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Executive Summary

(U) ~~(S//REL)~~ Final Environmental Site Characterization and Operational Health Risk Assessment, Stronghold Freedom, Karshi Khanabad Airfield, Uzbekistan
27 October – 27 November 2001

1. **(U) ~~(S//REL)~~ Purpose.** To conduct an environmental site characterization and identify existing environmental conditions that could pose a significant health risk and to make recommendations to mitigate those risks, if any, to US and its allied military personnel assigned at Stronghold Freedom, Karshi Khanabad Airfield, Uzbekistan. The characterization was performed in accordance with DoD Directive 6490.2, DoD Instruction 6490.3, and Joint Staff Memorandum MCM-251-98 dated 4 December 1998.

2. **(U) ~~(S//REL)~~ Scope of Work.** The U.S. Army Center for Health Promotion and Preventive Medicine – Europe (CHPPM-EUR) conducted an environmental site characterization at Stronghold Freedom during the period 27 October –27 November 2001. The CHPPM-EUR employed a multidisciplinary approach that evaluated a broad range of contaminants and potential exposure pathways that could impact health. The assessment focused on the following areas of interest at Stronghold Freedom:

a. (U) ~~(S//REL)~~ Environmental Contamination from Fuel Storage and Distribution;

[redacted]

c. (U) ~~(S//REL)~~ Former Weapons/Munitions Storage Areas, also known as the Air-to- Air Missile/ Air-to- Surface Missile (AAM/ ASM) Storage Facility (Site 1);

d. (U) ~~(C//REL)~~ Tent City and the force protection berms;

e. (U) ~~(S//REL)~~ Aircraft hangers, bunkers, and buildings present at Stronghold Freedom from 27 Oct 01 - 27 Nov 01;

f. (U) ~~(S//REL)~~ Former Soviet and current Uzbek Air Force Aircraft Maintenance Facility;

g. (U) ~~(S//REL)~~ Targeted expansion area to east of the easternmost force protection berm (as it existed from 27 Oct 01 - 27 Nov 01). This site is also referred to Site 3 in this report;

h. (U) ~~(S//REL)~~ Area outside westernmost force protection berm (as it existed from 27 Oct 01 - 27 Nov 01);

i. (U) ~~(C//REL)~~ Hantavirus disease threat. CHPPM-EUR recommended a survey to determine the disease threat from Hantavirus because of Stronghold Freedom climatic conditions and rodent populations. The Preventive Medicine Detachment at Stronghold Freedom performed this survey after the departure of the CHPPM-EUR team.

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3. (U) ~~(C//REL)~~ Conclusions. The following environmental media were sampled at the areas of interest above and a summary of the contamination discovered and corresponding health risk findings are provided.

a. (U) Soil.

(1) (U) ~~(C//REL)~~ Surface Conditions. Surface soils contain low levels of various contaminants at and just below ground surface. These contaminants pose a low health risk at the levels detected in this study.

(2) (U) ~~(C//REL)~~ Subsurface Conditions. Elevated levels of volatile organic compounds (VOCs) and total petroleum hydrocarbons (TPH) were detected at numerous locations throughout Stronghold Freedom, including tent city, eastern expansion area (Site 3), and adjacent to the aircraft maintenance facility. The elevated levels of VOCs and TPH appear to be related to fuel transmission or storage activities that pre-date the presence US Forces on the Stronghold. Potential health effects resulting from exposures to these chemicals at measured concentrations are considered mild illness or temporary irritation. These health outcomes are consistent with those reported by exposed personnel. The resulting health risk level is considered low since limited personnel are exposed to subsurface soils and the anticipated health effects are mild.

b. (U) ~~(C//REL)~~ Air. Ambient air is the main exposure pathway of concern for environmental contaminants at Stronghold Freedom. Inhalation of vapors from exposed, subsurface fuel contaminated soils could potentially cause adverse health effects to personnel at Stronghold Freedom if sufficient exposure circumstances occur. The clay soils in these areas greatly mitigate ambient air exposures from subsurface fuel contaminated soils to either very low or non-detectable levels in ambient air. Additionally, visual observations and air sampling confirmed that inhalation of respirable particulates could also be a viable exposure pathway for personnel stationed at Stronghold Freedom. An attempt should be made to mitigate the source of these concentrations. No heavy metals were detected on analysis of particulate filters. However, the detection levels were greater than the long-term Air-MEGs for many chemicals. In the absence of this data, it cannot be concluded that ambient air does not pose a long-term health risk to deployed troops.

c. (U) ~~(C//REL)~~ Water Quality. The available water data indicate that the product water is suitable for consumption. Levels of boron were slightly greater than the long-term Water-MEG and present a low health risk if ROWPU source water is used for potable purposes.

d. (U) ~~(C//REL)~~ Radiological. The operational risk management level estimate from ionizing radiation hazards is LOW to personnel within the confines of the force protection berm and personnel occupying bunkers and/or buildings of Stronghold Freedom. A potential radiation hazard exists for any personnel who could occupy the Site 1 area (located outside the force protection berm).

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e. (U) ~~(C//REL)~~ Asbestos. The operational risk management level estimate from asbestos is LOW from any airborne exposure from asbestos-containing materials present at Stronghold Freedom. When recommended control measures are observed, the resulting operational risk management would be Negligible.

f. (U) ~~(C//REL)~~ Hantavirus Survey. A Hantavirus survey was conducted by the Preventive Medicine Detachment at Stronghold Freedom based on recommendations by the CHPPM EUR team. Assuming representative sampling and proper sample collection/ preservation procedures were followed, there is a negligible health risk for the Tula, Puumala, Hantaan, and Dobrava Hantavirus strains at Stronghold Freedom.

g. (U) ~~(C//REL)~~ Operational Risk Management Estimate. When recommended controls are implemented the overall operational risk management estimate of Stronghold Freedom is LOW. Of the eleven chemicals detected in environmental media that exceeded guidelines, all appear to pose a LOW operational risk. All chemicals are considered health threats. The risk to all chemicals in soil was considered LOW but an attempt should be made to avoid contact with subsurface soils that may have elevated concentrations of fuels and related chemicals. Boron was detected in water at levels that slightly exceeded guidelines. However, the operational OEH risk for water was considered LOW and the water is suitable for consumption. Exposures to chemicals in ambient air pose a LOW operational risk based on evaluation of available sampling data. Air exposure should be handled similarly to soil. Areas with noticeable vapors should be avoided if possible. Finally, the operational OEH Radiation risk at both Stronghold Freedom and Site 1 is LOW.

h. (U) ~~(C//REL)~~ Risk Communication. Because of the high probability that service members will be concerned (in varying degrees) about possible health risks, a risk communication strategy is critical to the ORM process. Developing and incorporating a risk communication strategy will help ensure that critical information is delivered effectively, while minimizing potential concerns.

4. (U) ~~(C//REL)~~ Recommendations. The following countermeasures are recommended in order to minimize exposures from environmental media and provide adequate force health protection from identified environmental health risks.

a. (U) ~~(C//REL)~~ All Environmental Exposures. Develop and implement a plan for communicating risk to the soldiers and airmen that summarizes our findings and conclusions in a manner consistent with effective environmental risk communication principles. Although the health effects of the radioactivity, chemical uranium, and the asbestos are likely to be nonexistent, the perception of a potential health risk is likely to be present among the Stronghold population.

b. (U) ~~(C//REL)~~ Exposure to Contaminated Soil and Vapors from Contaminated Soil.

(1) (U) ~~(C//REL)~~ Prohibit digging into soil contaminated with jet fuel (tent city, the hangar area, and the eastern expansion area [Site 3]).

(2) (U) When digging must be done, back fill the resulting hole/trench with clean dirt at the earliest opportunity. If digging is to be done manually, then the following personal protective equipment is recommended:

(a) (U) Half- or full-face respirator with organic vapor cartridge and high efficiency particulate (HEPA) filter. The M40 mask meets this requirement. If the M40 mask is used, it is recommended that the cartridge/filter be changed when the digging work is complete so that the mask will be fully functional in case of chemical agent attack.

(b) (U) Tyvek suit with Saranex coating.

(c) (U) Nitrile gloves (or similar impermeable gloves).

(d) (U) Rubberized overboots.

c. (U) ~~(C//REL)~~ Ambient Air Exposures - Respirable Particulate Inhalation (including inhalation of radiological particulates from Site 1). Implement methods to keep the dust level to a minimum (i.e., dust that could originate from the former missile storage site). For example, gravel or pave the berm road adjacent to the former missile storage site. Consider capping the area with clean soil. If this is done, the current soil should not be disturbed; clean fill (e.g., such as that found west of the westernmost force protection berm) should be compacted over the top of the existing topsoil. Additionally, wet down existing berms and dirt areas on a periodic basis to prevent suspension of soil particles and position diesel exhaust sources away from highly trafficked living and working areas.

d. (U) ~~(C//REL)~~ Radiological Exposures. Declare the former missile storage site (Site 1) as "off-limits." Properly and permanently mark and cordon the area and check on a periodic basis to ensure markings are still in place. Follow ambient air exposure recommendations in paragraph 4c above to minimize exposure to inhaled radioactive particulate matter from Site 1.

e. (U) Asbestos Exposures.

(1) (U) Wet, double-bag, label, and properly dispose of asbestos tiles on the ground. Workers should wear a half or full-face respirator, which has a HEPA or NIOSH Class 100 (N-, P-, R-100) filter. The M40 mask is appropriate; however the cartridge should be changed once the job is completed so that the mask is fully functional in case of any chemical agent attack. Once the tiles are wet, workers should wear nitrile or similar nonpermeable gloves to handle the tiles. Workers should wash their hands after the work is completed.

(2) (U) Do not disturb roof tiles currently in place on existing structures. If work needs to be done in which the roof tiles would be disturbed or replaced, contact CHPPM-Europe for recommendations on protective measures.

f. (U) Hantavirus/ Rodent Borne Disease Exposures. Implement rodent control programs/ measures as necessary to prevent potential rodent-borne health threats.

g. (U) ~~(C//REL)~~ Future Environmental Monitoring. Additional environmental monitoring must be performed to document exposure levels for identified environmental health threats, review the efficacy of proposed countermeasures, and identify any new potential health threats that might result from base camp expansion or significant operational or environmental changes.

(1) (U) ~~(C//REL)~~ Conduct radiological air monitoring for uranium (soluble and insoluble) in or near the fighting positions nearest to the former missile storage site. Instructions and equipment/supplies were provided to the Preventive Medicine Detachment for conducting this monitoring. Ensure that these samples are sent back to the CHPPM laboratories for analysis.

(2) (U) ~~(C//REL)~~ Perform radon air sampling in the fighting positions nearest to the former missile storage site. Radon detectors were provided by CHPPM-Europe for this purpose. The Preventive Medicine Detachment at Stronghold Freedom has been instructed how to conduct this monitoring. Ensure that these samples are sent back to the CHPPM laboratories for analysis.

(3) (U) ~~(C//REL)~~ Continue monitoring for organic contaminants and respirable particulates at Stronghold Freedom in accordance with requirements in references 7 and 8. Sample analysis methods should provide results that allow for comparison to long-term Air-MEGs to determine potential long-term health threats. Forward samples to CHPPM-EUR for sample analysis and technical support.

(4) (U) ~~(C//REL)~~ Continue to monitor water quality at Stronghold Freedom IAW references 7 and 8 on a quarterly basis to ensure water meets applicable health standards. Monitor new water sources as necessary using USACHPPM deployment test kits or other approved methods.

h. (U) ~~(C//REL)~~ Risk Communication Guidelines. Develop a risk communication strategy to effectively communicate risk-related information.

5. (U) Point of Contact. The POC is COL [redacted] Commander, CHPPM-EUR, APO AE 09180, [redacted], emai[redacted]

//signed//
[redacted]
COL, MS
Commanding

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1. (U) References. A list of references is provided in Appendix A.

2. (U) ~~(S//REL)~~ Purpose. To assess and characterize potential occupational and environmental health (OEH) risks from contaminants at Stronghold Freedom, Karshi Khanabad Airfield, Uzbekistan and make recommendations to mitigate identified health risks. Additionally, this survey establishes baseline conditions for deployment environmental surveillance mandated by the Department of Defense (DoD). This report provides final findings, conclusions, and recommendations and supersedes the interim report published 30 November 2001 (reference 13).

3. (U) Authority.

a. (U) DoD Directive 6490.2, dated 30 August 1997.

b. (U) DoD Instruction 6490.3, dated 7 August 1997.

c. (U) Joint Staff Memorandum, MCM-251-98, dated 4 December 1998.

d. (U) Headquarters Department of the Army Policy Letter, Force Health Protection (FHP): Occupational and Environmental Health Threats, 27 June 2001.

e. (U) Request for services from the Commander, US CENTCOM to the Commander, US Army Center for Health Promotion and Preventive Medicine – Europe (CHPPM-EUR) 26 October 2001.

4. (U) ~~(S//REL)~~ Scope.

a. (U) ~~(S//REL)~~ Environmental Health-Based Complaints. In mid-October 2001, US Forces constructed an earthen force protection berm (using host nation construction workers) to establish a defensive perimeter. The earth to construct the berm was taken from trenches excavated to a depth of 9-12 feet immediately outside the perimeter. While excavating the berm material on the northeastern and eastern perimeters, host nation workers using heavy equipment uncovered a malodorous and discolored soil with an obvious petroleum smell. US soldiers that were working and manning fighting positions on top of the constructed berm complained of adverse health effects from petroleum odors. Reported symptoms included headaches, nausea, and stomach cramps. Once removed from areas directly adjacent to the exposed waste pit on the eastern perimeter, personnel no longer experienced these symptoms. These odors were most prevalent for the force protection berms on the northeastern and eastern portions. Additionally, as the berm was constructed with these same contaminated soils, personnel complained of unpleasant odors associated with both the berm material and the berm. The layout of Karshi

Khanabad Airfield and the Stronghold Freedom portion of the airfield is depicted in Figures 1 and 2, respectively.

b. (U) ~~(S//REL)~~ Scope of Work. This situation led to the original request for assistance by the Joint Special Operations Task Force (JSOTF) Commander to determine the nature of contamination and the health threat to forces. As a result, movement into the tent city being constructed was halted until the contamination could be identified and health risks determined. Subsequently, a CHPPM-EUR team deployed to Karshi Khanabad Airfield on 27 October 2001 and identified and characterized health risks from this site. Additionally, recommendations were provided to mitigate health risks from environmental contamination. The latter situation prompted a request from the TF Dagger commander and CENTCOM to characterize the rest of the camp and targeted expansion areas. This assessment was conducted during the period 27 October – 27 November 2001.

c. (U) DoD Requirements. The Department of Defense, Joint Staff, Department of Army, and US CENTCOM policies require that deployed forces identify the risks from OEH hazards as part of the overall Force Health Protection efforts. The CHPPM has developed tactics, techniques and procedures to assess these risks using Operational Risk Management (ORM) practices. These practices were used to conduct this assessment.

d. (U) ~~(S//REL)~~ Areas of Interest. The CHPPM-EUR, in coordination with command medical and engineering personnel supporting TF Dagger, [redacted] and interviews with host nation personnel, identified a number of areas of historical or current activity. These areas were investigated to determine potential health threats to personnel at Stronghold Freedom. The CHPPM-EUR employed a multidisciplinary approach that characterized a wide range of possible air, water, and soil contaminants and possible exposure pathways that could potentially impact soldiers' health. This environmental site characterization focused on the following areas of interest at Stronghold Freedom:

(1) (U) ~~(S//REL)~~ Environmental Contamination from Fuel Storage and Distribution (shown in Figures 3 and 4); (Figures 1 through 9 are available on CHPPM SIPRNET Web Site);

(2) (U) ~~(S//REL)~~ Former Suspected Chemical Decontamination Line [redacted] This chemical decontamination line is also within the boundaries of Site 1 (shown in Figure 5);

(3) (U) ~~(S//REL)~~ Former Weapons/Munitions Storage Areas, also known as the Air- to-Air Missile/ Air-to- Surface Missile (AAM/ ASM) Storage Facility (Site 1) (shown in Figure 6);

(4) (U) ~~(S//REL)~~ Tent City and the force protection berms (shown in Figure 7);

(5) (U) ~~(S//REL)~~ Aircraft hangers, bunkers, and buildings present at Stronghold Freedom from 27 Oct 01 - 27 Nov 01 (shown in Figure 8);

(6) (U) ~~(S//REL)~~ Former Soviet and current Uzbek Air Force Aircraft Maintenance Facility (shown in Figure 9);

(7) (U) ~~(S//REL)~~ Targeted expansion area to east of the easternmost force protection berm (as it existed from 27 Oct 01 - 27 Nov 01). This site is also referred to Site 3 in this report (shown in Figure 1);

(8) (U) ~~(S//REL)~~ Area outside westernmost force protection berm (as it existed from 27 Oct 01 - 27 Nov 01) (shown in Figure 2);

(9) (U) ~~(C//REL)~~ Hantavirus disease threat. The combination of dry climate and an abundant mouse population at Stronghold Freedom led to a CHPPM-EUR recommendation for a survey to determine the disease threat from Hantavirus. The Preventive Medicine Detachment at Stronghold Freedom performed this survey after the departure of the CHPPM-EUR team. Results of this survey are provided in Appendix H of this report.

e. (U) ~~(C//REL)~~ CHPPM-EUR Team Members. A multidisciplinary team from CHPPM-EUR conducted the assessment. This team included:

(1) COL [redacted], Commander, CHPPM-EUR and environmental toxicologist.

(2) LTC [redacted], MD, occupational health physician.

(3) MAJ [redacted], PE, environmental engineer.

(4) CPT [redacted], PG, PE, geologist/engineer.

(5) CPT [redacted], nuclear medical science officer.

(6) SGT [redacted], preventive medicine NCO.

(7) SPC [redacted], preventive medicine specialist

5. (U) ~~(S//REL)~~ Background.

a. (U) ~~(S//REL)~~ Location. Stronghold Freedom is located on Karshi-Khanabad Airfield, in southern Uzbekistan and approximately 100 nautical miles north of the Uzbekistan-Afghanistan border. Uzbekistan was formerly a part of the former Soviet Union and was granted its independence in 1992. Stronghold Freedom was established in October 2001 on the western/ northwestern end of Karshi Khanabad Airfield. This airfield is a military airfield actively operated by the Uzbekistan Air Force. The airfield has reportedly been in operation for over 50 years and was under the control of the former Soviet Union for most of that time. When under Soviet control, it served as a frontal air base and supported primarily fighters and fighterbombers during the later stages of Soviet operation. During the 1980s it was used as a Soviet Air Base in support of their operations in Afghanistan. Figure B-1 (Appendix B) provides an aerial photograph of Karshi-Khanabad Airfield showing local terrain, approximate boundaries, and major features of interest in relation to each other.

b. (U) ~~(S//REL)~~ Surrounding Area. Stronghold Freedom is surrounded by agricultural (cotton) fields to the immediate west and north and host nation air force operations to the east and south (Figure B-1). These cotton fields contain the former AAM/ ASM Storage Facility and the former Chemical Decontamination Site. Figure B-2 shows an aerial photograph with the respective areas of interest labeled.

c. (U) ~~(S//REL)~~ Site History and Current Activities. This section describes known current and historical activities with potential to cause adverse health effects from environmental contamination. These contaminants would potentially be discharged to the soil, water, or air in the Stronghold Freedom area through poor waste disposal practices and would potentially expose personnel through inhalation, ingestion, or dermal pathways.

(1) (U) ~~(S//REL)~~ AAM/ ASM Storage Facility. Aerial photographs from 1987 and 1993 reveal a pentagon shaped, fortified complex of multiple facilities that encompassed approximately 20 acres. Explosion and/or fire reportedly destroyed this area in 1993. Approximately 30% of the former complex is located in the northwest corner of Stronghold Freedom (tent city area). The remaining part of this site (approximately 70%) is located north-northwest of the current Stronghold Freedom perimeter and it is presently overgrown with cotton (indicating recent agricultural use) and contains remnants of building foundations. This area outside of the berm also contains a wide variety of ordnance debris (some unexploded) (e.g., assorted small-caliber ammunition, mid-caliber ammunition, sub-munitions, grenade fragments, and missile components) scattered across the surface. Figures B-3 and B-4 show this facility both prior to and after the explosion, respectively. Figure 2 depicts the location of this site in relation to Stronghold Freedom.

[redacted]

(3) (U) ~~(S//REL)~~ Petroleum, Oil, and Lubricants (POL) Distribution and Storage Facility. The Uzbekistan Air Force operates a tank farm with an approximate 125,000-gallon capacity for Jet Fuel (labeled TS-1, equivalent to US Jet A-1 fuel) in both above and below ground storage tanks. The tanks primarily contain kerosene based jet fuel. Fuel was transmitted by lines located beneath the ground running under the northern portion of Stronghold Freedom (e.g. most of the tent city and Site 3 areas). These fuel lines are no longer in service. The POL "tank farm" is located to the northeast and immediately adjacent to Stronghold Freedom - especially the eastern (Site 3) expansion area. Figures 3 and 4 show the location of the fuel lines and POL tank farm in relation to Stronghold Freedom.

(4) (U) ~~(C//REL)~~ The Uzbekistan Air Force operates an aircraft maintenance facility that includes two aircraft maintenance hangers. This complex is located to the southeast and immediately adjacent to Stronghold Freedom. Figure 9 depicts the layout of the maintenance facility, while Figure B-2 shows an aerial photograph of the facility in relation to Stronghold Freedom.

d. (U) ~~(S//REL)~~ Current Site Use. Stronghold Freedom is currently serving as a Forward Operating Base (FOB) to US and allied forces that are in support of Operation Enduring Freedom. The camp has a current population of several thousand personnel. Activities include a Forward Surgical Team (FST), aviation operations, and other combat support and combat service support functions. The camp includes a tent city to house forces; a runway, former aircraft hangars and ammunition bunkers that are now used to support both US and other allied forces. The Uzbekistan Air Force still controls a majority of the facilities on the Karshi-Khanabad Airfield, especially those on the central and eastern portions of the runway.

6. (U) ~~(S//REL)~~ Methodology and Procedures.

a. (U) ~~(C//REL)~~ Soil Sampling.

(1) (U) Methodology. A soil sampling methodology was established for each of the four areas of interest as described below. Table C-1 provides a summary of all soil samples collected for this assessment. Sampling locations for the areas of interest are depicted in Figures 3-9.

(a) (U) ~~(C//REL)~~ Existing and Known Fuel Contamination. Fuel contamination was identified in an open trench that had been excavated to provide material to construct a defensive perimeter berm. The CHPPM-EUR confirmed the fuel contamination by collecting samples from the bottom of the open trench (2 meters below ground surface [BGS]) and at 1 meter below the bottom of the open trench (3 meters BGS). Subsequently, the CHPPM-EUR advanced soil borings, typically to the point of refusal (i.e., boring drill penetration stops), to determine the presence of fuel contamination in nearby areas that were occupied or intended for occupation by military forces. Several soil gas samples were also collected at intervals ranging from 0.5 to 1.5 meters BGS in order to determine relative concentrations of soil gas in suspected contaminated subsurface soils and to assess the upward migration potential of these gases that could pose a health risk. Samples were submitted for chemical analysis that included total petroleum hydrocarbons (TPH) and volatile organic compounds (VOCs). Selected samples were also analyzed for polynuclear aromatic hydrocarbons (PAHs) and metals. The vertical extent of hydrocarbon contamination was not delineated.

(b) (U) ~~(S//REL)~~ Former Weapons/Munitions Storage Area. [redacted] CHPPM-EUR advanced several borings throughout the former location of the storage area. The borings were advanced to the point of refusal and selected samples were submitted for chemical analysis to determine the presence of suspect contaminants.

(c) (U) ~~(S//REL)~~ Former Chemical Decontamination Line. [redacted] CHPPM-EUR advanced several borings at selected locations along the apparent decontamination line to include the bottom of existing remnants of brick-concrete drainage structures. The borings were advanced to the point of refusal and selected samples were submitted for chemical analysis to determine the presence of chemical agent breakdown products and known Soviet decontamination agents.

(d) (U) ~~(S//REL)~~ Historical and Current Aircraft Maintenance and Operations Facilities.

(i) (U)~~(S//REL)~~ Facilities used by US Forces. On Stronghold Freedom, US Forces are currently using aircraft bunkers for various purposes. The CHPPM-EUR selected two aircraft bunkers on Stronghold Freedom to be representative of all occupied aircraft bunkers. The CHPPM-EUR collected three discrete surface samples from the exterior perimeter of each bunker, one composite surface sample from the surrounding parking apron, and one composite sample from a 1-meter boring that was collected immediately adjacent to the bunker and parking apron areas. Overland flow/ drainage patterns were used to site the boring and surface samples, as it was assumed that rainwater would drain potential contaminants away from the aprons and bunkers and into the surrounding soils.

(ii) (U) ~~(S//REL)~~ Facilities adjacent to US Forces. Adjacent to Stronghold Freedom are aircraft maintenance facilities that are currently used by the Uzbekistan Air Force. The CHPPM-EUR was given a walking tour of the facilities by the Uzbekistan Air Force. Sampling was conducted based on authorization received from Uzbekistan Air Force authorities.

(2) (U) Procedures.

(a) (U) Sample Collection. At each sample location, soil samples were collected in one-meter increments using a direct-push system equipped with a Macro-Core™ soil sample tube (1.2-m long, 5-cm outside diameter) with a clear plastic liner inside. This method of sampling continued to the desired sampling depth or until the sampler encountered refusal. The plastic liner and cutting shoe on the leading edge of the sample tube were the only parts of the sampling system that contacted the soil. After each sample was collected the plastic liner was replaced with a new one and the cutting shoe was decontaminated. Decontamination of the cutting shoe consisted of removing gross accumulations of soil with a wire brush, washing the cutting shoe with tap water and Alconox™ (a type of soap), rinsing it with deionized water, and then allowing it to air dry. Portions of the collected soil were screened on-site for volatile organic vapors with a Foxboro™ Toxic Vapor Analyzer-1000 (TVA-1000; photo and flame ionization detectors; PID and FID respectively). On-site screening enabled adjustment of the sampling plan to more accurately identify contaminated areas.

(b) (U) Sample Handling. Soil for each analysis was placed into individual glass sample jars with a Teflon-lined screw-top cap. Samples for analysis of volatile organic compounds (VOCs), such as benzene, toluene, ethylbenzene, and xylene (BTEX) and chlorinated hydrocarbons (CHCs), were submitted without headspace in the sample jar. Groundwater samples were collected in amber 1-L bottles, plastic 1-L bottles, and 3 amber 40ml vials for TPH, metals, and VOCs, respectively. Water samples for TPH and metals were each preserved with 5ml of sulfuric acid and 5 ml of nitric acid, respectively. All samples were stored and shipped in a cooler with ice packs until analyzed.

b. (U)Air Sampling.

(1) (U) Purpose and Scope. Ambient air sampling methodology was primarily based on defining the health threat of inhaling volatilized fuel vapors from soils contaminated with fuels and other possible organic contaminants. This is particularly important because exposure to vapors resulted in the original health concerns driving the need for the site characterization. In general, this sampling methodology sought to evaluate ambient air concentrations from exposed, fuel contaminated soils (e.g. at the source); concentrations at exposed fighting/ defensive positions on the perimeter berm near the waste sites; inside fighting positions established in various portions of the berm (possibly surrounded by contaminated soils); and concentrations inside the tent city life support area. These data can be compared to occupational and environmental health criteria to determine potential health risks from levels measured and to evaluate the effectiveness of the recommended countermeasures. Ambient air sampling was also performed to determine the health risk from inhalation of respirable particles (e.g. particulate matter with a mean diameter less than 10 microns or PM_{10}). These data can be compared to PM_{10} air quality standards. PM_{10} filters were also analyzed for heavy metals (as were surface soils) in order to develop health risks and exposure levels from respirable particulate matter with specific contaminants. All air sampling data are provided in Appendix C, Tables C-9 through C-11 and C-20. Air sampling locations are depicted in Figures 3 through 7.

(2) (U) Procedures. Air sampling for organic compounds was performed using SKC Airchek Model 52 personal air sampling pumps and SKC 50/100 charcoal tube media. Sampling flowrates ranged between 0.2 and 0.5 liters per minute (l/min), in accordance with guidelines established for the sample media. Sample pumps used the low-flow controller and were calibrated immediately prior and after each sampling event using a Dry-Cal flow calibrator. All pre- and post- calibration flowrates were very consistent (less than 5% variation in flow rate); an average of the pre and post calibration flowrates was used to determine the total sample volume. Initial sampling times and sample volumes to determine the nature of the organic contamination in the Site 3 waste pit and at nearby exposure points were based on direct readings taken with a Foxboro TVA, Model 1000, Dual Flame Ionization Detector (FID)/ and Photo-Ionization Detector (PID). The Foxboro TVA 1000 was calibrated daily with methane and isobutylene in

accordance with manufacturer recommendations. Based on the fairly high readings recorded with the Foxboro TVA 1000 in the waste pit, sample volumes at this location were generally bracketed between 1 and 10 liters (total volume) to prevent breakthrough. Ambient air sampling volumes at potential exposure locations (e.g., berm fighting positions) were initially bracketed in the 10 to 100 liter range and based on TVA readings for initial samples. After initial air sampling results were provided by the CHPPM-EUR laboratory, ambient air sampling volumes (and corresponding flowrates/ sampling times) were adjusted for total volumes in the 50 to 100 liter range. Collocated air samplers were used at a number of locations as a quality assurance method. Inorganic air sampling for respirable particulate matter (PM_{10}) was performed using Airmetrics MiniVol Air Samplers. Two air samplers were initially deployed in the Tent City area. These samplers were operated, maintained, and calibrated in accordance with USACHPPM Technical Guide 251 (reference 12).

c. (U) ~~(C//REL)~~ Water Sampling

(1) (U) ~~(C//REL)~~ Purpose and Scope. Some limited water sampling was performed as part of this assessment. This sampling was limited in scope because ingestion of contaminated drinking water was not a major issue for this assessment, as virtually all deployed personnel were consuming bottled water obtained from approved sources and airlifted into Uzbekistan. Stronghold Freedom was also producing water using Reverse Osmosis Water Purification Units (ROWPUs). The ROWPU water was primarily used for cooking and shower/ wash water. The ROWPU source was a water distribution pipe from a host nation source that was fairly high quality. Therefore, the scope of water sampling for this assessment was primarily limited to testing the source water for a number of organic and inorganic parameters. Additionally, a ROWPU product water sample taken by one of the organic preventive medicine units indicated a possible increase in lead concentrations above those in the source water. Confirmatory sampling was performed to define this potential problem and recommend operational practices. Water sampling data are located in Appendix C, Tables C-12 and C-13.

(2) (U) Procedures. Water sampling was performed using USACHPPM 40 ml deployment water test kits. Samples were collected using these kits, preserved, and then air shipped to the CHPPM-EUR laboratory for analysis using US Environmental Protection Agency (EPA) approved test methods. Analytical parameters included over 100 volatile organic, semi-volatile organic, heavy metal, pesticides, herbicides, and PCB compounds.

d. (U) ~~(C//REL)~~ Radiological Sampling.

(1) (U) Equipment. The following equipment was utilized in the surveying, sampling, and characterization plan of locations within the U.S. perimeter and potential occupancy areas outside the force protection berm:

(a) (U) Eberline 600 (E-600) w/ NaI scintillation probe (SPA-9) and alpha/beta pancake probe (SHP-330)

(b) (U) Bicron w/ FIDDLER scintillation probe.

(c) (U) DART Portable Gamma Spectroscopy System

(d) (U) Siemens Electronic Thermoluminscent Dosimeter

(e) (U) High Volume Staplex Air Sampler w/ paper filters

(f) (U) Daily calibration checks were conducted on the respective equipment to measure background and ensure equipment was within 5% of dedicated check sources utilized during calibration.

(2) (U) Methodology. Radiological assessments were conducted for ionizing radiation sources or material. A scoping survey plan was implemented for the entire base camp to include the perimeter outside the force protection berm. A characteristic survey plan was implemented in those areas containing potential radiological material or contamination. Each survey plan evaluated soils and air. Within the base camp, bunkers and structures occupied by deployed forces were evaluated via direct reading instrumentation and wipe tests for removable contamination. Laboratory analyses were submitted to the radiochemistry laboratory at U.S. Center for Health Promotion and Preventive Medicine (USACHPPM), Aberdeen Proving Ground, MD, which has International Organization for Standardization (ISO) 9000 accreditation for soils and accreditation for human radiobiossay. Radiological assessments, evaluations, and analyses were conducted for the following areas:

(a) (U) Base Camp Baseline. A uniform distribution of survey points was established to obtain a baseline of natural radioisotopes. A total of 30, one kilogram (kg) soil samples were collected at a depth of 10 cm below ground surface (BGS) at various locations within the base camp, Site 1, and Site 3. Soil samples were analyzed with the DART Portable Gamma Spectroscopy System and compared to two background reference samples. Figure D-7 illustrates baseline survey locations.

(b) (U) Bunker and Building Evaluations. All buildings and bunkers either currently or formerly occupied within the U.S. perimeter were evaluated for elevated levels of radioactivity and/or contamination. Each bunker and building was evaluated with the E-600, SPA-9, NaI scintillation probe for direct exposure measurements. Removable wipe tests of 100 cm^2 were also conducted for evaluation of potential removable contamination. Wipe tests were submitted to Test, Measurement, and Diagnostic Equipment (TMDE) - Europe, Nucleonics Laboratory, for gross alpha/beta evaluation.

(c) (U) ~~(C//REL)~~ Site 1. A scoping and characterization survey plan was developed to delineate the extent of radiological contamination. Methodology was IAW Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), August 2000, which was developed in a concerted effort between the U.S. Environmental Protection Agency, U.S. Nuclear Regulatory Commission, U.S. Department of Energy, and U.S. Department of Defense for the characterization of contaminated radiological sites. The area was divided into 4 quadrants measuring approximately 9,000 m^2. Quadrants were designated A, B, C, and D, respectively. Within each quadrant, ten -1 kg soil samples were taken utilizing triangular grids and non-parametric statistics. A derived concentration guidance limit (DCGL) of 35 picocuries per gram (pCi/g) was established. An alpha error of 0.05 and a beta error of 0.10 were utilized for determining the number of samples per quadrant. The alpha error represents the potential of obtaining a false negative and the beta error represents the potential of obtaining a false positive. These levels were established to err on the side of conservatism. The sampling points were plotted on an east and north axis within each quadrant on triangular grids. Samples were taken between 5-20 cm BGS in depth. Subsequently, samples were measured with a direct measurement alpha/beta pancake probe for surface exposure and also counted for 1500 seconds with the portable DART gamma spectroscopy system. Each gamma spectroscopy graph was compared to the quality assurance background graph to determine if any other elevated energy peaks existed. All the soil samples were submitted to the radiochemistry laboratory at USACHPPM, Aberdeen Proving Ground, Maryland, and German Laboratory for final analyses. Direct meter surface measurements were conducted on each quadrant. Areas with elevated count rates greater than background were flagged accordingly and investigated further to determine the location and extent of contamination. Each sample was documented and submitted to USACHPPM Main for analysis. Figure D-8 illustrates the radiological characterization survey at Site 1.

(d) (U) ~~(C//REL)~~ Air Sampling. High volume air samples were collected in the area of greatest contamination (i.e., Site 1 area outside the force protection berm), occupied fighting positions, and center of base camp living quarters. This sampling helped evaluate potential radiological hazards that may potentially pose inhalation hazards. Air sampling was performed using a Staplex High Volume Air Sampler and 10 cm paper filters. Each sample was collected for a minimum of 2 hours and at a flow rate between 42-54 m^3/hr. Two background samples were collected on the east and southwest perimeters for background reference. Appendix D illustrates locations of the air sampling. Samples were submitted to USACHPPM for analysis and determination of potential radiological inhalation hazards.

(e) (U) ~~(C//REL)~~ Dosimetry. Dosimetry was conducted to quantify the amount of potential radiation exposure to personnel occupying positions near the area of contamination and for personnel surveying the area of contamination. External exposure evaluation utilized portable ion chambers with electronic readout and internal exposure evaluations utilized radiobioassays. A portable ion chamber with electronic readout was placed in the fighting position closest to Site 1 to evaluate any potential external exposures. The dosimeter was in place for seven days to construct a rudimentary dose assessment for personnel occupying the fighting position for an extended period of time. Radiobioassays were collected for selected individuals surveying and working with suspect soils to measure potential internal exposures. Radiobioassays consisted of a 1-liter urine collection over a 24-hour period.

e. (U) ~~(C//REL)~~ Asbestos Sampling.

(1) (U) Methodology and procedures. A sampling methodology and procedure was established for main areas of interest as described below.

(a) (U) ~~(C//REL)~~ Aircraft hangars. Several earthen-covered hangars are arrayed at the Stronghold. These hangars were used by the Uzbekis for housing fighter jets. The rear area of the hangar was suspected to be coated with an asbestos-containing material since the fighter jet engines were tested in place with the engines facing into the hanger backblast area. One representative sample of the backblast area wall coating was submitted for laboratory analysis as a bulk sample. In order to quickly define possible health threats, air monitoring for asbestos was done in the backblast area before the results from the bulk sample were received. Air samples were collected using a personal air-sampling pump as an area sampler. Samples were collected using mixed cellulose ester (MCE) media (for use in phase contrast microscopy) and transmission electron microscopy (TEM) media. Air sample volumes were set at 5 liters per minute for 8-hour periods.

(b) (U) ~~(C//REL)~~ Roofing material. Most existing structures at the Stronghold and the newly constructed portable latrines are roofed with a corrugated sheet tile. In addition, in several areas of the Stronghold, there are piles of broken tiles on the ground. A bulk sample of this material was taken from a broken piece atop a gazebo within an orchard outside the field PX. In conjunction with this, air monitoring was done at a point between the gazebo, the PX, and an adjacent road. Vehicles and pedestrians travel the road heavily, the sidewalk along the PX is heavily traveled, and the gazebo usually has soldiers/airmen under it. Air samples were collected using a personal air-sampling pump as an area sampler. Samples were collected using MCE and TEM media. Air sample volumes were set at 5 liters per minute for 8-hour periods.

(c) (U) ~~(C//REL)~~ Missile debris. In the former weapons/munitions storage area, missile debris was found. Some of this debris was friable and suspicious as an asbestos-containing material. A bulk sample was submitted for laboratory analysis. In addition, air monitoring for asbestos was done at the firing positions nearest to the former weapons/munitions storage area; this is the point at which the highest exposure to asbestos generated from the missile debris would occur. Initial samples were taken using a high volume air sampler with MCE media at 15 liters per minute for an 8-hour period in order to screen for possible traces of airborne asbestos fibers. Subsequent samples were collected using personal air sampling pumps as an area sampler. Samples were collected using MCE and TEM media. Air sample volumes were set at 5 liters per minute for 8-hour periods.

f. (U) Laboratory.

(1) (U) Laboratory Accreditation.

(a) (U) All samples were submitted to the Department of Laboratory Sciences (DLS), CHPPM-EUR for analysis. The Deutscher Akkreditierungs Rat (DAR, German Accreditation Council) recognizes the accreditation by the Deutsches Akkreditierungssystem Prüfwesen GmbH (DAP) for all 15 European countries, by the DLS, CHPPM-EUR. The DAP has determined that the DLS is competent under the terms of Deutsche Institut für Normung (DIN) EN 45001 to carry out physical, physical-chemical, and chemical analysis of water, soils, sediments, and other environmental media. The present accreditation is valid until 3 July 2001. The DLS's DAR registration number is DAP-P-03.000-00-95-02. The DLS has also established the equivalency of EPA and German methods (reference 2).

(b) (U) The American Association for Laboratory Accreditation (A2LA) has also accredited the DLS, CHPPM-EUR according to the requirements of ISO/IEC Guide 25-1990 "General Requirements for the Competence of Calibration and Testing Laboratories" and additional requirements in the field of environmental media. The DLS's A2LA certificate number is 729.01 and is valid until 31 May 2002.

(c) (U) The DLS submitted selected samples for analysis by the German Laboratory, Institut Fur Analytische Chemie (IAC), Mannheim, Germany. DAR also accredits this laboratory. This laboratory analyzed all soil and water samples for arsenic, selected soil samples for BTEX and CHCs, and groundwater samples for TPH.

(2) (U) Parameter Selection and Analytical Methods.

(a) (U) Metals. Metal contamination is commonly associated with heavy maintenance and industrial operations. Each sample was analyzed for arsenic, cadmium, chromium, copper, lead, nickel, and zinc. Arsenic was analyzed by IAC according to DIN 11885 E2, lead by the DLS according to EPA Method 7000B, and the other metals by the DLS according to EPA Method 200.7 (reference 2).

(b) (U) VOCs. BTEX are components of fuel. CHCs are commonly used in solvents. Both are classified as VOCs. Each sample was analyzed for VOCs. Selected VOC samples were analyzed by IAC according to EN ISO 10301 F4 (CHCs) and DIN 38407 F9 (BTEX). The remaining samples were analyzed by the DLS according to EPA Method 8260 for soil samples and EPA Method 524.2 for water samples (reference 2).

(c) (U) TPH. Petroleum contamination is commonly associated with fuel storage and dispensing operations. JP-8 and low range gasoline hydrocarbons are detectable when analyzing for TPHs. The soil samples were analyzed by the DLS according to EPA Method 418.1. This method has been accepted by the Forschungs- und Materialprüfungsanstalt, Baden-Württemberg, as equivalent to the DIN Method 38 409 H18 (German TPH method). The groundwater samples were analyzed by IAC according to DIN Method 38409 H18 (reference 2).

(d) (U) Pesticides/Herbicides. Composite surface soil samples were collected and analyzed for selected pesticides and herbicides throughout the project area. The project site is located in and adjacent to agricultural area. The analyses were conducted according to EPA method 8151.

(e) (U) Munitions. Composite surface soil samples were collected and analyzed for selected explosives at select locations in the project area that were related to the former Weapons/Munitions Storage Area. The analyses were conducted according to EPA method 8330.

(f) (U) Polynuclear aromatic nuclear hydrocarbons (PAHs). Discrete soil samples were collected and analyzed for PAHs at selected locations in the project area. The analyses were conducted according to EPA method 8270 or for contracted analyses, by a similar method employed by a German contracted laboratory.

(g) (U) Polychlorinated biphenyls (PCBs). Composite and discrete surface soil samples were collected and analyzed for selected PCBs at select locations in the project area. Sample collection was typically associated with locations of obvious former electrical transformers. The analyses were conducted according to EPA method 8270 or for German laboratory contracted analyses, by DIN method 38414 S2.

(h) (U) Chemical Agent Breakdown Products (CBPs). Certain samples from the former suspected chemical decontamination site were collected and analyzed for CBPs. This analysis was performed by a chemical surety laboratory operated by the Soldier, Biological, and Chemical Command (SBCCOM), Aberdeen Proving Ground, Maryland.

(i) (U) Hantavirus Specimen Analysis. Hantavirus specimen analysis was performed by the State of Baden-Wurttemberg health office laboratory in Stuttgart, Germany.

7. (U) ~~(C//REL)~~ Findings.

a. (U) ~~(C//REL)~~ Soil Contamination.

(1) (U) ~~(C//REL)~~ POL Distribution and Storage Facilities. Fuel contamination was confirmed in the vicinity of the trench excavated by US forces in October 2001. TPH and volatile organic compounds were detected at elevated concentrations in subsurface borings throughout northeast quadrant of the area occupied by US Forces. Contamination appeared to be limited to a clay layer at a depth of approximately 1.5 to 3 meters below ground surface. TPH ranged from 10,000 mg/kg to 50,000 mg/kg at approximately 2 meters below ground surface. Various components of jet fuel, including kerosene, and methylene chloride, a common solvent, were also detected. Local host nation military personnel acknowledged fuel contamination in this area and attributed it to a former fuel transmission line.

(2) (U) ~~(C//REL)~~ AAM/ ASM Storage Facility. Composite surface soils were collected and analyzed for a broad range of parameters to characterize potential exposures to deployed personnel from surface activities and dusty conditions. Typical analytes included herbicides, pesticides, PCBs, explosives, select metals, and TPH. Herbicides, pesticides, explosives, PCBs, and metals were detected at some sampling locations at trace levels.

(3) (U) ~~(C//REL)~~ Former Chemical Decontamination Site. Discrete surface and subsurface samples were collected at selected locations along the decontamination line. These samples were analyzed for select chemical agent breakdown products. Chemical agent breakdown products were not detected in any samples.

(4) (U) ~~(C//REL)~~ Former Soviet and current Uzbek Air Force Aircraft Maintenance Facilities. TPH and VOCs were detected in the vicinity of a host nation sump that is located off the southeast corner of the host nation aircraft maintenance facilities. Local host nation military personnel report that the sump is used for disposal of small volumes of petroleum based wastes. High levels of TPH were detected in surface samples at locations that appeared limited to current maintenance operations.

(5) (U) ~~(C//REL)~~ One soil boring was collected to perform soil classification and certain soil engineering and physical properties. This analysis indicated an estimated hydraulic conductivity of 1.5×10^{-6} cm/s for the surface soil and 7.3×10^{-7} cm/s for the shallow sub-surface soil, with tighter soils and lower permeabilities expected with compactive effort. The soil classifications ranged from clays to inorganic silts/clayey sands (CL-ML) from the surface to 1.0 meter with ML occupying the remainder of the profile. CL indicates inorganic clays of low to medium plasticity, while ML indicates inorganic silts and very fine sands, silty or clayey fine sands, and clayey silts. The analysis indicated that soils at Stronghold Freedom should be good materials for cap liner, as the measured permeability should exhibit good containment of liquid and provide adequate separation between contaminated soil and human receptors.

b. (U) ~~(C//REL)~~ Ambient Air. Air sampling for both inorganic and organic contaminants revealed some elevated concentrations resulting from the suspension of particulate matter and volatilization of organic compounds present in fuel contaminated soil.

(1) (U) ~~(C//REL)~~ Organic Air Sampling in Waste Pit and Surrounding Area. On 28 October 2001, a total of eight ambient air samples and a field blank (numbered A-1 through A-9 [latter is blank]) were collected at locations in and adjacent to the original Site 3 waste fuel pit. The purpose of this sampling event was to evaluate inhalation levels of organic contaminants at various distances and locations in relation to the waste pit. These locations included: inside the waste pit at contaminated soil locations (at the source); at the fuel distribution manhole adjacent to the waste pit (at ground surface near the source); and at the main observation post/ defensive position exposed to volatilized vapors. A schematic showing the locations of samples collected on this date is provided in Appendix B, Figure B-6.

(a) (U) ~~(C//REL)~~ Samples A-1 and A-2 were collocated samples placed in top of the observation post south of the waste pit. Samples A-3 and A-4 were collocated samples placed on the fuel distribution manhole. Samples A-5, A-6, A-7, and A-8 were placed at various locations in the waste pit. Sampling times and volumes varied based on the locations sampled in order to prevent breakthrough of contaminants captured on the sample media. In essence, lower sampling volumes and times were used at the source, ranging between 1 liter and 10 liters of air sampled and 5 - 25 minutes. Sample volumes and times for manhole and observation post samples ranged between 10 and 100 liters and 50 to 250 minutes. Sample flow rates for all sampling pumps were set between 0.2 and 0.4 liters per minute (l/ min). A Foxboro TVA 1000 was used to take direct readings at sampling locations and assist with determination of sampling times and volumes. Table C-10 (Appendix C) provides results and other pertinent information for this sampling event.

(b) (U) ~~(C//REL)~~ Results from this sampling event indicate that organic compounds volatilizing from fuel-contaminated soils may impact personnel if directly exposed at the source of contamination. The health risk assessment in Section 8 provides an evaluation of this exposure pathway. Levels measured at sampling locations A-5 through A-8 indicated concentrations of kerosene fraction hydrocarbons at 14.6 (milligrams per cubic meter) (mg/m^3); 63.55 mg/m^3; 3.7 mg/m^3; and 33 mg/m^3, respectively, for relatively short sampling times (5 to 25 minutes). These correlated with soil sampling locations 1E, 1F, 1A, and 1C having total petroleum hydrocarbon (TPH) levels ranging from 2,200 mg/ kg (1C3-1) to 50,000 mg/kg (1E2-1). Direct readings from the Foxboro TVA at these same sites ranged between 180 and over 500 ppm as methane. Sample A-6 also detected isomers of ethyl toluene, trimethylbenzene, and tetra methylbenzene at levels ranging from 0.5 to 5 mg/m^3. Samples A-3 and A-4 exhibited much lower levels (0.75 and 0.95 mg/m^3) of the same contaminants over a longer averaging time, indicating greater mixing and dispersion/ dilution with ambient air (manhole was approximately 10-12 feet in elevation higher than the pit bottom and soils in the immediate 5-10 foot radius had not been excavated). Finally, samples A-1 and A-2 at the observation post measured levels of 0.34 and 0.48 mg/m^3, indicating the dilution effects and mixing with ambient air tend to reduce concentrations at a greater distance from the exposed contaminants.

(2) (U) ~~(C//REL)~~ Organic Air Sampling in Tent City, the Force Protection Berm, and Surrounding Area. Air samples A-10 through A-36 were collected at various locations in tent city and in exposed fighting positions from 29 October 2001 to 12 November 2001. These were collected as follows: samples A-11 through A-15 (29 October 01); samples A-16 through A-18 (31 October 01); samples A-19 through A-25 (3 Nov 01); and samples A-26 through A-36 (12 November 01). Table C-9 provides the locations, sample times, flow rates, and volumes for all air samples. Organic analytical data for samples A-10 through A-36 are summarized below by sampling event. Appendix B, Figures B-6 and B-8, show the locations in tent city where samples were collected.

(a) (U) ~~(C//REL)~~ Samples A-11 through A-15. This sampling event included a combination of berm fighting position and tent city sampling in order to determine organic air concentrations from exposed contaminated soil volatilization. The berm fighting position sampling location was chosen as the most exposed position to the contaminated soils east of the force protection berm. Tent city locations were unoccupied at the time of sampling and were closest to the exposed fuel contaminated soils in the waste pit. Results indicated only one location where a measurable level of kerosene fraction hydrocarbons was detected (Sample A-11, inside Tent 2, at 0.36 mg/m^3). None of the other samples detected analytes above the detection limit. All sample times during this event were in excess of 270 minutes (4 hours, 30 minutes).

(b) (U) ~~(C//REL)~~ Samples A-16 through A-18. A fighting position that was partially dug into the eastern force protection berm and never manned was sampled during this event. This position was never manned because an alternate location was found and, in the process of digging this position, fuel contaminated soils in the berm material were encountered (both visual and odor). Hence, this location was sampled in order to measure approximate exposure levels in this "worst - case" situation. Results indicated concentrations of 11 mg/m^3 of kerosene fraction hydrocarbons in each sample. Sample volumes were equivalent (approximately 10 liters), whereas the sampling time, flow rate, and duration were varied. Sampling flow rates were approximately 0.2 and 0.4 liters per minute for 50 and 25 minutes, respectively. Sample A-18 was the field blank. Sampling results from this event reaffirmed the technical recommendation to avoid digging in the tent city area and avoiding areas with gray colored soil when digging fighting positions in the northeastern portions of the force protection berm.

(c) (U) ~~(C//REL)~~ Samples A-19 through A-25. These samples were collected to measure organic air concentrations in a number of new fighting positions that were being improved and re-positioned in the force protection berm and to monitor ambient air within the tent city area. Again, sampling flow rates varied between 0.2 and 0.4 liters/minute, with volumes ranging between 50 and 100 liters. All sample times were in excess of 240 minutes. Samples A-20 through A-23 were placed in newly established positions around the western, northern, and northeastern berms, while samples A-19 and A-24 were collocated with particulate samplers on the eastern and western ends of tent city. Of these samples, only sample A-23, located on the northeastern force protection berm, measured any detectable concentration (0.55 mg/m^3 of kerosene fraction hydrocarbons). This corner position overlooked exposed contaminated soils in excavated trenches to both the east and west, in addition to being situated at a location on the berm that was constructed with contaminated soils from those excavations. Sample A-25 was the field blank.

(d) (U) ~~(C//REL)~~ Samples A-26 through A-35. This sampling event was conducted to measure ambient concentrations at exposed fighting positions overlooking exposed soil contamination in excavations and in the tent city area. Sampling flow rates varied between 0.2 and 0.4 liters/minute, with volumes ranging between 50 and 100 liters. All sample times were 239 minutes or greater. Results indicated detectable levels of kerosene hydrocarbons in samples A-26 (0.15 mg/m^3), A-27 (0.16 mg/m^3), A-28 (0.11 mg/m^3), A-33 (0.24 mg/m^3), and A-34 (0.11 mg/m^3). These results are consistent with other observations and showed that ambient hydrocarbon concentrations were fairly low and consistently measurable primarily at locations near exposed contaminated soils in excavations just outside the berms.

(3) (U) ~~(C//REL)~~ Summary of Organic Air Sampling Results. As one would expect, air concentrations were measured at high levels where fuel contaminant levels were highest (e.g., in exposed, fuel contaminated soils in existing excavations), shown by results from samples A-1 through A-9. Additionally, soldiers may be exposed to high chemical concentrations when digging fighting positions in the northeastern corner of the existing force protection berm (results from A-16 and A-17). Much of the soil used to construct this berm was excavated from contaminated soils in the waste pit (eastern pit) and in portions of the existing northeastern waste pit. Fortunately, the one location where obvious fuel contaminated soils were encountered in the construction of these positions was abandoned in favor of a different location. Concentrations measured at other fighting position locations and in the tent city area were either not detectable or measured at a very low level, indicating that existing clay cover over subsurface fuel contamination and distance from exposed contaminated soils is preventing exposures.

(4) (U) ~~(C//REL)~~ Inorganic Air Sampling. During the period 1-14 November 2001, inorganic sampling for respirable particulate matter (PM_{10}) was also performed. Two, "Mini-Vol" air samplers were placed at locations in the tent city area in order to evaluate the potential for suspended PM_{10} to cause adverse health effects through inhalation. In addition to evaluating PM_{10}, separate analyses were performed for heavy metals on the particulate filters collected. Similarly, surface soil samples were tested for a number of inorganic and organic contaminants in order to help further evaluate this exposure pathway. Visual observations made during the time of this assessment confirmed that this pathway could be a significant exposure pathway for personnel stationed there. The combination of a very dry environment, wind, and constant construction/ vehicle activity seems to suspend available surface soils (and particulates from diesel exhaust) in the air almost constantly. Fortunately, surface soil samples collected to date do not indicate heavy metal, PAH, PCB, pesticide, or herbicide contaminants that would prompt additional health concerns. This was confirmed by performing heavy metal analysis on the particulate filters; no heavy metals were detected on any of the filters. Typically, particulate levels for a given location will vary widely with weather conditions, seasons of the year, industrial activity and vehicular traffic, among other factors. For this reason, annual averages are

calculated. When sampling is done for shorter periods of time to calculate averages, they are greatly affected by individual high values, particularly when the number of samples is small. Therefore it is important to conduct routine sampling to determine actually annual average concentrations. These results are provided in Appendix C, Table C-11 and indicate that suspended particulate matter was measured at elevated concentrations.

c. (U) ~~(C//REL)~~ Water Quality.

(1) (U) ~~(C//REL)~~ ROWPU Source Water. As mentioned, the ROWPU source was a host nation distribution system pipe that traversed Stronghold Freedom in a number of locations. This pipe appeared to be approximately a 6 to 8 inch diameter ductile iron pipe that originated from a local municipal supply. This water was sampled on 29 October 2001 (sample W-K-1). Table C-12 contains the raw water analytical results. The raw water result indicates fairly high quality source water with low turbidity (0.45 NTU) and the pH, calcium, magnesium, hardness and alkalinity levels seem to indicate a probable ground water source - possibly a limestone aquifer.

(2) (U) ~~(C//REL)~~ Heavy Metals Issue. A ROWPU product water sample collected on 22 October 2001 indicated an elevated level of lead that exceeded the EPA and Overseas Environmental Baseline Guidance Document (OEBGD) action level of 0.015 milligrams per liter (mg/l). The lead level measured in this sample was 0.023 mg/l. However, the lead level measured in the source water was only 0.001 mg/l, indicating that the ROWPU operational practices could be the source of the elevated levels. The actual ROWPU sampled was at the site of the original mess hall on Stronghold Freedom (near HAS 21), which discontinued operation on 12 November 2001. Resampling to confirm the original result and to define the possible problem was performed prior to the ROWPU discontinuing operations. Table C-13 provides analytical results of the resampling event (Samples DW1A-E, 1B-E, 1C-E, 1D-E, and 1E-E). These results indicated the following:

(a) (U) ~~(C//REL)~~ Lead in distribution system (raw water) verified previous result (Sample W-K-1 on 29 Oct 2001): 0.001 mg/l.

(b) (U) ~~(C//REL)~~ ROWPU brine water showed a 7-fold concentration over initial concentration: 0.007 mg/l. This indicated that ROWPU brine was concentrating lead levels from distribution system. Product water storage tank showed concentration of 0.005 mg/l, indicating a mix of re-treated brine water (currently being practiced by operators due to high quality of source water and to prevent wastewater disposal problems) and treated distribution system water.

(c) (U) ~~(C//REL)~~ Sample from nozzle indicates concentration of 0.013 mg/l. This most likely indicates imperfect mixing in the raw water tank but could also indicate some low-level leaching of lead in metal parts of nozzle.

(d) (U) ~~(C//REL)~~ Therefore, lead levels above those in source water were most likely caused by re-treating/ recycling more concentrated brine water. The lead concentration in brine was 7 times the level of lead in source water (but was still only half the action level). Other metals concentrations also increased over source water concentrations by a factor of 2 or more. Decreasing or eliminating the practice of recycling brine water will help to reduce some metals contaminant levels in product water (e.g., increase amount of treated distribution system water blended with re-cycled brine water). ROWPUs currently in use at showers and the new dining facility were also tested for heavy metals. This information was reported to personnel responsible for potable water production at Stronghold Freedom.

(e) (U) ~~(C//REL)~~ Water Quality Summary. Water consumed at Stronghold Freedom was primarily bottled water procured from approved sources, while ROWPU water was used for personal hygiene uses and cooking. Raw water sample analysis indicated fairly high quality source water that probably originates from a limestone aquifer in the local community. ROWPU product water sampling initially detected lead concentrations above the EPA action level. However, this result was not repeated upon resampling and it was determined the higher lead levels initially observed were likely a result of ROWPU operational practices.

d. (U) ~~(C//REL)~~ Radiological Contamination. A total of 80 soil samples, 12 air samples, and 13 hard wipe samples were submitted to USACHPPM, radiochemistry laboratory and Institut fur Analytische Chemie, a German contract laboratory, for radiological analyses. Each laboratory is accredited to conduct the respective soil, air, and wipe test, and internal dosimetry analyses. Radiological data are provided in Appendix C, tables C-14 through C-17.

(1) (U) ~~(C//REL)~~ Base Camp Baseline. A total of 30 soil samples were taken throughout the base camp and analyzed for total uranium concentration and man-made gamma emitting radionuclides. Soil samples were analyzed by determination of total and isotopic uranium by inductively coupled plasma-mass spectrometry (ICP-MS). Quality control data was within the acceptance limits. Final lab analysis of the base camp samples determined the total uranium concentration and activity to reflect the concentration and activity inherent to Uzbekistan and surrounding region. There were no significant levels of man-made gamma emitting radionuclides detected. Trace amounts of cesium-137 were detected but not at levels that pose health hazards or exceed regulatory limits.

(2) (U) ~~(C//REL)~~ Bunker and Building Evaluations. A total of 13 hard wipe samples were collected at occupied bunkers and structures and analyzed for gross alpha and gross beta contamination. Quality control data was within the acceptance limits. The hard wipe samples revealed no removable levels of alpha or beta contamination that require mitigation and/or remediation. Although gross beta counts were detected, the amount does not exceed US regulatory limits. Standards were obtained from U.S. Army Regulation 11-9 (Reference 14).

(3) (U) ~~(C//REL)~~ Site 1. A total of 50 soil samples were submitted for analysis to characterize the extent and amount of contamination. Soil samples were analyzed utilizing the same protocols for the base camp baseline assessment. Results were compared to background reference samples and determined to be less than or equal to background reference samples. There were no samples that exceeded the 35 pCi/g derived concentration guidance limit (DCGL)

(Reference 15). The confirmed radioactive samples did have elevated natural uranium activity that was determined by ICP-MS. However, the progeny for natural uranium was absent, suggesting that the uranium underwent a concentration process. The potential radiation exposure hazard at this site is an internal health hazard. Interpretation of all data points for Site 1 suggests that the radiological/ uranium contamination is centralized within an area of 300 m^2.

(4) (U) ~~(C//REL)~~ Air Sampling. A total of 12 air samples, which included two background/ reference samples, were collected in order to determine the potential for internal radiological exposures via the air pathway from Site 1. All samples revealed elevated levels of radioactivity upon removal from the high volume air sampler. The range of exposure was between 40-75 kdpm/100cm^2. During the course of time, these products decayed to levels less than or equal to background exposure. Thus, preliminary analysis determined the elevated exposures were attributed to radon presence on the filters, which, over time, decayed to background levels. All air samples were submitted for laboratory analysis to determine if potential airborne radiological contamination exists from Site 1. Samples were analyzed for total uranium content per filter, compared to the two background reference air samples, and determined to be less than or equal to background reference samples. Thus, radiological contamination from Site 1 did not appear to pose a health threat via the air pathway.

(5) (U) ~~(C//REL)~~ Dosimetry.

(a) (U) ~~(C//REL)~~ The electronic dosimeter placed in the fighting position closest to Site 1 did not detect any significant external gamma or high-energy beta radiation exposure. The dosimeter was in place for eight days to assess potential external radiological exposure to personnel occupying the fighting position. Since this is the closest position to Site 1, the remaining fighting positions receive a minimum of four times less the exposure than the monitored position.

(b) (U) ~~(C//REL)~~ The final bioassay results for the preliminary and post analysis did not reflect any significant levels of internal radiation exposure to personnel operating in or around Site 1. Radio-biossay samples were analyzed for gamma in urine using gamma spectroscopy. These samples were analyzed by General Engineering Laboratories (GEL), a contract lab that is accredited to conduct the analyses. Final lab results shall be filed in the respective medical record for documentation and future reference.

e. (U) ~~(C//REL)~~ Asbestos.

(1) (U) ~~(C//REL)~~ Aircraft hangars. The bulk sample (wall coating in the backblast area) did not contain asbestos. Transmission electron microscopy did not detect asbestos fibers in air samples.

(2) (U) ~~(C//REL)~~ Roofing material. The bulk sample of roofing material contains 10% chrysotile asbestos. Transmission electron microscopy did not detect asbestos fibers in air samples collected in the gazebo/PX/road area.

(3) (U) ~~(C//REL)~~ Missile debris. The bulk sample of missile debris from the former weapons/munitions storage area contains 5% chrysotile asbestos. Transmission electron microscopy did not detect asbestos fibers in air samples collected from the fighting positions nearest to the former missile storage area.

f. (U) ~~(C//REL)~~ Hantavirus Survey. A hantavirus survey was conducted by the Preventive Medicine Detachment at Stronghold Freedom based on recommendations by the CHPPM EUR team. A box with 49 rodent specimens arrived at CHPPM-EUR on 12 December 2001 and was immediately transported to the analytical laboratory in Stuttgart for Polymerase Chain Reaction (PCR) testing. Upon receipt, the dry ice preservation of the specimens appeared to be successful, as there was still adequate dry ice quantity in the shipping box. Assuming representative sampling and proper sample collection and preservation procedures were followed, there is very little health risk from the presence of Tula, Puumala, Hantaan, and Dobrava Hantavirus strains at Stronghold Freedom. Antibody screening was performed in addition to PCR testing. Two positive serology results from antibody screening indicate only that Hantavirus strain Hantaan has been present in the area where the two mice were trapped. Appendix H contains a report detailing results, conclusions, and recommendations for this survey.

8. (U) ~~(C//REL)~~ **Health Risk Assessments.** The sampling data discussed previously in this report were used to characterize the potential operational OEH risks for field units deployed at Stronghold Freedom, Karshi Khanabad Airfield, Uzbekistan. Exposure to chemicals and radiation in soil, ambient air, and drinking water were characterized. The health risk assessments were performed according to doctrine described in US Army FM 100-14 and USACHPPM Technical Guides 248 and 230 (References 3-5). The first portion of this section presents the health risk assessment for chemical exposures. The second portion of this section contains the assessment for radiation exposures. This is presented in this manner due to the differing assumptions used in each assessment.

a. (U) ~~(C//REL)~~ HRA for Chemical Exposures

(1) (U) Hazard Identification. An OEH chemical hazard is any chemical or chemical mixture that can cause injury, illness, disease, adverse health conditions, or death for personnel (a health threat). Such conditions may also affect the health status of the field unit or command, in terms of mission effectiveness (a medical threat). OEH hazards are identified through environmental surveillance and sampling.

(2) (U) Exposure Profile. An exposure profile is a description of predicted patterns of exposure field personnel will experience while deployed. Exposure patterns describe the frequency and duration of potential personnel exposures to OEH hazards. These patterns also contribute to determining the nature and magnitude of health effects that may be experienced

upon exposure to unsafe levels of chemicals. The primary purpose of the exposure profile is to identify one or more exposure periods and exposure media for personnel in the field unit.

(a) (U) ~~(C//REL)~~ Activity Patterns. Stronghold Freedom personnel may eventually consist of units that live in and patrol the area for up to 24 hours a day. The specific deployment duration is not known at this time so a 1-year exposure was assumed for this evaluation. The type of activities personnel may partake in can affect exposure. Information is not known on specific activity patterns for most personnel at Stronghold Freedom so general assumptions were used based on general knowledge of typical activities from past military operations. In cases where specific information was available on activity patterns, they are discussed in context with the hazard probability for the environmental media of concern.

(b) (U) ~~(C//REL)~~ Exposure Patterns. Based on the sampling data available, it is impossible to provide a complete assessment of potential exposure over time. However, it was assumed for this assessment that the samples collected represent the overall condition of the Stronghold environment for the deployment duration.

(c) (U) ~~(C//REL)~~ Exposure Periods. This report assessed the potential for health threats based on daily exposures to chemicals detected in soil, drinking water, and ambient air during the October/November 2001 sampling event. It was assumed that soldiers would be present at the Stronghold Freedom 24 hours per day for the duration of their deployment. This should be a conservative assumption that adds a margin of safety to the evaluation.

(3) (U) ~~(C//REL)~~ Preliminary Threat Analysis. Potential chemical hazards in air, water, and soil can be classified into threat categories based on a comparison of sampled concentrations to available Military Exposure Guidelines (MEGs) listed in TG 230 (reference 5). If a MEG was not available, occupational or environmental screening guidelines were used for comparison as indicated. Table 1 presents the maximum detected concentrations for each chemical that exceeded its respective guideline for each environmental media. Many chemicals that were detected did not have guidelines available. In addition, there were many instances where the detection levels were greater than available guidelines. These conditions are not included in Table 1 and Appendix C provides a complete list of all detected chemicals. Even though these chemicals cannot be evaluated using the same screening approach included in Table 1, it is important to include them in the overall risk assessment.

Table 1. (U) ~~(C//REL)~~ Chemical Data Analysis Summary for Stronghold Freedom

Soil					
Chemical	**Max. Conc. (mg/kg)**	**Guideline (mg/kg)**		**Source**	
Methylene Chloride	240	21		PRG	
Xylenes	270	210		MEG	
Soil Gas					
Chemical	**Max. Conc. (mg/m³)**	**Guideline (mg/m³)**			
		1-hr Min MEG	**8-hour MEG**	**14-day MEG**	**Other**
1,2,4-Trimethylbenzene	97	NA	NA	NA	123 8-hr TWA

Benzene	270	160	1.6	0.16	479 1-hr Sig MEG
Ethylbenzene	177	542	435	10.5	na
Xylenes	569	650	435	10.6	na
Propylbenzene	69	NA	NA	NA	0.025 1-yr MEG
Drinking Water					
Chemical	**Concentration (mg/L)**	**TG 230 Long-term MEG (mg/L)**			
		5 L/day		**15 L/day**	
Boron	0.47	1.7		0.4	
Ambient Air					
Chemical	**Max. Concentration (mg/m^3)**	**TG 230 MEG (mg/m^3)**			
		14-day		**1-year**	
1,2,4-Trimethylbenzene	4.3	NA		3.06	
Particulate Matter (PM_{10})	0.394	NA		0.074	
Kerosene Fraction	63.55	NA		3*	

* ATSDR Minimal Risk Level for exposures >14-364 days (MEG not available)

NA – Indicates no guideline is available.

na – not appropriate

(U) ~~(C//REL)~~ In addition to the chemical analyses, general water quality indicators were measured as well, including pH, turbidity, and total dissolved solids (TDS). Each of these was within the acceptable range as listed in TB MED 577 and are included in Appendix G. Since the nine different chemicals listed in Table 1 exceed their respective guidelines and many chemicals cannot be confirmed at levels lower than the MEGs, exposure to soil, water, and air in the vicinity of Stronghold Freedom is considered to pose a potential medical threat and will be evaluated further in the following sections.

(4) (U) Hazard Probability. The Hazard Probability Ranking Chart in TG 230 was used to assign a hazard probability to each environmental media included in Table 1.

(a) (U) ~~(C//REL)~~ Soil. For the purpose of this assessment, it was assumed that troops occupying Stronghold Freedom would live and patrol the area 24 hours per day for up to 1 year. Therefore, the potential for daily contact with chemicals in soil exists for up to 100% of the field unit. However, the potential for daily direct contact is limited to surface soils. The sampling data suggest that most of the elevated chemical concentrations in soil were found in subsurface soils. The concentrations of methylene chloride and xylenes noted in Table 1 (as well as other sample concentrations exceeding guidance) were obtained from 1-3 meters below ground surface. Therefore the potential for direct contact is significantly reduced. The resulting hazard probability ranking for exposure to methylene chloride and xylenes in soil is classified as UNLIKELY since less than 10% of personnel are expected to experience exposures above the guidelines.

(b) (U) ~~(C//REL)~~ Soil Gas. Another exposure pathway for soil exists for select personnel at Stronghold Freedom due to specific activity patterns. These personnel may be exposed to chemicals in subsurface soils when constructing berms and digging trenches as described in Section 4. Soil gas samples were obtained from an area where visual contamination was observed in open trenches. The concentrations significantly increased with depth and several exceeded corresponding Air-MEGs. Since this pathway is focused on a specific area where sampling was conducted and only certain personnel partake in these activities, the resulting hazard probability is SELDOM.

(c) (U) ~~(C//REL)~~ Drinking Water. Personnel at Stronghold Freedom are currently drinking bottled water. However, this evaluation assumes that the treated water sample results represent the overall quality of the drinking water source for the Stronghold. Therefore, if the source water were to be used for drinking water purposes, nearly all (more than 90%) of the soldiers stationed a Stronghold Freedom would be exposed to chemicals in drinking water. It was assumed that soldiers would consume up to 15 L per day for the duration of their deployment. The evaluation was limited to the data obtained from the treated water in the "storage bladder" and "mess hall" as these are representative of water that troops would be drinking. Based on these assumptions, the hazard probability is considered FREQUENT for exposure to elevated concentrations of chemicals in drinking water.

(d) (U) ~~(C//REL)~~ Ambient Air. The levels of chemicals detected in the air samples varied widely with sample location. Most samples did not indicate the presence of chemicals above the detection limit. However, for over half the heavy metals sampled and many VOCs, the detection limit was greater than the long-term Air-MEGs. This is a significant uncertainty in the evaluation for long-term health effects from ambient air since it is not possible to know whether sampled concentrations warrant further evaluation. The results from soil gas sampling and personnel complaints (paragraph 4a) suggest that elevated concentrations of VOCs may be a concern if fuel contaminated soil is exposed through excavation. In addition, measured kerosene fractions were compared to the Agency for Toxic Substances and Disease Registry's (ATSDR's) Minimal Risk Level (MRL) (reference 18) in the absence of an available MEG. Jet fuels JP-5 and JP-8 are measured as kerosene fraction samples and are believed to represent the type of fuel contaminant present at this site. Results from this comparison indicated that six samples obtained near the waste pit and berm were greater than the MRL supporting the need for further evaluation.

(e) (U) ~~(C//REL)~~ Concerns from long-term exposure to VOCs cannot be confirmed since those chemicals in soil gas exceeding guidelines have Air-MEGs that are significantly less than the detection levels used for the ambient air sampling. This uncertainty needs to be considered in the overall assessment even though it cannot be evaluated in the same way as specific chemicals exceeding the Air-MEGs. For those chemicals that had Air-MEGs greater than the detection levels, 1,2,4- trimethylbenzene and particulate matter $<10\mu$ (PM_{10}) had samples exceeding guidelines. Since only one 1,2,4-trimethylbenzene sample was slightly greater than the long-term Air-MEG, the hazard probability is considered OCCASIONAL. The kerosene fraction concentrations of concern were measured at specific waste pit and berm areas and not the tent city locations. As a result, the hazard probability is also considered OCCASIONAL. Since the averaged concentration for all PM_{10} samples was greater than the long-term Air-MEG and it is recognized that ambient air concentrations can vary significantly over time, the hazard probability ranking for PM_{10} is classified as OCCASIONAL.

(5) (U) Hazard Severity. The hazard severity levels associated with exposures to the chemicals hazards in each media were classified using the Chemical Hazard Severity Ranking Chart for Military Deployments provided in TG 230. The assigned hazard severities for each chemical hazard are presented in the following section. The preliminary health threat classification was reevaluated and resulting threat levels are included in Appendix G. Potential health outcomes from exposure to each chemical are also included in Appendix G.

(a) (U) ~~(C//REL)~~ Soil. The comparison guidelines for soil consider multiple routes of exposure: direct dermal contact, inhalation, and ingestion. Concentrations of xylenes and methylene chloride were greater than comparison guidelines in a few locations. A MEG was not available for methylene chloride so concentrations were compared to the PRG for industrial soils. The PRG is developed based on the general population and provides a more protective estimate of risk. Therefore, short-term exposures to concentrations even ten times greater than the PRG may not result in health effects. The anticipated health effects resulting from exposures to either chemical at these concentrations are irritation of eyes and respiratory system and other mild reversible symptoms such as headache and lightheadedness. As indicated in the hazard probability evaluation, it is not likely that soldiers will be exposed to subsurface soils on a daily basis for an entire year. Therefore, less than 10% of personnel are expected to experience these health effects as a result of exposures to concentrations exceeding guidelines. The hazard severity for methylene chloride and xylenes is NEGLIGIBLE.

(b) (U) ~~(C//REL)~~ Soil Gas. Measured soil gas concentrations were compared to available Air-MEGs or occupational exposure guidelines (when military guidelines were not available). It is anticipated that exposures to soil gas would be short-term, therefore guidelines for exposures less than 14-days were used for comparison. The 1-hour Minimal Effects Air-MEG represents a concentration above which mild, disabling, transient, reversible, health effects may appear. Therefore, even 1-hour exposures to measured concentrations of benzene may begin to produce health effects. Specific health effects associated with benzene exposure include respiratory and eye irritation, weakness, nausea, headache, and fatigue. The hazard severity for benzene is considered MARGINAL since these health effects may impair the functional ability of some personnel and the exposure duration is likely to exceed 1 hour. Exposures to 1,2,4-Trimethylbenzene and propylbenzene may result in mild symptoms such as eye and respiratory irritation and nausea if exposures exceed comparable guidelines. Short-term Air-MEGs are not available for these chemicals so this assumption is based on concentrations less than the American Conference of Governmental Industrial Hygienists (ACGIH) 8-hour time-weighted-average (TWA) (reference 19) and 1-year Air-MEG, respectively. The hazard severity for these two chemicals is considered MARGINAL. Ethylbenzene and xylenes have short-term Air-MEGs available. Both chemical concentrations are less than the 1-hour Minimal effects Air-MEG but greater than the 14-day Air-MEG. The anticipated health effects from exposure to ethylbenzene are eye, skin, and mucous membrane irritation, and headache. Health effects resulting from exposure to xylenes include lightheadedness, nausea, headache, confusion, respiratory irritation, sore throat, and gastrointestinal (GI) distress. Since more than 10% of exposed personnel may experience at least mild health effects, the hazard severity is considered

MARGINAL for both chemicals. The potential health effects resulting from exposures to the chemicals in this section are consistent with symptoms reported by exposed personnel.

(c) (U) ~~(C//REL)~~ Drinking Water. Exposure to chemicals in water is evaluated for exposure via ingestion of drinking water only. For the purpose of this assessment, it was assumed that all personnel will be using the sampled source for drinking water purposes and may consume up to 15 L/day. Sampled concentrations for each chemical were compared to available Water-MEGs. The concentration of boron in the treated water at the storage bladder was slightly greater than the long-term Water-MEG for consumption of 15 L/day. It is important to recognize that water concentrations can vary over time. Anticipated health effects for low level exposures to boron are GI effects and other effects such as headache and weakness. Less than 10% of personnel are estimated to exhibit such symptoms since the Water-MEGs are designed to reflect levels that will result in no adverse health effects and the boron concentration is only slightly over this value. In addition, the consumption rate of 15 L/day may overestimate exposure for many personnel so actual exposures would likely be less. Therefore, the hazard severity rank for boron is NEGLIGIBLE.

(d) (U) ~~(C//REL)~~ Ambient Air. As discussed in the hazard probability evaluation, air concentrations can vary significantly over time and by location. Maximum concentrations were used for comparison purposes to provide a conservative estimate of risk in the absence of additional surveillance. Only one sampled concentration of 1,2,4-trimethylbenzene was greater than the available long-term Air-MEG and six kerosene fraction samples were greater than the MRL used for comparison. However, as previously discussed, the detection limits associated with the sample methods did not provide results that could be used to determine if concentrations were less than the long-term Air-MEGs. Therefore, it cannot be determined if other chemicals also had sampled concentrations greater that may be of concern for long-term exposures. This is a source of uncertainty in this evaluation. However, the hazard severities for exposures to 1,2,4-trimethylbenzene and kerosene fraction were assessed independently. Continuous exposure to the maximum level of 1,2,4-trimethylbenzene detected may result in health effects classified as mild illness or temporary irritation such as skin, eye, and respiratory irritation or nausea and fatigue. These potential health effects are not expected to occur in more than 10% of exposed personnel. Short-term MEGs for 1,2,4-trimethylbenene are not available. Since concentrations are not significantly greater than the 1-year MEG, anticipated health effects are minor, and maximum variable concentrations were used, less than 10% of personnel should exhibit health effects resulting in a severity ranking of NEGLIGIBLE for 1,2,4-trimethylbenzene. The MRL is an estimate of a continuous daily exposure that will not result in adverse health effects for sensitive people in the general population. Therefore, intermittent exposures to concentrations slightly greater than the MRL for JP-5/JP-8 may result in mild, reversible health effects such as headache and dizziness if any. Therefore, the resulting hazard severity for exposures to kerosene fraction is NEGLIGIBLE.

(e) (U) ~~(C//REL)~~ Measured PM_{10} concentrations also exceeded the 1-year Air-MEG during four days samples were collected. The averaged concentration for the 14-days sampling data were obtained (excluding torn filter samples) was slightly greater (97 $\mu g/m^3$) than the long-term

Air-MEG of 74 µg/m³. The MEG is based on military populations, which do not account for sensitive groups within the general population (e.g. elderly and children) that US National Ambient Air Quality Standards (NAAQS) are designed to protect. The current NAAQS standard for PM_{10}, established by the EPA, is set at an annual daily average of 50 µg/m³ and a 24-hour value of 150 µg/m³. The 24-hour value should not be exceeded for any one 24-hour sample and the annual daily average value should not be exceeded when the 24-hour daily samples are averaged over a one-year period. The NAAQS are set at levels that should safeguard the general population from increased illness associated with respiratory conditions. PM_{10} is the current indicator of interest, as particulates in this size range are inhaled deeply into the respiratory tract. Potential health effects from long-term PM_{10} exposure include irritation of the eyes, skin, throat, and respiratory system. These effects are considered temporary irritation and it is estimated that less than 10% of personnel may experience health effects. Therefore, the hazard severity for PM_{10} exposure is considered NEGLIGIBLE.

(6) (U) ~~(C//REL)~~ Risk Characterization. In order to evaluate the overall operational risk posed by chemical OEH hazards at Stronghold Freedom, the hazard probability and severity for each identified chemical hazard were used with the Risk Assessment Matrix provided in TG 248. The confidence in the estimate for each chemical is also provided. Table 2 presents a summary of the risk estimates for chemicals exceeding guidelines at Stronghold Freedom. A more extensive summary table is presented in Appendix G. In addition, to adequately estimate the overall operational risk level for Stronghold Freedom, the uncertainties associated with using current sampling methods to compare chemical concentrations to long-term MEGs must be considered.

Table 2. (U) ~~(C//REL)~~ Operational Risk Levels for Stronghold Freedom

		Soil		
Chemical	**Hazard Probability**	**Hazard Severity**	**Operational Risk**	**Confidence**
Methylene Chloride	Unlikely	Negligible	Low	Low
Xylenes	Unlikely	Negligible	Low	Low
		Soil Gas		
1,2,4-trimethylbenzene	Seldom	Marginal	Low	Low
Benzene	Seldom	Marginal	Low	Low
Ethylbenzene	Seldom	Marginal	Low	Low
Xylenes	Seldom	Marginal	Low	Low
Propylbenzene	Seldom	Marginal	Low	Low
		Water		
Boron	Frequent	Negligible	Low*	Low
		Ambient Air		
1,2,4-trimethylbenzene	Occasional	Negligible	Low	Low
PM_{10}	Occasional	Negligible	Low	Low
Kerosene Fraction	Occasional	Negligible	Low	Low

*Based on the Risk Assessment Matrix and professional judgment.

(a) (U) ~~(C//REL)~~ All eleven chemical hazards pose a LOW operational risk based on this assessment. The potential for frequent exposure to boron exists if ROWPU-treated water is used for drinking water purposes. However, concentrations are only slightly above the guidelines for the higher consumption rate and routine monitoring would better estimate potential fluctuations in concentrations if used for potable purposes. Therefore, the operational risk level for exposures to boron in drinking water is based on both the Risk Assessment Matrix and professional judgment. All of the chemical hazards identified in this assessment are considered HEALTH THREATS rather than medical threats since exposures are not expected to result in health effects that would impact the current mission.

(b) (U) ~~(C//REL)~~ A LOW confidence level was assigned for all media evaluated in this assessment. The low ranking for soil and water was based on the quality of the field data, a probable overestimate of true field exposures, and the lack of detailed information regarding true soldier exposures. The confidence in the risk estimate for soil gas was considered low due to the quality and availability of data for a specific area of interest, specific information of activity patterns, and information on health effects reported from exposed soldiers consistent with detected chemicals. The confidence in the air assessment was considered low due to the highly variable nature of air concentrations and the limited temporal scope of the available sampling data.

(7) (U) Develop Controls.

(a) (U) ~~(C//REL)~~ Soil. Potential health risks due to soil exposures can be reduced by minimizing contact with potentially contaminated soils. Since most of the elevated levels of chemicals in soil were found in subsurface soils, excavation should be limited. If excavation is necessary sampling should be conducted and personal protective equipment (PPE) used, especially in areas with obvious staining of the soil or where vapors are noticeable. Troops should avoid prolonged contact with areas where subsurface soils have been exposed or brought to the surface during berm construction or other excavation activities. In addition, proper basic sanitation measures should be taken to include frequent hand washing and laundering of uniforms as available. If these controls are observed, the overall operational risk level would be maintained as LOW.

(b) (U) ~~(C//REL)~~ Drinking Water. The available water data indicate that the product water is suitable for consumption. If treated water from the ROWPU is used for drinking, quarterly monitoring should occur in order to ensure continued treatment effectiveness. If monitoring indicates that levels of boron and other chemicals are maintained below their respective guidelines for the appropriate consumption rate, the operational OEH risk will remain LOW. If bottled water use is continued, the operational OEH risk is NO RISK.

(c) (U) ~~(C//REL)~~ Ambient Air. Most of the air samples collected did not indicate measurable levels of compounds. However, the detection levels were greater than the long-term Air-MEGs for many chemicals. Therefore, it is recommended that a method be used for sample analysis, which is capable of determining if sample concentrations are less than the long-term Air-MEGs. In the absence of this data, it cannot be concluded that ambient air does not pose a long-term health risk to deployed troops. Elevated PM_{10} concentrations were seen during four days of the sampling with an averaged concentration greater than the long-term Air-MEG. An attempt should be made to mitigate the source of these concentrations. Mitigation techniques to minimize the amount of suspended particulate matter include: provide gravel or pavement for existing dirt roads; wetting down existing berms and dirt areas to prevent suspension of soil particles (particularly during windy periods); and strategic positioning of diesel sources (i.e., especially generators) away from highly trafficked living and working areas. Continuous particulate monitoring needs to be performed at in order to monitor exposure levels and the efficacy of mitigation techniques, which could assist in updating the PM_{10} operational risk estimate. If these mitigation strategies are implemented and adhered to the OEH risk level from exposures to particulates will remain LOW.

(8) (U) ~~(C//REL)~~ Uncertainties in the Chemical HRA. Overall, this OEH evaluation is meant to be conservative and should be adequately protective of soldiers' health under the conditions evaluated. However, a degree of uncertainty is inherently associated with this type of assessment. The true exposure patterns for Stronghold Freedom personnel were not known for most exposure pathways so it was assumed that soldiers would be exposed to the detected hazards continuously for an entire year. However, the samples collected to date are only representative of environmental conditions over a brief time period. It is impossible to account for natural variation in the levels throughout the course of a year. This is particularly true for ambient air quality, which can change rapidly and may be highly variable from one day to the next. In addition, the potential cumulative effects of exposure to similar chemicals in different media, or different chemicals with similar mechanisms of action, cannot be quantified. There were some chemicals detected that did not have toxicological data and guidelines available for comparison. These compounds were not evaluated in this assessment. This is a significant source of uncertainty in the evaluation. Lastly, as previously discussed, the sample analysis methods used did not provide results that allowed for comparison of concentrations with long-term MEGs for some environmental media. Future sampling should ensure that the analysis methods are able to provide concentrations comparable to long-term MEGs. Future iterations of this evaluation will allow for a more accurate evaluation of potential hazard.

b. (U) ~~(C//REL)~~ HRA for Radiation Exposures

(1) (U) Hazard Identification. An OEH radiological hazard is any radiation dose that may cause injury, illness, disease, adverse health conditions, or death for personnel (a health threat). The hazard may result from either external or internal radiation exposure. Such conditions may also affect the health status of the field unit or command, in terms of mission effectiveness (a medical threat). OEH hazards are identified through personnel monitoring and environmental surveillance and sampling.

(2) (U) Exposure Profile. An exposure profile is a description of predicted patterns of exposure field personnel may experience while deployed. Exposure patterns describe the frequency and duration of potential personnel exposures to OEH hazards. These patterns also contribute to determining the nature and magnitude of health effects that may be experienced upon exposure to radiation. The primary purpose of the exposure profile is to identify one or more exposure periods and exposure media for personnel in the field unit.

(a) (U) ~~(C//REL)~~ Activity Patterns. Stronghold Freedom personnel may eventually consist of units that live in and patrol the area for up to 24 hours a day. The specific deployment duration is not known at this time, so a 1-year exposure will be assumed for this evaluation. The type of activities personnel may partake in can affect exposure. Information is not known on specific activity patterns for most personnel at Stronghold Freedom so general assumptions were used based on general knowledge of typical activities from past military operations. It is assumed that occupation of the AAM/ASM area (Site 1) will be minimized, and there will be little or no digging activities in this area. In cases where specific information was available on activity patterns, they are discussed in context with the hazard probability for the environmental media of concern.

(b) (U) ~~(C//REL)~~ Exposure Patterns. Based on the sampling data available, it is impossible to provide a complete assessment of potential exposure over time. However, it is assumed for this assessment that the samples collected represent only a snapshot of overall condition of the Stronghold environment for the deployment duration. The exposure patterns may be different from the patterns indicated by the collected radiation samples.

(c) (U) ~~(C//REL)~~ Exposure Periods. This report assesses the potential for health threats based on daily exposures to radiation detected in soil, drinking water, and ambient air during the October/November 2001 sampling event. It was assumed that soldiers would be present at the Stronghold Freedom 24 hours per day for the duration of their deployment. This should be a conservative assumption.

(3) (U) Preliminary Threat Analysis.

(a) (U) ~~(C//REL)~~ Stronghold Freedom Confine. Potential internal and external radiation hazards in air, water, and soil can be classified into threat categories based on a comparison of sampled concentrations and external radiation measurements to available radiation dose standards for appropriate Radiation Exposure States (RES). External radiation doses are characterized based on direct reading instrument measurements. There are no identified ionizing radiological hazards associated with any areas within the Stronghold Freedom perimeter. External radiation measurements were at background levels. Internal radiation dose estimates are predicated on the results of environmental media analysis. Air sampling results for gamma emitting radionuclides and for uranium were below the results for release criteria for unrestricted areas according to the Nuclear Regulatory Commission (Reference 15) and do not pose an internal or external radiation exposure threat. Analysis of the ROWPU potable water for nonconsumptive uses indicated the water met the World Health Organization (WHO) screening criteria for radionuclides in drinking water (References 16 and 17). Bottled water is used for drinking and is assumed to meet WHO screening criteria for radionuclides in drinking water. The potable water does not pose an internal or external radiation exposure threat.

(b) (U) ~~(C//REL)~~ Site 1. The only area with detected external radiation measurements above background were in the Site 1 area soil surveys, which is a restricted access area, outside the Stronghold Freedom perimeter. The external radiation measurements at Site 1 do not indicate an acute external health hazard. Air sampling results for gamma emitting radionuclides and uranium were below the release criteria for unrestricted areas according to the Nuclear Regulatory Commission. Airborne radionuclides do not pose an internal or external radiation acute exposure threat. The only soil samples with higher than typical background levels of radionuclides were from Site 1 area and from subsurface soil collections. Appendix C, Tables C-14 through C-17, provides a complete list of all detected radiological isotopes. In addition, the Figure in Appendix G graphically displays the radiation samples taken at Site 1.

(4) (U) ~~(C//REL)~~ Hazard Probability. The Hazard Probability Ranking Chart in TG 248 was used to assign a hazard probability for radiological hazards in soil and air at Stronghold Freedom and Site 1.

(a) (U) ~~(C//REL)~~ Stronghold Freedom Confine. For the purpose of this assessment, it was assumed that troops occupying Stronghold Freedom would live and patrol the area 24 hours per day for up to 1 year. Therefore, the potential for daily contact with radiation exists for up to 100% of the field unit. However, less than 10% of personnel will experience exposures above background, therefore, the resulting hazard probability ranking for exposure to radiation above background is classified as UNLIKELY.

(b) (U) ~~(C//REL)~~ Site 1. For the purpose of this assessment, it was assumed that fewer than 20% of troops occupying Stronghold Freedom would be in the Site 1 area and then only during daylight hours for only a few hours per day for up to 1 year. The air sampling results for this area indicate no internal inhalation hazard. No water is consumed from this area. Even though the external radiation measurements were higher than background, the external radiation was not a significant radiation hazard, as evidenced by the electronic dosimetry, which did not detect any significant external or high-energy beta radiation exposure at fighting positions nearest Site 1. Therefore, the resulting hazard probability ranking for exposure to radiation above background is classified as UNLIKELY.

(5) (U) ~~(C//REL)~~ Hazard Severity. The hazard severity levels associated with exposures to the radiation were classified using The Hazard Severity Ranking Chart in TG 248. For the radiation exposure levels encountered at Stronghold Freedom, no medical effects nor nonstochastic effects are expected from radiation exposure. Far less than 10% of the exposed persons would be expected to exhibit chronic/permanent injury or disease ascribable to the estimated above background radiation received during this mission. The hazard severity for estimated radiation doses received during this mission is NEGLIGIBLE.

(6) (U) ~~(C//REL)~~ Risk Characterization. In order to evaluate the overall operational risk posed by OEH radiation hazards at Stronghold Freedom, the hazard probability and severity for radiation doses were used with the Risk Assessment Matrix provided in TG 248. The confidence in the estimate is also provided. For the estimated radiation doses received during deployment at Stronghold Freedom, the ORM risk estimate is LOW. A LOW confidence level was assigned for the radiation exposures discussed in this report. This low confidence level is due to the highly variable nature of air concentrations, the lack of detailed information regarding true

soldier exposures, the limited temporal scope of the available sampling data, and the limited availability of data on health effects due to the low-level radiation exposure. Table 3 summarizes the radiation ORM estimates for Stronghold Freedom.

Table 3. (U) ~~(C//REL)~~ Radiation Operational Risk Management Estimates

Location	Hazard Probability	Hazard Severity	Operational Risk	Confidence
Stronghold Freedom Confine	Unlikely	Negligible	Low	Low
Site 1	Unlikely	Negligible	Low	Low

(7) (U) ~~(C//REL)~~ Develop Controls. Risks due to exposure to soil at Site 1 (AAM/ASM) can be reduced by minimizing contact with potentially contaminated soils. Since most of the elevated levels of chemicals in soil were found in subsurface soils, excavation should be limited. If excavation is necessary sampling should be conducted and personal protective equipment used. Troops should avoid prolonged contact with areas where subsurface soils have been exposed or brought to the surface during berm construction or other excavation activities. In addition, proper basic sanitation measures should be taken to include frequent hand washing and laundering of uniforms as available. If these controls are observed, the overall operational risk level would be maintained as LOW.

(8) (U) ~~(C//REL)~~ Radiological ORM Uncertainties. Overall, this radiation OEH evaluation is meant to be conservative and should be adequately protective of soldiers' health under the conditions evaluated. However, a degree of uncertainty is inherently associated with this type of assessment. The true exposure patterns for Stronghold Freedom personnel were not known for most exposure pathways so it was assumed that soldiers would be exposed to the detected hazards continuously for an entire year. However, the samples collected to date are only representative of environmental conditions over a brief time period. It is impossible to account for natural variation in the levels throughout the course of a year. This is particularly true for ambient air quality, which can change rapidly and may be highly variable from one day to the next. This is a significant source of uncertainty in the evaluation. Future iterations of this evaluation may allow for a more accurate evaluation of potential hazard.

c. (U) ~~(C//REL)~~ Risk Communication Guidelines. The Camp Freedom Commander is responsible for providing risk-related information in an accurate and timely manner, while balancing the responsibility of minimizing the level of concern among service members. Factors that complicate this requirement include service members' preoccupation with both professional and personal issues, such as separation from family, financial obligations, and deployment activities; and skepticism or distrust in the message and/or messenger. Although perception of the risks will vary among service members, it is likely that service members will be concerned. The Commander will ensure that a risk communication strategy is developed as early as possible. Refer to Appendix I for Risk Communication Guidelines.

9. (U) ~~(C//REL)~~ Conclusions. The CHPPM-EUR makes the following conclusions based on the findings of this study, understanding that the exposure period is up to one year, and military exposure guidelines established by USACHPPM TG 230 (reference 5).

a. (U) ~~(C//REL)~~ Soil Contamination.

(1) (U) ~~(C//REL)~~ Surface Conditions. The soil contains low levels of various contaminants at and below the surface. These contaminants pose a low health risk at the levels detected in this study.

(2) (U) ~~(C//REL)~~ Subsurface Conditions. Elevated levels of VOCs were detected at distinct locations below the surface. The elevated levels of VOCs and TPH appear to be related to fuel transmission or storage activities that predate US Forces on the Stronghold Freedom area. Comparison of measured concentrations to short-term guidelines indicated that five chemicals exceeded guidance. Potential health effects resulting from exposures to these chemicals at measured concentrations are considered mild illness or temporary irritation. These health outcomes are consistent with those reported by exposed personnel. The resulting health risk level is considered low since limited personnel are exposed to subsurface soils and the anticipated health effects are mild.

b. (U) ~~(C//REL)~~ Ambient Air Quality. Inhalation of vapors from subsurface fuel contaminated soils could potentially cause adverse health effects in personnel at Stronghold Freedom. Much of the Site 3 future expansion area, the dirt area immediately behind the Uzbek Aircraft Maintenance Hangars, and the areas around the former mess hall and shower facility (near HAS 21) also contain visible petroleum contamination in subsurface soils. The clay soils in these areas greatly mitigate ambient air exposures from subsurface fuel contaminated soils to either very low or non-detectable levels. For this reason, a "no digging" directive must be implemented and enforced for these areas to minimize/ prevent exposures via the air pathway. Additionally, visual observations and air sampling confirmed that inhalation of respirable particulates could be a viable exposure pathway for personnel stationed at Stronghold Freedom. There were four observations that exceeded the TG 230 annual guideline of 74 ug/ m^3, with several exceeding this standard by a factor of four (e.g., over 300 ug/ m^3). Surface soil samples did not indicate heavy metal, PAH, PCB, pesticide, or herbicide contaminants that would prompt additional health concerns at this time (i.e., from a re-suspension event). Particulate filters did not detect the presence of heavy metals. However, the detection levels for the analysis methods were greater than the long-term Air-MEGs for many metals and VOCs. Monitoring for organic and inorganic air contaminants should continue at Stronghold Freedom in order to provide additional exposure data (IAW requirements of references 7 and 8) and evaluate the efficacy of countermeasures. Equipment, environmental media, and sample analysis to perform this monitoring have been provided by USACHPPM. Preventive medicine personnel assigned to Stronghold Freedom will be best suited to perform this mission.

c. (U) ~~(C//REL)~~ Drinking Water Quality. The available water data indicate that the product water is suitable for consumption. Levels of boron were slightly greater than the long-term Water-MEG and present a low health risk if ROWPU source water is used for potable purposes.

d. (U) ~~(C//REL)~~ Radiological Contamination. The operational risk management level estimate from ionizing radiation hazards is low to personnel within the confines of the force protection berm and personnel occupying bunkers and/or buildings of Stronghold Freedom. A potential radiation hazard exists for any personnel who could occupy the Site 1 area (located outside the force protection berm).

(1) (U) ~~(C//REL)~~ Base Camp Assessment. There are no potential ionizing radiological health hazards associated with any areas within the Stronghold Freedom perimeter.

(2) (U) ~~(C//REL)~~ Site 1 contained primarily natural uranium 238 contamination that has undergone a concentration process and would pose a potential radiation hazard to personnel occupying this area. There is no health hazard to personnel within the force protection berm.

(3) (U) ~~(C//REL)~~ Bunker and Building Evaluations. There is no potential radiological health hazard to personnel who previously occupied or are presently occupying the bunkers or buildings within the Stronghold. Direct meter measurements do not indicate elevated levels of radioactivity, and wipe tests reveal no removable radiological contamination.

(4) (U) ~~(C//REL)~~ Radiological Air Sampling. Air samples were determined to be less than or equal to background reference samples.

(5) (U) ~~(C//REL)~~ Dosimetry. Personnel occupying fighting positions will not receive external exposures from the radiological contamination detected at Site 1. Furthermore, continuous external and internal personnel dosimetry is not warranted.

e. (U) ~~(C//REL)~~ Asbestos.

(1) (U) ~~(C//REL)~~ Corrugated roof tiles at Stronghold Freedom are asbestos-containing materials. Some of these tiles are broken; there is a possibility that the broken tiles could be releasing asbestos into the air. Since air sampling did not reveal airborne asbestos fibers, the health risk from the asbestos in these roof tiles is low.

(2) (U) ~~(C//REL)~~ Broken asbestos tiles on the ground in some areas of the Stronghold pose a possible risk of airborne exposure to asbestos, albeit slight. However, proper handling of broken tiles (see below recommendations below) on the ground will pose a low risk

(3) (U) ~~(C//REL)~~ The hangars pose no risk of asbestos exposure from the wall coating in the backblast areas.

(4) (U) ~~(C//REL)~~ Missile debris found in the former weapons/munitions storage area contains asbestos. The soil likely contains asbestos fibers to some degree. The fibers are

harmless unless inhaled. The fighting positions nearest to the former weapons/munitions storage area are most at risk for asbestos inhalation exposure. Results of asbestos air monitoring reveal that no asbestos fibers were detected in the air at the nearest fighting position. Therefore, the health risk from asbestos present in the former missile storage site is low at the point at which soldiers would be most at risk.

f. (U) ~~(C//REL)~~ Hantavirus. There is a low health risk for the Tula, Puumala, Hantaan, and Dobrava Hantavirus strains at Stronghold Freedom from the specimens provided by the Preventive Medicine Detachment. Antibody screening results from two specimens indicate that Hantavirus (Hantaan strain) has been in the area and may still be existing in mouse populations not tested..

g. (U) ~~(C//REL)~~ Operational Risk Management Estimate. Of the eleven chemicals detected in environmental media that exceeded guidelines, all appear to pose a LOW operational risk. All eleven chemicals are considered HEALTH THREATS rather than medical threats. The risk to all chemicals in soil was considered LOW but an attempt should be made to avoid contact with subsurface soils that may have elevated concentrations of fuels and related chemicals. Boron was detected in water at levels that slightly exceeded long-term guidelines. However, the operational OEH risk was considered LOW and the water is suitable for consumption. Exposures to chemicals in ambient air pose a LOW operational risk based on evaluation of available sampling data. Air exposure should be handled similarly to soil. Areas with noticeable vapors should be avoided if possible. Finally, the operational OEH radiation risk at both Stronghold Freedom and Site 1 is LOW.

h. (U) ~~(C//REL)~~ Risk Communication. Because of the high probability that service members will be concerned (in varying degrees) about possible health risks, a risk communication strategy is critical to the ORM process. Developing and incorporating a risk communication strategy will help ensure that critical information is delivered effectively, while minimizing potential concerns.

10. (U) ~~(C//REL)~~ Recommendations. The following countermeasures are recommended in order to minimize exposures from environmental media and provide adequate force health protection from identified environmental health risks.

a. (U) ~~(C//REL)~~ All Environmental Exposures. Develop and implement a plan for communicating risk to the soldiers and airmen that summarizes our findings and conclusions in a manner consistent with effective environmental risk communication principles. Although the health effects of the radioactivity, uranium, and the asbestos are likely to be nonexistent, the perception of a potential health risk is likely to be present among the stronghold population.

b. (U) ~~(C//REL)~~ Exposure to Contaminated Soil and Vapors from Contaminated Soil.

(1) (U) ~~(C//REL)~~ It is essential that "no digging" be allowed in large portions of the tent city and hangar area in order to minimize health effects. Similarly, much of the Site 3 future expansion area, the dirt area immediately behind the Uzbek Maintenance Hangars, and the areas around the former mess hall and shower facility (near HAS 21) also contain visible petroleum contamination in subsurface soils. There should be no digging allowed in these areas in order to prevent future exposures to organic air contaminants.

(2) (U) When digging must be done, back fill the resulting hole/trench with clean dirt at the earliest opportunity. If digging is to be done manually, then the following personal protective equipment is recommended:

(a) (U) Half- or full-face respirator with organic vapor cartridge and HEPA filter. The M40 mask meets this requirement. If the M40 mask is used, it is recommended that the cartridge/filter be changed when the digging work is complete so that the mask will be fully functional in case of chemical agent attack.

(b) (U) Tyvek suit with Saranex coating.

(c) (U) Nitrile gloves (or similar impermeable gloves).

(d) (U) Rubberized overboots.

c. (U) ~~(C//REL)~~ Ambient Air Exposures - Respirable Particulate Inhalation (including potential inhalation of radiological particulates from Site 1). Implement methods to keep the dust level to a minimum (i.e., dust that could originate from the former missile storage site or other locations). For example, gravel or pave the berm road adjacent to the former missile storage site. Consider capping the area with clean soil. If this is done, the current soil should not be disturbed; clean fill (e.g., such as that found west of the westernmost force protection berm) should be compacted over the top of the existing topsoil. Additionally, wet down existing berms and dirt areas on a periodic basis to prevent suspension of soil particles and position diesel exhaust sources away from highly trafficked living and working areas.

d. (U) ~~(C//REL)~~ Radiological Exposures. Declare the former missile storage site (Site 1) to be off-limits. Properly and permanently mark and cordon the area and check on a periodic basis to ensure markings are still in place. Follow ambient air exposure recommendations in paragraph 11c above to minimize exposure to inhaled radioactive particulate matter from Site 1.

e. (U) Asbestos Exposures.

(1) (U) Wet, double-bag, label, and properly dispose of asbestos tiles on the ground. Workers should wear a half or full-face respirator, which has a HEPA or NIOSH Class 100 (N-, P-, R-100) filter. The M40 mask is appropriate; however the cartridge should be changed once the job is completed so that the mask is fully functional in case of any chemical agent attack. Once the tiles are wet, workers should wear nitrile or similar nonpermeable gloves to handle the tiles. Workers should wash their hands after the work is completed.

(2) (U) Do not disturb roof tiles currently in place on existing structures. If work needs to be done in which the roof tiles would be disturbed or replaced, contact CHPPM-EUR for recommendations on protective measures.

f. (U) Hantavirus/ Rodent Borne Disease Exposures. Implement rodent control programs/ measures as necessary to prevent potential rodent-borne health threats.

g. (U) ~~(C//REL)~~ Future Environmental Monitoring.

(1) (U) ~~(C//REL)~~ Conduct radiological air monitoring for uranium (soluble and insoluble) in or near the fighting positions nearest to the former missile storage site. Sampling instructions and equipment/supplies were provided to the Preventive Medicine Detachment for conducting this monitoring. Ensure that these samples are sent back to the CHPPM laboratories for analysis.

(2) (U) ~~(C//REL)~~ Perform radon air sampling in the fighting positions nearest to the former missile storage site. Radon detectors were provided by CHPPM-EUR for this purpose. The Preventive Medicine Detachment at Stronghold Freedom has been briefed regarding the conduct of this monitoring. Ensure that these samples are sent back to the equipment manufacturer, via CHPPM-EUR, for analysis.

(3) (U) ~~(C//REL)~~ Organic air monitoring should be continued to ensure existing countermeasures remain effective and to evaluate new exposures that might occur as a result of changing the configuration of the base camp. Continue monitoring for inorganic air contaminants at Stronghold Freedom in accordance with requirements in references 7 and 8. In addition, sample analysis methods should provide results that allow for comparison to long-term Air-MEGs to determine potential long-term health threats. Forward samples to USACHPPM for sample analysis and technical support.

(4) (U) ~~(C//REL)~~ Monitoring for heavy metals should continue on a quarterly basis to ensure that ROWPU operational practices (e.g., recycling brine water) do not concentrate heavy metals in product water, especially if used for drinking water purposes. Monitor new water sources as necessary using deployment test kits or other approved methods.

h. (U) ~~(C//REL)~~ Risk Communication Guidelines. Develop a risk communication strategy to effectively communicate risk-related information, based on information provided in Appendix I.

11. (U) Point of Contact. The POC for this action is the undersigned and can be reached by telephone at [redacted]; email: [redacted] or by US mail: Commander, CHPPM-EUR, CMR 402, APO AE 09180.

//signed//
[redacted]
COL, MS
Commanding

Appendices:

A. (U) ~~(S//REL)~~ References
B. (U) ~~(S//REL) Site Maps~~ REDACTED
C. (U) Tables of Results
D. (U) Site Photographs
E. (U) ~~(S//REL)~~ Sampling Locations
F. (U) ~~(S//REL)~~ Communications to Local Command
G. (U) ~~(C//REL)~~ Operational Risk Management Estimate Summary Tables
H. (U) Hantavirus Survey Results
I. (U) Risk Communication Guidelines

FIGURES 1 THROUGH 9 OF MAIN REPORT BODY ARE PDF FILES AND ARE LOCATED ON THE CHPPM SIPRNET WEB SITE (http://usachppm1.army.smil.mil).

(U) ~~(S//REL)~~ APPENDIX A

REFERENCES

1. (REDACTED) [redacted]

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(REDACTED) ~~(S//REL) APPENDIX B~~

~~SITE MAPS AND FIGURES~~

B-1