Military Deployment
Periodic Occupational and Environmental Monitoring Summary (POEMS):
Dakar Airfield, Senegal
Calendar Years: (2014 to 2015)

AUTHORITY: This POEMS has been developed in accordance with Department of Defense (DoD) Instructions 6490.03, 6055.05, and Joint Chiefs of Staff memorandum MCM 0017-12 (References 1-3).

PURPOSE: This POEMS documents the Department of Defense (DOD) assessment of occupational and environmental health (OEH) risk for Dakar Airfield, Senegal. It presents a qualitative summary of OEH risks identified at this location and their potential medical implications. The report is based on information collected from 01 September 2014 through 31 December 2015 to include deployment OEH surveillance sampling and monitoring data (e.g., air, water, and soil), field investigation and health assessment reports, as well as country and area-specific information on endemic diseases.

This assessment assumes that environmental sampling at Dakar Airfield during this period was performed at representative exposure points selected to characterize health risks at the *population-level*. Due to the nature of environmental sampling, the data upon which this report is based may not be fully representative of all the fluctuations in environmental quality or capture unique occurrences. While one might expect health risks pertaining to historic or future conditions at this site to be similar to those described in this report, the health risk assessment is limited to 01 September 2014 through 31 December 2015.

The POEMS can be useful to inform healthcare providers and others of environmental conditions experienced by individuals deployed to Dakar Airfield during the period of this assessment. However, it does not represent an individual exposure profile. Individual exposures depend on many variables such as; how long, how often, where, and what someone is doing while working and/or spending time outside. Individual outdoor activities and associated routes of exposure are extremely variable and cannot be identified from or during environmental sampling. Individuals who sought medical treatment related to OEH exposures while deployed should have exposure/treatment noted in their medical records on a Standard Form (SF) 600 (Chronological Record of Medical Care).

SITE DESCRIPTION: Senegal, which is slightly smaller than South Dakota (approximately 75,954 square miles), has a mostly flat terrain and can be divided into three geographic regions: the coastal areas and low inland plateaus located in the Cap Vert area in western Senegal, the low mountainous terrain (massifs) located in the eastern and southeastern areas, and the barren shallow basin located between Cap Vert to the west and the eastern region.

In August 2014, the first and only case of the Ebola virus was confirmed in Dakar, the capital of Senegal. Dakar Airfield (a.k.a. Léopold Sédar Senghor International Airport) served as the airport for Ebola aid in support of OUA (Operation United Assistance). Medicines, equipment, food, and water were brought in to support the humanitarian aid during the ebola outbreak in western Africa.

Media samples collected in 2014-2015 from Dakar Airfield were assessed for risk.

SUMMARY: Conditions that may pose a Moderate or greater health risk are summarized in Table 1. Table 2 provides population based risk estimates for identified OEH conditions at

Dakar Airfield. As indicated in the detailed sections that follow Table 2, controls established to reduce health risk were factored into this assessment. In some cases, (e.g., ambient air), specific controls are noted, but not routinely available/feasible.

Table 1: Summary of Occupational and Environmental Conditions with MODERATE or Greater Health Risk

***Short-term health risks & medical implications*:**

The following hazards may be associated with potential acute health effects in some personnel during deployment at Dakar Airfield:

Food/waterborne diseases (e.g., bacterial diarrhea, hepatitis A, typhoid/paratyphoid fever, diarrhea-cholera, diarrhea-protozoal, brucellosis, hepatitis E); other endemic diseases (malaria, Dengue fever, Yellow fever, Rift Valley fever, Chikungunya, Zika, Rickettsioses-tickborne, West Nile fever, cutaneous leishmaniasis (acute), Crimean-Congo hemorrhagic fever, Schistosomiasis, Leptospirosis, Tuberculosis (TB), Meningococcal meningitis, rabies, Q fever, Lassa fever, soil transmitted helminthes (hookworm, strongyloidiasis, cutaneous larva migrans)); and heat stress. For food/waterborne diseases (e.g., bacterial diarrhea, hepatitis A, typhoid/paratyphoid fever, diarrhea-cholera, diarrhea-protozoal, brucellosis, hepatitis E), if ingesting local food and water, the health effects can temporarily incapacitate personnel (diarrhea) or result in prolonged illness (hepatitis A, typhoid/paratyphoid fever, brucellosis, hepatitis E). Risks from food/waterborne diseases may have been reduced with preventive medicine controls and mitigation, which includes hepatitis A and typhoid fever vaccinations and only drinking from approved water sources in accordance with standing U.S. Africa Command (AFRICOM) policy. For other vector-borne endemic diseases (malaria, Dengue fever, Yellow fever, Rift Valley fever, Chikungunya, Zika, Rickettsioses-tickborne, West Nile fever, cutaneous leishmaniasis (acute), Crimean-Congo hemorrhagic fever,), these diseases may constitute a significant risk due to exposure to biting vectors; risk reduced to 'Low' by proper wear of the treated uniform, application of repellent to exposed skin, bed net use, and appropriate chemoprophylaxis, as well as minimizing areas of standing water and other vector-breeding areas. For water contact diseases (Leptospirosis, Schistosomiasis) activities involving extensive contact with surface water increase risk. For respiratory diseases (TB, Meningococcal meningitis), personnel in close-quarter conditions could have been at risk for person-to-person spread. Animal contact diseases (rabies, Q fever), pose year-round risk. For soil transmitted helminthes (hookworm, strongyloidiasis, cutaneous larva migrans), risk may have been reduced by limiting exposure to soil contaminated with human or animal feces (including not sleeping on bare ground, and not walking barefoot). For heat stress, risk can be greater for susceptible persons including those older than 45, of low fitness level, unacclimatized, or with underlying medical conditions, and those under operational constraints (equipment, personal protective equipment (PPE), vehicles). Risks from heat stress may have been reduced with preventive medicine controls, work-rest cycles, proper hydration and nutrition, and mitigation.

Air quality: For inhalable coarse particulate matter (PM) less than 10 micrometers in diameter (PM_{10}) and less than 2.5 micrometers in diameter ($PM_{2.5}$) from environmental dust (including any burn pits or incinerators that might have existed), the PM_{10} and $PM_{2.5}$ overall short-term health risk was not evaluated due to insufficient data. However, Dakar Airfield and vicinity area may have experienced dust-prone environmental conditions, also subject to vehicle traffic. Consequently, exposures to PM_{10} and $PM_{2.5}$ may vary, as conditions may vary and may result in mild to more serious short-term health effects (e.g., eye, nose or throat and lung irritation) in some personnel while at this site, particularly exposures to high levels of dust such as during high winds or dust storms. For PM_{10} and $PM_{2.5}$, certain subgroups of the deployed forces (e.g., those with pre-existing asthma/cardiopulmonary conditions) are at greatest risk of developing notable health effects. Burn pits and/or incinerators might have existed at Dakar Airfield and vicinity (for example, burn pits used by the local population); however, there are no reports or sampling data to indicate their presence or absence. Consequently, the PM_{10} and the $PM_{2.5}$ overall short-term health risks specifically for burn pits were not evaluated—see Section 10.7. Where burn pits and/or incinerators might have existed, exposures may vary, and exposures to high levels of PM_{10} and $PM_{2.5}$ from smoke may result in mild to more serious short-term health effects (e.g., eye, nose or throat and lung irritation) in some personnel and certain subgroups. Although most short-term health effects from exposure to PM and burn-pit smoke should have resolved post-deployment, providers should be prepared to consider the relationship between deployment exposures and current complaints. Some individuals may have sought treatment for acute respiratory irritation while at Dakar Airfield and vicinity. Personnel who reported with symptoms or required treatment while at site(s) with burn-pit activity should have exposure and treatment noted in medical record (e.g., electronic medical record and/or on a SF 600 (Chronological Record of Medical Care).

***Long-term health risks & medical implications*:**

The following hazards may be associated with potential chronic health effects in some personnel during deployment at Dakar Airfield:

Long-term health risks and medical implications (continued):

Air quality: For inhalable fine PM less than 2.5 micrometers in diameter ($PM_{2.5}$) from environmental dust (including burn pits or incinerators that might have existed), the overall long-term health risk was 'not evaluated due to insufficient data.' Inhalable coarse PM less than 10 micrometers in diameter (PM_{10}) from environmental dust (including burn pits or incinerators that might have existed) was not evaluated for long-term health risk due to no available health guidelines. However, the Dakar Airfield and vicinity area may have experienced dust-prone environmental conditions, also subject to vehicle traffic, and conditions may have varied. Burn pits and/or incinerators might have existed at Dakar Airfield and vicinity (for example, burn pits used by the local population); however, there are no reports or sampling data to indicate their presence or absence. Consequently, the PM_{10} and the $PM_{2.5}$ overall long-term health risks specifically for burn pits were not evaluated – see Section 10.7. However, burn pit exposures may vary, as conditions may have varied. For inhalational exposure to high levels of dust containing PM_{10} and $PM_{2.5}$, such as during high winds or dust storms, and for exposures to burn pit smoke, it is considered possible that some otherwise healthy personnel, who were exposed for a long-term period to dust and PM, could develop certain health conditions (e.g., reduced lung function, cardiopulmonary disease). Personnel with a history of asthma or cardiopulmonary disease could potentially be more likely to develop such chronic health conditions. While the dust and PM exposures and exposures to burn pits are acknowledged, at this time there were no specific recommended, post-deployment medical surveillance evaluations or treatments. Providers should still consider overall individual health status (e.g., any underlying conditions/susceptibilities) and any potential unique individual exposures (such as burn pits/barrels, incinerators, occupational or specific personal dosimeter data) when assessing individual concerns. Certain individuals may need to be followed/evaluated for specific occupational exposures/injuries (e.g., annual audiograms as part of the medical surveillance for those enrolled in the Hearing Conservation Program; and personnel covered by Respiratory Protection Program and/or Hazardous Waste/Emergency Responders Medical Surveillance).

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Table 2. Population-Based Health Risk Estimates—Dakar Airfield, Senegal [1, 2]

Source of Identified Health Risk[3]	Unmitigated Health Risk Estimate[4]	Control Measures Implemented	Residual Health Risk Estimate[4]
AIR			
Particulate matter less than 10 micrometers in diameter (PM_{10})	Short-term: Not enough data to evaluate health risk. Daily levels vary, acute health effects (e.g., upper respiratory tract irritation) more pronounced during peak days. More serious effects are possible in susceptible persons (e.g., those with asthma/pre-existing respiratory diseases).	Limiting strenuous physical activities when air quality is especially poor; and actions such as closing tent flaps, windows, and doors.	Short-term: Not enough data to evaluate health risk. Daily levels vary, acute health effects (e.g., upper respiratory tract irritation) more pronounced during peak days. More serious effects are possible in susceptible persons (e.g., those with asthma/pre-existing respiratory diseases).
	Long-term: No health guidelines		Long-term: No health guidelines
Particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$)	Short-term: Not enough data to evaluate health risk. A majority of the time mild acute (short-term) health effects are anticipated; certain peak levels may produce mild eye, nose, or throat irritation in some personnel and pre-existing health conditions (e.g., asthma, or cardiopulmonary diseases) may be exacerbated.	Limiting strenuous physical activities when air quality is especially poor; and actions such as closing tent flaps, windows, and doors.	Short-term: Not enough data to evaluate health risk. A majority of the time mild acute (short-term) health effects are anticipated; certain peak levels may produce mild eye, nose, or throat irritation in some personnel and pre-existing health conditions (e.g., asthma, or cardiopulmonary diseases) may be exacerbated.
	Long-term: Not enough data to evaluate health risk. A small percentage of personnel may be at increased risk for developing chronic conditions. Particularly those more susceptible to acute effects (e.g., those with asthma/pre-existing respiratory diseases).		Long-term: Not enough data to evaluate health risk. A small percentage of personnel may be at increased risk for developing chronic conditions. Particularly those more susceptible to acute effects (e.g., those with asthma/pre-existing respiratory diseases).
SOIL			
Metals, Organic and Inorganic Compounds	Short-term: Not an identified source of health risk.		Short-term: Not an identified source of health risk.
	Long-term: No concentrations exceeded the 1-year Negligible MEGs for dermal contact.		Long-term: No concentrations exceeded the 1-year Negligible MEGs for dermal contact.
WATER			
Drinking Water	Short-term: Not enough data to evaluate health risk.	Use of U.S. Army Public Health Center (APHC) Army Institute of Public Health (AIPH) former U.S. Army Veterinary Command (VETCOM) approved bottled water and treated water only from approved potable water sources	Short-term: Not enough data to evaluate health risk.
	Long-term: Not enough data to evaluate health risk.		Long-term: Not enough data to evaluate health risk.
Non-Drinking Water	Short-term: Not enough data to evaluate health risk.	Water treated in accordance with standards applicable to its intended use	Short-term: Not enough data to evaluate health risk.
	Long-term: Not enough data to evaluate health risk.		Long-term: Not enough data to evaluate health risk.
MILITARY UNIQUE			
Ionizing Radiation	Short-term: No data available		Short-term: No data available
	Long-term: No data available		Long-term: No data available

Source of Identified Health Risk[3]	Unmitigated Health Risk Estimate[4]	Control Measures Implemented	Residual Health Risk Estimate[4]
Non-ionizing Radiation	Short-term: No data available		Short-term: No data available
	Long-term: No data available		Long-term: No data available
ENDEMIC DISEASE			
Food borne/Waterborne (e.g., diarrhea-bacteriological)	Short-term: Variable; High (bacterial diarrhea, diarrhea-protozoal, hepatitis A, typhoid/paratyphoid fever) and Moderate (diarrhea-cholera, brucellosis, and hepatitis E)	Preventive measures include hepatitis A and typhoid fever vaccination, consumption of food, water, and ice only from approved sources, and proper handwashing.	Short-term: Low to none
	Long-term: None identified		Long-term: No data available
Arthropod Vector Borne	Short-term: Variable; High (malaria, dengue fever), to Moderate (yellow fever, Rift Valley fever, chikungunya, Zika, rickettsioses-tickborne, West Nile fever, leishmaniasis-cutaneous, Crimean-Congo hemorrhagic fever), and Low (sindbis, typhus-murine).	Preventive measures include proper wear of permethrin treated uniform, application of insect repellent to exposed skin, bed net use, wearing sleeves and bloused boots, minimizing areas of standing water, and malaria medication as directed.	Short-term: Low
	Long-term: Low for leishmaniasis-visceral infection.		Long-term: Low
Water-Contact (e.g., wading, swimming)	Short-term: High for schistosomiasis and Moderate for leptospirosis	Avoid skin contact with fresh surface water (rivers, lakes, irrigated fields)	Short-term: Low.
	Long-term: No data available		Long-term: No data available
Respiratory	Short-term: Moderate for tuberculosis (TB) and High for meningococcal meningitis.	Providing adequate living and work space; avoid prolonged close contact with local populations which may be experiencing outbreaks, medical screening for latent TB infection, vaccination for meningoccal meningitis as is required for deployment to AFRICOM	Short-term: Low
	Long-term: No data available		Long-term: No data available
Animal Contact	Short-term: High for rabies, Moderate for Q-fever, and Low for anthrax	Prohibiting contact with, adoption, or feeding of feral animals in accordance with AFRICOM General Order #1. Risks may be further reduced by reduction of animal habitats, active pest management programs, timely treatment of feral animal scratches/bites, and immunizations if required.	Short-term: No data available
	Long-term: Low (rabies)		Long-term: No data available
Aerosolized Dust or Soil-contact	Short-term: Moderate for Lassa fever and soil transmitted helminthes (hookworm, strongyloidiasis, cutaneous larva migrans), and Low for	Risk was reduced to Low by limiting exposure to soil contaminated with human or animal feces (including	Short-term: Low

Source of Identified Health Risk[3]	Unmitigated Health Risk Estimate[4]	Control Measures Implemented	Residual Health Risk Estimate[4]
	Hantavirus hemorrhagic fever with renal syndrome.	sleeping on bare ground, and walking barefoot).	
	Long-term: No data available		Long-term: No data available
Person to Person Diseases	Short-term: None to Low for Ebola hemorrhagic fever	Overall risk was reduced with mitigation measures including strict barrier precautions for personnel in direct contact with blood or body fluids of sick or recently deceased patients.	Short-term: None to Low
	Long-term: No data available		Long-term: No data available
VENOMOUS ANIMALS			
Snakes, scorpions, and spiders	Short-term: Low; If encountered, effects of venom vary with species from mild localized swelling to potentially lethal effects.	Risk reduced by avoiding contact, proper wear of uniform (especially footwear), and proper and timely treatment.	Short-term: Low; If encountered, effects of venom vary with species from mild localized swelling to potentially lethal effects.
	Long-term: No data available		Long-term: No data available
HEAT/COLD STRESS			
Heat	Short-term: Low to High	Work-rest cycles, proper hydration and nutrition, and Wet-bulb Globe Temperature (WBGT) monitoring.	Short-term: Low to High, mitigated to Low.
	Long-term: Low. However, the risk may be greater to certain susceptible persons–those older (i.e., greater than 45 years), in lesser physical shape, or with underlying medical/health conditions.		Long-term: Low. However, the risk may be greater to certain susceptible persons–those older (i.e., greater than 45 years), in lesser physical shape, or with underlying medical/health conditions.
Cold	Short-term: No risk of cold stress/injury.		Short-term: No risk of cold stress/injury.
	Long-term: No risk of long-term cold stress/injury.		Long-term: No risk of long-term cold stress/injury.
NOISE			
Continuous (Flightline, Power Production)	Short-term: No data available	Hearing protection used by personnel in higher risk areas	Short-term: Not evaluated.
	Long-term: No data available		Long-term: No data available
Impulse	Short-term: No data available		Short-term: No data available
	Long-term: No data available		Long-term: Not evaluated.
Unique Incidents/ Concerns			
Waste Sites/Waste Disposal	Short-term: No data available		Short-term: No data available
	Long-term: No data available		Long-term: No data available
Fuel/petroleum products/ industrial chemical spills	Short-term: No data available		Short-term: No data available
	Long-term: No data available		Long-term: No data available
Pesticides/Pest Control	Short-term: No data available	See Section 10.4	Short-term: No data available
	Long-term: No data available		Long-term: No data available
Asbestos	Short-term: No data available		Short-term: No data available
	Long-term: No data available		Long-term: No data available

Source of Identified Health Risk[3]	Unmitigated Health Risk Estimate[4]	Control Measures Implemented	Residual Health Risk Estimate[4]
Lead Based Paint	Short-term: No data available		Short-term: No data available
	Long-term: No data available	Risks reduced by limiting strenuous physical activities when air quality was especially poor; and action such as closing tent flaps, windows, and doors. Other control measures included locating burn pits downwind of camps, increased distance from troop populations, and improved waste segregation and management techniques	Long-term: No data available
Burn Pits/Burn Barrels	Short-term: Burn pits and/or incinerators might have existed Dakar Airfield (for example, burn pits used by the local population); however, there are no reports or sampling data to indicate their presence or absence. Consequently, the PM_{10} and the $PM_{2.5}$ overall short-term health risks specifically for burn pits were not evaluated – see Section 10.7. Because Dakar Airfield is situated in a dusty semi-arid desert environment, a majority of the time mild acute (short-term) health effects are anticipated; certain peak levels may produce mild eye, nose, or throat irritation in some personnel and pre-existing health conditions (e.g., asthma, or cardiopulmonary diseases) may be exacerbated.		Short-term: Burn pits and/or incinerators might have existed Dakar Airfield (for example, burn pits used by the local population); however, there are no reports or sampling data to indicate their presence or absence. Consequently, the PM_{10} and the $PM_{2.5}$ overall short-term health risks specifically for burn pits were not evaluated – see Section 10.7. Because Dakar Airfield is situated in a dusty semi-arid desert environment, a majority of the time mild acute (short-term) health effects are anticipated; certain peak levels may produce mild eye, nose, or throat irritation in some personnel and pre-existing health conditions (e.g., asthma, or cardiopulmonary diseases) may be exacerbated..
	Long-term: Burn pits and/or incinerators might have existed Dakar Airfield (for example, burn pits used by the local population); however, there are no reports or sampling data to indicate their presence or absence. Consequently, the PM_{10} and the $PM_{2.5}$ overall long-term health risks specifically for burn pits were not evaluated – see Section 10.7. Typically, exposure to burn pit smoke is variable. Exposure to high levels of PM_{10} and $PM_{2.5}$ in the smoke may be associated with some otherwise healthy personnel, who were exposed for a long-term period, possibly developing certain health conditions (e.g., reduced lung function, cardiopulmonary disease). Personnel with a history of asthma or cardiopulmonary disease could potentially be more likely to develop such chronic health conditions.		Long-term: Burn pits and/or incinerators might have existed Dakar Airfield (for example, burn pits used by the local population); however, there are no reports or sampling data to indicate their presence or absence. Consequently, the PM_{10} and the $PM_{2.5}$ overall long-term health risks specifically for burn pits were not evaluated – see Section 10.7. Typically, exposure to burn pit smoke is variable. Exposure to high levels of PM_{10} and $PM_{2.5}$ in the smoke may be associated with some otherwise healthy personnel, who were exposed for a long-term period, possibly developing certain health conditions (e.g., reduced lung function, cardiopulmonary disease). Personnel with a history of asthma or cardiopulmonary disease could potentially be more likely to develop such chronic health conditions.

Source of Identified Health Risk[3]	Unmitigated Health Risk Estimate[4]	Control Measures Implemented	Residual Health Risk Estimate[4]

[1]This Summary Table provides a qualitative estimate of population-based short- and long-term health risks associated with the occupational and environment health conditions at Dakar Airfield, Senegal. It does not represent an individual exposure profile. Actual individual exposures and health effects depend on many variables. For example, while a chemical may have been present in the environment, if a person did not inhale, ingest, or contact a specific dose of the chemical for adequate duration and frequency, then there may have been no health risk. Alternatively, a person at a specific location may have experienced a unique exposure, which could result in a significant individual exposure. Any such person seeking medical care should have their specific exposure documented in an SF 600.

[2]This assessment is based on specific environmental sampling data and reports obtained from 01 September 2014 through 31 December 2015. Sampling locations are assumed to be representative of exposure points for the camp population but may not reflect all the fluctuations in environmental quality or capture unique exposure incidents.

[3]This Summary Table is organized by major categories of identified sources of health risk. It only lists those subcategories specifically identified and addressed at Dakar Airfield, Senegal. The health risks are presented as Low, Moderate, High or Extremely High for both acute and chronic health effects. The health risk level is based on an assessment of both the potential severity of the health effects that could be caused and probability of the exposure that would produce such health effects. Details can be obtained from the APHC. Where applicable, "None Identified" is used when though a potential exposure is identified, and no health risks of either a specific acute or chronic health effects are determined. More detailed descriptions of OEH exposures that are evaluated but determined to pose no health risk are discussed in the following sections of this report.

[4]Health risks in this Summary Table are based on quantitative surveillance thresholds (e.g., endemic disease rates; host/vector/pathogen surveillance) or screening levels, e.g., Military Exposure Guidelines (MEGs) for chemicals. Some previous assessment reports may provide slightly inconsistent health risk estimates because quantitative criteria such as MEGs may have changed since the samples were originally evaluated and/or because this assessment makes use of all historic site data while previous reports may have only been based on a select few samples.

1 Discussion of Health Risks at Dakar Airfield, Senegal by Source

The following sections provide additional information about the OEH conditions summarized above. All risk assessments were performed using the methodology described in the U.S. Army Public Health Command (USAPHC) Technical Guide 230 (*Environmental Health Risk Assessment and Chemical Exposure Guidelines for Deployed Military Personnel*) (Reference 4). All OEH risk estimates represent residual risk after accounting for preventive controls in place. Occupational exposures and exposures to endemic diseases are greatly reduced by preventive measures. For environmental exposures related to airborne dust, there are limited preventive measures available, and available measures have little efficacy in reducing exposure to ambient conditions.

2 Air

2.1 Site-Specific Sources Identified

Inhalational exposure to high levels of dust and PM, such as during high winds or dust storms may result in mild to more serious short-term health effects (e.g., eye, nose or throat and lung irritation) in some personnel. Additionally, certain subgroups of the deployed forces (e.g., those with pre-existing asthma/cardio pulmonary conditions) are at greatest risk of developing notable health effects.

2.2 PM

PM is a complex mixture of extremely small particles suspended in the air. The PM includes solid particles and liquid droplets emitted directly into the air by sources such as power plants, motor vehicles, aircraft, generators, construction activities, fires, and natural windblown dust. The PM can include sand, soil, metals, volatile organic compounds (VOCs), allergens, and other compounds such as nitrates or sulfates that are formed by condensation or transformation of combustion exhaust. The PM composition and particle size vary considerably depending on the source. Generally, PM of health concern is divided into two fractions: PM_{10}, which includes coarse particles with a diameter of 10 micrometers (µm) or less, and fine particles less than 2.5 µm ($PM_{2.5}$), which can reach the deepest regions of the lungs when inhaled. Exposure to excessive PM is linked to a variety of potential health effects.

2.3 PM_{10}

2.3.1 Exposure Guidelines:

Short-Term (24-hour) PM_{10} (micrograms per cubic meter, µg/m^3):

- Negligible MEG = 250
- Marginal MEG = 420
- Critical MEG = 600

Long-term PM_{10} MEG (µg/m^3):

- Not defined and not available.

2.3.2 Sample data/Notes:

Dakar Airfield: A single valid PM_{10} air sample (203 µg/m^3) was collected on 26 December 2014. Although an insufficient number of air samples were available to assess risk at this location, it

should be noted that the PM_{10} air concentration did not exceed the 24 hour Negligible MEG (250 µg/m^3).

2.3.3 Short-term health risks:

The data quantity (small sample size) was insufficient to characterize the potential short-term health risks from PM_{10} air exposure to U.S. personnel.

2.3.4 Long-term health risk:

Not Evaluated-no available health guidelines. The U.S. Environmental Protection Agency (EPA) has retracted its long-term standard (National Ambient Air Quality Standards, NAAQS) for PM_{10} due to an inability to clearly link chronic health effects with chronic PM_{10} exposure levels.

2.4 $PM_{2.5}$

2.4.1 Exposure Guidelines:

Short-Term (24-hour) $PM_{2.5}$ (µg/m^3):

- Negligible MEG = 65
- Marginal MEG = 250
- Critical MEG = 500

Long-term (1-year) $PM_{2.5}$ MEGs (µg/m^3):

- Negligible MEG = 15
- Marginal MEG = 65.

2.4.2 Sample data/Notes:

Dakar Airfield: A single valid $PM_{2.5}$ air sample (50 µg/m^3) was collected on 26 December 2014. Although an insufficient number of air samples were available to assess risk at this location, it should be noted that the $PM_{2.5}$ concentration did exceed the 1-year Negligible MEG (15 µg/m^3).

2.4.3 Short-term and Long-term health risks:

The data quantity (small sample size) was insufficient to characterize the potential short- and long-term health risks from $PM_{2.5}$ air exposure to U.S. personnel. It should be noted that the $PM_{2.5}$ concentration (50 µg/m^3) did not exceed the 24-hour (short-term) Negligible MEG (65 µg/m^3) but did exceed the 1-year (long-term) Negligible MEG (15 µg/m^3).

2.5 Airborne Metals

2.5.1 Exposure Guidelines:

2.5.2 Airborne Metals from PM_{10}:

2.5.2.1 Sample data/Notes:

Dakar Airfield: A single valid PM_{10} airborne metals sample was collected on 26 December 2014. Although an insufficient number of air samples were available to assess risk at this location, it should be noted that the PM_{10} airborne metals concentrations did not exceed their respective 1-year Negligible MEGs.

2.5.2.2 Short-term and Long-term health risks:

The data quantity (small sample size) was insufficient to characterize the potential short- and long-term health risks from PM_{10} airborne metals exposure to U.S. personnel. However, it should be noted that the PM_{10} metals concentrations did not exceed their respective short- and long-term MEGs.

2.5.3 Airborne Metals from $PM_{2.5:}$

2.5.3.1 Sample data/Notes:

Dakar Airfield: A single valid $PM_{2.5}$ airborne metals sample was collected on 26 December 2014. Although an insufficient number of air samples were available to assess risk at this location, it should be noted that the $PM_{2.5}$ airborne metals concentrations did not exceed their respective 1-year Negligible MEGs.

2.5.3.2 Short-term and Long-term health risks:

The data quantity (small sample size) was insufficient to characterize the potential short-and long-term health risks from $PM_{2.5}$ airborne metals exposure to U.S. personnel. However, it should be noted that the $PM_{2.5}$ metals concentrations did not exceed their respective short- and long-term MEGs.

2.6 VOCs

2.6.1 Exposure Guidelines:

2.6.2 Sample data/Notes:

Dakar Airfield: No VOC air samples were collected; therefore, risk could not be assessed at this location.

2.6.3 Short- and long-term health risks:

Not Evaluated - no samples were available. The data quantity (lack of samples) was insufficient to characterize the potential short- and long-term health risks from VOC exposure to U.S. personnel.

3 Soil

3.1 Site-Specific Sources Identified

3.2 Sample data/Notes

Surface soil samples were collected in December 2014 to assess OEH health risk to deployed personnel. The primary soil contamination exposure pathways are dermal contact and dust inhalation. Typical parameters analyzed for included semi-volatile organic compounds (SVOCs), heavy metals, polychlorinated biphenyls, pesticides, and herbicides. If the contaminant was known or suspected, other parameters may have been analyzed for (i.e., total

petroleum hydrocarbons and polycyclic aromatic hydrocarbons near fuel spills). For the risk assessment, personnel are assumed to remain at this location for 4-5 months.

Dakar Airfield: A total of three valid surface soil samples were collected in December 2014 and evaluated for this health risk assessment. No soil parameter concentrations exceeded their respective 1-year Negligible MEGs.

3.3 Short-term health risk

Not an identified source of health risk. Currently, sampling data for soil are not evaluated for short-term (acute) health risks**.**

3.4 Long-term health risk

None identified based on available sample data. The data quantity (small sample size) was insufficient to characterize the potential health risks from soil exposure to U.S. personnel. However, it should be noted that no parameters exceeded their respective 1-year Negligible MEGs for dermal contact. The dust inhalation exposure pathway is addressed in Section 2 above.

4 Water

In order to assess the health risk to U.S. personnel from exposure to water in theater, the APHC identified the most probable exposure pathways. These are based on the administrative information provided on the field data sheets submitted with the samples taken over the time period being evaluated. The sources of water used by U.S. personnel at Dakar Airfield were from reverse osmosis water purification units (ROWPUs) or bottled water. There is a possibility that personnel, particularly at small outlying camps, may use water that is not regularly disinfected for showering, personal hygiene, or cleaning. Field data sheets indicate that bottled water is the only approved source of drinking water.

4.1 Drinking Water

4.1.1 Site-Specific Sources Identified:

4.1.2 Sample data/Notes:

To assess the potential for adverse health effects to troops, the following assumptions were made about dose and duration: A conservative (protective) assumption was that personnel routinely ingested 5 liters per day (L/day) of bottled water for up to 365 days (1-year).

Dakar Airfield: A total of two valid drinking water samples were collected in December of 2014. Both samples were collected from bottles (brands Dea® and Sidi Ali®).

4.1.3 Short-term and Long-term health risk:

The data quantity (small sample size) was insufficient to characterize the potential short- and long-term health risks from drinking water exposure to U.S. personnel. However, it should be noted that all samples were below the 1-year Negligible MEG for the 5-L/day consumption rate.

4.2 Non-Drinking Water

4.2.1 Site-Specific Sources Identified:

Although the primary route of exposure for most microorganisms is ingestion of contaminated water, dermal exposure to some microorganisms, chemicals, and biologicals may also cause adverse health effects. Complete exposure pathways would include drinking, brushing teeth, personal hygiene, cooking, providing medical and dental care using a contaminated water supply or during dermal contact at vehicle or aircraft wash racks.

4.2.2 Sample data/Notes:

To assess the potential for adverse health effects to troops the following assumptions were made about dose and duration: A conservative (protective) assumption is that personnel routinely consumed less than 5 L/day of non-drinking water for up to 365 days (1-year). It is further assumed that control measures and/or personal protective equipment were not used.

Dakar Airfield: A total of 2 valid non-drinking water samples were collected in December of 2014.

4.2.3 Short-term and Long-term health risks:

The data quantity (small sample size) was insufficient to characterize the potential short-term health risks from non-drinking water exposure to U.S. personnel. However, it should be noted that the water concentrations did not exceed 2.5 times the 1-year Negligible MEG for the 5L/day consumption rate.

5 Military Unique

5.1 Chemical Biological, Radiological Nuclear Weapons

No specific hazard sources were documented in the Defense Occupational and Environmental Health Readiness System (DOEHRS) or the Military Exposure Surveillance Library (MESL) from 01 September 2014 through 31 December 2015 (References 1 and 6).

5.2 Depleted Uranium

No specific hazard sources were documented in the DOEHRS or MESL from 01 September 2014 through 31 December 2015 (References 1 and 6).

5.3 Ionizing Radiation

No specific hazard sources were documented in the DOEHRS or MESL from 01 September 2014 through 31 December 2015 (References 1 and 6).

5.4 Non-Ionizing Radiation

No specific hazard sources were documented in the DOEHRS or MESL from 01 September 2014 through 31 December 2015 (References 1 and 6).

6 Endemic Diseases

This document lists the endemic diseases reported in the region, its specific health risks and severity and general health information about the diseases. AFRICOM Force Health Protection Requirements and Medical Guidance (Reference 7) lists deployment requirements, to include immunizations and chemoprophylaxis, in effect during the timeframe of this assessment.

6.1 Food-borne and Waterborne Diseases

Public health protection of food and water supplies may exist in some areas but is absent in most of the country. Sanitation is poor, including major urban areas. Local food and water sources (including ice) are heavily contaminated with pathogenic bacteria, parasites, and viruses to which most U.S. Service members have little or no natural immunity. Effective disease surveillance does not exist within the country. Only a small fraction of diseases are identified or reported. Diarrheal diseases can be expected to temporarily incapacitate a very high percentage of personnel within days if local food, water, or ice is consumed. Hepatitis A and typhoid fever can cause prolonged illness in a smaller percentage of unvaccinated personnel. In addition, although not specifically assessed in this document, viral gastroenteritis (e.g., norovirus) and food poisoning (e.g., *Bacillus cereus*, *Clostridium perfringens*, *Staphylococcus*) may cause significant outbreaks. Key disease risks are summarized below:

Mitigation strategies were in place and included consuming food and water from approved sources, vaccinations (when available), frequent hand washing, and general sanitation practices.

6.1.1 Diarrheal diseases (bacteriological):

High, mitigated to Low: Diarrheal diseases are expected to temporarily incapacitate a very high percentage of personnel (potentially over 50% per month) within days if local food, water, or ice is consumed. Field conditions (including lack of hand washing and primitive sanitation) may facilitate person-to-person spread and epidemics. Typically, diarrheal diseases are a mild disease treated in an outpatient setting with recovery and return to duty in less than 72 hours with appropriate therapy. A small proportion of infections may require greater than 72 hours limited duty or hospitalization.

6.1.2 Hepatitis A, typhoid/paratyphoid fever, and diarrhea-protozoal:

High, mitigated to Low: Unmitigated health risk to U.S. personnel is High year round for hepatitis A typhoid/paratyphoid fever, and diarrhea-protozoal. Mitigation strategies in place include immunization, consumption of approved food, water, and ice; hand washing; and applied food/water safety mechanisms. Vaccination for Hepatitis A is required for all military personnel (Reference 7). Hepatitis A, typhoid/paratyphoid fever, and diarrhea-protozoal disease may cause prolonged illness in a small percentage of personnel (less than 1% per month).

6.1.3 Diarrhea-cholera:

Moderate, mitigated to Low: Unmitigated health risk to U.S. personnel is Moderate year round for diarrhea-cholera. Mitigation strategies in place include consumption of approved food, water, and ice; hand washing; and applied food/water safety mechanisms. Most symptomatic

cases are mild, with recovery and return to duty in less than 72 hours with appropriate outpatient treatment. Severe cases may require 1-7 days of supportive or inpatient care, followed by return to duty. Diarrhea-cholera may cause prolonged illness in a small percentage of personnel (less than 1% per month).

6.1.4 Brucellosis:

Moderate, mitigated to Low: Unmitigated health risk to U.S. personnel is Moderate year round for brucellosis. It is a common disease in cattle, sheep, goats, swine, and some wildlife species and is contracted via consumption of contaminated dairy products (or foods made with such products) or by occupational exposures to infected animals. Mitigation strategies in place include consumption of approved food (i.e., pasteurization of dairy products), and applied food/water safety mechanisms. Rare cases (less than 0.1% per month attack rate) could occur among personnel consuming local dairy products or having direct occupational-type contact with livestock. With appropriate treatment, brucellosis is a febrile illness of variable severity, may require inpatient care, and convalescence is usually over 7 days even with appropriate treatment.

6.1.5 Hepatitis E:

Moderate, mitigated to Low: Unmitigated health risk to U.S. personnel is Moderate year round for hepatitis E. Hepatitis E occurs in four major genotypes. Genotypes 1 and 2 are found primarily in Africa and cause large numbers of sporadic cases, as well as large outbreaks. The most common source of exposure is fecal contamination of drinking water. Mitigation strategies in place include consumption of approved food and applied food/water safety mechanisms. Potential disease rates (1% per month) among personnel consuming local food, water, or ice may exceed 1% per month for personnel heavily exposed during outbreaks in the local population. Typical cases involves 1 to 3 weeks of debilitating symptoms and return to duty may require a month or more.

6.1.6 Short-term Health Risks:

Variable, unmitigated; Low, mitigated: The overall unmitigated short-term risk associated with food borne and waterborne diseases are considered High (bacterial diarrhea, diarrhea-protozoal, hepatitis A, typhoid/paratyphoid fever) to Moderate (diarrhea-cholera, brucellosis, and hepatitis E) if local food or water is consumed. Preventive Medicine measures reduced the risk to Low. Confidence in the health risk estimate is high.

6.1.7 Long-term Health Risks:

None identified based on available data.

6.2 Arthropod Vector-Borne Diseases

The climate and ecological habitat support large populations of arthropod vectors, including mosquitoes, ticks, and sand flies. Significant disease transmission is sustained year-round and countrywide, including urban areas. Rift Valley fever may be a major risk during peaks of transmission. Mitigation strategies were in place and included proper wear of treated uniforms, application of repellent to exposed skin, and use of bed nets and chemoprophylaxis (when applicable). Additional methods included the use of pesticides, reduction of pest/breeding habitats, and engineering controls.

6.2.1 Malaria:

High, mitigated to Low: The potential unmitigated risk to U.S. personnel is High year round but is reduced to Low with mitigation measures. Malaria incidents are often associated with the presence of agriculture activity, including irrigation systems and standing water, which provide breeding habitats for vectors. A small number of cases may occur among personnel exposed to mosquito (Anopheles spp.) bites. Potential disease rates (11-50% per month) among personnel may occur. Malaria incidents may cause debilitating febrile illness typically requiring 1 to 7 days of inpatient care, followed by return to duty. Severe cases may require intensive care or prolonged convalescence.

6.2.2 Dengue Fever:

High, mitigated to Low: The potential unmitigated health risk is High year-round but is reduced to Low with mitigation measures. Disease rates of 1-50% per month could occur among personnel exposed to mosquito bites. Dengue fever is transmitted by *Aedes spp.* mosquitos, day-biting mosquitos that often breed in artificial containers, such as flower pots or discarded tires. Dengue fever is a debilitating febrile illness typically requiring 1 to 7 days of inpatient care, followed by return to duty. Some cases may require a longer recovery period.

6.2.3 Yellow Fever:

Moderate mitigated to Low: The potential unmitigated health risk to U.S. personnel is Moderate year round but is reduced to Low with mitigation measures. Yellow fever is transmitted by *Aedes spp*. and other mosquitos may transmit infection between primates and humans. During peak transmission, disease rates of 1% per month could occur among unvaccinated personnel exposed to mosquito bites. Yellow fever is a potentially severe disease that may require intensive care. Mortality rates may be 20-80% in hemorrhagic cases.

6.2.4 Chikungunya:

Moderate mitigated to Low: The potential unmitigated health risk to U.S. personnel is Moderate year-round but is reduced to Low with mitigation measures. Chikungunya is transmitted primarily by *Aedes aegypti* (a morning- and evening biting mosquito), and possibly *Aedes albopictus* (a day biting mosquito). During peak transmission, operationally significant disease rates of 1-50% per month could occur among personnel exposed to mosquito bites, primarily during the day. Chikungunya causes a debilitating febrile illness typically requiring 1-7 days of inpatient care, followed by return to duty. In some cases, join pain severe enough to limit activities may persist for weeks to months.

6.2.5 Zika:

Moderate mitigated to Low: The potential unmitigated health risk to U.S. personnel is Moderate year-round but is reduced to Low with mitigation measures. Zika is spread by daytime mosquitos, such as *A. aegypti* and *A. albopictus*. During peak transmission, operationally significant disease rates (potentially 1-50% per month) could occur among personnel exposed to mosquito bites, primarily during the day. Zika causes a debilitating febrile illness typically requiring 1-7 days of inpatient care, followed by return to duty. Symptoms of Zika infection (e.g., fever, rash, joint and muscle pain, red eyes, and vomiting) may last for several days to a week. In some cases, severe neurological complications (Guillain-Barre) may occur.

6.2.6 Rickettsioses, tickborne (spotted fever group):

Moderate, mitigated to Low: The potential unmitigated health risk to U.S. personnel is Moderate year-round but is reduced to Low with mitigation measures. A small number of cases (less than 1% per month) is possible among personnel exposed to tick bites. Rickettsioses are transmitted by multiple species of hard ticks, including *Rhipicepahalus spp*. and *Ixodes spp*. A debilitating febrile illness requiring 1 to 7 days of supportive care followed by return to duty is typical with appropriate treatment. More prolonged and severe infections may occur with rare fatalities.

6.2.7 West Nile fever:

Moderate, mitigated to Low: The potential unmitigated health risk to U.S. personnel is Moderate year-round but is reduced to Low with mitigation measures. Potential disease rates of less than 1% per month can occur among personnel under worst case conditions. The disease is maintained in bird reservoirs and causes periodic outbreaks in humans and animals, including horses. Multiple species of *Culex* mosquitos can transmit the infection to humans. The majority of infections in young, healthy adults are asymptomatic although fever, headache, tiredness, body aches (occasionally with a skin rash on trunk of body), and swollen lymph glands can occur. In many parts of the world, even symptomatic cases typically are undiagnosed and unreported. A febrile illness requiring 1-7 days of inpatient care followed by return to duty is typical.

6.2.8 Leishmaniasis—cutaneous:

Moderate, mitigated to Low: The potential unmitigated health risk to U.S. personnel is Moderate year-round but is reduced to Low with mitigation measures. Leishmaniasis is transmitted by sandflies typically at night. Rare cases (less than 0.1% per month) could occur among personnel exposed to sandfly bites in areas with infected people, rodents, dogs, or other reservoir animals. In groups of personnel exposed to heavily infected sandflies in focal areas, disease rates can be very high (over 50%). The leishmaniasis parasites may survive for years in infected individuals and this infection may go unrecognized by physicians in the U.S. when infections become symptomatic years later. Cutaneous infection is unlikely to be debilitating, though lesions may be disfiguring.

6.2.9 Crimean-Congo hemorrhagic fever:

Moderate, mitigated to Low: The potential unmitigated health risk to U.S. personnel is Moderate but is reduced to Low with mitigation measures. Crimean-Congo hemorrhagic fever occurs in rare cases (less than 0.1% per month attack rate among personnel exposed to tick bites, particularly *Hyalomma*, *Boophilus*, or *Rhipicephalus spp*). Direct contact with blood or body fluids from infected animals or people may also transmit infection. The severe illness typically requires intensive care with fatality rates from 5% to 50%.

6.2.10 Sindbis (and Sindbis-like viruses):

Low: The potential unmitigated health risk to U.S. personnel is Low year-round. Rare cases (less than 0.1% per month) are possible among personnel exposed to *Culex* spp. mosquito bites. Risk is elevated during periods of increased vector mosquito activity. Sindbis is a debilitating febrile illness often accompanied by rash, typically requiring 1 to 7 days of supportive care; significant arthralgias can persist for several weeks or more in some cases.

6.2.11 Typhus murine (fleaborne):

Low: The potential unmitigated health risk to U.S. personnel is Low year-round. Rare cases (less than 0.1% per month) are possible among personnel exposed to rodents (particularly rats, *Rattus rattus* and *R. norvegicus*) and flea bites. Murine typhus usually occurs as sporadic cases or occasionally in clusters of cases, associated with flea bites. Risk is highest where rats and humans occupy the same buildings. The disease can cause debilitating febrile illness typically requiring 1 to 7 days of inpatient care, followed by return to duty. Fatalities are rare.

6.2.12 Rift Valley Fever:

Moderate: The potential unmitigated health risk to U.S. personnel is Moderate year-round. Conditions may support unpredictable and explosive increases in transmission. During peak transmission, attack rates of 1-10% per month could occur. Rift Valley Fever is transmitted by *Aedes spp*. found in close proximity to livestock, typically in rural settings. Rift Valley Fever is a debilitating febrile illness typically requiring 1-7 days of supportive care, followed by return to duty. Retinopathy sometimes leading to blindness may occur in up to 10% of patients. Severe complications including hepatitis with hemorrhage, and encephalitis may occur, leading to fatalities.

6.2.13 Short-term health risks:

Low: The unmitigated health risk is High for Malaria and Dengue fever, Moderate for Chikungunya, Zika, Rickettsioses-tickborne, West Nile fever, Leishmaniasis-cutaneous, Rift Valley fever, Yellow fever, and Crimean-Congo hemorrhagic fever; Low for Sindbis and Typhus-murine. Health risk is reduced to Low by proper wear of the uniform, application of repellent to exposed skin, and appropriate chemoprophylaxis. Confidence in health risk estimate was high.

6.2.14 Long-term health risks:

None identified based on available data.

6.3 Water Contact Diseases

Operations or activities that involve extensive water contact may result in personnel being temporarily debilitated with leptospirosis in some locations. Leptospirosis health risk typically increases during flooding. In addition, although not specifically assessed in this document, bodies of surface water are likely to be contaminated with human and animal waste. Activities such as wading or swimming may result in exposures to enteric diseases such as diarrhea and hepatitis via incidental ingestion of water. Prolonged water contact also may lead to the development of a variety of potentially debilitating skin conditions such as bacterial or fungal dermatitis. Mitigation strategies were in place and included avoiding water contact and recreational water activities, proper wear of uniform (especially footwear), and protective coverings for cuts/abraded skin.

6.3.1 Schistosomiasis:

High, mitigated to Low: The potential unmitigated health risk to U.S. personnel is High year-round but is reduced to Low with mitigation measures. A disease rate of 1-10% per month is possible among personnel wading or swimming in fecally contaminated bodies of water. In groups with prolonged exposure to heavily contaminated foci, disease rates can exceed 10%.

Humans are the principal reservoir for schistosomes; humans shed schistosome eggs in urine or feces. When water temperatures are at or above 68 degrees Fahrenheit (°F), the eggs hatch, releasing larvae. If a suitable freshwater snail species is present, the larvae penetrate the snail and, after a period of development, emerge as free-swimming cercariae. Cercariae infect human hosts by penetrating skin, usually while the person is wading or swimming. Mild infections of Schistosomiasis are generally asymptomatic. In very heavy acute infections, a febrile illness (acute schistosomiasis) may occur, especially with *S. japonicum* and *S. mansoni*, requiring hospitalization and convalescence over 7 days.

6.3.2 Leptospirosis:

Moderate, mitigated to Low: The potential unmitigated health risk to U.S. personnel is Moderate year-round but is reduced to Low with mitigation measures. Human infections occur through exposure to water or soil contaminated by infected animals and is associated with wading, and swimming in contaminated, untreated open water. The occurrence of flooding after heavy rainfall facilitates the spread of the organism because as water saturates the environment *Leptospira* present in the soil passes directly into surface waters. *Leptospira* can enter the body through cut or abraded skin, mucous membranes, and conjunctivae. Infection may also occur from ingestion of contaminated water. The acute, generalized illness associated with infection may mimic other tropical diseases (for example, dengue fever, malaria, and typhus), and common symptoms include fever, chills, myalgia, nausea, diarrhea, cough, and conjunctival suffusion. Manifestations of severe disease can include jaundice, renal failure, hemorrhage, pneumonitis, and hemodynamic collapse. Recreational activities involving extensive water contact may result in personnel being temporarily debilitated with leptospirosis. Incidence could result in debilitating febrile illness typically requiring 1 to 7 days of inpatient care, followed by return to duty; some cases may require prolonged convalescence.

6.3.3 Short-term health risks:

Variable, unmitigated; Low, mitigated: Unmitigated health risk of Schistosomiasis is High and Leptospirosis is Moderate year-round. Mitigation measures reduce the risk to Low. Confidence in the health risk estimate is high.

6.3.4 Long-term health risks:

None identified based on available data.

6.4 Respiratory Diseases

Although not specifically assessed in this document, deployed U.S. Forces may be exposed to a wide variety of common respiratory infections in the local population. These include influenza, pertussis, viral upper respiratory infections, viral and bacterial pneumonia, and others. The U.S. military populations living in close-quarter conditions are at risk for substantial person-to-person spread of respiratory pathogens. Influenza is of particular concern because of its ability to debilitate large numbers of unvaccinated personnel for several days. Mitigation strategies were in place and included routine medical screenings, vaccination, enforcing minimum space allocation in housing units, implementing head-to-toe sleeping in crowded housing units, implementation of proper PPE when necessary for healthcare providers and detention facility personnel.

6.4.1 TB:

Moderate, mitigated to Low: The potential unmitigated health risk to U.S. personnel is Moderate year round but is reduced to Low with mitigation measures. Transmission typically requires close and prolonged contact with an active case of pulmonary or laryngeal TB, although it also can occur with more incidental contact. Individuals with prolonged indoor exposure to the local population are at increased risk for latent TB infection.

6.4.2 Meningococcal meningitis:

High, mitigated to Low: The potential unmitigated health risk to U.S. personnel is High year-round but is reduced to Low with mitigation measures. The peak transmission period is November through May and the disease is transmitted from person to person through droplets of respiratory or throat secretions. Close and prolonged contact facilitates the spread of this disease. Rare cases (less than 0.1% per month) could occur among unvaccinated personnel. Meningococcal meningitis is potentially a very severe disease typically requiring intensive care; fatalities may occur in 5-15% of cases.

6.4.3 Short-term health risks:

Moderate, unmitigated; Low, mitigated: Unmitigated health risk of TB and Meningococcal meningitis is Moderate to High year-round. Mitigation measures reduce the risk to Low. Confidence in the health risk estimate is high.

6.4.4 Long-term health risks:

None identified based on available data. Tuberculosis is evaluated as part of the post deployment health assessment. A TB skin test is required post-deployment if potentially exposed and is based upon individual service policies.

6.5 Animal-Contact Diseases

6.5.1 Rabies:

High, mitigated to Low: The potential unmitigated health risk to U.S. personnel is High (among the highest in the world) year-round but is reduced to Low with mitigation measures. Rabies is transmitted by exposure to the virus-laden saliva of an infected animal, typically through bites, but could occur from scratches contaminated with the saliva. Although the vast majority (>99%) of persons who develop rabies disease will do so within a year after a risk exposure, there have been rare reports of individuals presenting with rabies disease up to six years or more after their last known risk exposure. Mitigation strategies included command emphasis on AFRICOM's no contact with local animals' restriction and timely treatment of feral animal scratches/bites.

6.5.2 Q-Fever:

Moderate, mitigated to Low: The potential unmitigated health risk to U.S. personnel is Moderate year round but is mitigated to Low with mitigation measures. Rare cases (less than 0.1% per month) are possible among personnel exposed to aerosols from infected animals, with clusters of cases possible in some situations. Significant outbreaks (affecting 1-50%) can occur in personnel with heavy exposure to barnyards or other areas where animals are kept.

Unpasteurized milk may also transmit infection. The primary route of exposure is respiratory, with an infectious dose as low as a single organism. Incidence could result in debilitating febrile illness, sometimes presenting as pneumonia, typically requiring 1 to 7 days of inpatient care followed by return to duty. Mitigation strategies in place include avoiding contact with livestock, or areas heavily contaminated by livestock such as barnyards, and only drinking unpasteurized milk.

6.5.3 Anthrax:

Low: The potential unmitigated health risk to U.S. personnel from naturally occurring anthrax is Low year-round. Rare cases (less than 0.1% per month) could occur among personnel with occupational-type exposure to livestock (e.g., cattle, sheep, goats, horses, pigs, water buffalo) or wild herbivores (e.g., antelopes, elephants, giraffes, zebras), or hides or wool products from these species, as well as handling or consumption of undercooked meat. Cutaneous anthrax (typically requiring 1 to 7 days of supportive care with return to duty) and gastrointestinal anthrax (typically requiring hospitalization, and fatality if untreated) are the most common forms of naturally occurring anthrax. The risk of naturally acquired inhalation (pulmonary) anthrax is remote. Inhalation anthrax is very severe, often requiring intensive care with potential fatalities occurring even in treated cases. Mitigation strategies in place include avoiding contact with livestock or consumption of undercooked meat.

6.5.4 Short-term health risks:

Low: The short-term unmitigated risk is High for rabies, Moderate for Q-fever, and Low for Anthrax. Mitigation measures reduced the overall risk to Low. Confidence in risk estimate is high.

6.5.5 Long-term health risks:

Low: A Low long-term risk exists for rabies because, in rare cases, the incubation period for rabies can be several years.

6.6 Aerosolized Dust or Soil-contact Diseases

6.6.1 Soil-transmitted helminths (hookworm, strongyloidiasis, cutaneous larva migrans)

Moderate, mitigated to Low: The potential unmitigated health risk to U.S. personnel is Moderate year-round but is mitigated to Low with mitigation measures. A significant attack rate (potentially 1-10% per month) could occur among personnel with direct skin exposure to soil contaminated with human or animal feces (including sleeping on bare ground, walking barefoot). Initial skin symptoms typically are mild and are not debilitating. However, systemic symptoms of fever, cough, abdominal pain, nausea, and diarrhea may develop weeks to months after initial infection with hookworm or *Strongyloides*. More severe infections with high worm burden may be debilitating in some cases. Mitigation strategies in place include avoiding bare skin contact with moist soil, which may be contaminated with human or animal feces.

6.6.2 Lassa fever:

Moderate, mitigated to Low: The potential health risk to U.S. personnel is Moderate year-round (peak transmission period is January through April) but is mitigated to Low with mitigation measures. Multimammate mice (*Mastomys natalensis*) are the reservoir for Lassa fever, and

shed the virus in urine and feces. Lassa fever is transmitted primarily by inhalation of aerosols containing infected rodent urine or feces, although it can also be transmitted by consuming food or water contaminated with rodent urine or feces. A small number of cases (less than 1% per month attack rate) could occur among personnel exposed to dust or aerosols in rodent-infected areas, particularly in or around local dwellings. Though most infections are asymptomatic or cause moderate self-limited febrile illness, severe cases requiring intensive care may occur, overall fatality rate may be 2-3%.

6.6.3 Hantavirus hemorrhagic fever with renal syndrome (HFRS):

Low: The potential health risk to U.S. personnel is Low year-round. HFRS is transmission to humans is associated with exposure to aerosolized virus excreted in the urine or feces of an infected rodent host. Disturbance of earth, soil, dust, or debris in areas where the rodent host is active increases the risk of human exposure. Transmission can occur at any time of the year. Attack rates exceeding 1% could occur in small groups exposed to areas with very heavy rodent infestation and dusty conditions. HFRS is a very severe disease typically requiring prolonged hospitalization, including intensive care. Fatalities may occur.

6.6.4 Short-term health risks:

Low: Moderate for soil transmitted helminthes and Lassa fever, Low for HFRS. Overall risk was reduced to Low with mitigation measures. Confidence in the health risk estimate is high.

6.6.5 Long-term health risks:

None identified based on available data.

6.7 Person-to-Person Diseases

6.7.1 Ebola hemorrhagic fever:

None to Low: It should be noted that the risk during the 2014-2015 Ebola outbreak was none to Low for U.S. personnel since they were only in Senegal for support purposes (i.e., humanitarian efforts at Dakar Airfield). Ebola virus is maintained in asymptomatic animal reservoirs, possibly fruit bats. Primates become infected via exposure to the bat or other reservoir, often with a fatal outcome. Transmission from infected primates to humans occurs very rarely, and likely requires extensive contact with blood or the consumption of infected primate meat. Once a human case occurs, the infection can be transmitted person to person, leading to limited outbreaks. Outbreaks remain limited because the virus can be transmitted only through direct contact with blood or body fluids of an infected person. Ebola hemorrhagic fever is a very severe illness, typically requiring isolation and supportive care. The fatality rate may be as high as 50-90%. Mitigating measures in place include strict barrier precautions for healthcare personnel or others in direct contact with blood or body fluids of sick or recently deceased patients.

6.7.2 Short-term health risks:

None identified based on available data.

6.7.3 Long-term health risks:

None identified based on available data.

7 Venomous Animals

All information was taken directly from the Armed Forces Pest Management Board (AFPMB) (Reference 8) and the Clinical Toxinology Resources website from the University of Adelaide, Australia (Reference 9). The species listed below have home ranges that overlap the location of Dakar Airfield, and may present a health risk if they are encountered by personnel. See Section 9 for more information about pesticides and pest control measures.

7.1 Spiders

- *Latrodectus renivulvatus*: Clinical effects are uncertain, but related to medically important species, therefore major envenoming cannot be excluded. Spider bites are mostly minor and even significant envenoming is unlikely to be lethal.

7.2 Scorpions

- *Androctonus amoreuxi* and *Androctonus dekeyseri*: Severe envenoming possible and potentially lethal. Local and systemic effects, cardiotoxicity and hypovolaemic hypotension possible in severe cases.
- *Babycurus kirki, Buthacus clevai, Buthacus villiersi, Butheoloides monodi:* There are a number of dangerous Buthid scorpions but also others known to cause minimal effects only. Without clinical data it is unclear where this species fits within that spectrum.
- *Buthus elhennawyi*: Severe envenoming possible and potentially lethal. Local and systemic effects, cardiotoxicity, and hypovolaemic hypotension possible in severe cases.
- *Hottentotta hottentotta*: Mild envenoming only, not likely to prove lethal. Stings by these scorpions are likely to cause only short lived local effects, such as pain, without systemic effects.
- *Isometrus maculatus:* Mild envenoming only, not likely to prove lethal. Stings by these scorpions are likely to cause only short lived local effects, such as pain, without systemic effects.
- *Pandinus gambiensis* and *Scorpio maurus*: Mild envenoming only, not likely to prove lethal. Stings by these scorpions are likely to cause only short lived local effects, such as pain, without systemic effects.

7.3 Snakes

- *Amblyodipsas unicolor*: Unlikely to cause significant envenoming, possible minor local pain, or swelling, systemic effects not likely.
- *Atractaspis aterrima* and *Atractaspis microlepidota*: Severe envenoming possible and potentially lethal. May cause local and systemic effects. *Atractaspis dahomeyensis and Atractaspis micropholis*: Moderate envenoming possible but unlikely to prove lethal. May cause local and systemic effects.
- *Bitis arietans* and *Bitis rhinoceros:* Severe envenoming possible and high lethality potential. Marked local effects, moderate to severe necrosis, may cause systemic

effects, and other common effects include coagulopathy plus haemorrhagins causing bleeding, cardiotoxicity, and shock is likely in severe cases.
- *Dendroaspis polylepis* and *Dendroaspis viridi:* Severe envenoming possible and high lethality potential. Bites can cause severe, even lethal systemic (paralytic) effects.
- *Dispholidus typus:* Severe envenoming possible and high lethality potential. Bites can cause severe, even lethal coagulopathy.
- *Echis leucogaster* and *Echis ocellatus:* Severe envenoming possible and high lethality potential. Bites can cause moderate to severe, potentially lethal envenoming.
- *Naja haje, Naja katiensis, Naja melanoleuca, Naja nigricollis,* and *Naja senegalensis:* Severe envenoming possible and potentially lethal. Bites are potentially severe and may cause local tissue damage and paralysis.

7.4 Short-term health risk

Low. If encountered, effects of venom vary with species from mild localized swelling to potentially lethal effects. See effects of venom above. Mitigation strategies included avoiding contact, proper wear of uniform (especially footwear), and timely medical treatment. Confidence in the health risk estimate is low (Reference 4, Table 3-6).

7.5 Long-term health risk

None identified.

8 Heat/Cold Stress

8.1 Heat

Dakar has a hot semi-arid climate with a short rainy season (i.e., July – October) and lengthy dry season. Temperatures are lowest along the coast and highest inland. In Dakar, the hot season (May – November) monthly mean temperatures range from 74°F to 85°F with an average temperature of 79°F. Work intensity and clothing/equipment worn pose greater health risk of heat stress/injury than environmental factors alone (Reference 10). Managing risk of hot weather operations included monitoring work/rest periods, proper hydration, and taking individual risk factors (e.g., acclimation, weight, and physical conditioning) into consideration. Risk of heat stress/injury was reduced with preventive measures

8.1.1 Short-term health risk:

Low to High, mitigated to Low. Risk of heat injury in unacclimatized or susceptible populations (older, previous history of heat injury, poor physical condition, underlying medical/health conditions), and those under operational constraints (equipment, PPE, vehicles) is High. The risk of heat injury was reduced to Low through preventive measures such as work/rest cycles, proper hydration and nutrition, and monitoring WBGT. Confidence in the health risk estimate is low (Reference 4, Table 3-6).

8.1.2 Long-term health risk:

Low. However, the risk may be greater for certain susceptible persons–those older (i.e., greater than 45 years), in lesser physical shape, or with underlying medical/health conditions. Long-term health implications from heat injuries are rare but may occur, especially from more

serious injuries such as heat stroke. It is possible that high heat in conjunction with various chemical exposures may increase long-term health risks, though specific scientific evidence is not conclusive. Confidence in these risk estimates is medium (Reference 4, Table 3-6).

8.2 Cold

8.2.1 Short-term health risks:

Although Dakar typically does not have a cold season since there is little change in temperature throughout the year, the temperatures during the cool season (December - April) ranges from 65°F to 79°F with an average temperature of 71°F. As with heat stress/injuries, cold stress/injuries are largely dependent on operational and individual factors instead of environmental factors alone (Reference 10).

None. There is no risk of cold injury. Confidence in the health risk estimate is medium.

8.2.2 Long-term health risk:

None. There is no risk of cold injury. Confidence in the health risk estimate is medium (Reference 4, Table 3-6).

9 Noise

9.1 Continuous

No specific hazard sources were documented in the DOEHRS or MESL from 01 September 2014 through 31 December 2015.

9.1.1 Short-term health risks:

Not evaluated.

9.1.2 Long-term health risks:

Not evaluated.

9.2 Impulse

No specific hazard sources were documented in the DOEHRS or MESL from 01 September 2014 through 31 December 2015 timeframe.

9.2.1 Short-term health risks:

Not evaluated.

9.2.2 Long-term health risks:

Not evaluated.

10 Unique Incidents/Concerns

10.1 Potential environmental contamination sources

DOD personnel are exposed to various chemical, physical, ergonomic, and biological hazards in the course of performing their mission. These types of hazards depend on the mission of the unit and the operations and tasks, which the personnel are required to perform to complete their mission. The health risk associated with these hazards depends on a number of elements including what materials are used, how long the exposure last, what is done to the material, the environment where the task or operation is performed, and what controls are used. The hazards can include exposures to heavy metal particulates (e.g., lead, cadmium, manganese, chromium, and iron oxide), solvents, fuels, oils, and gases (e.g., carbon monoxide, carbon dioxide, oxides of nitrogen, and oxides of sulfur). Most of these exposures occur when performing maintenance task such as painting, grinding, welding, engine repair, or movement through contaminated areas. Exposures to these occupational hazards can occur through inhalation (air), skin contact, or ingestion; however, exposures through air are generally associated with the highest health risk.

10.2 Waste Sites/Waste Disposal

No specific hazard sources were documented in the DOEHRS or MESL from 01 September 2014 through 31 December 2015.

10.3 Fuel/petroleum products/industrial chemical spills

No specific hazard sources were documented in the DOEHRS or MESL from 01 September 2014 through 31 December 2015.

10.4 Pesticides/Pest Control:

The health risk of exposure to pesticide residues is considered within the framework of typical residential exposure scenarios, based on the types of equipment, techniques, and pesticide products that have been employed, such as enclosed bait stations for rodenticides, various handheld equipment for spot treatments of insecticides and herbicides, and a number of ready-to-use (RTU) methods such as aerosol cans and baits. The control of rodents required the majority of pest management inputs, with the acutely toxic rodenticides staged as solid formulation lethal baits placed in tamper-resistant bait stations indoors and outdoors throughout cantonment areas. Nuisance insects, including biting and stinging insects such as bees, wasps, and ants, also required significant pest management inputs. Use of pesticides targeting against these pests generally involved selection of compounds with low mammalian toxicity and short-term residual using pinpoint rather than broadcast application techniques. No specific hazard sources were documented in the DOEHRS or MESL from 01 September 2014 through 31 December 2015.

10.5 Asbestos

No specific hazard sources were documented in the DOEHRS or MESL from 01 September 2014 through 31 December 2015.

10.6 Lead-Based Paint

No specific hazard sources were documented in the DOEHRS or MESL from 01 September 2014 through 31 December 2015.

10.7 Burn Pit

While not specific to Dakar Airfield, the consolidated epidemiological and environmental sampling and studies on burn pits that have been conducted as of the date of this publication have been unable to determine whether an association does or does not exist between exposures to emissions from the burn pits and long-term health effects (Reference 11). The Institute of Medicine committee's (Reference 11) review of long-term health consequences of exposure to burn pits in Iraq and Afghanistan suggests that service in Iraq or Afghanistan (i.e., a broader consideration of air pollution than exposure only to burn pit emissions) may be associated with long-term health effects, particularly in susceptible (e.g., those who have asthma) or highly exposed subpopulations, such as those who worked at or near the burn pit. Such health effects would be due mainly to high ambient concentrations of PM from both natural and anthropogenic sources, including military sources. If that broader exposure to air pollution turns out to be relevant, potentially related health effects of concern are respiratory and cardiovascular effects and cancer. Susceptibility to the PM health effects could be exacerbated by other exposures, such as stress, smoking, local climatic conditions, and co-exposures to other chemicals that affect the same biologic or chemical processes. Individually, the chemicals measured at burn pit sites in the study were generally below concentrations of health concern for general populations in the United States. However, the possibility of exposure to mixtures of the chemicals raises the potential for health outcomes associated with cumulative exposure to combinations of the constituents of burn pit emissions and emissions from other sources.

There are no known burn pits located at Dakar Airfield.

10.7.1 Short-term and Long-term health risks:

None.

11. References

1. Department of Defense. 2006. Department of Defense Instruction (DoDI) 6490.03, *Deployment Health*. Defense Occupational and Environmental Health Readiness System (referred to as the DOEHRS-EH database) at https://doehrs-ih.csd.disa.mil/Doehrs/.

2. Department of Defense. 2008. DoDI 6055.05, *Occupational and Environmental Health.*

3. Joint Chiefs of Staff. 2012. Joint Staff Memorandum (MCM) 0017-12, *Procedures for Deployment Health Surveillance*.

4. U.S. Army Public Health Command. June 2013 Revision. Technical Guide 230, *Environmental Health Risk Assessment and Chemical Exposure Guidelines for Deployed Military Personnel*.

5. U.S. Environmental Protection Agency (EPA). 2014. ProUCL 5.0.00 - *Statistical Software for Environmental Applicatins for Datasets with and without Nondetect Observations,* Office of Research and Development. Prepared by: Singh, A. and Singh, A.K., Washington, D.C.

6. Department of Defense. DoD MESL Data Portal, https://aphc-mesl.amedd.army.mil/mesl/. Some of the data and reports used may be classified or otherwise have some restricted distribution.

7. AFRICOM Automated Message Handling System (AMHS) General Administration (GENADMIN) message, 112243ZSep14, Force Health Protection Requirements and Medical Guidance for Entry into the U.S. Africa Command Theater, Version 1.

8. Armed Forces Pest Management Board. https://www.acq.osd.mil/eie/afpmb/docs/lhd/venomous_animals_bycountry.pdf. U.S. Army Garrison - Forest Glen, Silver Spring, MD (Accessed July 2017).

9. University of Adelaide, Australia. Clinical Toxinology Resources. http://www.toxinology.com/ (Accessed July 2017).

10. Goldman RF. Ch1. Introduction to heat related problems in military operations. *In: Textbook of Military Medicine: Medical Aspects of Harsh Environments* (Vol. 1), Pandolf KB, and Burr RE (eds), Office of the Surgeon General, Department of the Army, Washington DC. 2001. (Accessed July 2017).

11. Institute of Medicine. 2011. Long-term health consequences of exposure to burn pits in Iraq and Afghanistan. Washington, DC: *The National Academies Press*.

12 Where Do I Get More Information?

If a provider feels that the Service member's or Veteran's current medical condition may be attributed to specific OEH exposures at this deployment location, he/she can contact the Service-specific organization below. Organizations external to DOD should contact Deputy Assistant Secretary of Defense for Health Readiness Policy and Oversight (HRP&O).
Army Public Health Center Phone: (800) 222-9698. http://phc.amedd.army.mil/
Navy and Marine Corps Public Health Center (NMCPHC) (formerly NEHC) Phone: (757) 953-0700. http://www.med.navy.mil/sites/nmcphc/Pages/Home.aspx
U.S. Air Force School of Aerospace Medicine (USAFSAM) (formerly AFIOH) Phone: (888) 232-3764. http://www.wpafb.af.mil/afrl/711hpw/usafsam.asp
DOD Health Readiness Policy and Oversight (HRP&O) Phone: (800) 497-6261. http://fhpr.dhhq.health.mil/home.aspx