRAD simulations are peak-of-the mean estimates from probabilistic calculations. Doses for hand calculations are deterministic values.

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6.0 ALTERNATIVES CONSIDERED AND RATIONALE FOR THE CHOSEN ALTERNATIVE

6.1 ALTERNATIVES CONSIDERED

Two alternatives for license termination were considered. The first was decontamination to allow unrestricted release in accordance with the requirements of 10 *CFR* 20.1402. The second was termination of the license with restrictions according to the requirements of 10 *CFR* 20.1403. Each of these alternatives is discussed in the following paragraphs.

6.1.1 DU Decontamination to Fulfill Unrestricted Release Criteria of 10 *CFR* 20.1402

Decontamination of the DU Impact Area to allow the termination of the NRC license without restriction would involve four major actions. These actions are discussed below:

- **Road Construction** – Clear a two-lane road into the DU Impact Area to support UXO detection and removal and DU detection and removal activities. The DU Impact Area lies within a portion of JPG where UXO is present.

- **UXO Detection and Removal** – Detect and remove UXO from the area where DU concentrations are above the limits considered acceptable for unrestricted use plus a surrounding buffer area to allow safe detection and removal of UXO. The size of the area requiring UXO removal is estimated to be on the order of several hundred acres. This area is forested and is sloped toward Big Creek. The UXO would have to be detected and removed to depths estimated at 6 to 10 ft. Both detection and removal actions would be slow because of the safety protocols and hazards associated with the presence of UXO and its removal. Removal of surface DU penetrator or penetrator fragments would occur subsequent to UXO detection and removal. The location and removal of buried UXO would disturb the local habitat. Consequently, mitigative measures would be implemented to minimize ecological impacts and erosion. Operational procedures would be defined to minimize the potential for commingling of uncontaminated DU soil with DU-contaminated soils.

- **Detection and Removal of DU Fragments and Contaminated Soil** – Detection and removal of buried DU fragments and removal of soil contaminated above free release concentrations would be completed in this stage. The examination for DU contamination would proceed immediately after an area was determined to be free of UXO (i.e., in accordance with distance requirements for UXO clearance actions). The soil in the impact trench is expected to be generally above free release concentrations. Outside of the trench, the DU contamination is expected to be highly non-homogeneous as a result of penetrators, or penetrator fragments, contacting and impacting the soil during their trajectory. Surveys for contaminated soil would occur within the DU Impact Area as well as near the firing point and along the firing lines. After areas of DU contamination above the limits for unrestricted release are identified, contaminated soil would be removed, packaged, and shipped for off-site disposal.

- **Verification Survey** – After contaminated soil is removed, a survey grid would be constructed, and a final survey would be completed to determine if the DU concentration is below the free release concentration limits.

Implementation of this alternative would require significant resources to detect and remove both UXO and DU, pose high risks to on-site personnel, and destroy the local environment. Some of these impacts are estimated to support the ALARA analysis presented in Section 7.0 of this DP.

6.1.2 License Termination Under Restricted Conditions of 10 *CFR* 20.1403

Implementing this alternative would require the establishment of land use controls[1] to limit public access to any activities within the DU Impact Area. These controls have been developed, and the U.S. Army has issued permits to allow two Federal agencies (the FWS and the USAF) to use portions of the site outside the DU Impact Area (U.S. Army 2000b and c). One of the permit conditions is to implement the land use control measures specified by the Army. The Army will audit compliance with the Army-specified control measures. Details of the land use control measures currently being implemented, which include physical, legal, and administrative measures, are provided in the MOA (Appendix A) and in Section 16.0 of this DP. The Army will ensure controls such as these are implemented and maintainedin the event the MOA is terminated.

Administratively, terminating the license with restrictions would require:

- **Institutional Control Analysis** – Completion of an analysis that demonstrates that: (1) doses to the average member of the critical group would meet the requirements of 10 *CFR* 20.1403(a) with enforceable institutional controls, and (2) doses to the average member of the critical group would meet the requirements of 10 *CFR* 20.1403(e) in the event the institutional controls were no longer in effect.

- **ALARA Analysis** – Completion of an analysis that demonstrates that any residual contamination levels are ALARA.

6.2 RATIONALE FOR SELECTED ALTERNATIVE

License termination under restricted conditions was selected because this alternative meets the requirements of 10 *CFR* 20.1403 and has contamination levels that are consistent with ALARA. The cost of detecting and removing UXO and DU from the DU Impact Area to meet unrestricted release requirements is greater than the benefit that would accrue from detection and removal actions. The ALARA analysis in Section 7.0 of this DP presents related discussions.

[1]According to the U.S. Department of Defense's land use control policy (DoD 2001), land use controls include any type of physical, legal, or administrative mechanism that restricts the use of, or limits access to, real property to prevent or reduce risks to human health or the environment. Physical mechanisms limit access to the property and include engineered controls and/or physical barriers. Legal mechanisms (e.g., deed notices, restrictive covenants, etc.) generally are imposed to ensure the continued effectiveness of land use restrictions. Legal mechanisms are the same as the institutional controls discussed in the National Contingency Plan. Administrative mechanisms include land use planning, construction permitting, and other measures to ensure compliance with restrictions. At Jefferson Proving Ground, all three types of land use controls are in effect. In this document, the Nuclear Regulatory Commission's "institutional controls" are synonymous with DoD's definition of "land use controls."

7.0 ALARA ANALYSIS

This chapter presents the ALARA analysis performed in support of the U.S. Army's request to terminate license SUB-1435 under restricted conditions. No additional ALARA analysis is planned to support the license termination because the proposed license termination will not involve additional site characterization or removal of DU contamination.

This analysis was conducted to determine if the residual DU contamination in the DU Impact Area is consistent with ALARA. Section 7.1 presents the ALARA analysis. The conclusions of this analysis are summarized in Section 7.2. The need for additional analyses (if any) is addressed in Section 7.3.

7.1 ALARA ANALYSIS

This section presents the quantitative ALARA analysis in support of JPG's license termination. This analysis consists of identifying and quantifying, to the extent practical, the benefits and costs (Sections 7.1.1 and 7.1.2, respectively) that would be associated with decontamination of the DU Impact Area to meet unrestricted release conditions. Because of uncertainty about the nature and extent of both UXO and DU contamination and the evolution of remediation technologies, there are uncertainties about the cost of remediation. As indicated in Section 7.2, this uncertainty does not limit the Army's ability to develop conclusions based on this ALARA analysis.

7.1.1 Benefits

Several benefits were identified as being associated with decontamination of the DU Impact Area to unrestricted release conditions. The benefits were identified using the potential benefits identified in Table D1 of the NRC's NMSS Decommissioning Standard Review Plan (SRP) [NRC 2000]. The benefits identified for the JPG include: averted population dose, avoided regulatory and institutional costs, increased land value, aesthetics, and reduced public opposition. The total discounted benefit accruing from decontamination of the DU Impact Area to terminate the license without restrictions is estimated to range from $268,286 to $349,429 (see Table 7-1). Sections 7.1.1.1 to 7.1.1.5 provide additional detail on each of these possible benefits.

Table 7-1. Benefits of License Termination for Unrestricted Use of the DU Impact Area Jefferson Proving Ground, Indiana

Parameter	Benefit ($)[a]
Averted Population Dose	61,143 to 146,286
Avoided Regulatory and Institutional Costs	207,143
Increased Land Value	--[b]
Aesthetics	--[b]
Reduced Public Opposition	--[b]
Total	**268,286 to 353,429**

[a]Based on an annual discount rate of 7 percent calculated over 1,000 years.
[b]Benefit is minimal to none relative to other benefits quantified.

7.1.1.1 Averted Population Dose

For the proposed license termination with restrictions, site workers, occasional visitors, and off-site individuals could be exposed to DU. Off-site receptors could come in contact with water from sources originating from the DU Impact Area.

Appendix C presents estimated doses for on-site recreationists, on-site hunters, and on-site fishermen, and water users in Bedford, Indiana, which is the nearest downstream community. Exposure pathways for the on-site receptors include external exposure, inhalation, and ingestion while the exposure pathway for Bedford water users is ingestion. Table 7-2 summarizes the annual exposure for each of these receptors and the corresponding population dose.

Table 7-2. Estimated Annual Population Dose for Restricted Reuse Jefferson Proving Ground, Indiana

Receptor	Annual Dose (mrem)		Estimated Annual Receptors	Population dose (person-rem)	
	Low	High		Low	High
On-site Hunter (2 weeks per year)	1.5	3.6	635[a]	.95	2.28
On-Site Fisherman	3.3	7.9	350[b]	1.15	2.76
Bedford, Indiana, Water Users	--[c]	2.9E-6	13,768	--[c]	0.04
Total				2.1	5.08

[a]Number of deer and turkey hunters allowed according to Interim Hunting and Fishing Plan for Big Oaks National Wildlife Refuge (NWR) [FWS 2001b].

[b]Based on Interim Hunting and Fishing Plan for Big Oaks NWR, which will allow 60 fishermen per day, up to 10 days per month for 7 months (FWS 2001b).

[c]One dose estimated.

The total population dose estimate (5.08 person-rem/yr) represents a high estimate of the averted population dose that would result from decontaminating the DU Impact Area to free release conditions.

This annual population dose is converted to dollar equivalent using the $2,000/person-rem and the 7% discount rate identified in Table D2 of the NMSS Decommissioning SRP (NRC 2000). Prior to adjustments for discounting, the annual benefit each year would be between $4,200 and $10,160. The total benefit from 100 years, discounted at the annual rate of 7%, would range from $61,072 to $147,117. Use of longer time periods does not increase the benefit substantially. The total benefit over 1,000 years, discounted at 7%, would range from $61,143 to $146,286.

7.1.1.2 Avoided Regulatory and Institutional Control Costs

No regulatory costs are associated with license termination under restricted and unrestricted conditions. Therefore, there is no reduction in regulatory costs for decontaminating to meet unrestricted release conditions.

The Army expects to incur approximately $162,500 annually for implementing institutional controls costs at JPG (see Section 15.0 of this DP). Only a small fraction of this ($14,500) is associated with the DU Impact Area. The avoided institutional control cost that would be a benefit if the DU Impact Area were decontaminated to allow unrestricted release would be $14,500 per year. The total benefit from 100 years with an annual rate of 7% is $206,904. Use of longer time periods does not increase the benefit substantially. The total benefit over 1,000 years, discounted at 7%, is $207,143.

7.1.1.3 Increased Land Value

Farmland in the area of the JPG has a market value of $3,000 to $5,000 per acre based on classified ads in local newspapers in April 2002. The DU Impact Area is located in the central portion of the JPG and includes, and is surrounded by, areas containing UXO. It also is adjacent to an area being used for

laser-guided bombing practice. Therefore, the Army would not be able to release the DU Impact Area for other uses if it were decontaminated. Any benefit associated with increased land values would be minimal.

7.1.1.4 Reduced Public Opposition

The public has expressed concern regarding the termination of the JPG license with restrictions. This concern related primarily to possible doses to the public if institutional controls fail or DU contamination migrates. This conclusion is based on a review of the RAB meeting minutes (and review of related documentation prepared by local activist groups such as Save the Valley (STV) [STV 2001]). The benefit associated with reduced public opposition as a result of license termination for unrestricted use is difficult to quantify but is considered negligible relative to other benefits quantified in this analysis and is not quantified.

7.1.1.5 Aesthetics

The DU Impact Area is in the central portion of the JPG and covered by wood and grassy areas. There are no DU-contaminated structures that would have to be removed to meet the requirements for license termination without restrictions. In the short-term, remediation would impact the aesthetic value of the DU Impact Area negatively. Over time (5 to 10 years) and with appropriate mitigative measures implemented during remediation, the area would be restored to its present state. No additional aesthetic value is estimated to accrue for license termination without restrictions.

7.1.2 Costs

Several categories of costs were identified for decontamination of the DU Impact Area to unrestricted release conditions. These costs were also identified using the potential costs identified in Table D1 of the NMSS Decommissioning SR Plan (NRC 2000). The costs identified for the JPG are: remediation costs, occupational and public exposure at JPG, occupational non-radiological risk to on-site personnel during decontamination, radiological and non-radiological transportation risks, and environmental degradation. These cost elements are presented in Sections 7.1.2.1 to 7.1.2.5.

Because of the limited information on the distribution of the DU fragments and contamination and the unique nature of a UXO-DU remediation project, there are uncertainties associated with some of the cost estimates. For this reason, a range of cost estimates is provided to reflect the uncertainty in estimating these costs.

7.1.2.1 UXO and DU Remediation

UXO remediation of the DU Impact Area will occur sequentially. The protocol includes UXO identification and removal of surface DU fragments, followed by UXO removal down to depths of 6 to 10 ft (1.8 to 3.0 m), and identification and removal or excess DU contamination after the UXO hazard is removed.

There is uncertainty about the cost of remediation of UXO and DU within the DU Impact Area. This uncertainty is the result of several factors; the major factors include the following:

- the area and depth of DU-contaminated soil and, therefore, the area that must be cleared of UXO before DU decontamination can occur;
- the unit cost ($/acre) for UXO detection, removal, and disposition;

- the volume of DU-contaminated soil, which is a function of the volume of soil assessed and the fraction determined to be contaminated; and
- unit costs for disposal of contaminated soil.

Table 7-3 summarizes the range of values for each of these parameters. Other parameters, such as unit transportation costs and unit disposal costs for DU metal pieces, are not reflected in this analysis; however, these parameters do not have a significant impact on total cost.

Table 7-3. Key Parameters Impacting DU Impact Area Remediation Costs Jefferson Proving Ground, Indiana

Parameter	Unit	Estimated Values	Source
Area Requiring UXO Detection, Removal and Disposition	acres	250 – 1,300	Estimate based on existing characterization information (SEG 1995, 1996)
Unit Cost for UXO Detection, Removal and Disposition	$/acre	9,800 – 100,800	1995 JPG EIS with costs adjusted for inflation (U.S. Army 1995a)
Area Requiring Soil Survey for DU (acre)	acres	150 – 1,300	Estimate based on existing characterization information (SEG 1995, 1996)
DU Contamination Depth	ft	2 – 4	Estimate based on existing characterization information (SEG 1995, 1996)
Soil Processing Cost	$/ft^3	3 – 6	Miller et al. 2000
Volume percent of soil determined to be contaminated with DU	percent	0.5 – 2	Estimate based on existing characterization information (SEG 1995, 1996)
Unit Cost for Contaminated Soil Disposal	$/ft^3	5 – 17	Bentz et al. 2000

Conversion factors: Acres to km^2, multiply by 0.00405; ft to m, multiply by 0.3048; ft^3 to m^3, multiply by 0.028.
ft = foot or feet.
ft^3 = cubic feet.
DU = depleted uranium.
EIS = Environmental Impact Statement.
UXO = unexploded ordnance.

The 1995 EIS for Disposal and Reuse of the JPG (U.S. Army 1995a) included estimated UXO clearance costs. These cost depend on the clearance depth and the type of land cover (bare vs. forested land). These costs were escalated to 2002 dollars using the consumer price index. The updated unit costs ($/acre) range from about $9,800/acre ($40/km^2) for 4 ft (1.2 m) clearance of clear land to over $100,000/acre ($450/km^2) for 10 ft (3.0 m) clearance of forested land.

Miller et al. (2000) documented the cost and performance of excavating and screening DU-contaminated soil using a conveyor system with radiation detection systems that diverted contaminated soil from conveyor belt. The costs are assumed to be typical for detecting and sorting contaminated soil. The costs were reported as $3.1/ft^3 ($110/m^3) [neglecting mobilization and demobilization costs and $6/ft^3 ($212/m^3)] when mobilization and demobilization costs are considered.

The unit disposal costs also are variable. Bentz et al. (2000) reviews disposal costs at both commercial and DOE low-level radioactive waste disposal sites. The lowest commercial costs are those associated with Envirocare. These disposal costs are reported to range from $4.8/ft^3$ to $17/ft^3$ ($170 to $600/m^3$).

Other cost elements that are less significant to the overall cost estimate (detection and removal of metal penetrator fragments, packaging and transportation costs) were obtained from an earlier estimate prepared for JPG (SEG 1996).

The total cost estimate changes with changes in these major parameters. Table 7-4 summarizes the total cost estimate by remediation activity given the variation in major parameters presented in Table 7-3.

Table 7-4. Estimated Remediation Costs
Jefferson Proving Ground, Indiana

Remediation Activity	Estimate ($)
UXO Detection, Removal, and Disposition	2,450,000 – 131,000,000
DU Metal Detection and Removal	854,000[a]
Contaminated Soil Identification and Removal	39,400,000 – 1,365,000,000
Contaminated Soil Transportation and Disposal	2,000,000 – 111,000,000
Total[b]	**45,000,000 – 1,609,000,000**

[a]Not considered a major cost element; therefore, a sensitivity analysis was conducted.

[b]Total cost rounded to nearest million dollars.

DU = depleted uranium.

UXO = unexploded ordnance.

The costs presented in Table 7-4 show the potential for considerable variation in the total remediation cost estimate depending on the area and depth of soil that must be remediated and the unit remediation and disposal costs. The total cost is dominated by the cost of identifying, processing, and disposing of UXO and DU-contaminated soil.

7.1.2.2 Occupational and Public Radiological Exposure

Occupational exposures during DU remediation activities will be minimal with appropriate health and safety protocols. For example, SEG estimates of soil removal requirements suggest 16,000 person-hours to remove 500,000 ft^3 (14,100 m^3) of contaminated soil (SEG 1996). If similar labor requirements are required for UXO detection and removal, the total labor hours could approach 50,000 person-hours.

Assuming an occupational exposure rate on the order of 15 μR/hr (some of the higher direct exposure rates measured during the SEG characterization survey), the cumulative occupational exposure would be less than 1 person-rem. If this value was converted to a dollar equivalent at the rate of $2,000 per person-rem, the $2,000 total is insignificant when compared to the direct and indirect costs for remediation.

7.1.2.3 Occupational Non-radiological Risk

The estimated monetary value of the occupational non-radiological risk is presented in this section. This estimate is based on the cumulative labor requirements (50,000 person-hours), workplace accident fatality rate identified in Table D2 of the NMSS Decommissioning SRP (4.2E-8 fatalities per worker hour) [NRC 2000], and the monetary value of a fatality ($3,000,000). This estimate is $6,300, which also is insignificant when compared to the other remediation costs. The occupational non-radiological risk could be higher because the fatality accident rate used may underestimate the fatality risk associated with UXO.

If the UXO detection and removal fatality rate were twice the value identified in Table D2 of the NMSS Decommissioning SRP (NRC 2000), the cost would double to $12,600, which is a small fraction of the total remediation cost.

7.1.2.4 Non-radiological Transportation Risk

Transportation of contaminated soil from JPG to the disposal site at Clive, Utah (approximately 1,750 miles from JPG), would pose risks to the public. The number of shipments depends on the area remediated and the volume of contaminated soil excavated. The number of shipments ranges from about 400 to over 11,000 based on the data in Table 7-2.

Based on the transportation accident fatality rate (3.8E-8 fatalities per km) identified in Table D2 of the NMSS Decommissioning SRP (NRC 2000) and the monetary value of a fatality ($3,000,000), an estimate of the monetary value of the non-radiological transportation risk was developed. This estimate ranges from $132,000 to $3.67 million. While these costs are larger than those for radiological and non-radiological risk, these costs are a small percentage (0.2%) of the total remediation costs.

7.1.2.5 Environmental Degradation

Environmental degradation would result if UXO and DU detection and removal were implemented. The environmental degradation would be the result of tree and brush removal, soil disturbance in the DU Impact Area and the banks of Big Creek, and soil erosion. In the short-term, the habitat would be destroyed and the terrain modified as a result of remediation. With appropriate mitigative measures (e.g., soil erosion controls, site restoration, etc.) and over time, the site would be restored, thereby resulting in no environmental degradation costs. Therefore, no irreversible and irretrievable loss in environmental resources in the long-term is expected.

The total major ALARA cost elements for remediation of the DU Impact Area to meet requirements for unrestricted use are presented in Table 7-5. As noted in the discussion above, the ALARA costs are dominated by the direct costs for detection, removal, and disposition of the UXO and the contaminated soil.

Table 7-5. Costs of License Termination for Unrestricted Use of the DU Impact Area Jefferson Proving Ground, Indiana

Remediation Cost Element	Estimate ($)
UXO and DU Remediation Cost[a]	45,000,000 – 1,609,000,000
Occupational and Public Radiological Exposure	2,000
Occupational Non-Radiological Risk	6,300
Non-radiological Transportation Risk	132,000 – 3,670,000
Environmental Degradation	0[b]
Total[c]	**45,000, 000 – 1,613,000,000**

[a]Cost breakdown presented in Table 7-2.
[b]No environmental degradation costs are anticipated over the long-term.
[c]Total cost rounded to nearest million dollars.

7.2 ALARA CONCLUSIONS

The costs of remediation of the DU Impact Area to meet the criteria for unrestricted use are greater than the benefits. The costs are about 167 to almost 4,500 times the benefits. The ALARA analysis demonstrates that terminating the JPG license with restrictions would be consistent with the ALARA requirement of 20.1403(a).

In addition to the ALARA analysis, a "net public or environmental harm" analysis was conduced in accordance with the NMSS Decommissioning SRP (NRC 2000). This analysis compares the benefits of dose reduction with costs. These costs include occupational fatalities, occupational doses, transportation fatalities, and environmental degradation. These benefits and costs were quantified above. The benefits were estimated to range between $268,286 and $353,429. Table 7-6 summarizes the costs for the categories enumerated above.

Table 7-6. Summary of Costs for "Net Public or Environmental Harm" Analysis Jefferson Proving Ground, Indiana

Cost Element	Estimated Cost ($)
Occupational Fatalities (Non-Radiological)	6,300 – 12,600
Occupational and Public Radiological Exposures	2,000
Transportation Fatalities	132,000 – 3,670,000
Environmental Degradation	0
Total	**140,300 – 3,684,000**

This analysis indicates that for most situations, the benefits are less than the net public or environmental harm cost elements. It is expected that remediation of the DU Impact Area would most likely result in "net public or environmental harm."

7.3 METHOD FOR SHOWING COMPLIANCE WITH ALARA AT THE TIME OF LICENSE TERMINATION

The proposed action for license termination will not generate any additional information to refine the ALARA analysis presented in this section. Furthermore, the ALARA costs are significantly greater than the ALARA benefits. Based on these considerations, no additional analysis is planned in support of license termination.

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8. PLANNED DECOMMISIONING ACTIVITIES

Because license termination under restricted conditions is anticipated, no decommissioning tasks (i.e., DU remediation activities) are envisioned. Therefore, no related tasks will be implemented.

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9.0 PROJECT MANAGEMENT AND ORGANIZATION

This section identifies the project management and organization within the U.S. Army that is responsible for license termination of JPG's SUB-1435 (Sections 9.1 and 9.2). In addition, the key positions within this organizational structure are described (Section 9.3). Related training and contractor support are identified in Sections 9.4 and 9.5, respectively.

9.1 LICENSE TERMINATION MANAGEMENT ORGANIZATION

The key organizations supporting the license termination process include the SBCCOM, USACHPPM, Los Alamos National Laboratory (LANL), and stakeholders. Each of these organizations is described in Sections 9.1.1 through 9.1.4. The reporting hierarchy is addressed in Section 9.1.5.

9.1.1 U.S. Army Soldier and Biological Chemical Command

SBCCOM's mission is to develop, integrate, acquire, and sustain soldier and nuclear, biological, and chemical (NBC) defense technology, systems, and services and to provide for the safe storage, treaty compliance, and destruction of chemical materiel (see http://www.sbccom.army.mil/). SBCCOM has responsibility for completing the license termination process. This organization also identifies and manages the resources to complete this process and implements corrective action, as appropriate and necessary.

The SBCCOM Safety Office coordinates the license termination process with the NRC Headquarters and Region III, and other federal and states agencies, such as the EPA Region 5, FWS, USAF, Indiana ANG, and IDEM. SBCCOM also coordinates with the USACHPPM on health physics and radiological health issues. SBCCOM regards safety as being the responsibility of all participants in the license termination process. Concerns and corrective actions regarding the license termination process at JPG are resolved through the SBCCOM.

9.1.2 USACHPPM

USACHPPM's mission is to provide technical support for implementing preventive medicine, public health, and health promotion/wellness services into all aspects of America's Army and the Army Community (see http://chppm-www.apgea.army.mil/). USACHPPM's Health Physics Program (HPP) has supported the license termination process, including preparation of earlier versions of the DP and conducting the monitoring and sampling program of the DU Impact Area at JPG.

USACHPPM's Radiologic, Classic, and Clinical Chemistry Division (RCCCD) manages the radiochemistry laboratory activities for SBCCOM. RCCD provides technical assistance to the HPP and conducts all necessary laboratory analyses for samples generated for this project.

9.1.3 Los Alamos National Laboratory

LANL is a DOE laboratory, managed by the University of California. The Lab's post-Cold War mission includes efforts in threat reduction, strategic research, and stockpile stewardship. Other recent missions include nuclear emergency response, national infrastructure modeling, remote sensing, and biological agent identification and characterization (see http://www.lanl.gov/worldview/). LANL's Environmental Science Group has conducted initial studies, dose assessments, and modeling to support license termination.

9.1.4 Stakeholders

A RAB, an advisory organization composed of local citizens and staff from the Army, EPA, the IDEM, county officials, and members of the local communities, was established in 1994 under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the BRAC program. The RAB, which meets quarterly, provides the public and community an opportunity to identify environmental and reuse issues and concerns and to participate in the Army's decision-making process. Meeting minutes are documented and included in the JPG Administrative Record file. The U.S. Army developed and is implementing its Community Involvement Plan (SAIC 1997b) and maintains a web site to inform the public on the site closure process (http://jpg.sbccom.army.mil/). Public participation requirements associated with 10 *CFR* Part 20.1403 (d) are being conducted through this forum.

One of the more active organizations participating in the license termination process is Save the Valley (STV), a non-profit volunteer organization for the protection of air, water, and land in the Valley of the Ohio River between Lawrenceburg, Indiana, and Louisville, Kentucky. STV represents environmental and public interests before regulatory agencies, and at all levels of the court system, and has been an active participant in the JPG RAB (see http://www.oldmadison.com/stv/).

9.1.5 Lines of Authority

As the license holder, SBCCOM has responsibility for oversight, development, and execution of the license termination process and the authority to assign and manage resources within its command to this project. As Figure 9-1 indicates, SBCCOM reports to the U.S. Army Materiel Command. The key supporting organizations, USACHPPM and LANL, as well as contractors, report to SBCCOM.

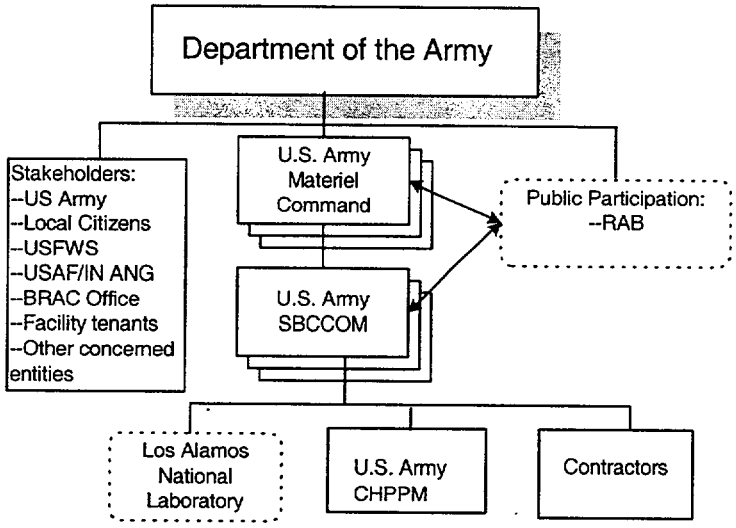

Figure 9-1. Chain of Command for the License Termination Process at Jefferson Proving Ground within the U.S. Department of the Army

9.2 DECOMMISSIONING TASK MANAGEMENT

SBCCOM is managing the development of the DP and Environmental Report (ER) for license termination at JPG. Because license termination under restricted conditions is anticipated, no decommissioning tasks are envisioned. Therefore, related tasks will not be implemented.

9.3 KEY LICENSE TERMINATION MANAGEMENT POSITIONS

The roles and responsibilities of key organizations and key positions within these organizations that support the license termination process are described briefly in this section. Table 9-1 lists the key organizations, positions, and contact information.

Table 9-1. Key Organizations, Positions, and Contact Information for the License Termination Process Jefferson Proving Ground, Indiana

Organization	Position	Contact Information
SBCCOM	Radiation Safety Officer	Joyce Kuykendall (410) 436-7118 joyce.kuykendall@sbccom.apgea.army.mil
SBCCOM	BRAC Environmental Coordinator	Mr. Paul Cloud (410) 436-2381 pdcloud@sbccom.apgea.army.mil
USACHHPM	Project Manager	LTC Mark A. Melanson (410) 436-3502 mark.melansen@apg.amedd.army.mil
USACHHPM	Project Chemists	Angel Christman, Jon Beegle(410) 436-3983 angel.christmanA@apg.amedd.army.mil tom.beegle@apg.amedd.army.mil
LANL	Principal Investigator	Mike Ebinger, Ph.D. (506) 667-3147 mhe@lanl.gov

JPG = Jefferson Proving Ground.
LANL = Los Alamos National Laboratory.
LTC = Lieutenant Colonel.
SBCCOM = Soldier and Biological Chemical Command.
USACHHPM = U.S. Army Center for Health Promotion and Preventive Medicine.

9.3.1 SBCCOM

Key positions within the U.S. Army's SBCCOM include the Radiation Safety Officer (RSO) and BRAC Environmental Coordinator. The RSO coordinates and addresses radiation safety issues. This individual also reviews monitoring data; conducts annual reviews and/or audits of site activities or related policies; and recommends corrective actions, as required, to the SBCCOM.

The BRAC Environmental Coordinator manages environmental restoration activities at the installation. This individual is responsible for identifying BRAC closure requirements and implementing related measures to ensure the site closeout process is achieved.

9.3.2 USACHPPM

The Project Manager in HPP is the overall lead for USACHPPM's support to SBCCOM. This individual is responsible for project planning, control, monitoring, and completion of all technical deliverables. The Project Chemist under the RCCCD is responsible for leading radiological analytical activities and coordinates activities with the Project Manager.

9.3.3 LANL

The Principal Investigator of LANL's Environmental Science Group is responsible for leading and conducting modeling and dose assessments in support of license termination.

9.3.4 USAF/IANG

The USAF/IANG is operating an approximately 50-acre laser bombing range, a 983-acre conventional bombing range, and the Old Timbers Lodge in accordance with the MOA (see Appendix A). Under the provisions of this agreement, the USAF/IANG is responsible for infrastructure maintenance requirements and must adhere to certain restrictions on its activities relative to the DU Impact Area.

9.3.5 FWS

The FWS established and is managing the Big Oaks NWR in accordance with the MOA (see Appendix A). Under the provisions of this agreement, the FWS is responsible for infrastructure maintenance requirements and must adhere to certain restrictions on its activities relative to the DU Impact Area.

9.4 TRAINING

The Army has provided training materials and initial UXO and DU safety training to FWS and USAF/IANG personnel. After this initial training, the FWS and USAF/IANG are responsible for training their personnel and visitors in accordance with the requirements of the MOA (Appendix A). The FWS has developed a comprehensive public access plan that includes safety training and related protocols and reporting requirements (FWS 2001).

9.5 CONTRACTOR SUPPORT

Contractors are used to support the license termination process. Among the contractors is SAIC, who prepared this DP and the ER (SAIC 2002) for this project. Contractors accessing the DU Impact Area will be provided site training and will report to SBCCOM. Contractors working on-site must comply with radiation safety and license requirements.

10.0 RADIATION SAFETY AND HEALTH PROGRAM DURING LICENSE TERMINATION

Remediation of the DU Impact Area is not planned for license termination under restricted release criteria. Therefore, a radiation safety and health plan for remediation is not required.

The Army requires implementation of a health and safety plan for the environmental monitoring program currently in effect (U.S. Army 2002). In addition, the Army requires implementation of safety protocol and briefings to all visitors and workers who access the area north of the firing line. Additional details on these requirements are provided in Section 16.0 of this DP and in the permits and MOA (Appendix A).

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11.0 ENVIRONMENTAL MONITORING AND CONTROL PROGRAM

With license termination under restricted release criteria, the Army will not implement an environmental monitoring and control program. Under restricted release criteria, doses to the general public and occupational doses will be maintained ALARA pursuant to 10 *CFR* 20. Employees will be made aware of their responsibilities to the ALARA commitment through the DU safety training. Training has been provided to the FWS and USAF personnel. In addition, the FWS and USAF personnel provide site orientation training to visitors of their respective areas north of the firing line in accordance with the provisions of the MOA (Appendix A). Finally, it is noted that data from the environmental monitoring program (U.S. Army 2002) over the past 19 years indicate that DU contamination is confined to the DU Impact Area and has not migrated off-site (Ebinger and Hansen 1996).

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12.0 RADIOACTIVE WASTE MANAGEMENT PROGRAM

Remediation of the DU Impact Area is not planned for license termination under restricted release criteria. Therefore, radioactive waste will not be generated or managed.

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13.0 QUALITY ASSURANCE PROGRAM

Remediation of the DU Impact Area is not planned for license termination under restricted release criteria. Therefore, a QA program for remediation is not required.

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14.0 DU IMPACT AREA RADIATION SURVEYS

Historical site information and scoping and characterization surveys conducted in 1994 and 1995 identified specific areas within JPG that are contaminated with DU (SEG 1995c; SEG 1996). Section 4.0 of this DP describes how the radiological status of the facility was determined consistent with the guidance of NUREG-1727. Information presented in Section 4 includes descriptions of the methods and procedures as well as the results of the surveys.

The scoping and characterization surveys identified a 125-acre (0.5-km^2) area within the DU Impact Area that contains the majority of residual contamination at JPG. The results indicated that soil in the immediate vicinity of, or immediately below, penetrators contain relatively high levels of DU and that soil samples collected in locations not in the immediate vicinity of penetrators contain low or background levels of DU. Surface water and wildlife samples contain background levels of radioactivity. These results indicate that residual contamination at JPG is concentrated in a heterogeneous manner in trenches located along three lines of fire and that movement of DU through the environment has been confined to the immediate vicinity of penetrators. In addition, the presence of large quantities of UXO poses risk to the individuals present in the DU Impact Area.

Results of the scoping and characterization surveys indicate that conduct of a final survey would introduce high risk to survey workers and not provide additional information needed to protect public health and safety. Based on these considerations, the Army proposes that the results of the scoping and characterization surveys be used in place of a final survey, and that collectively, the results of the surveys and dose analysis demonstrate compliance with the radiological criteria for license termination. The sensitivity and uncertainty analysis included in the dose analysis provide assurance that the dose criteria will not be exceeded given the expected variability of parameters at JPG. Because the objective of the dose analysis was to assess dose using actual concentrations of residual radioactivity as discussed in Section 3.3 of Appendix C of NUREG-1727, derived concentration guideline levels were not calculated for JPG.

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15.0 FINANCIAL ASSURANCE

This section provides information on the annual costs to support license termination (Section 15.1), certification requirements (Section 15.2), and the Army's intent to request Congressional funding to ensure compliance with restricted release criteria (Section 15.3).

15.1 COST ESTIMATE

The annual costs to support license termination, presented in Table 15-1, are approximately $162,500. These costs are sufficient to allow an independent third party to assume responsibility for institutional controls and associated maintenance activities.

Table15-1. Estimated Annual Institutional Control Costs for Jefferson Proving Ground License Termination

Task/Activity/Component	Annual Cost ($)
Road Maintenance	17,500.00
Perimeter Mowing	20,000.00
Perimeter Fence Inspection	96,500.00
Fence Repair	10,000.00
Fence Sign Monitor/Replace	4,000.00
DU Impact Area Surveillance	12,500.00
DU Sign Monitor/Replace	2,000.00
Total	**162,500.00**

Note: These are the total funds the U.S. Army would require if the MOA with the USAF and the FWS is terminated. With the MOA in effect, estimated U.S. Army expenses are approximately $15,000.00 per year.

DU = depleted uranium.
FWS = U.S. Fish and Wildlife Service.
JPG = Jefferson Proving Ground.
MOA = Memorandum of Agreement.
USAF = U.S. Air Force.

15.2 CERTIFICATION STATEMENT

Based on the objective, scope, and approach to termination of the NRC License No. SUB-1435, as outlined in this DP, a certification statement is not required.

15.3 FINANCIAL ASSURANCE MECHANISM

As a federal government entity, the Army will satisfy the financial assurance requirement with a Statement of Intent. This statement of intent indicates that the Commanding General of SBCCOM has the authority and responsibility to request funds for implementation and maintenance of institutional controls to ensure compliance with restricted release criteria as specified in 10 *CFR* 20.1403 (b). Appendix D includes SBCCOM's Statement of Intent regarding funding requests.

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16. RESTRICTED USE

This section demonstrates that the JPG meets the requirements of 10 *CFR* 20.1403. Included in this discussion is the eligibility determination (Section 16.1), a discussion of institutional controls in place to support this action (Section 16.2), a discussion of public involvement (Section 16.3), and a summary of dose modeling and ALARA demonstration (Section 16.4).

16.1 ELIGIBILITY DEMONSTRATION

The ALARA analysis (Section 7.0) of this DP demonstrates that the existing contamination levels are ALARA given that the costs of reducing the non-homogeneous residual DU contamination intermixed with UXO are much higher than any accrued benefits. The ALARA analysis also concludes that UXO and DU decontamination activities necessary to remove residual DU likely would result in net public or environmental harm. This net public or environmental harm primarily is a result of the occupational hazards and the hazards of transporting contaminated soil to a distant disposal site (see Section 7.3). This analysis demonstrates that the Army is eligible to request release of the site under the provisions of 10 *CFR* 20.1403.

16.2 INSTITUTIONAL CONTROLS

UXO contamination is present on a large portion of the area North of the Firing Line, including the DU Impact Area, which includes DU contamination. In addition, portions of the JPG are still being used for bombing practice. Figure 16-1 shows the general location of areas with UXO, the DU Impact Area, and the active bombing areas. Because of the presence of UXO and the occasional bombing practices, access to and use of the area North of the Firing Line is limited. Agricultural, residential, or industrial activities are not permitted. To control access to and use of the area North of the Firing Line, the U.S. Army has and will continue to use a variety of institutional controls. These institutional controls and the Army's permitting system for the FWS and USAF are discussed.

The specific institutional controls[1] to be implemented by the Army include physical, legal, and administrative mechanisms. These include:

1. The U.S. Army will retain title to the JPG, North of the Firing Line.

   The U.S. Army will control access to, and activities on, the portion of the JPG North of the Firing Line. Access to the approximately 51,000 acres North of the Firing Line is and will continue to be restricted by a fence around the entire area. Warning signs are and will continue be posted along the fence line. No demolition, excavation, digging, drilling, or other disturbance of the soil, ground, or groundwater, or use of soil, ground, or groundwater for any purpose will be permitted without written approval of the Army. Public access will only be allowed in selected areas that have a reduced potential for the presence of UXO and no DU. These areas primarily are along the inside of the perimeter fence and on the northern portion of the JPG as shown in Figure 16-1. When public access is allowed, the visitors will receive a safety briefing on the hazards and will be required to sign a statement acknowledging the hazard and agreeing to hold the Army harmless.

[1]Refer to the footnote in Section 6.0 regarding the U.S. Department of Defense's definition of land use controls. This definition includes physical, legal, and administrative mechanisms to control access to and/or use of real property. Institutional controls are legal controls under the National Contingency Plan; however, in the context of this DP, institutional controls and land use controls are synonymous. At Jefferson Proving Ground, all three types of land use controls are and will be in effect.

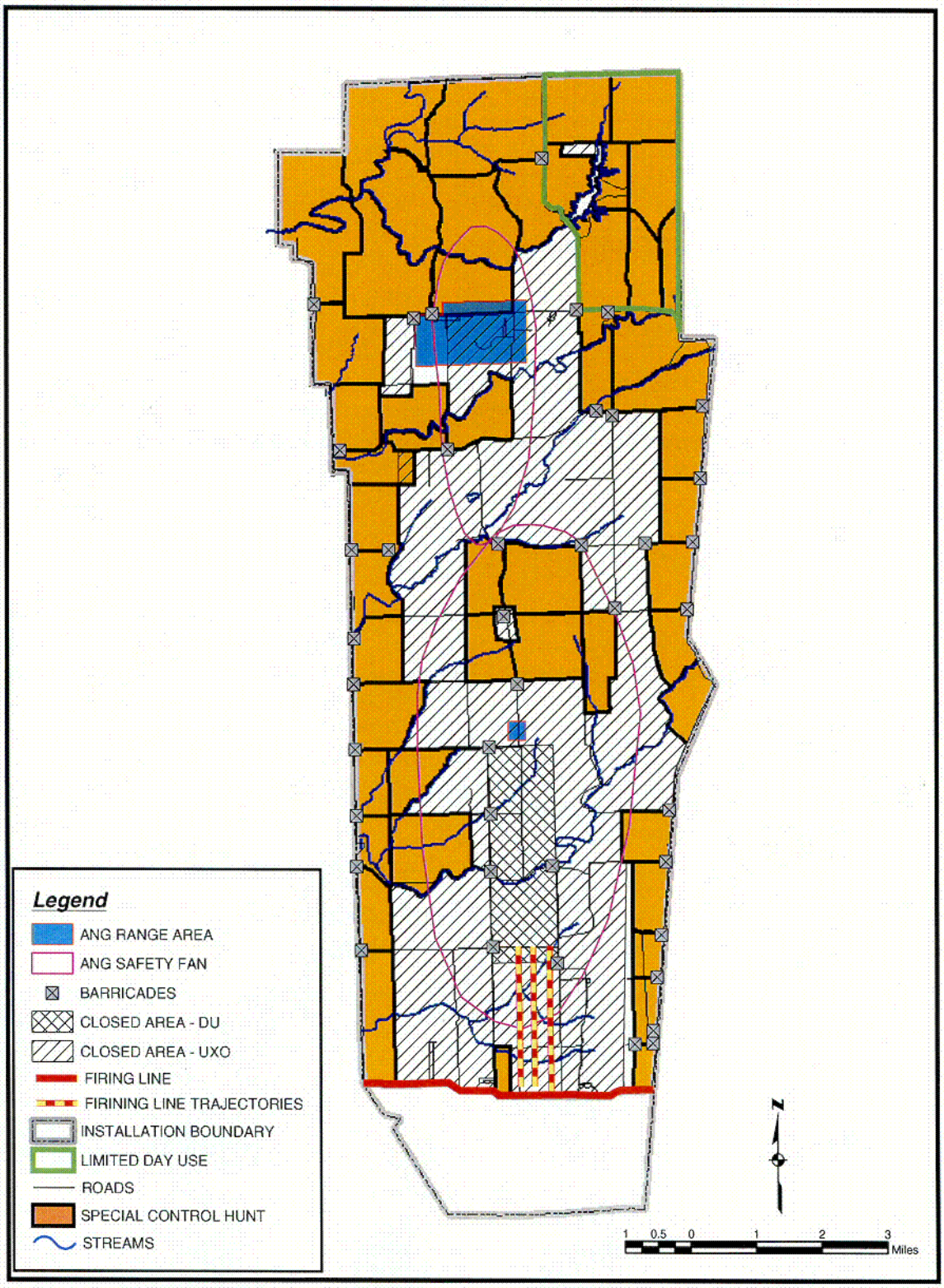

Figure 16-1. Potential Public Uses at the Big Oaks National Wildlife Refuge

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3. In 1995, the U.S. Army retroceded exclusive jurisdiction over JPG to the State of Indiana (U.S. Army 1995b). Under the Interim Public Access Plan for the Big Oaks NWR (see Appendix A), the FWS, in consultation with the USAF, developed and coordinated law enforcement strategies to enforce refuge trespasses and other public use violations.

4. Additional access controls are applied to the DU Impact Area, including locked barricades on access roads and signs around the perimeter stating, "No trespassing" and "Caution – Radioactive Material." Key access for the barricades is limited to personnel formally authorized by the U.S. Army. Quarterly lock and key inventories are conducted. Access to the DU Impact Area is limited to individuals conducting official U.S. government business.

5. The Army may authorize permits for other U.S. government agencies to use the land, but such permits will require compliance with all the controls listed above and maintenance requirements listed in this section of the plan. At the present time, the Army has an agreement with the FWS for management of the Big Oaks NWR and with the USAF for use of portions of the JPG as a bombing range (see Appendix A). The Army will conduct inspections to ensure compliance with the terms of the permit, as appropriate. If violations of the permit conditions are identified, the Army retains the right to suspend the site activities of the other government agency until appropriate corrective action is taken. The Army will conduct a formal review of the effectiveness of any permits and the effectiveness of the land use controls every 5 years.

6. Records of visitors to the area North of the Firing Line will be prepared and maintained by the federal authority (the U.S. Army or a U.S. Army-permitted federal authority) granting access to the area. The Army will also maintain a record of its review of the effectiveness of the institutional controls.

These institutional controls are planned to remain in place for the foreseeable future because of the presence of, and hazards associated with, both the UXO and DU.

16.3 MAINTENANCE

The Army, or its permitted federal agencies, will patrol and inspect the perimeter fence weekly. The inspections will be documented to show the inspection date, the inspector, and the location of any fence damage. The Army, or its permitted federal agencies, will repair any damage to the perimeter fence.

The Army, or its permitted federal agencies, also will maintain all required roads, road shoulders, low water crossings, bridges, and culverts and provide access control signs at specified locations. In addition, the Army, or its permitted federal agencies, will maintain the barricading and marking of all roads surrounding the DU Impact Area with radiation warning signs.

The Army has committed to request Congressional funding for the implementation and maintenance of institutional controls necessary to support license termination with restrictions. This commitment is presented in Appendix D of this DP.

16.4 OBTAINING PUBLIC ADVICE

The U.S. Army has solicited local input as it plans and implements its cleanup and management of the JPG. In 1994, the U.S. Army established the RAB as a voluntary advisory group. The RAB members include individuals from state and Federal regulatory agencies, as well as residents from the surrounding three counties. All of the RAB meetings are open to the public, and the Army solicits comments from the

general public in addition to the RAB members at the RAB meetings. Meeting minutes are documented and included in the JPG Administrative Record.

There are typically three to five RAB meetings a year. There have been four RAB meetings that have had extensive discussions of the SBCCOM's proposal for terminating the JPG license under restricted conditions. Among the key meetings were the January 7, 1997, May 31, 2000, February 6, 2001, and February 6, 2002, RAB meetings (SAS 1997, 2000, 2001, and 2002). These meetings discussed the institutional controls the Army proposed to NRC, controls that where identified in the August 1999 (U.S. Army 1999) and the July 2001 DPs (U.S. Army 2001).

The following list summarize the concerns expressed by the RAB members and public on the three aspects of the proposed JPG institutional controls that are identified in 10 *CFR* 20.1403(d), specifically:

- whether the institutional controls provide reasonable assurance that the TEDE from residual DU will not exceed 25 mrem/yr,

- whether the institutional controls will be enforceable,

- whether the institutional controls will impose an undue burden on the local community or affected parties, and

- whether the financial assurances will allow an independent third party to assume and carry out the responsibilities for control and maintenance of the site.

The RAB members and public had some concerns about whether the proposed institutional controls would provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group would not exceed 25 mrem (0.25 mSv) TEDE per year. The RAB meeting minutes do not indicate there were questions raised regarding whether or not institutional controls for the Big Oaks NWR would keep visitors (hunters, fishermen, etc.) from inadvertently venturing into the DU Impact Area when there would be no fence around that specific area. The U.S. Army did discuss the hazards and costs of installing and maintaining a fence around the DU Impact Area, given the pervasive presence of UXO.

Questions were raised about the reliability of predictions about future doses when there would be no environmental monitoring to corroborate predictions about DU concentration in the various environmental media. Furthermore, there was concern about there being insufficient data on the fate and transport of DU in the environment. Questions were also asked about whether the IANG bombing practices would occur in the DU Impact Area. Such actions would disturb the site and might displace and mobilize DU. Finally, there was a concern that DU is contaminated with plutonium.

At several RAB meetings (SAS 1997, 2000, 2001, and 2002), RAB members and the public were concerned about the enforceability of the proposed institutional controls. The U.S. Army indicated that unauthorized access to the DU Impact Area would be trespassing on federal property, which is a Federal offense. STV, a local community activist group, commented on the earlier License Termination Plan (U.S. Army 2001), indicating reservations about the enforceability of the institutional controls (STV 2001).

While RAB members and some of the public expressed concerns about the uncertainty that was associated with projected future doses, and expressed a desire for the Army to continue environmental monitoring, these individuals did not articulate a concern that license termination under restrictions would impose undue burdens on the local community.

Responding to these concerns, this DP responds to these concerns by completing the following actions:

- presents an expanded discussion and analysis of exposure scenarios, including ones that involve transport and exposure of off-site personnel and the uncertainty associated with the estimates (Appendix C);

- provides an expanded discussion of institutional controls, including the enforcement of access controls by the U.S. Army or permitted federal agencies; and

- provides an expanded discussion of the license termination alternatives, including the general nature of the impacts that would be associated with achieving unrestricted release (see Section 6.0).

16.5 DOSE MODELING AND ALARA DEMONSTRATION

The summary of dose modeling for the situation where institutional controls are in place is presented in Section 5.1 of this DP. This analysis shows the dose with institutional controls in place is less than 25 mrem/yr even when using high (conservative) assumptions about average DU concentrations in the soil.

The summary of dose modeling for the situation where institutional controls are no longer in place is presented in Section 5.2 of this DP. This analysis shows the dose where institutional controls are no longer in place is less than 100 mrem/yr.

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APPENDIX A

PERMITS AND MEMORANDUM OF AGREEMENT

This Appendix contains the following permits:

- Department of Army Permit to the Fish and Wildlife Service
- Department of Army Permit to the Department of the Air Force

The Memorandum of Agreement, which establishes the framework for the partnership between the Department of Army, Fish and Wildlife Service, and Department of Air Force, is included as an exhibit in each permit.

DEPARTMENT OF ARMY PERMIT TO FISH AND WILDLIFE SERVICE TO USE PROPERTY LOCATED ON JEFFERSON PROVING GROUND, MADISON, INDIANA

DEPARTMENT OF ARMY PERMIT TO FISH AND WILDLIFE SERVICE TO USE PROPERTY LOCATED ON JEFFERSON PROVING GROUND, MADISON, INDIANA

This permit is organized as follows:

- Permit
- Exhibit A. Site Map. This exhibit also includes descriptions and maps of permitted areas.
- Exhibit B. Memorandum of Agreement. This document includes five enclosures:
  - Enclosure 1. Site Map
  - Enclosure 2. Department of Army Permit to FWS to Use Property Located on JPG. The Interim Public Access Plan for the Proposed Big Oaks National Wildlife Refuge is included in this enclosure.
  - Enclosure 3. Department of Army Permit to the Department of Air Force to Use Property Located on JPG. The Range Access Plan is included with this enclosure.
  - Enclosure 4. North of the Firing Line UXO Response Standard Operating Procedure
  - Enclosure 5. FWS/Air Force Infrastructure Maintenance Responsibilities
- Exhibit C. Interim Public Access Plan
- Exhibit D. Road and Bridge Commitments

Maps depicting the potential location of unexploded ordance (UXO) were current at the time of permit execution. Refer to the main body of this report for the current status of UXO within the installation.

DEPARTMENT OF THE ARMY
PERMIT TO FISH AND WILDLIFE SERVICE
TO USE PROPERTY LOCATED ON
JEFFERSON PROVING GROUND
MADISON, INDIANA

THE SECRETARY OF THE ARMY, hereinafter referred to as the Secretary, hereby grants to the United States Fish and Wildlife Service (USFWS), hereinafter referred to as the Grantee, a permit for the establishment of a National Wildlife refuge at Jefferson Proving Ground (JPG), Indiana, over, across, in and upon the lands identified in Exhibit "A", attached hereto and made a part hereof, hereinafter referred to as the premises. The Secretary and the Grantee are collectively hereinafter referred to as the "Parties".

THIS PERMIT is granted subject to the following conditions.

1. This permit is hereby granted for a term of twenty-five (25) years, beginning 1 July 2000 and ending 30 June 2025, with renewable ten (10) year periods upon mutual agreement of the Parties. This permit may be terminated earlier, by either the Secretary or Grantee, by providing one hundred eighty (180) days' written notice.

2. The consideration given by the Grantee is the management of the premises as a National Wildlife Refuge as well as the care and maintenance of the premises as specified in the Memorandum of Agreement (MOA) attached hereto as Exhibit "B" and made a part hereof.

3. All correspondence and notices to be given pursuant to this permit shall be addressed, if to the Grantee, to USFWS, Bishop Henry Whipple Federal Building, 1 Federal Drive, Ft. Snelling, Minnesota 55111 (Attn: Mr. John Christian) and, if to the Secretary, to the District Engineer, Louisville District, P.O. Box 59, Louisville, Kentucky 40201 (Attn: CELRL-RE-C), with a copy furnished to the Jefferson Proving Ground (JPG) Commander, Newport Chemical Depot, P.O. Box 160, Newport, Indiana 47966-0160, or as may from time to time otherwise be directed by the parties. Notice shall be deemed to have been duly given if and when enclosed in a properly sealed envelope or wrapper addressed as aforesaid

and deposited, postage prepaid, in a post office regularly maintained by the United States Postal Service.

4. The use and occupation of the premises shall be without cost or expense to the Department of the Army and under the general supervision of the JPG Commander and in accordance with the terms and conditions of the MOA. In the event of a conflict between the MOA and this permit, the MOA shall be the controlling instrument.

5. The Grantee acknowledges that it has inspected the premises, knows its condition, and understands that same is granted without any representations or warranties whatsoever and without obligation on the part of the Department of the Army, except as provided in the MOA.

6. In accordance with the MOA, the Grantee shall, at its own expense and without cost or expense to the Department of the Army, maintain and keep the premises at a level sufficient to support Refuge operations and in accordance with the tasks in Enclosure 5 of the MOA.

7. The Department of the Army shall not be responsible for providing utilities to the Grantee and it shall be the Grantee's responsibility for obtaining any utilities necessary for its use and occupation of the premises at no expense to the Department of the Army.

8. No additions or alterations of the premises shall be made without the prior written approval of the District Engineer.

9. On or before the expiration of this permit or the termination by either party, in accordance with paragraph one (1), the Grantee shall vacate the premises, remove its property therefrom and restore the premises to a condition satisfactory to the District Engineer, ordinary wear and tear and damage beyond the control of the Grantee excepted.

10. The Grantee shall comply with all applicable Federal, state, interstate, and local laws and regulations wherein the premises are located.

11. The Army will provide the Grantee with baseline information concerning the environmental condition of the premises in accordance with paragraph III 1(a) of the MOA documenting the known history of the property with regard to storage, release or disposal of hazardous substances

on the property. Upon expiration or termination of this permit, the Grantee shall, at its own expense and without cost or expense to the Department of the Army, document any storage, release or disposal of hazardous substances in excess of 40 CFR Part 373 reportable quantities and any petroleum products in excess of 55 gallons. A comparison of the two assessments will assist the Army in determining any environmental restoration requirements of the Grantee. Any such requirements will be completed by the Grantee in accordance with the Environmental Remediation provisions in the MOA and paragraph nine (9) of this permit.

12. It is understood that the requirements of this permit pertaining to maintenance, repair, protection, and restoration of the premises and providing utilities and other services shall be effective only insofar as they do not conflict with the MOA or any other agreement pertaining to such matters made between local representatives of the Army and Grantee in accordance with existing regulations.

13. Access to and use of JPG shall be controlled in accordance with the Grantee's Interim Public Access Plan for the Proposed Big Oaks National Wildlife Refuge included in the MOA and attached hereto as Exhibit "C". The Army must first approve any variation from this Plan and a revised Site Access Plan shall be made a part of this permit.

14. The Grantee shall not use the premises for the storage, treatment or disposal of non-Department of Defense owned hazardous or toxic materials as defined in 10 U.S.C. 2692, unless authorized under 10 U.S.C. and properly approved by the Government.

15. The Grantee is hereby informed and does acknowledge that all buildings on the premises, which were constructed or rehabilitated prior to 1978, are presumed to contain lead-based paint. For those buildings the Grantee uses and occupies, it shall comply with all applicable Federal, state and local laws and regulations pertaining to lead-based paint and/or lead-based paint hazards. The Grantee shall restrict access (e.g., secure buildings to the extent practical, post warning signs, etc.) to all unoccupied buildings except those buildings located in UXO Restricted Areas (see Site Map at MOA Enclosure 1). The Grantee shall restrict access to the UXO Restricted Areas in accordance with the Site Access Plan. The Grantee shall not permit the use of any of the buildings or structures on the premises for residential habitation. Residential habitation does not include use of the Old Timbers

Lodge for conference purposes including overnight visits on a non-permanent basis. The Grantee assumes all lead-based paint related liability arising from its use of the premises.

16. The Grantee is hereby informed and does acknowledge that friable and non-friable asbestos or asbestos containing materials (ACM) has been found on the premises. The Grantee acknowledges that it will inspect any building it proposes to occupy as to its asbestos content and condition and any hazardous or environmental conditions relating thereto. The Grantee shall restrict access (e.g., secure buildings to the extent practical, post warning signs, etc.) to all unoccupied buildings except those buildings located in UXO Restricted Areas (see Site Map at MOA Enclosure 1). The Grantee shall restrict access to UXO Restricted Areas in accordance with the Site Access Plan. The Grantee shall be deemed to have relied on its own judgment in assessing the condition of the premises with respect to any asbestos hazards or concerns. The Grantee covenants and agrees that its use and occupancy of a building will be in compliance with all applicable laws relating to asbestos. The Grantee assumes all asbestos related liability arising from its use of the premises.

17. The Grantee does not plan to occupy any buildings this fiscal year; however, Exhibit "D" attached hereto identifies Road & Bridge Maintenance Commitments for FY 2000. This information will be updated at least annually by the Grantee.

THIS PERMIT is not subject to Title 10, United States Code, Section 2662, as amended.

IN WITNESS whereof, I have hereunto set my hand by authority of the Secretary of the Army this 30th day of JUNE 2000.

Michael G Barter

MICHAEL G. BARTER
Chief, Real Estate Division
Louisville District, Corps of Engineers
Louisville, Kentucky

This permit is also executed by the Grantee this 27 day of June 2000.

U.S. FISH AND WILDLIFE SERVICE

By: _____

Title: Assistant Regional Director
Indiana/Michigan/Ohio and
Wisconsin

EXHIBIT A. SITE MAP

JEFFERSON PROVING GROUND
SITE MAP

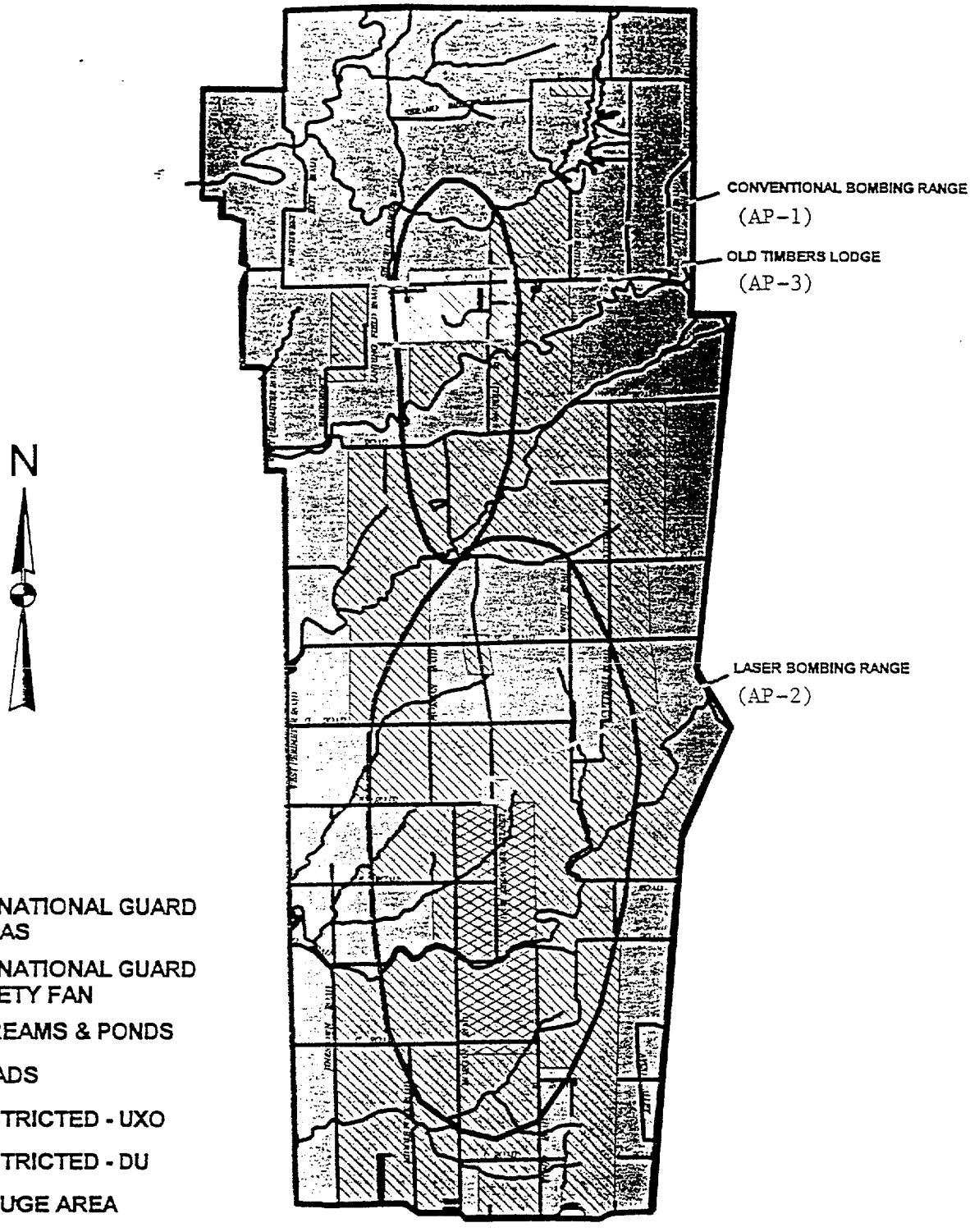


EXHIBIT A

PERMIT AREA NO. AP-1
FOR U.S. AIR FORCE

JEFFERSON PROVING GROUND
MILITARY RESERVATION
JEFFERSON COUNTY, INDIANA

PERMIT DESCRIPTION

Situate in the State of Indiana, County of Ripley, Township of Shelby, Township 6 North, Range 10 East, in parts of Sections 4 and 5, and Township 7 North, Range 10 East, in parts of Sections 32 and 33, in the Jefferson Proving Ground reservation, and more particularly described with referenced to the attached map showing coordinates based on the Universal Transverse Mercator (UTM) Metric Grid Coordinate System (NAD 27), Zone 16S, as follows:

Beginning at a point having an approximate UTM value of FU634749E/4318620N, said point being in the center of 'K' Road at the eastern boundary of the County of Ripley, and being at or near the west quarter corner of said Section 32; thence

North 88 degrees 13 minutes 20 seconds East 741.36 meters to a point having an approximate UTM value of FU635490E/4318643N; thence

North 00 degrees 32 minutes 51 seconds West 314.01 meters to a point having an approximate UTM value of FU635487E/4318957N; thence

East 2,118.00 meters to a point having an approximate UTM value of FU637605E/4318957N; thence

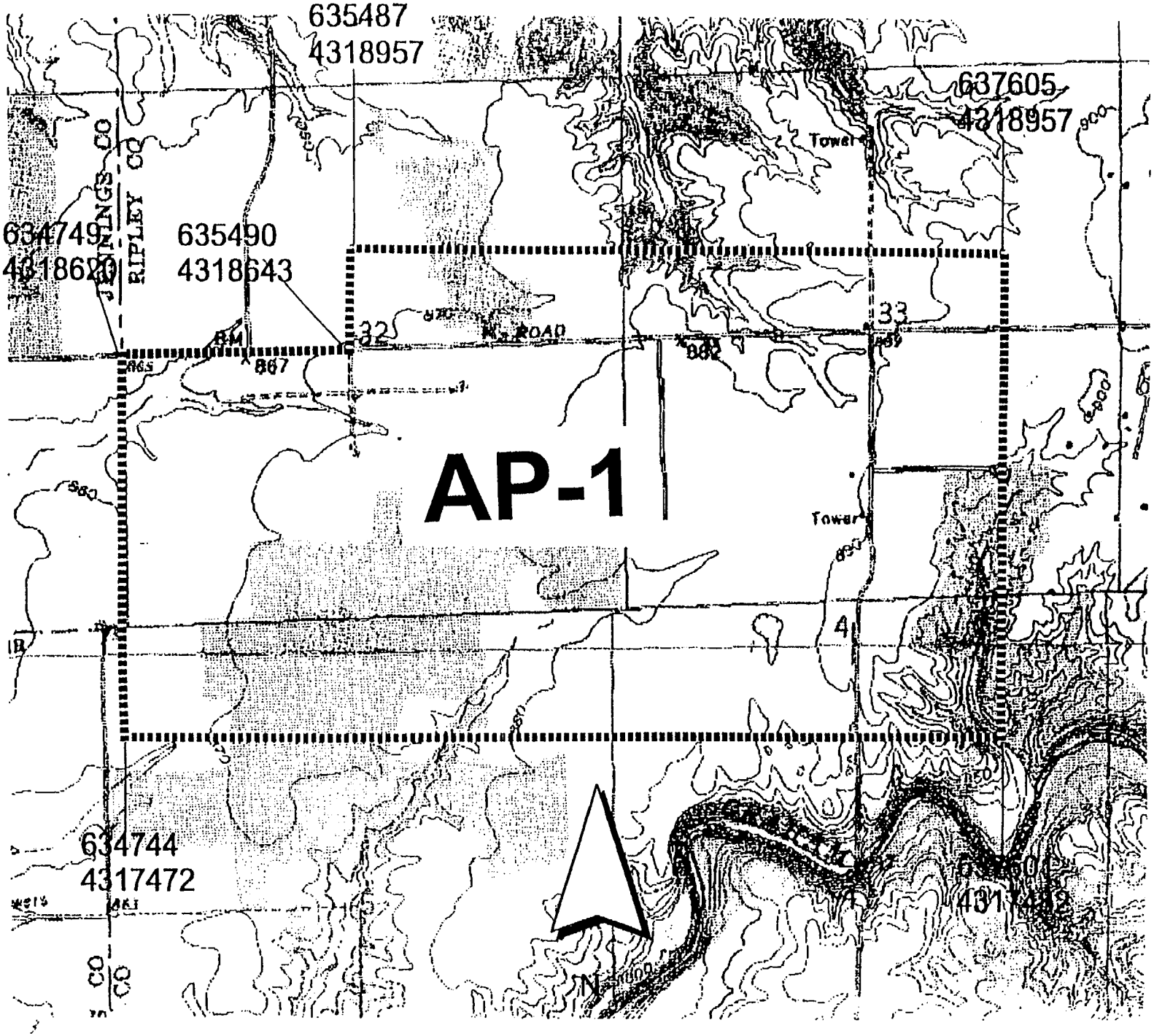
South 00 degrees 09 minutes 19 seconds West 1475.01 meters to a point having an approximate UTM value of FU637601E/4317482N; thence

South 89 degrees 47 minutes 58 seconds West 2,857.02 meters to a point having an approximate UTM value of FU634744E/4317472N; thence

North 00 degrees 14 minutes 58 seconds East 1,148.01 meters to the point of beginning, containing 398.611 hectares (984.967 acres), more or less.

15 June 2000, BLB; Rev 23 June 2000, BLB (3,4)

ANG Jefferson Range Area



PERMIT AREA NO. AP-2
FOR U.S. AIR FORCE

JEFFERSON PROVING GROUND
MILITARY RESERVATION
JEFFERSON COUNTY, INDIANA

PERMIT DESCRIPTION

Situate in the State of Indiana, County of Ripley, Township of Shelby, Township 6 North, Range 10 East, in part of Section 33, in the Jefferson Proving Ground reservation, and more particularly described with referenced to the attached map showing coordinates based on the Universal Transverse Mercator (UTM) Metric Grid Coordinate System(NAD 27), Zone 16S, as follows:

Beginning at a point having an approximate UTM value of FU637038E/4308284N, said point being 205 meters west of Center Recovery Road and 90 meters north of 'F' Road; thence

North 00 degrees 46 minutes 21 seconds West 445.04 meters to a point having an approximate UTM value of FU637032E/4308729N; thence

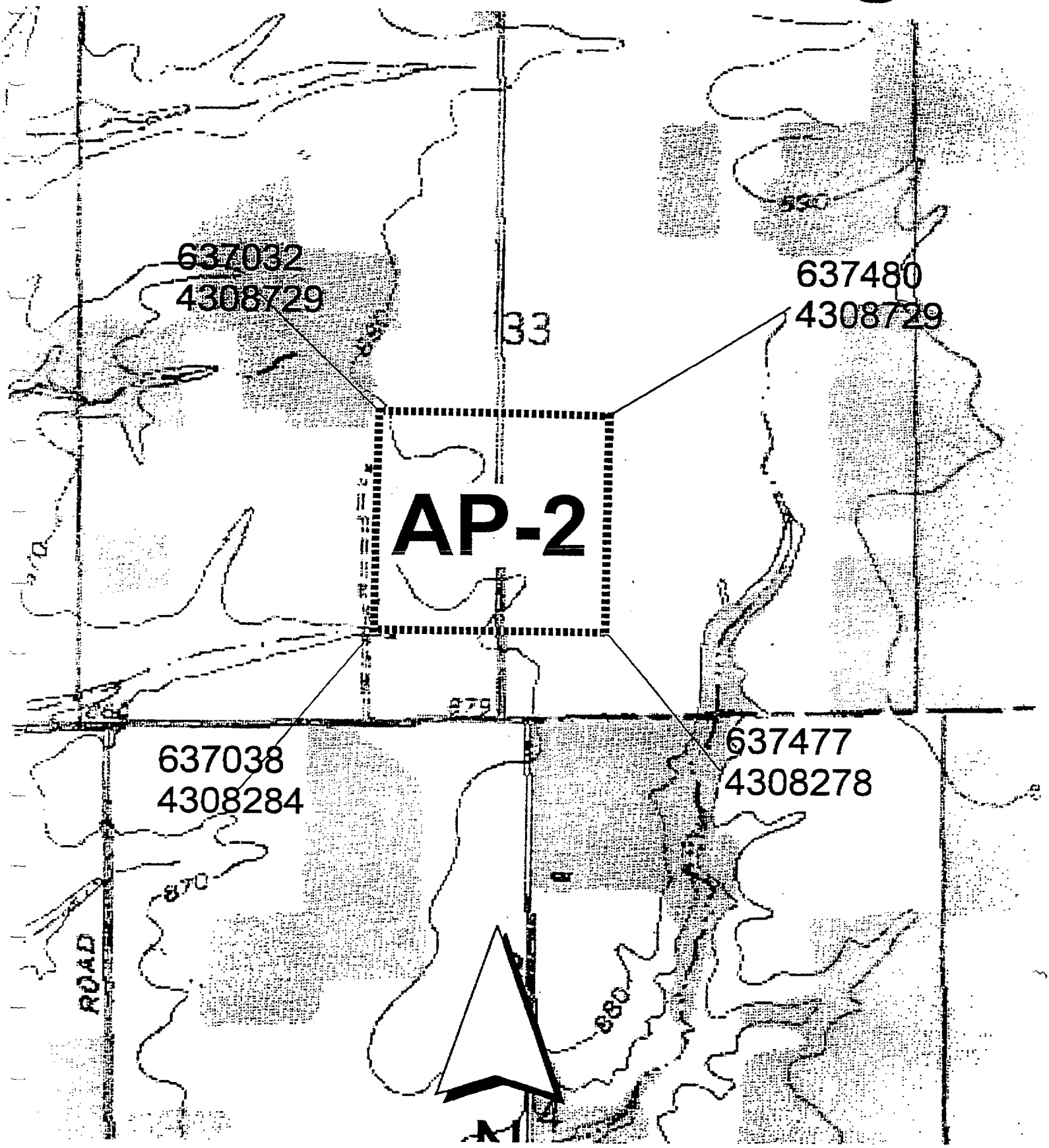
East 448.00 meters to a point having an approximate UTM value of FU637480E/4308729N; thence

South 00 degrees 22 minutes 52 seconds East 451.01 meters to a point having an approximate UTM value of FU637477E/4308278N; thence

North 89 degrees 13 minutes 01 seconds West 439.04 meters to the point of beginning, containing 19.869 hectares (49.096 acres), more or less.

15 June 2000, BLB; Rev 23 June 2000, BLB (3,4)

50-acre PGM Target



PERMIT AREA NO. AP-3
FOR U.S. AIR FORCE

JEFFERSON PROVING GROUND
MILITARY RESERVATION
JEFFERSON COUNTY, INDIANA

PERMIT DESCRIPTION

Situate in the State of Indiana, County of Ripley, Township of Shelby, Township 7 North, Range 10 East, in part of Section 34, in the Jefferson Proving Ground reservation, and more particularly described with referenced to the attached map showing coordinates based on the Universal Transverse Mercator (UTM) Metric Grid Coordinate System (NAD 27), Zone 16S, as follows:

Beginning at a point having an approximate UTM value of FU63947E/431876N, said point being 4731.5 meters east of the intersection of 'K' Road with the eastern boundary of the County of Ripley, and being at or near the west quarter corner of Section 32; thence

East 30.0 meters to a point having an approximate UTM value of FU63950E/431876N; thence

South 250.0 meters to a point having an approximate UTM value of FU63950E/431851N; thence

South 84 degrees 17 minutes 22 seconds West 100.5 meters to a point having an approximate UTM value of FU63940E/431850N; thence

South 210 meters to a point having an approximate UTM value of FU63940E/431829N; thence

West 70 meters to a point having an approximate UTM value of FU63933E/431829N; thence

North 05 degrees 11 minutes 40 seconds East 220.9 meters to a point having an approximate UTM value of FU63935E/431851N; thence

North 85 degrees 14 minutes 11 seconds East 120.4 meters to a point having an approximate UTM value of FU63947E/431852N; thence

North 240.0 meters to the point of beginning, containing 2.18 hectares (5.388 acres), more or less.

15 June 2000, BLB

AP-3

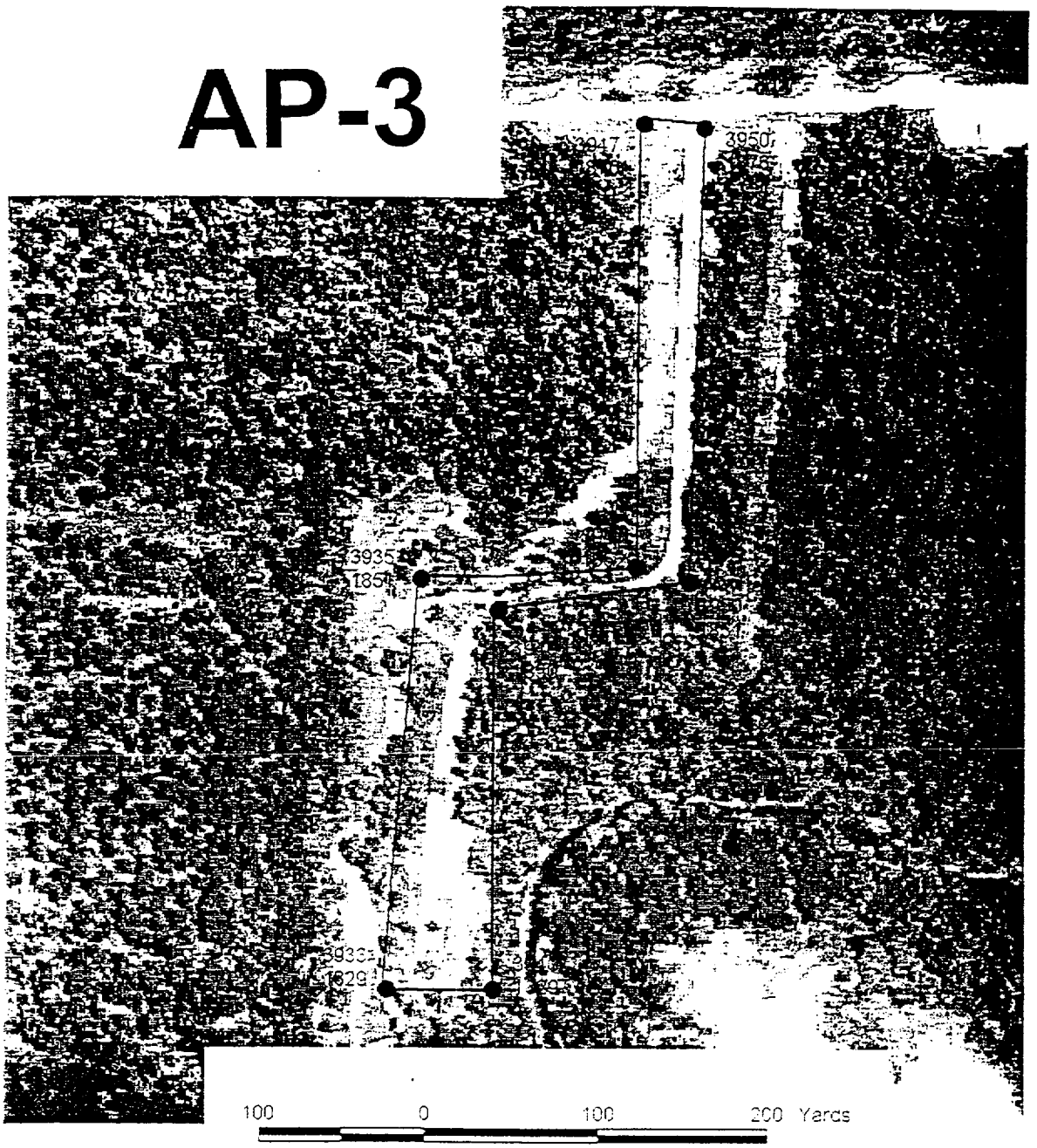


EXHIBIT B. MEMORANDUM OF AGREEMENT

JEFFERSON PROVING GROUND FIRING RANGE MEMORANDUM OF AGREEMENT (MOA)

This is a Memorandum of Agreement (MOA) among the Department of the Army (Army), the Department of Air Force (Air Force), and the Department of the Interior-United States Fish and Wildlife Service (FWS), all hereafter collectively referred to as the "parties".

I. BACKGROUND AND PURPOSE

1. As a result of the Base Closure and Realignment Act (BRAC) of 1988, the Army's mission at Jefferson Proving Ground (JPG) terminated in September 1995. The JPG property consists of about 55,000 acres located in southeastern Indiana. It is composed of an approximate 4000-acre cantonment area and an approximate 51,000-acre firing range area (Firing Range). The purpose of this MOA is to establish the framework for authorizing the future use of the Firing Range by the U.S. Fish and Wildlife Service (FWS) and continued use by the Air Force. The cantonment area of JPG is being transferred under the BRAC process and is outside the scope of this agreement.

2. Due to unexploded ordnance (UXO), depleted uranium (DU) and other environmental contamination from past Army activities, the Firing Range area is not suitable for commercial or residential development. Despite the UXO and DU contamination, the Firing Range provides wildlife habitat of regional and national significance. In addition, portions of the Firing Range are being used by the Air Force as a bombing range (Bombing Range). The Bombing Range consists of an approximate 983-acre conventional bombing range and an approximate 50-acre laser bombing range, as well as large safety fans, when in use, for each range and associated air space (see map at Enclosure 1). These safety fans overlay significant portions of the Firing Range and are off limits to unauthorized personnel during flight operations involving training munitions or laser energy. The Air Force Bombing Range activities involve training munitions (i.e. an inert munition with a spotting charge) and laser energy, which have had no known significant adverse impact on the wildlife at the Firing Range. As a result of the unique property conditions associated with the Firing Range, the FWS is interested in establishing a National Wildlife

EXHIBIT B

Refuge (Refuge) to preserve significant wildlife habitat values, and the Air Force requires continued use of the Bombing Range as a mission-essential training facility.

3. In order to support the establishment of the Refuge and the continued use of the Bombing Range, the Army agrees to the following:

a. The Army will grant the FWS a real estate permit for the entire Firing Range except for the Bombing Range and the Old Timbers Lodge and associated acreage (See Enclosure 2).

b. The Army will grant the Air Force a real estate permit for the Bombing Range and the Old Timbers Lodge and associated acreage (See Enclosure 3).

The FWS and the Air Force real estate permits will be subject to the terms and conditions set forth in this MOA.

4. The restoration requirements of this MOA and the permits issued under it are authorized by 10 U.S.C. § 2691.

II. OVER-ARCHING PRINCIPLES

The parties recognize the importance of having periodic meetings/conference calls, at least quarterly, among the Jefferson Proving Ground Commander, the Refuge Manager, and the Bombing Range Commander. The relationships between the parties will be governed by the following overarching principles:

1. The Army will consult and coordinate with the other parties to ensure that all Army activities (e.g., remediation activities, UXO demonstration projects, or other future activities) are consistent with Refuge and Bombing Range activities.

2. The FWS will consult and coordinate with the other parties to ensure that all Refuge activities (e.g., development of the interim public access plan, the comprehensive public access plan, the Comprehensive Conservation Plan, any modifications to a public access plan, reviews of requests to conduct non-FWS activities, refuge management activities, etc.) are consistent with Army and Bombing Range activities. The FWS specifically agrees that Refuge activities will be consistent with existing environmental conditions and will not otherwise increase the Army's environmental remediation costs.

3. The Air Force will consult and coordinate with the other parties to ensure that all Bombing Range activities (e.g., development of the site access plan (including any modifications to the site access plan), reviews of requests to conduct non-Air Force activities, training operations, etc.) are consistent with Army and FWS activities. The Air Force specifically agrees that Bombing Range activities will be consistent with existing environmental conditions and will not increase the Army's environmental remediation costs.

4. Except as otherwise provided in this MOA, all disputes between the parties relating to the terms and conditions of this MOA will be subject to the dispute resolution procedure set forth in Section VI.

III. ARMY RESPONSIBILITIES

1. Environmental Remediation.

a. The Army will provide the FWS and Air Force with baseline information concerning the environmental condition of the Firing Range utilizing such reports as The Final Study Cleanup and Reuse Options (Mason and Hanger Report 1992). the Environmental Sampling Plan for the Open Detonation Unit (1994), The Resource Conservation and Recovery Act Facility Assessment (1992), The Community Environmental Response Facilitation Act Report (1994), The Depleted Uranium Decommissioning Plan (Draft 1999), The Archives Search Report for Ordnance and Explosive Waste Chemical Warfare Materials (1995) and the Environmental Impact Statement for Disposal and Reuse (1995).

b. The Army will retain all authority, responsibility, and liability for remediation of all contamination resulting from past Army activities or present on the Firing Range on the date of this MOA, including UXO, DU, and other contamination. In addition, the Army is responsible for all remediation resulting from present and future site activities as set forth in paragraph III(3). Except as otherwise provided in this MOA, the FWS and Air Force shall not have authority, responsibility, or liability for remediation of UXO, DU, and other contamination (see paragraphs IV(3)(a) and (b), V(6))(a) and (b), and V(8)(b)). The Army shall not be responsible for any environmental requirements resulting from operation of the Refuge or the Bombing Range.

c. For purposes of the regulation proposed as 32 CFR 178, *Closed, Transferred, and Transferring Ranges Containing Military Munitions* (Range Rule), should it become a final rule, and any Department of Defense (DoD) Directive or Instruction relating to closed, transferred, or transferring ranges, to the extent any of them apply to the Firing Range, the Army will remain the "responsible DoD component". Unless otherwise required by the Range Rule or DoD Directive or Instruction, the designation of the Army as the "responsible DoD component" will not alter the parties' liabilities under this MOA.

d. The Army is pursuing a license termination under restricted release conditions for the current license issued by the U.S. Nuclear Regulatory Agency (NRC) for its possession of DU for decommissioning at the Firing Range. This license indicates the licensed material (*i.e.*, DU) is onsite in the area known as the "DU Impact Area", located in the southern portion of the Firing Range. The parties recognize the Army will be solely responsible for finalizing the NRC license termination and conducting any actions required by the License Termination Plan at the Firing Range.

2. UXO.

a. UXO Training Materials. The Army will provide training materials and initial UXO and DU safety training for FWS and Air Force personnel. The training materials will include general information regarding the types of munitions used at the Firing Range but are not intended to be an exhaustive/all inclusive listing. After the training, and based on training materials provided by the Army, the FWS and Air Force will be responsible for providing UXO and DU safety training to all of their respective personnel and visitors based on such training materials and knowledge of the FWS and the Air Force of local site conditions.

b. Emergency UXO Removal. If the FWS or Air Force discovers UXO which poses an imminent and substantial hazard to Refuge or Bombing Range operations (e.g., UXO has migrated to the surface of a roadway), the FWS or Air Force will immediately restrict access to the UXO site and notify the Army. The Army will provide for timely removal of UXO found which it determines to be an imminent and substantial hazard to Refuge or Bombing Range operations. The Army will not be required to remove UXO it determines does not pose an imminent and substantial hazard to Refuge or Bombing Range operations (See Enclosure 4 - UXO Response Standing Operating Procedures [SOP]).

c. Non-Emergency UXO Removal. The FWS and Air Force accept that there is no Army plan or budget authority to remove UXO in the Firing Range. However, the Army will make a good faith effort to request non-emergency UXO removal in connection with Army Reserve and/or Army National Guard training exercises to support Refuge or Bombing Range operations. Any type of non-emergency UXO removal in the Firing Range will be subject to the License Termination Plan as approved by the NRC. The FWS and Air Force recognize that any such Army support is contingent on the availability and timing of Army Reserve or Army National Guard exercises. To obtain Army non-emergency UXO removal support, the FWS and Air Force will follow these procedures:

(1) FWS Non-Emergency UXO Removal Support. The FWS will request non-emergency UXO removal support from the Army. To facilitate the support process, the FWS will incorporate building designs that minimize ground disturbance and will provide the Army a minimum 2-year advance notice of their request to complete non-emergency UXO removal. The Army will make a good faith effort to request UXO removal in connection with Army Reserve and/or Army National Guard Training exercises to support Refuge operations. If the Army is not able to obtain non-emergency UXO removal support as part of a training exercise, the FWS agrees to withdraw its request and terminate any plans/operations requiring non-emergency UXO support.

(2) Air Force Non-Emergency UXO Removal Support. The Air Force may request non-emergency UXO removal support from the Army in accordance with paragraph III 2. c. above or it may conduct its own non-emergency UXO removals. Any Air Force non-emergency UXO removals must be conducted by properly certified personnel and in accordance with Department of Defense Explosive Safety Board (DDESB) and all other applicable requirements. If the Air Force elects to conduct its own non-emergency UXO

removal action, the Army and FWS will have no responsibility for any costs resulting from the UXO removal action.

3. Future Site Activity.

The Army is specifically authorized to conduct the following activities on the Firing Range:

a. Army Environmental Restoration Activities. The Army is authorized to conduct environmental restoration and remediation activities to the extent required by law. For purposes of this MOA, environmental restoration and remediation include NRC license termination activities. The Army assumes no liability should its restoration and remediation activities interfere with FWS or Air Force operations.

b. UXO Removal Technology Demonstration Projects. The Army reserves the right to authorize UXO Removal Technology Demonstration Projects and other similar UXO related projects on the Firing Range.

c. Property Administration. The Army reserves the right to enter the property to conduct property administration activities (e.g., site inspections, etc.).

Any Army proposals to conduct other activities on the Refuge or Bombing Range will be processed in accordance with the terms and conditions of this MOA (see paragraph IV(4) or paragraph V(4)).

4. Future Property Transfer.

The Army will not transfer fee title or other property interests in the Firing Range without consulting with the FWS and Air Force. If in the future the Firing Range is determined suitable for transfer, the Army shall, to the extent legally authorized, provide the FWS and Air Force the right of first refusal on their respective property interests before conveying any property interests. If the Air Force no longer requires use of the Bombing Range and the property is no longer needed for other military purposes, the Army will offer the FWS a real estate permit for the Bombing Range subject to the same terms of this agreement or any other mutually agreeable terms.

5. Tort Claims.

The Army will be responsible for accepting and processing any tort claims for incidents arising out of UXO, DU, or any other conditions related to the Army's past, present, or future use of the Firing Range. The FWS and Air Force will cooperate in providing information relating to any such tort claims. Any liability on the part of parties will be determined in accordance with the Federal Torts Claim Act and other applicable laws.

IV. FWS RESPONSIBILITIES

1. National Wildlife Refuge.

a. The Refuge will be called Big Oaks National Wildlife Refuge. It will be managed as a unit of the National Wildlife Refuge System in accordance with the National Wildlife Refuge Administration Act of 1966 as amended (16 U.S.C. 668 et. seq.) and other applicable laws, regulations, and policies. Following the issuance of the real estate permit, the FWS will be responsible for all natural resource management decisions on the Refuge. As the Refuge includes the DU Impact Area, management of the Refuge will be subject to the License Termination Plan as approved by the NRC.

b. The FWS will develop a Comprehensive Conservation Plan (CCP) outlining its management plan for the Refuge. The CCP will provide natural resource management at a level typical of units of the National Wildlife Refuge System.

c. The FWS will conduct any National Environmental Policy Act (NEPA) analysis required to support establishment of the Refuge.

d. The FWS will be responsible for infrastructure maintenance and repairs as outlined in Enclosure 5 (FWS/Air Force Infrastructure Maintenance Responsibilities).

2. Site Security.

a. The FWS will be responsible for providing UXO, DU and environmental contamination Safety/Awareness Training to all Refuge personnel and visitors (see paragraph III.2.a. above). The FWS will develop an interim public access plan prior to the Army executing a real estate permit. After the interim public access plan, the FWS will develop a comprehensive public access plan that identifies appropriate public uses of the property and ensures that all visitors are provided UXO, DU and environmental contamination Safety/Awareness Training. The public access plan will include: (a) types of public use, (b) UXO, DU and environmental contamination Safety Training protocols (e.g., training materials, training rosters, and waivers), and (c) annual public use reporting requirements. The interim public access plan and the comprehensive public access plan and any revisions will be subject to Army approval.

b. The FWS will provide staffing at a level consistent with the safe operation of the Refuge. With the expectation of limited or no UXO cleanup in the future, public use levels will be low and may be limited to hunting, gathering, fishing, and guided tours as determined by the interim or comprehensive public access plan. All visitors will be escorted or receive a safety briefing on the hazards found on the property. If the FWS fails to maintain adequate public access control, the Army reserves the right to suspend the FWS's right of access to the Firing Range until such time as the FWS takes appropriate corrective action.

3. Environmental Remediation.

a. The FWS shall not be responsible for any environmental requirements related to the Army's past, present, or future activities at the Firing Range or the Air Force activities at the Bombing Range. However, the FWS will be responsible for all environmental compliance and remediation requirements resulting from operation of the Refuge.

b. The FWS shall not be responsible for remediation of UXO, DU, and other environmental contamination related to past, present, or future Army activities, or present on the Firing Range on the date of this MOA, or resulting from Air Force Bombing Range activities. If a FWS Refuge activity will result in increased remediation costs for the Army (e.g. UXO removal, fencing, or site remediation), the FWS shall terminate the activity.

c. The FWS will not undertake any Refuge activities that interfere with the Army environmental remediation program at the Firing Range.

4. Other Activities on the Refuge.

The FWS will be responsible for reviewing all requests to conduct non-FWS activities on the Refuge (i.e. requests from other organizations to conduct activities not otherwise authorized by the CCP), not otherwise allowed by this MOA. All requests for non-FWS activities on the Refuge will be reviewed in accordance with the National Wildlife Refuge Administration Act and other applicable laws, regulations, or policies. The interim or comprehensive public access plan will be revised as necessary to ensure that any approved non-FWS operations on the Refuge are conducted in a safe manner.

5. Tort Claims.

The FWS will be responsible for accepting and processing any tort claims for incidents arising out of its operation of the Refuge. The Army and Air Force will cooperate in providing information relating to any such tort claims. Any liability on the part of the parties will be determined in accordance with the Federal Torts Claim Act and other applicable laws.

V. AIR FORCE RESPONSIBILITIES

1. Air Force Bombing Range.

a. The Air Force will operate a Bombing Range which includes an approximate 50-acre laser bombing range, an approximate 983-acre conventional bombing range, and the Old Timbers Lodge with associated acreage of approximately 5 acres, which shall be excluded from the real estate permit for the Refuge. The bombing ranges, when in use, will have large safety fans that will be off limits for FWS personnel and visitors during flight operations involving training munitions or laser energy. While the safety fans overlay significant portions of the Firing Range,

their land area is included in the real estate permit for the Refuge. As the laser bombing range safety fan includes the DU Impact Area, management of the Bombing Range will be subject to the License Termination Plan as approved by the NRC. The Air Force will comply with Air Force Instruction 13-212, Test and Training Ranges, concerning range maintenance, ammunition, explosives, and dangerous articles (AEDA), and range residue cleanup/decontamination on the Bombing Range.

b. The Air Force will conduct any NEPA analysis required to support operation of the Bombing Range.

c. The Air Force will take the following actions to ensure that its operation of the Bombing Range is not inconsistent with the establishment of the Refuge:

(1) The Air Force will limit its total annual bombing sorties to 3000 sorties per year (including non- Air Force sorties). The Air Force is authorized to conduct 4000 sorties in any one-year period provided the additional sorties are conducted in accordance with applicable laws and regulations. The Air Force may only exceed the 3000 sorties per year cap once every three years. Any increase in sorties above these levels will be negotiated in good faith by the parties.

(2) The Air Force will provide wildfire suppression support on the Refuge for situations arising from Air Force actions or activities, as to be determined by the Bombing Range Commander and the FWS Refuge Manager.

2. Perimeter Fence/Road and Warning Signs.

a. The Air Force will be responsible for patrolling and maintaining the perimeter fence and related infrastructure to ensure the overall security of the Firing Range. The perimeter fence infrastructure includes warning signs, the road system associated with the perimeter fence, and mowing the perimeter fence area. The Army and FWS staff will report to the Air Force in a timely manner any damage to the perimeter fence that they observe in the course of performing their respective activities on the Firing Range.

b. The Air Force will maintain warning signs around the entire perimeter, the submunitions area west of Machine Gun Road, the DU area and the former Open Detonation area. If additional fencing, cleanup, or site security improvements are required due to past, present, or future Army activities, the Army will be responsible for the additional requirement. The Air Force agrees to negotiate in good faith regarding appropriate arrangements to assist the Army in meeting the new requirements.

3. Maintenance of Firing Range Infrastructure.

The FWS/Air Force infrastructure maintenance responsibilities are provided in Enclosure 5. The properties permitted to the Air Force (i.e., the Old Timbers Lodge and the four stone

arch bridges) shall be preserved in accordance with the Jefferson Proving Ground Cultural Resource Management Plan dated August 1996. The Army and Air Force will prepare an Interservice Support Agreement to cover the Army's historic preservation responsibilities for the Oakdale School House. If other infrastructure maintenance requirements are subsequently identified, the Air Force agrees to negotiate in good faith regarding appropriate arrangements to assist the Army in meeting the new requirements.

4. Other Bombing Range Activities.

The Air Force will be responsible for reviewing all requests to conduct non-Air Force operations (including Army and FWS requests) on the Bombing Range. All requests for non-Air Force operations on the Bombing Range will be reviewed in accordance with the provisions of Air Force Instruction 13-212 and the License Termination Plan as approved by the NRC. The comprehensive site access plan will be revised as necessary to ensure that any approved non-Air Force operations on the Bombing Range are conducted in a safe manner.

5. Site Security.

a. The Air Force will be responsible for providing UXO, DU and environmental contamination Safety/Awareness Training to all Bombing Range personnel and visitors. Prior to the Army executing a new real estate permit, the Air Force will develop a comprehensive site access plan that includes: (a) types of official use, (b) UXO, DU and environmental contamination Safety Training protocols (e.g., training materials, training rosters, and waivers), and (c) annual official use reporting requirements. The comprehensive site access plan and any revisions will be subject to Army approval.

b. The Air Force will provide staffing at a level consistent with the safe operation of the Bombing Range. It is anticipated that the Air Force access will consist primarily of Bombing Range personnel, support personnel, and official visitors. If the Air Force fails to maintain adequate access control, the Army reserves the right to suspend Air Force's right of access to the Firing Range until such time as the Air Force takes appropriate corrective action.

6. Environmental Remediation.

a. The Air Force shall not be responsible for any environmental requirements related to the Army's past, present, or future activities at the Firing Range or the FWS activities at the Refuge. However, the Air Force will be responsible for all environmental compliance and remediation requirements resulting from its operation of the Bombing Range.

b. The Air Force shall not be responsible for remediation of UXO, DU, and other environmental contamination related to past, present, or future Army activities, or present on the Firing Range on the date of this MOA (except as provided in paragraph V.8.b. below), or resulting from FWS Refuge activities. If an Air Force Bombing Range activity will result in increased environmental remediation costs for the Army (e.g. UXO removal, fencing, or site

remediation), the Air Force will be solely responsible for these increased costs or shall terminate the activity.

c. The Air Force will not conduct any Bombing Range activities that interfere with Army environmental remediation activities at the Firing Range.

7. Tort Claims.

The Air Force will be responsible for accepting and processing any tort claims for incidents arising out of its operation of the Bombing Range. The Army and FWS will cooperate in providing information relating to any such tort claims. Any liability on the part of the parties will be determined in accordance with the Federal Torts Claim Act and other applicable laws.

8. Existing Permit to the Air Force

a. Pending issuance of the new real estate permit (Enclosure 3), the existing permit between the Department of the Army and the Department of the Air Force, DACA 27-4-83-03, dated 23 July 1982, to use property on JPG will continue in effect without change. Upon the effective date of the new permit, the existing permit will terminate.

b. Nothing in this MOA will be construed to affect any liability or responsibility of the Air Force or Army established by the existing permit between the Department of the Army and the Department of the Air Force, DACA 27-4-83-03, dated 23 July 1982, or any prior permits between the Air Force and Army relating to the Firing Range.

9. Licensing to Indiana Air National Guard

The Air Force may grant a license to the Indiana Air National Guard to assume its rights and responsibilities under the real estate permit. Any such license may include and apply all the responsibilities of the Air Force under this MOA and the permit to the Indiana Air National Guard, excluding only the authority to amend this MOA or the real estate permit.

VI. DISPUTE RESOLUTION PROCEDURE

1. Except as otherwise provided in this MOA, all disputes between the parties relating to the terms and conditions of this MOA will be subject to the following dispute resolution procedures:

a. Informal - All parties to this agreement shall make reasonable efforts to informally resolve disputes at the Installation Commander, the Bombing Range Commander, and the Refuge Manager Level. If the parties can not resolve a dispute informally, any party may invoke dispute resolution procedures by requesting a Level I meeting. The request to invoke dispute resolution shall include a written summary of the dispute, the party's position, and any other information necessary to the resolution of the dispute. In the event that a dispute involves a matter of national significance, the parties may mutually agree to elevate the dispute directly to the Level II dispute

resolution process.

b. Level I - The Level I dispute resolution shall consist of a meeting/conference call among the Army Materiel Command (AMC) Point of Contact (POC), the FWS's Regional Office POC, and Air National Guard Readiness Center POC. Any agreed resolution shall be in writing and signed by all the parties. If agreement cannot be reached within 30 days, AMC shall state its position in writing and provide it to the other parties. Within 30 days of receipt of the AMC statement of position, the other parties may submit a written notice to AMC elevating this matter to Level II for resolution. If the matter is not elevated to Level II dispute resolution within 30 days, the other parties will be deemed to have agreed with the AMC statement of position.

c. Level II - The Level II dispute resolution shall consist of a meeting/conference among the Department of the Army (DA), HQ FWS POC, and HQ Air Force POC. The agreed resolution shall be in writing and signed by all the parties.

2. No resolution of a dispute under this provision shall result in a change to the MOA or to any permit issued pursuant to it unless the modification is executed in accordance with paragraph VIII below or the terms of the permit.

VII. FUNDING

Unless otherwise agreed, all parties will be solely responsible for funding their respective responsibilities under this Memorandum of Agreement. Nothing in this agreement shall be interpreted to require obligation or payment of funds in violation of the Anti-Deficiency Act. 31 U.S.C. Section 1341.

VIII. EFFECTIVE DATE, MODIFICATION, AND TERMINATION

1. This agreement may be executed in multiple copies, each of which shall be considered an original document. This agreement shall take effect upon the date last executed by the parties, and shall remain in effect for 25 (twenty five) years. This agreement may be renewed for additional 10 (ten) year periods upon mutual agreement.

2. Modifications to this agreement may be submitted in writing by any party at any time and shall become effective upon the written acceptance of all the parties. Such modifications must be signed by the signatories hereto or their successors in office.

3. This agreement may be terminated by any party by providing a written 180 (one hundred eighty) day notice to the other parties. A decision to terminate this agreement is not subject to the dispute resolution provision of this MOA. In the event of termination, any Air Force and FWS built improvements will be disposed of following applicable disposal regulations.

IX. ENTIRE AGREEMENT

It is expressly understood and agreed that this written instrument and its enclosures when executed embody the entire agreement among the parties regarding the use of the Firing Range. and there are no understandings or agreements, verbal or otherwise, among the parties except as expressly set forth herein.

APPROVED BY:

PAUL W. JOHNSON
Deputy Assistant Secretary of the Army
(Installations and Housing)

Date 12 MAY 2000

JAMIE RAPPAPORT CLARK
Director
U.S. Fish and Wildlife Service

Date 5/15/00

JIMMY G. DISHNER
Deputy Assistant Secretary
Of the Air Force (Installations)

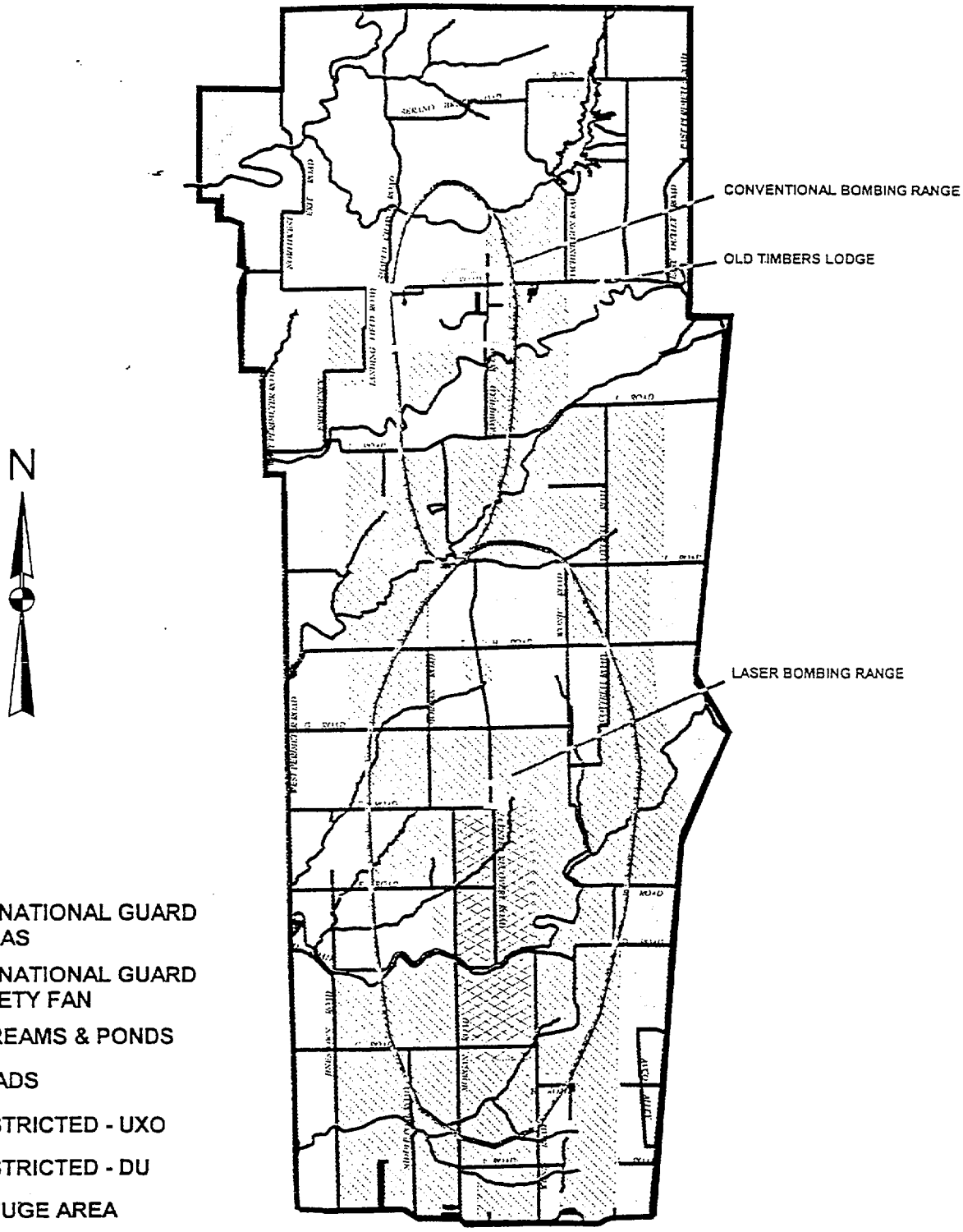
Date 5/11/2000

Enclosures

1. Site Map
2. FWS Real Estate Permit
3. Air Force Real Estate Permit
4. UXO Response Standing Operating Procedures
5. FWS/Air Force Infrastructure Maintenance Responsibilities

Enclosure 1. Site Map

JEFFERSON PROVING GROUND
SITE MAP



Enclosure 1

Enclosure 2. Department of Army Permit to FWS to Use Property Located on JPG

ENCLOSURE 2

NO._____

DEPARTMENT OF THE ARMY

PERMIT TO FISH AND WILDLIFE SERVICE

TO USE PROPERTY LOCATED ON JEFFERSON PROVING GROUND

THE SECRETARY OF THE ARMY, hereinafter referred to as the Secretary hereby grants to the United States Fish and Wildlife Service, hereinafter referred to as the grantee, a permit for the establishment of a National Wildlife Refuge at the Jefferson Proving Ground (JPG), over, across, in and upon the lands identified in Exhibit "A", attached hereto and made a part hereof, hereinafter referred to as the premises. The Secretary and the grantee are collectively hereinafter referred to as the "Parties".

THIS PERMIT is granted subject to the following conditions.

1. This permit is hereby granted for a term of twenty-five (25) years, with renewable ten (10) year periods upon mutual agreement of the Parties. This permit may be terminated earlier, by either the Secretary or grantee, by providing 180 days written notice.

2. The consideration given by the grantee is the management of the Property as a National Wildlife Refuge as well as the care and maintenance of the property as specified in the Memorandum of Agreement (MOA) attached hereto and made part of hereof..

3. All correspondence and notices to be given pursuant to this permit shall be addressed, if to the grantee , to _____, and if to the Secretary, to the District Engineer, Louisville District, _____ with a copy furnished to the JPG Commander, _____ , or as may from time to time otherwise be directed by the parties. Notice shall be deemed to have been duly given if when enclosed in a properly sealed envelope or wrapper addressed as aforesaid, and deposited, postage prepaid, in a post office regularly maintained by the United States Postal Service.

4. The use and occupation of the premises shall be without cost or expense to the Department of the Army, and under the general supervision of the JPG Commander, and in accordance with the terms and conditions of the MOA, attached

hereto and made apart hereof. In the event of a conflict between the MOA and this permit, the MOA shall be the controlling instrument.

5. The grantee acknowledges that it has inspected the premises, knows its condition, and understands that same is granted without any representations or warranties whatsoever and without obligation on the part of the Department of the Army, except as provided in the MOA.

6. In accordance with the MOA, the grantee shall, at its own expense and without cost or expense to the Department of the Army, maintain and keep the premises at a level sufficient to support Refuge operations and in accordance with the tasks in Enclosure 5 of the MOA.

7. The Department of the Army shall not be responsible for providing utilities to the grantee and it shall be the grantee's responsibility for obtaining any utilities necessary for its use and occupation of the premises at no expense to the Department of the Army.

8. No additions or alterations of the premises shall be made without the prior written approval of the JPG commander.

9. On or before the expiration of this permit or the termination by either party, in accordance with paragraph one (1), the grantee shall vacate the premises, remove its property therefrom and restore the premises to a condition satisfactory to the JPG commander, ordinary wear and tear and damage beyond the control of the grantee excepted.

10. The grantee shall comply with all applicable Federal, state, interstate, and local laws and regulations wherein the premises are located.

11. The Army will provide the grantee with baseline information concerning the environmental condition of the premises in accordance with paragraph III 1 (a), of the MOA, documenting the known history of the property with regard to storage, release or disposal of hazardous substances on the property. Upon expiration or termination of this permit, the grantee shall, at its own expense and without cost or expense to the Department of the Army, document any storage, release or disposal of hazardous substances in excess of 40 CFR Part 373 reportable quantities and any petroleum products in excess of 55 gallons. A comparison of the two assessments will assist the Army in determining any environmental restoration requirements of the grantee. Any such requirements will be completed by the grantee in accordance with the Environmental Remediation provisions in the MOA and paragraph nine (9) of this permit.

12. It is understood that the requirements of this permit pertaining to maintenance, repair, protection, and restoration of the premises and providing utilities

and other services, shall be effective only insofar as they do not conflict with the MOA or any other agreement, pertaining to such matters made between local representatives of the Army and grantee in accordance with existing regulations.

13. Access to and use of JPG shall be controlled in accordance with the grantee's Site Access Plan that is attached hereto and is made apart hereof. The Army must first approve any variation from this Plan and a revised Site Access Plan shall be made part of this permit.

14. The grantee shall not use the Premises for the storage, treatment or disposal of non-Department of Defense owned hazardous or toxic materials, as defined in 10 U.S.C 2692, unless authorized under 10 U.S.C. and properly approved by the Government.

15. NOTICE OF THE PRESENCE OF LEAD BASED PAINT AND COVENANT AGAINST THE USE OF THE PROPERTY FOR RESIDENTIAL PURPOSES.

The grantee is hereby informed and does acknowledge that all buildings on the Property, which were constructed or rehabilitated prior to 1978, are presumed to contain lead-based paint. For those buildings the grantee uses and occupies it shall comply with all applicable federal, state, and local laws and regulations pertaining to lead-based paint and/or lead-based paint hazards. The grantee shall restrict access (e.g., secure buildings to the extent practical, post warning signs, etc.) to all unoccupied buildings except those buildings located in UXO Restricted Areas (See Site Map at MOA Enclosure 1). The grantee shall restrict access to the UXO Restricted Areas in accordance with the Site Access Plan. The grantee shall not permit the use of any of the buildings or structures on the Property for residential habitation. Residential habitation does not include use of the Old Timbers Lodge for conference purposes including overnight visits on a non-permanent basis. The grantee assumes all lead based paint related liability arising from its use of the property.

16. NOTICE OF THE PRESENCE OF ASBESTOS AND COVENANT:

The grantee is hereby informed and does acknowledge that friable and non-friable asbestos or asbestos containing materials (ACM) has been found on the Property. The grantee acknowledges that it will inspect any building it proposes to occupy as to its asbestos content and condition and any hazardous or environmental conditions relating thereto. The grantee shall restrict access (e.g., secure buildings to the extent practical, post warning signs, etc.) to all unoccupied buildings except those buildings located in UXO Restricted Areas (See Site Map at MOA Enclosure 1). The grantee shall restrict access to the UXO Restricted Areas in accordance with the Site Access Plan. The grantee shall be deemed to have relied on its own judgment in assessing the condition of the property with respect to any asbestos hazards or concerns. The grantee covenants

and agrees that its use and occupancy of a building will be in compliance with all applicable laws relating to asbestos. The grantee assumes all asbestos related liability arising from its use of the property.

17. Prior to the start date of this Permit the grantee will provide a map with clear identification of the buildings it shall occupy. This map will be updated annually by the grantee.

THIS PERMIT is not subject to Title 10, United States Code, Section 2662, as amended.

IN WITNESS whereof, I have hereunto set my hand by authority of the Secretary of the Army, this _____ day of _____, _____.

_____

This permit is also executed by the grantee this _____ day of _____, _____.

_____

Interim Public Access Plan for the Proposed Big Oaks National Wildlife Refuge

Prepared by:
U. S. Fish and Wildlife Service

Lee Herzberger
Refuge Manager
Muscatatuck National Wildlife Refuge

Reviewed by:
Air National Guard

Maj. William Nolen
Commander
Jefferson Range

Approved by:
U. S. Army

Maj. Mark A. Welch
Commander
Jefferson Proving Ground

Introduction

Approximately 50,000 acres of the decommissioned military base known as Jefferson Proving Ground (JPG) is proposed for inclusion into the National Wildlife Refuge (NWR) System via a Memorandum of Agreement (MOA) with the U.S. Army (Army). The area will become Big Oaks NWR. The primary purposes for this overlay NWR are derived from 2 specific acts:

> 1) The Fish and Wildlife Act of 1956 [16 USC 742a-742j] as amended authorizes the Secretary of the Interior to acquire interests in property "...for the development, advancement, management, conservation, and protection of fish and wildlife resources..."
>
> 2) The Endangered Species Act authorizes the Secretary of Interior to acquire interests in lands "to conserve fish, wildlife, and plants, including those which are listed as endangered or threatened..." [16 USC 1534].

The mission of Big Oaks NWR derives from these two purposes and is "to preserve, conserve, and restore biodiversity and biological integrity for the benefit of present and future generations of Americans." There is also a potential for limited public use in areas designated for such activities. This Interim Public Access Plan (Plan) was developed to allow the Army to review and approve safety procedures prior to public use occurring on Big Oaks NWR. This Plan is in accordance with the terms and conditions of the MOA between the U. S. Fish and Wildlife Service (FWS), Army, and Air Force (AF), and in the event of a conflict between the MOA and this agreement, the MOA shall be the controlling document.

Much of the proposed Big Oaks NWR contains unexploded ordnance (UXO), depleted uranium (DU), and other contaminants. The existence of these contaminants causes safety, management and funding concerns specific to Big Oaks NWR. The FWS accepts that there is no Army plan or budget authority to remove UXO in the Firing Range. However, the Army has agreed to make a good faith effort to request UXO removal in connection with Army Reserve and/or Army National Guard training exercises to support refuge operations. To facilitate the support process, the FWS will incorporate building designs that minimize ground disturbance and will provide the Army a minimum 2-year advance notice of their request to complete UXO removal. If the Army is not able to obtain UXO removal support as part of a training exercise, the FWS agrees to withdraw its request and terminate any plans/operations requiring non-emergency UXO support.

In the central portion of JPG is an active 1,033-acre AF training area known as Jefferson Range. Jefferson Range is composed of a 983-acre air-to-ground bombing and strafing range and a 50-acre Precision Guided Munitions (PGM) range. Both the 983-acre range and the 50-acre range have associated safety fans that extend over a portion of the area proposed as Big Oaks NWR (Fig. 1). A composite footprint of approximately 5,100 acres supports the primary target area and a composite footprint of approximately 14,860 acres supports the PGM target area. During flight operations no personnel other than AF personnel will be allowed access inside the weapons footprints. The use of both footprints will be coordinated with the Refuge Manager through monthly scheduling or as necessary to meet mission requirements. When not in use, FWS personnel will have access to the safety footprints. Safety fans and other closed areas will be

consultation with the Army. These areas are 1) Limited Day Use Recreation and 2) Special Control Hunt Zones; a third zone would have no public access and would be considered closed to all types of entry except on established roads or under emergency conditions (Fig. 1). The Limited Day Use Zone will be used for hunting (deer and turkey), fishing (Old Timbers Lake), and limited opportunities for wildlife observation and photography, and guided (accompanied by FWS staff) environmental education and interpretation tours. The Special Control Hunt Zone will only have public access during a limited deer and turkey hunting season, and limited guided tours. All of these recreational units were previously used in the Army recreation program (Fig. 1).

Public use areas will be delineated by maps and by signs placed on their boundaries as required by NWR policies. Recreational opportunities during posted hours and periods will be available to the general public provided they have completed all necessary safety requirements, proper state licenses, appropriate permits for lottery seasons, and there are areas/staff available for the requested activity. Unescorted access will be limited to April through November (Table 1). Recreation units will have maximum capacity limits at any one time for all off-road visitor activities (Table 1, Fig. 1). Guided tours oriented toward environmental education, wildlife observation, interpretation, and the unique story of the property will be scheduled and completed without exposing the public participants to undue risk.

Protocols on How Public Use will be Monitored, Limited, and Controlled

Public access will be limited to specific days of the week and by seasonal periods (e.g., fishing, deer, and turkey seasons) (Table 1). The Army and the FWS will periodically reevaluate public access to determine if different limits are more appropriate.

The standard protocol for public access will be a check-in/check-out procedure to specific areas (e.g., Area 1, see Fig. 1) for those members of the public that have undergone a safety briefing. They will be allowed in areas identified as suitable for that type of activity (e.g., deer hunting in a Special Control Hunt Area; fishing in Old Timbers Lake). A daily entrance log/database will be kept of all public use on Big Oaks NWR. Information on types and locations of public use will be compiled in an annual report that will be distributed to the Army, AF and the FWS Region 3 Office.

Prior to unescorted public access occurring (June 3, 2000), the AF will install road barricades on the East Perimeter Road and the FWS will place closed area signs on these barricades to limit public access into interior areas of the refuge (Fig. 2). A total of 19 barricades will be placed around the periphery of the southern Special Control Hunt Zone. These barricades will be located at the point where all interior roads leave the East and West Perimeter Roads. The barricades on the West Perimeter Road will be in place by deer season (November 1, 2000). Other than during the limited deer and turkey hunts, these barricade gates will remain closed and locked at all times. FWS will control access into these areas during the annual turkey and deer hunts with the previously described protocols. Besides these hunt periods, only AF and FWS personnel or required contractors will be allowed access to these interior areas and the safety fan footprints. Closed area signs will also be placed alternating with the warning signs placed by the Army for closed access areas, especially for those areas adjacent to recreation units. Signs will

be placed on existing structures (i.e., fence posts, buildings, etc.), live trees, or on posts with weighted bases to avoid ground intrusion of sign posts.

As described in the MOA, the FWS will work closely with the AF on controlling visitor access and monitoring refuge visitors. The AF will be responsible for maintaining the perimeter fence and overall site security at JPG. The FWS will notify the AF of any damage to the perimeter fence in a timely manner.

The FWS will not tolerate individuals who violate safety regulations. For this reason, anyone who does not comply with safety regulations will forfeit his/her refuge access privileges as determined by the Refuge Manager or by a court of law. The FWS will also continue access restrictions made by the Army to specific individuals because of documented safety violations.

Enforcement of refuge trespass and other public use violations will be the primary responsibility of commissioned Refuge Law Enforcement Officers and cooperatively by Indiana Conservation Officers and other law enforcement agencies. General trespass, poaching, and other violations will be cooperatively enforced by these agencies. The FWS will meet with local law enforcement agencies and develop coordinated law enforcement strategies (these strategies will be in place by June 3, 2000) that will be coordinated with the AF. Procedures for obtaining law enforcement assistance will be based on legal jurisdiction where the incident occurs (e.g., in Ripley County the Ripley County Communication Supervisor will be contacted, likewise, in Jefferson or Jennings Counties the appropriate Communication Radio Dispatch Centers will be contacted). For emergency response situations, the cooperating agency will coordinate activities with a 24 hr point of contact (POC) listed in Attachment 1.

Fire suppression capabilities will be negotiated with a local Volunteer Fire Department and will be in place by June 3, 2000. The agreement will include protocols on suppression of wild fires and on-call assistance during prescribed fires. Protocols will instruct fire fighters to not leave roadways and to follow other Army safety directives. For fire department response after hours, the local fire department will be instructed to coordinate with the POC and to cut the lock on the gate most advantageous to their response. In this case, the fire department response will only occur if it is apparent that the fire could cause loss of life or property damage outside the perimeter fence.

Key Control

The AF will change all locks on the perimeter fence and will issue an appropriate number of perimeter and interior gate keys to the FWS for official use. These keys will be controlled in accordance with standard lock and key control protocols (Air National Guard 181st Fighter Wing Instruction 32-1003). All keys will be signed for on the Jefferson Range key control log. The FWS will inventory these keys quarterly in accordance with these key control protocols. The FWS will coordinate distribution of keys with law enforcement and emergency response agencies. The FWS will be responsible for the control of these keys. The party responsible for missing keys shall bear the cost for the re-coring of locks as applicable. The Jefferson Range Commander has the ultimate responsibility for lock and key control on the range and refuge.

Use of Refuge by Old Timber's Lodge (AF) Guests

The FWS will schedule priority refuge events for Old Timbers Lodge with the Jefferson Range AF Commander; at all other times the Old Timbers Lodge area will be off limits for refuge visitors. The refuge will allow Old Timbers Lodge guests access to refuge recreational activities on days/times those activities are available to the general public. Old Timbers Lodge guests must obtain a valid Big Oaks NWR Public Access Permit to participate in these activities and these guests must participate in an AF safety briefing. While on the refuge, all rules and regulations of the refuge will apply to Old Timbers Lodge guests.

Old Timbers Lodge guests must check-in and check-out at the refuge office to participate in recreational opportunities (e.g., fishing at Old Timbers Lake). If guests do not check-in, especially for fishing at Old Timbers Lake, they cannot be guaranteed the opportunity to participate in the recreational activity. For permitted deer or turkey hunts, Old Timbers Lodge guests must either have a valid state lottery permit for the specific hunt or participate in a reserved hunt drawing during the hunting season at the refuge office.

Table 1. Public use limits (use-days) for activities on Big Oaks NWR [a].

Activity	Description of where use will occur	Maximum one-time capacity	When allowed
Deer Hunting	See Public Access Map	423	November (6 days archery and 9 days gun)
Turkey Hunting	½ of the number hunters/area given on Public Access Map	212	April to Mid- May (15 Days)
Fishing	Max. 10 boats and Max. 40 on shore at Old Timbers Lake. No fishing allowed on any other body of water.	60 [b]	5 - 10 days per month; April through October
Wildlife Observation and Photography	½ of the number persons/area given on Public Access Map; only within Limited Day Use Zone	78 [b]	5 - 10 days per month; April through October
Guided tours (interpretation and environmental education)	Dependent on conveyances available and activity. By definition, accompanied by FWS staff.	12-50	By reservation

[a] Based on staff and funds available in FY 2000.

[b] Based on parking and trail availability

Attachment 1

24 Hour Contact List

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