Military Deployment
Periodic Occupational and Environmental Monitoring Summary (POEMS): Thumrait Air Base (TRAB), Oman, Calendar Years: 2010 to 2015

AUTHORITY: This Periodic Occupational and Environmental Monitoring Summary (POEMS) has been developed in accordance with Department of Defense (DoD) Instructions 6490.03, 6055.05, and JCSM (MCM) 0028-07, *See REFERENCES.*

PURPOSE: This POEMS documents the Department of Defense (DoD) assessment of Occupational and Environmental Health (OEH) risk for TRAB in the immediate vicinity where US Personnel lived or worked. It presents a qualitative estimate of population-based health risks identified at this location and their potential medical implications. The report is based on information collected from 2010 through 2015 to include deployment OEH 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 TRAB 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 calendar years 2010-2015.

The POEMS can be useful to inform healthcare providers and others of environmental conditions experienced by individuals deployed to TRAB 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 documentation in their medical record on a Standard Form (SF) 600 (Chronological Record of Medical Care).

Health protective exposure assumptions are used in the assessment of all health risks, i.e. the resident population is assumed to be constantly exposed to environmental conditions. Small groups of personnel assigned to nearby sites addressed in this summary may be at greater risk than the general population due to operational requirements; these groups are identified when appropriate.

SUMMARY: Conditions with an estimated health risk of moderate or greater are summarized in Table 1. Table 2 provides population based risk estimates for identified OEH conditions at TRAB. 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.

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

Short-term health risks & medical implications:

The following may have caused acute health effects in some personnel during deployment at TRAB:

Food/waterborne diseases (e.g., bacterial diarrhea, hepatitis A, typhoid/paratyphoid fever, brucellosis, diarrhea-protozoal, hepatitis E); other endemic diseases (cutaneous/visceral leishmaniasis, Crimean-Congo hemorrhagic fever, sandfly fever, typhus-fleaborn, dengue fever, west nile fever, tick-borne rickettsioses, sindbis, leptospirosis, schistosomiasis, Tuberculosis (TB), meningoccal meningitis, rabies, Q fever); venomous animals/insects; and heat stress. For food/waterborne diseases (e.g., bacterial diarrhea, hepatitis A, typhoid fever, brucellosis, diarrhea-protozoal, hepatitis E), if ingesting local food and water, the health effects can temporarily incapacitate personnel (diarrhea) or result in prolonged illness (hepatitis A, typhoid 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 CENTCOM policy. For other vector-borne endemic diseases (cutaneous leishmaniasis, Crimean-Congo hemorrhagic fever, sandfly fever, typhus-fleaborn,dengue fever, west nile fever, tick-borne rickettsioses, sindbis), 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 and bed net, and appropriate chemoprophylaxis. For water contact diseases (leptospirosis, schistosomiasis) activities involving extensive contact with surface water increase risk. For respiratory diseases (tuberculosis, 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 venomous animals and insects, if encountered, effects of venom varied with species from mild localized swelling to potentially lethal effects; risks reduced by avoiding contact and proper and timely treatment. 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. Risks from heat stress may have been reduced with preventive medicine controls, work-rest cycles, and mitigation. Air quality: Exposures 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. For certain subgroups of the deployed forces (e.g., those with pre-existing asthma/cardiopulmonary conditions) are at greatest risk of developing notable health effects. Although most effects from exposure to particulate matter 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 during their time at TRAB. Personnel who reported with symptoms or required treatment while at this site should have exposure/treatment noted in medical record (e.g., electronic medical record and/or on a Standard Form (SF) 600 (Chronological Record of Medical Care).

Long-term health risks & medical implications:

Inhalation of dust: Fine particulate matter less than 2.5 micrometers in diameter (PM2.5) are routinely present in the air on TRAB at higher concentrations than would typically be experienced in the United States. The long-term risk related to exposure to PM 2.5 was **moderate**. Individuals who routinely worked outdoors and inhaled PM2.5 at levels present at TRAB may have developed health conditions such as chronic bronchitis, reduced lung function and asthma. Individuals with a history of asthma or pre-existing cardiopulmonary disease are likely at greatest risk. At this time, there are no specific recommended post-deployment medical surveillance evaluations for individuals with particulate exposures. Providers should consider individual health status (e.g., any underlying conditions/susceptibilities) and unique individual OEH exposures (such as welding fumes) when addressing individual concerns. Although short-term effects from exposure to dust should have resolved post-deployment, providers should consider the relationship between potential deployment exposures and current complaints.

Table 2: Population-Based Health Risk Estimates – TRAB, Oman[1, 2]

Source of Identified Health Risk[3]	Unmitigated Health Risk Estimate[4]	Control Measures Implemented[5]	Residual Health Risk Estimate[4]
Air			
Particulate matter less than 10 microns in diameter (PM_{10}) (see paragraph 2.3)	Short-term: **Not evaluated**;	Personnel live and work in air conditioned buildings. Paved roads limit dust.	**Not evaluated**; insufficient data exist upon which to base a health risk assessment.
	Long-term: **Health guidelines not defined**		Long-term: **Health guidelines not defined**
Particulate matter less than 2.5 microns in diameter ($PM_{2.5}$)	Short-term: - *the health risk associated with typical $PM_{2.5}$ exposures was* **Low.**	Personnel live and work in air conditioned buildings.	Short-term: Low

Table 2: Population-Based Health Risk Estimates – TRAB, Oman[1, 2]

Source of Identified Health Risk[3]	Unmitigated Health Risk Estimate[4]	Control Measures Implemented[5]	Residual Health Risk Estimate[4]
(see paragraph 2.4)	The majority of the time no acute health effects such as eye, nose, or throat irritation from exposure was anticipated to have occurred. Mild acute (short-term) health effects were possible for those individuals who spent much of their time outdoors. Existing medical conditions (e.g., asthma or respiratory diseases) may be exacerbated.	Paved roads limit dust.	
	Long-term: the health risk associated with typical $PM_{2.5}$ exposures was Moderate At the **moderate** risk level, a small percentage of individuals may have been at increased risk of developing chronic health conditions. These conditions include reduced lung function, chronic bronchitis, chronic obstructive pulmonary disease (COPD), asthma, and other cardiopulmonary diseases. Those with a history of asthma or pre-existing cardiopulmonary disease have a higher risk for developing these chronic conditions.		Long-term: Moderate
Airborne Metals (see paragraph 2.5)	Short-Term: Low Long-term: Low		Short-Term: Low Long-term: Low
Volatile Organic Compounds (VOC) (see paragraph 2.6)	Short-term: Not evaluated		Short-term: Not evaluated.
	Long-term: Not evaluated		Long-term: Not evaluated.
Soil			
Soil (see paragraph 3)	Short-term: **None evaluated**. Currently soil sampling data is not evaluated for short term (acute) health risks**.** Long-term: **None identified**.		Short-Term: None **evaluated** Long-term: None

Table 2: Population-Based Health Risk Estimates – TRAB, Oman[1, 2]

Source of Identified Health Risk[3]	Unmitigated Health Risk Estimate[4]	Control Measures Implemented[5]	Residual Health Risk Estimate[4]
Water			
Consumed Water (Water Used for Drinking) (see paragraph 4.2)	Short-term: Low U.S. Public Health Command approved bottled water and packaged water from the Expeditionary Water Packaging System was provided for drinking. No analytes were detected above the 14 day 15L/day negligible drinking water military exposure guidelines.	U.S. Public Health Command approved bottled water and Preventive Medicine/ Army Veterinary approved packaged water were supplied and consumed except for a brief period during the onset of the war. Active and ongoing drinking water surveillance program.	Short-term: Low
	Long-term: Low. U.S. Public Health Command approved bottled water and packaged water from the Expeditionary Water Packaging System were provided for drinking. No analyte was detected above the 14 day 15L/day negligible drinking water military exposure guidelines.		Long-term: Low
Water used for other purposes (non-drinking) (see paragraph 4.3)	Short-term health risk: Low based on data	Water surveillance programs which routinely monitor for disinfectant residual and bacteriological contamination.	Short-term: Low
	Long-term health risk : Low based on data		Long-term: Low
Military Unique			
Chemical Biological, Radiological Nuclear (CBRN) Weapons (see paragraph 5.1)	Short-term: None identified	Not Applicable	Short-term: None identified
	Long-term: None identified	Not Applicable	Long-term: None identified
Depleted Uranium (DU) (see paragraph 5.2)	Short-term: None identified	Not Applicable	Short-term: None identified
	Long-term: None identified	Not Applicable	Long-term: None identified
Ionizing Radiation (see paragraph 5.3)	Short-term: Low	ALARA	Short-term: Low
	Long-term: Low	ALARA	Long-term: Low
Non-ionizing Radiation (see paragraph 5.4)	Short-term: None identified	Personnel follow SOPs and hazard warnings.	Short-term: None identified
	Long-term: None identified	Personnel follow SOPs and hazard warnings.	Long-term: None identified
Endemic Disease			
Gastrointestinal Foodborne/Waterborne (e.g., diarrhea-bacteriological) (see paragraph 6.2)	Short-term: Variable: High (Bacterial Diarrhea, Hepatitis A, Typhoid/Paratyphoid fever) to Moderate (Diarrhea -Protozoal, Brucellosis and Hepatitis E). If ingesting local food/water, the health effects could have been temporarily incapacitating to personnel (Diarrhea) or resulted in prolonged illness (Hepatitis A, Typhoid Fever, Brucellosis, Hepatitis E).	Preventive measures included Hepatitis A and Typhoid fever vaccination, consumption of food and water used only from approved sources and routinely monitored. (MOD 12).	Based on efficacy of control measure as evidenced by lack of disease(s) reported in various medical surveillance data bases e.g, TMDS, MERS, DRSi. Short-term: Low Based on disease incident reporting from TRAB, bacterial and protozoal gastrointestinal diseases, cholera, brucellosis, and hepatitis E infections present a low risk.

Table 2: Population-Based Health Risk Estimates – TRAB, Oman[1, 2]

Source of Identified Health Risk[3]	Unmitigated Health Risk Estimate[4]	Control Measures Implemented[5]	Residual Health Risk Estimate[4]
	Long-term: Low		Long-term: Low
Arthropod Vector Borne (see paragraph 6.3)	Short-term: Moderate (Leishmaniasis-Cutaneous/Visceral, Crimean-Congo Hemorrhagic fever), Low (Sandfly Fever, Typhus-Fleaborn, Dengue Fever, West Nile Fever, Tick-borne Rickettsioses, Sindbis).	Preventive measures included proper wear of the treated uniform and application of repellent to exposed skin and appropriate chemoprophylaxis.	Based on efficacy of control measure as evidenced by lack of disease(s) reported in various medical surveillance data bases e.g, TMDS, MERS, DRSi. Short-term: Low for malaria and cutaneous leishmaniasis and all other vector-borne diseases based on disease incident reporting from TRAB.
	Long-term: Low. It is possible to be infected during deployment with leishmaniasis, but not to have clinically evident disease until redeployed.		Long-term: Low based on disease incident reporting from TRAB.
Water-Contact (e.g. wading, swimming) (see paragraph 6.4)	Short-term: Moderate (Leptospirosis, Schistosomiasis)	Avoidance of fresh water sources, such as puddles/ standing water, drainage areas, etc. Treatment (primarily chlorination) process for non-drinking water (water used for bathing, cooking, etc.).	Based on efficacy of control measure as evidenced by lack of disease(s) reported in various medical surveillance data bases e.g, TMDS, MERS, DRSi. Short-term: Low based on disease incident reporting from TRAB.
	Long-term: Low based on disease incident reporting from TRAB.		Long-term: Low based on disease incident reporting from TRAB.
Respiratory (see paragraph 6.5)	Short-term: Low for Tuberculosis, TB. The high rate of personnel turnover, shared dining, berthing, recreational facilities, and working spaces may allow for the easy transmission of upper respiratory infections, including influenza.	Influenza immunizations are given either before or during deployment. Local and third country national workers/contractors are required to complete health screening prior to employment. Potential tuberculosis exposure is addressed in the Post Deployment Health Assessment.	Based on efficacy of control measure as evidenced by lack of disease(s) reported in various medical surveillance data bases e.g, TMDS, MERS, DRSi. Short-term: Low for upper respiratory infections and tuberculosis.
	Long-term: Low. The majority of respiratory diseases do not cause prolonged illness.		Long-term: Low based on disease incident reporting from TRAB.
Animal Contact (see paragraph 6.6	Short-term: Low for rabies based on disease incident reporting	Standard preventive medicine measures, as well as	Based on efficacy of control measure as evidenced by

Table 2: Population-Based Health Risk Estimates – TRAB, Oman[1, 2]

Source of Identified Health Risk[3]	Unmitigated Health Risk Estimate[4]	Control Measures Implemented[5]	Residual Health Risk Estimate[4]
	from TRAB.	COCOM policy, generally prohibit contact with, adoption, or feeding of feral animals. Immunizations for anthrax and rabies (rabies vaccination and/or immune globulin given if clinically directed).	lack of disease(s) reported in various medical surveillance data bases e.g, TMDS, MERS, DRSi. Short-term: Low based on disease incident reporting from TRAB.
	Long-term: Low based on disease incident reporting from TRAB.		Long-term**:** Low based on disease incident reporting from TRAB.
Venomous Animal/ Insects			
Snakes, scorpions, and spiders (see paragraph 7)	Short-term: Low to High. If encountered, effects of venom vary with species from mild localized swelling (e.g *Scorpiops lindbergi*)) to potentially lethal (e.g. saw-scaled viper or *Gloydius halys*) based on disease incident reporting from TRAB.	Standard Preventive Medicine measures, such as the reduction of harborages for these animals, as well as education on how to avoid them (shake out boots before donning, etc.), reduce the risk of exposure and timely treatment.	Based on efficacy of control measure as evidenced by lack of disease(s) reported in various medical surveillance data bases e.g, TMDS, MERS, DRSi. Short-term: Low based on disease incident reporting from TRAB.
	Long-term: No long-term health risk identified		Long-term: **No long-term health risk identified**
Heat/Cold Stress			
Heat (see paragraph 8.2)	Short-term: Appropriately Moderate as per measured seasonal data risk of heat injury in summer months (April - October) for acclimatized personnel.	Adequate periods of acclimatization for newly reporting or returning personnel. Adjustment of work-rest cycles based on monitoring of climatic conditions, hydration recommendations and awareness training.	Based on efficacy of control measure and incidence of heat/cold injury(ies) reported in various medical surveillance data bases e.g, TMDS, MERS, DRSi. Short-term: Moderate
	Long-term**:** Generally Low		Long-term: Generally Low
Cold (see paragraph 8.3)	Short-term: Appropriately Low as per measured seasonal data. The risk for cold stress/injuries is largely dependent on clothing/equipment worn, operational work intensity and individual factors rather than environmental factors alone.	Risks from cold stress are reduced with protective measures such as proper wear of protective clothing.	Short-term**:** Low
	Long-term: Generally Low		Long-term: Generally Low
Noise			
Noise (Continuous) (Flightline, Power Production) (see paragraph 9.1)	Short-term: Low	Use of hearing protection. Labeling noise hazardous areas. Leadership enforcement of compliance with available PPE.	Based on efficacy of control measure typically practiced. Short-Term: Low based on available data
	Long-term: Low based on available data		Long-Term: Low based on available data
Impulse	Short-term: Insufficient data exist		Short-term: Insufficient data

Table 2: Population-Based Health Risk Estimates – TRAB, Oman[1, 2]

Source of Identified Health Risk[3]	Unmitigated Health Risk Estimate[4]	Control Measures Implemented[5]	Residual Health Risk Estimate[4]
(see paragraph 9.2)	upon which to base a health risk assessment		exist upon which to base a health risk assessment
	Long-term: Insufficient data exist upon which to base a health risk assessment		Long-term: Insufficient data exist upon which to base a health risk assessment
Unique Concerns			
Any incident of fire or spill that may have happened (see paragraph 10.1)	None	None	Short and Long Term: No data available
Waste Sites/Waste Disposal (see paragraph 10.2)	Short-term: Low	Waste disposal are performed by contractors.	Short-term: Low
	Long-term: Low		Long-term: Low
Fuel/petroleum products/ industrial chemical spills (see paragraph 10.2)	Short-term: Low	2012 spill: Aircraft maintenance personnel performed clean-up. PPE: Nitrile gloves.	Short-term: Low
	Long-term: Low		Long-term: Low
Pesticides/Pest Control (see paragraph 10.3)	Pest management has not sprayed any pesticides since last rotation.	See Section 10.4	Short-term: No data available
	Long-term: No data available		Long-term: No data available
Asbestos (see paragraph 10.4)	Not evaluated: no/insufficient data exist upon which to base a risk assessment	No control measures implemented.	Short-term: No data available
	Long-term: No data available		Long-term: No data available
Lead Based Paint (see paragraph 10.4)	Not evaluated: no/insufficient data exist upon which to base a risk assessment	No control measures implemented.	Short-term: No data available
	Long-term: No data available		Long-term: No data available
Burn Pits (see paragraph 10.5)	None identified NA	No burn pits at TRAB	Short-term: No data available
	Long-term: No data available		Long-term: No data available

POEMS

Table 2: Population-Based Health Risk Estimates – TRAB, Oman

[1] This Summary Table provides a qualitative estimate of population-based short-and long-term health risks associated with the occupational and environment conditions at TRAB and other locations frequented by U.S. military personnel in the immediate vicinity of TRAB, Oman. It does not represent an individual exposure profile. Actual individual exposures and health effects depend on many variables. For example, while a chemical may be present in the environment, if a person does not inhale, ingest, or contact a specific dose of the chemical for adequate duration and frequency, then there may be no health risk. Alternatively, a person at a specific location may experience a unique exposure, such as at the burn pit, which could result in a significant individual exposure. Any such person seeking medical care should have their specific conditions of exposure documented on Form SF600.

[2] This assessment is based on specific environmental sampling data and reports obtained from 2010 through 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

POEMS
Table 2: Population-Based Health Risk Estimates – TRAB, Oman

incidents.

[3] This Summary Table is organized by major categories of identified sources of health risk. It only lists those sub-categories specifically identified and addressed at TRAB. The health risks are presented as Low, Moderate, High or Extremely High for both acute and chronic health effects. The risk level is based on an assessment of both the potential severity of the health effects that could be caused and probability that exposure would occur at a level to produce such health effects. Details can be obtained from the AF Public Health Center. More detailed descriptions of OEH exposures that were evaluated are discussed in the following sections of this report.

[4] Risks in this Summary Table are based on quantitative surveillance thresholds (e.g. review of disease surveillance data) or screening levels (e.g. Military Exposure Guidelines (MEGs) for chemicals). Some previous assessment reports may provide slightly inconsistent 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 few samples.

[5] 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 in place. 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.

SITE DESCRIPTION:

TRAB is located in central Oman, approximately 71 kilometers (km) north of Salalah (nearest coastal city). The American encampment is inside the Royal AF of Oman (RAFO) base. In addition, the RAFO base includes Dyncorp Inc, which has a war readiness material (WRM) maintenance mission. The airfield has one runway and is used for Air Force C-17 and KC-10 aircrafts and RAFO F-16 fighters. TRAB has approximately 500 US military and civilian personnel. There are approximately 237 structures on TRAB including tent city, administrative town, Ops Town, and Maintenance. The adjacent property is primarily desert and used for agriculture.

Local Climate:

.

1 Discussion of Health Risks at TRAB, Oman 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 US Army Public Health Command Technical Guide 230, *Environmental Health Risk Assessment and Chemical Exposure Guidelines for Deployed Military Personnel* (USAPHC TG 230). All OEH risk estimates represent residual risk after accounting for controls measures 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 Area-Specific Sources Identified

Most of the buildings on base are trailers or tents. Living areas are all relocatable buildings (RLB) with tents for transitory personnel. Concrete sidewalks and walkways in the RLB living area were added in 2015. Work areas are mostly trailers with a few KSPANS. There are also few shops located in permanent (concrete) buildings. They are part of the base but are located outside the TRAB fence. These shops are in the RAFO (Ops) side of the base.

a. TRAB is situated in a dusty semi-arid desert environment. Inhalational exposure to high levels of dust and particulate matter, such as during high winds or dust storms may have resulted 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) were at greatest risk of developing notable health effects.

b. There are no off site industrial sources present in the immediate vicinity of the TRAB. However, A central power generation plant was constructed which reduced the use of tactical generators; however, exhaust products associated with diesel fuel for electric power generation persist.

C. No open air burning was conducted at TRAB

2.2 Particulate Matter

Particulate matter (PM) is a complex mixture of extremely small particles suspended in the air. PM includes solid particles and liquid droplets emitted directly into the air by sources such as: power plants, motor vehicles, aircraft, tactical generators, construction activities, fires, and natural windblown dust. PM can include sand, soil, metals, volatile organic compounds, allergens, and other compounds such as nitrates or sulfates that are formed by condensation or transformation of combustion exhaust. PM composition and particle size vary considerably depending on the source. Generally particulate matter of health concern is divided into two fractions: PM_{10}, which includes coarse particles with a diameter of 10 micrometers or less (0.0004 inches or one-seventh the width of a human hair), and fine particles less than 2.5 micron ($PM_{2.5}$), 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 Particulate Matter, less than 10 microns (PM_{10})

2.3.1 Exposure Guidelines: PM_{10} Air sampling was not conducted in TRAB.

2.3.2 Sample data:

Short-term (24-hour) PM_{10} (mg/m^3):	Long-term PM_{10} MEG (mg/m^3):
Negligible MEG=0.250	Not defined.
Marginal MEG=0.420	
Critical MEG=0.600	

There were no PM10 samples collected at TRAB from 2000-2015.

2.4 Particulate Matter, less than 2.5 microns ($PM_{2.5}$)

2.4.1 Exposure Guidelines:

Short-term (24-hour) $PM_{2.5}$ MEGs (mg/m3):	Long-term (1year) $PM_{2.5}$ MEGs (mg/m3):
Negligible MEG=0.065	Negligible MEG=0.015
Marginal MEG=0.250	Marginal MEG=0.065.
Critical MEG=0.500	

2.4.2 Sample data:

From April – Sep 2014, 15 valid ambient air $PM_{2.5}$ samples were collected at TRAB for $PM_{2.5.}$

Risk Summary: Low

Based on average (0.033 mg/m^3) and peak (0.066 mg/m^3) of $PM_{2.5}$ air sample concentrations, as compared with the short-term negligible MEG (0.065 mg/m^3.) The short-term health risk assessment for $PM_{2.5}$ sample concentrations and the likelihood of exposure at these health risk hazard is Low.

Medical implications:
At the low risk level, a small percentage of individuals may experience short-term health effects such as eye, nose, throat and lung irritation, coughing, sneezing, runny nose and shortness of breath. Some individuals might seek outpatient medical care although most individuals would have experienced only mild effects which would have typically resolve when exposure ceased. A small number of individuals may experience more pronounced effects such as decreased lung function and worsening of pre-existing medical conditions such as asthma.

Confidence in the risk assessment: Confidence in the risk assessment is Low based on the limited $PM_{2.5}$ air sampling data available and inconsistency of sampling.

2.4.4 Long-term (chronic) health risk for $PM_{2.5}$:

Approach: For chronic health risk, it was assumed that the longest deployment lasted twelve to fifteen months. To assess chronic risk associated with $PM_{2.5}$, the overall yearly average concentration of $PM_{2.5}$ was used to arrive at a long term health risk for 2010 through 2015. The average $PM_{2.5}$ concentration during this period was 0.033 mg/m^3, with a range from 0.012 mg/m^3 to 0.066 mg/m^3.

Risk Summary: Moderate

Based on average (0.033 mg/m^3) and peak (0.066 mg/m^3) of $PM_{2.5}$ air sample concentrations, as compared with the long-term 1year marginal MEG (0.065mg/m^3) and 1year negligible MEG (0.015 mg/m^3.) The long-term health risk assessment for $PM_{2.5}$ sample concentrations and the likelihood of exposure at these health risk hazard is Moderate.

Medical implications: At the low to moderate risk level, a small percentage of individuals may have been at increased risk of developing chronic health conditions. These conditions include reduced lung function, chronic bronchitis, chronic obstructive pulmonary disease, asthma and certain cardiopulmonary diseases. Those with a history of asthma or pre-existing cardiopulmonary disease have a higher risk for exacerbating these chronic conditions. However, as the majority of the population at TRAB and the adjacent camps did not work outdoors for more than eight to twelve hours/day the risk for these chronic conditions is likely overstated.

Confidence in the risk assessment: Confidence in the risk assessment is Low based on the limited $PM_{2.5}$ air sampling data available and inconsistency of sampling.

2.5 Airborne Metals

2.5.1 Sample data/Notes: From 2010-2015, metals analysis was performed on 15 ambient air particulate matter samples collected at TRAB. No metals were detected above their corresponding military exposure guidelines.

2.5.2 Short-term (acute) health risk: Low based on available sampling data.

2.5.3 Long-term (chronic) Health risk: Low based on available sampling data.

Confidence in the risk assessment: Confidence in this risk assessment is Low based on available sampling data.

Return to Table 2

2.6 Volatile Organic Compounds (VOC)

2.6.1 There were no VOC samples collected at TRAB from 2010-2015.

Confidence in risk estimate: Confidence in the risk assessment is Low based on available sampling data.

Return to Table 2

3 Soil

3.1 Site-Specific Sources Identified

3.1.2 Sample data*:*

In 2014, total of 3 surface soil samples were collected at TRAB. Laboratory analysis of all soil samples included semi-volatile organic compounds (SVOCs), heavy metals, polychlorinated biphenyls (PCB), pesticides, herbicides and radionuclides. The primary exposure pathways associated with soil are dermal contact and incidental ingestion. Individuals involved in construction, maintenance and post fire clean-up activities were at greatest potential for exposure to soil. These individuals comprise a relatively small proportion of the overall camp population.

According to field data sheets, all samples were collected from areas and/or activities where there was high potential for soil exposure such as in maintenance areas, physical training (PT) areas, during excavation, while filling sand bags and/or during construction activities. Laboratory analysis of soil samples included volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), heavy metals, polychlorinated biphenyls (PCB), pesticides, fungicides, herbicides, insecticides, and radionuclides. The primary exposure pathways associated with soil are dermal contact and incidental ingestion.

Individuals involved in construction and maintenance activities were at greatest potential for exposure to soil. These individuals comprise a relatively small proportion of the overall camp population.

Approach:

The sampling data for soil was not evaluated for short-term (acute) health risks**.**

For long-term health risk, sample results were compared with each of the corresponding long-term MEGs published in the USAPHC TG 230 screening purposes. Compounds detected without a single exceedance of the 1-year MEG were excluded from further consideration. Long-term risk estimates were based on the probability of exposure to the concentrations detected.

3.1.3 Short-term (acute) health risk for soil:

Risk Summary: None evaluated as no health guidelines associated with short-term exposures to soil have been established.

Medical Implications: None known**.**

Confidence in the Risk Assessment: **Not applicable**, soil is not evaluated for short-term health risks**.**

3.1.4 Long-term (chronic) health risk for soil:

Long-Term: Low based on data

Risk Summary: Low – based on lab data. There are no analytes that exceed guidelines.

Medical Implications: None

Confidence in risk estimate:
Confidence in the risk assessment is Low based on 3 samples collected across regional soils.

Despite the bulk of the samples being collected in areas with great potential for residual contamination from waste disposal and a large structural fire none of the soil constituents approached the MEG. Confidence in the risk assessment is Low

Return to Table 2

4 Water

4.1 Site-Specific Sources Identified

In order to assess the health risk to US personnel from exposure to water in theater, the APHC identified the most probable exposure pathways. These were based on the administrative information provided on the field data sheets submitted with the samples taken over the time period being evaluated. Bottled water is the primary source of drinking water for all deployed personnel at TRAB. Water is piped from the Royal Air Force of Oman (RAFO) water treatment plant (WTP) to the water storage tanks located inside the cantonment area. Another water source is from the Thumrait Municipal Utility Company where water is transported by truck to holding tanks supplying water to hardened showers and latrines. These facilities are located outside the cantonment area and by the flightline.

Historically, commercial bottled water was provided for drinking at all U.S. military sites in Oman. The primary approved bottled water source is el Jabal el Akhdar and the alternate is Tanuf bottled water.

There are eight water wells in the boundaries of Thumrait AB. 6/8 of the wells are operational at any given time. The distribution system is PVC piping and is mostly distributed to all points via the existing distribution system. Water is stored in 15 metal 10k gallon tanks. The Fire Department utilizes Ops Town fire hydrants to fill up their fire trucks. Latrine facilities in Ops Town that are not in permanent buildings are serviced (tanks filled/emptied) by contract water trucks. CE has the ability to also transport water in their truck, currently they are only filling the water buffalo used for the wash rack.

RAFO contractors operate the WTP, water treatment includes: coagulation, flocculation, sedimentation, multimedia membrane, and disinfection.

4.2 Consumed Water (Water for drinking or cooking consumption)

4.2.1 Sample data/notes:

The municipal water is used for food preparation at the dining facility (DFAC). The DFAC, Green Bean coffee shop (including ice machine) and CLAM ice machine are checked weekly for bacteria. The DFAC water is checked for Bacti, pH and FAC weekly. Monthly water sampling includes all tanks serviced by water trucks for bacteria, pH, and FAC.

All long-term potability (LTP) water samples collected at TRAB were below the regulated level. Sampling is conducted annually per local sampling plan. The water system was approved for personal hygiene during the January-May 2015 rotation.

4.2.2 Short-term (acute) health risk for drinking bottled water:

Approach: In order to determine acute health risk associated with consumption of bottled water the following assumptions were made.

- Camp residents ingest 15 liters of bottled water per day or less.
- All U.S. personnel at this location were expected to remain at this site for approximately 6 months.

Based on these assumptions, the maximum detected concentration for each analyte was compared to its respective 14-day, Negligible MEG for consumption of up to 15 liters of water per day (15L/day) and/or the short-term Field water standards published in TB MED 577, Sanitary Control and Surveillance of Field Water Supplies.

Risk Summary: Based on the above approach, the short-term risk associated with consumption of bottled water at TRAB is Low.

Medical implications:
No medical implications are expected from consuming water at the concentration detected at TRAB.

Confidence in the risk assessment: Despite the number of bottled water samples, confidence in the risk assessment is high because US Public Health Command personnel performed quarterly audits of all bottled water suppliers to ensure consistency of quality throughout of the AOR.

4.2.3 Long-term (chronic) health risk:

Approach: Bottled water was supplied to TRAB in distinct lots and from a single vendor. Thus it is inappropriate to average analytical results across the spectrum of water samples/suppliers. The maximum detected concentration for each analyte was used to perform the long-term health risk screening. This process could result in overestimation of the long-term health risk as it assumes that camp residents consume water at the maximum detected concentration consistently during their deployment.

Risk Summary:
No health risk identified based on available sampling data. Analytical results of the 600 bottled water samples collected at TRAB revealed that no analytes were detected above their respective 1-year, 15 L/day drinking water MEG or the respective long-term potability standard published in TB MED 577.

Medical implications:
No medical implications are expected from consuming water at the concentration detected at TRAB.

Confidence in the risk assessment: Despite the relatively limited number of bottled water samples, confidence in the risk assessment is high because US Public Health Command personnel performed

quarterly audits of all bottled water suppliers to ensure consistency of quality throughout the deployment.
Return to Table 2

4.3 Water for Non-Drinking/Other purposes (RAFO WTP treated water)

4.3.1 Sample data/notes:

From 2000- 2015, 7 sets of LPT treated and disinfected fresh water samples were collected at TRAB. Water samples were analyzed for inorganic compounds, VOC, SVOC and various physical characteristics. Preventive medicine surveillance for microbiological contaminants (coliforms/*E.coli*) is standard operating procedure, but data associated with bacteriological analyses was not available.

4.3.2 Short-term (acute) and long-term (chronic) health risks associated with water uses other than drinking:

Approach: In order to assess the health risk associated with water uses other than drinking, the following assumptions were made:

- Treated water was used for cooking and other personal hygiene purposes.
- The majority of personnel were on 6 month rotations.
- The primary routes of exposure associated with treated water were incidental ingestion through cooking and personal hygiene (i.e., brushing teeth/oral hygiene) and dermal contact when showering.
- Residents ingest far less than 5 liters (food preparation) of treated water per day.

Based on guidance provided in USAPHC Technical Guide 230, *Environmental Health Risk Assessment and Chemical Exposure Guidelines for Deployed Military Personnel* (USAPHC TG 230), any compound with a peak concentration less than or equal to 2.5 times the 14-day negligible MEG for consuming 5 liters of water per day/ (5-L/day) may be eliminated from further consideration. If a 14 day, 5-L/day negligible MEG was not available, the more conservative 1-year, 5-L/day negligible was used for screening purposes.

4.3.2.1 **Treated Water (used for cooking and personal hygiene).**

4.3.2.2 Sample data/notes:

Water from the RAFO WTP is monitored to ensure compliance with AFMAN 48-138 and the Sultanate of Oman Final Governing Standards. During the Water Vulnerability Assessment (WVA), monthly compliance reports kept by the WTP manager are reviewed to ensure water quality parameters are within these standards. Routine monitoring conducted by 405 AEG/EMDF/SGPB includes bacteriological, free available chlorine (FAC) and other sanitation surveillance parameters per AFMAN 48-138. Although primary route of exposure for most microorganisms is ingestion, dermal exposure to some microorganisms, chemicals and biological contaminants may cause adverse health effects. Complete exposure pathways include drinking, brushing teeth, personal

Risk Summary:
No acute or chronic health risks associated with incidental ingestion of treated water were identified at TRAB.

Medical Implications: None identified.

Confidence in the Risk Assessment: Confidence in the risk assessment is high. Complete chemical analysis of LTP sampling from the RAFO WTP and CE water tank farm taken in 2015 was robust. There was also an active and ongoing drinking water surveillance program at TRAB which further increases confidence in this assessment. Local agencies perform unscheduled inspections on RAFO WTP at least once a month. Results are kept in RAFO WTP.

4.3.2.1 **Disinfected Fresh Water (used for personal hygiene). NA**

Return to Table 2

5 Military Unique

5.1 Chemical Biological, Radiological Nuclear (CBRN) Weapons

There were no specific hazard sources or exposure incidents documented in the Defense Occupational and Environmental Health Readiness System (DOEHRS) or the Military Exposure Surveillance Library (MESL) during the 2000- 2015 time frame.

5.1.1 Short and long-term health risks:

Not Evaluated - No data were available specific to TRAB.

5.2 Depleted Uranium (DU)

There were no specific hazard sources or exposure incidents documented in DOEHRS or the MESL during the period from the 2000-2015 time frame.

5.2.1 Short and long-term health risks:

Not Evaluated - No data were available specific to TRAB.

5.3 Ionizing Radiation

One portable x-ray unit used by Explosive Ordnance Disposal (EOD) personnel, two stationary units located at the Commercial Processing Area (CPA) and one portable unit used by Security Forces (SF) personnel. Safety Operating Instructions and unit specific administrative and personal protective equipment (PPE) controls are in place to protect service members. BE performed scatter surveys on all x-ray units.

5.3.1 Short and long-term health risks:

Risk Summary: Low – base on the measurements, readings were below the occupational and general public exposure levels.

Medical Implications: None

Confidence in the Risk Assessment: High – SF personnel are not in the direct path of the x-ray unit when operating. Scatter survey readings where below occupational, general and hourly exposure levels. ALARA training was also conducted for all SF personnel.

5.4 Non-Ionizing Radiation

C-17 aircraft are equipped with Infrared Countermeasure Systems and aircraft maintenance personnel only clean the sensor as part of the preventive maintenance inspection. These systems are no when aircraft are on the ground. There is no potential exposure to these systems. There are Class 3R lasers utilized by personnel in 2 work centers. EOD have a bore sight finder on their robot and Emergency Management personnel use a CBRN detector, First Defender containing a laser. Administrative procedures and operating procedures are in place to protect service members. Accomplished Electromagnetic Frequency radiation surveys for Communications squadron's SATCOMs.

5.4.1 Short and long-term health risks:

SATCOMs estimated distances were calculated. However, BE do not have the equipment to capture the actual hazard distance. Recommendations were provided to 405 ESPTS for estimated distance. Contractors conduct maintenance on all SATCOMs.

Risk Summary: Low – SATCOMs are cordoned, leveled above ground and angled upwards.

Medical Implications: None - No data were available upon which to base a risk assessment specific to TRAB**.**

Confidence in the Risk Assessment: Moderate – Contract personnel follow SOPs and hazard warnings on satellites. There are control measurements when performing maintenance on satellites.

6 Endemic Diseases

6.1 Sample data/notes:

The assessed risk for endemic diseases addressed below represents the residual risk that exists in the presence of preventive measures.

Department of Defense Directive 6490.02 series, Comprehensive Health Surveillance, establishes policy for routine health surveillance of all DoD personnel throughout their military service.

The Armed Forces Health Surveillance Branch (AFHSB) maintains archives of medical event reports for all Services.

Medical event reports identified related to deployment in TRAB did not identify specific locations within the country, nor did they describe the probable site of the exposure; therefore, epidemiological analysis of medical event data was limited to the country level.

Endemic diseases present in Oman were assessed by referring to the World Health Organization's TRAB Communicable Disease Profile and the "Destinations" section of the Centers for Disease Control and Prevention (CDC) Travelers' Health website,
http://wwwnc.cdc.gov/travel/destinations/traveler/none/Oman

Where effective vaccines, such as those for Hepatitis A and B, are in place, risk to individuals is effectively reduced to none and these endemic diseases were excluded from further assessment.

Reporting of medical events from deployed environments is inconsistent. Identified reports of endemic disease associated with deployment to TRAB are assumed not to represent all cases of reportable endemic disease events among service personnel deployed to TRAB. Where available, additional relevant reports were used to supplement reportable medical event data for this assessment.

6.2 Gastrointestinal Diseases

U.S. Service members have little or no immunity to the food and waterborne diseases present in TRAB. To prevent food and waterborne diseases among individuals deployed to TRAB, food and water are purchased from approved sources. Food is prepared in facilities where there is public health oversight (certificate of sanitation, health screening of food service workers, periodic inspections, etc.). Due to the potential presence of disease causing organisms, as well as the high prevalence of improper food handling and preparation, local food and water were not approved for consumption. Viral gastroenteritis that is spread through contact or fomites (any inanimate object or substance capable of carrying infectious organisms) presents a recurrent risk due to a high rate of personnel turnover, and shared dining, berthing, bathroom facilities, and working spaces.

Approach: The health risk for fomite-borne gastrointestinal infections and endemic food and waterborne diseases to individuals deployed to TRAB during the period of this assessment was epidemiologically assessed based on the combination of identified endemic diseases, knowledge of preventive measures in place, review of medical event reports associated with deployment to TRAB, and review of military public health reports.

6.2.1 Short -term health risks*:*

Risk assessment:

The short-term risk for viral gastroenteritis was low**.** Risk due to a high rate of personnel turnover, shared dining, berthing, bathroom facilities, and working spaces is not substantially different than that expected in similar settings within the United States.

The short-term risk associated with food borne and waterborne diseases in TRAB was low (bacterial or viral gastroenteritis, protozoal diarrhea, cholera, brucellosis, hepatitis E).

Medical implications: Gastroenteritis, particularly from viral agents, can cause periodic outbreaks in spite of preventive measures. A small number of infections may require greater than 72 hours convalescence and/or hospitalization.

Confidence in the risk assessment: Confidence in the risk assessment is high. Food and water borne diseases, especially those with short convalescence and lack of long-term health effects are often underreported for deployed military populations.

6.2.2 Long-term (chronic) health risks:

Risk assessment: The long-term risk associated with food and waterborne diseases was low for protozoal diarrhea and brucellosis.

Medical implications: Long-term health effects resulting from infection with food and waterborne diseases are rare.

Confidence in the risk assessment: Confidence in the risk assessment was high. Incidence of protozoal diarrhea and brucellosis in the post deployment military population is known to be extremely low.
Return to Table 2

6.3 Arthropod Vector-Borne Diseases

The climate and ecological habitat found in Oman support populations of arthropod vectors, including mosquitoes, ticks, and sand flies. Risk for arthropod-borne disease is higher during warmer months (typically from April through November); with variable rates of disease transmission (vector-borne diseases occur at low or unknown levels throughout the country). Personnel may have been exposed to mosquitoes, ticks, sand flies, or other biting vectors both during the day or night. Risk is higher in urban and other densely populated areas, or near where animals were kept. Removing vector harborages, spraying for vectors within base camps, avoiding animals or areas where they were kept, proper wearing of insecticide-treated (permethrin) uniforms, use of bed nets in field conditions, and the application of insect repellent to the skin (DEET) were the main protective measures against vector-borne diseases. Of the endemic vector-borne diseases present in Oman, malaria is the only disease for which chemoprophylaxis is available. Individuals deployed to this location are at a low risk for Malaria, so no chemoprophylaxis have been issued.

Approach: The health risk for endemic vector-borne diseases to individuals deployed to TRAB during the period of this assessment was epidemiologically assessed based on the combination of identified endemic diseases, knowledge of preventive measures in place, review of medical event reports associated with deployment to high, and review of military public health reports.

6.3.1 Short-term (acute) health risks:

Risk assessment:

The short-term risk for the vector-borne diseases sandfly fever, West Nile Fever, Crimean-Congo hemorrhagic fever, typhus, and plague was low. Individuals who deploy from TRAB, to urban or rural outlying areas may experience increased short-term risk.

The short-term risk for malaria and cutaneous leishmaniasis was low. Individuals who deployed from TRAB in the immediate vicinity, to urban or rural outlying areas, may have experienced increased short-term risk.

Medical implications:

Malaria, sandfly fever, West Nile Fever, Crimean-Congo hemorrhagic fever, schistosomiasis, typhus, and plague present in Oman have fairly short incubation periods ranging from days to weeks. Any of these diseases would initially present as acute fever and malaise, some accompanied by rash, and would lead to acute, sometimes severe illness.

Cutaneous leishmaniasis typically presents as skin lesions, single or multiple, that start as a papule and enlarge into an ulcer.

Confidence in the risk assessment: Confidence in the risk assessment is high. Reports of vector borne disease, including malaria and leishmaniasis, were received through official DoD medical event reporting systems.

6.3.2 Long-term (chronic) health risks:

Risk assessment:

The long-term risk for leishmaniasis, cutaneous and visceral, was low.

The long-term risk for *vivax* (relapsing) malaria was low.

Medical implications:

Both visceral and cutaneous leishmaniasis may have extended incubation periods, ranging from a months to years. Although rare, it is possible to be infected during deployment, but not to have clinically evident disease until redeployed. Leishmaniasis should be considered in the differential diagnosis for any unusual skin lesions, or chronic, systemic disease. Plasmodium v*ivax* and P. *falciparum* malaria were the predominate species of malaria found in Oman. Relapses following *vivax* blood stage treatment are possible due to hypnozoites that remain dormant in the liver.

Confidence in the risk assessment: Confidence in risk assessment is high. Incidence of visceral leishmaniasis in the post deployment military population is known to be low. Cases of cutaneous leishmaniasis were detected and treated post deployment. The military medical community was/is aware of the presence of leishmaniasis in Oman. No cases of relapsing malaria have been reported in the Service-mandated reporting systems.

Return to Table 2

6.4 Water Contact Diseases

Operations or activities that involve extensive fresh water contact may result in individuals being exposed to leptospirosis. The occurrence of flooding after heavy rainfall facilitates the spread of leptospirosis because, as water saturates the environment, leptospirosis present in the soil pass directly into surface waters. Activities such as wading or swimming in fresh water sources 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 skin conditions, such as bacterial or fungal dermatitis. Elimination of standing, and/or open, bodies of fresh water protects against the spread of water contact diseases.

Approach: The health risk for endemic water contact diseases to individuals deployed to TRAB during the period of this assessment was epidemiologically assessed based on the combination of identified endemic diseases, knowledge of preventive measures in place, review of medical event reports associated with deployment to TRAB, and review of military public health reports.

6.4.1 Short-term (acute) health risks:

Risk assessment: The short-term risk for leptospirosis was low.

Medical implications: Leptospirosis, which has an incubation period of 5-14 days, presents as acute fever with nonspecific symptoms that last for 1 week to several months.

Confidence in the risk assessment: Confidence in the risk assessment is high. No reported cases of water contact diseases were identified from TRAB during the assessment period.

6.4.2 Long-term (chronic) health risks:

No long-term health risk was identified.

Return to Table 2

6.5 Respiratory Diseases

U.S. military populations living and working in close-quarter conditions were at risk for substantial person-to-person spread of respiratory virus infections such as the common cold and influenza. Primary exposure pathways for tuberculosis include prolonged close contact (generally several hours

per day for greater than three days per week in a closed space) with the local population or third country national contractors. U.S. personnel who remained on base had limited to no contact with the local population, and local and third country national workers/contractors were required to complete health screening prior to employment.

Approach: The health risk for respiratory diseases to individuals deployed to TRAB during the period of this assessment was epidemiologically assessed based on the combination of identified endemic diseases, knowledge of preventive measures in place, review of medical event reports associated with deployment to TRAB, and review of military public health reports.

6.5.1 Short-term (acute) health risks:

Risk assessment: The short-term risk for upper respiratory infections was low. Risk due to a high rate of personnel turnover, shared dining, berthing, recreational facilities, and working spaces is not substantially different than that expected in similar settings within the United States.

The short-term risk for tuberculosis was low.

Medical implications:

Upper respiratory infections, particularly from viral agents, can cause periodic outbreaks in spite of preventive measures. A small proportion of infections may require greater than 72 hours convalescence and/or hospitalization.

Symptoms of tuberculosis, including fever, weight loss, night sweats and cough, typically start within 1-6 months of infection. The lifetime risk for tuberculosis after becoming infected is 5-10%; half of this risk occurs in the first two years following infection.

Confidence in the risk assessment: Confidence in risk assessment is high. Upper respiratory infections, especially those with short convalescence and lack of long-term health effects are not reportable for deployed military populations. Tuberculosis prevalence in the local population is widespread, but no reports of tuberculosis were identified for individuals deployed to Oman during the assessment period.

6.5.2 Long-term (chronic) health risks:

Risk assessment: The long-term risk for tuberculosis was low.

Medical implications: Symptoms of tuberculosis can be delayed by two or more years following infection. Tuberculosis should be considered in assessing symptoms of fever accompanied by night sweats and cough.

Confidence in the risk assessment: Confidence in risk assessment is high. Prevalence of tuberculosis in the local population is widespread, but prevalence of tuberculosis in the post deployment military population is known to be extremely low.

Return to Table 2

6.6 Animal-Contact Diseases

Animals in Oman were not routinely vaccinated against vaccine preventable diseases such as rabies or anthrax. Q-fever, anthrax, and rabies are known to be present in Oman. Exposure to animals, and/or locations where animals were kept (stray dogs/cats, barnyards, slaughterhouses), were the primary

infection sources for all these diseases, and avoidance of companion and farm animal contacts was the primary prevention strategy. Preventive measures in place include anthrax vaccination, which is effective in preventing both cutaneous and inhalation anthrax, and rabies post exposure prophylaxis, which is effective for preventing onset of rabies in exposed individuals.

Approach: The health risk for endemic animal contact diseases to individuals deployed to TRAB during the period of this assessment was epidemiologically assessed based on the combination of identified endemic diseases, knowledge of preventive measures in place, review of medical event reports associated with deployment to TRAB, and review of military public health reports.

6.6.1 Short-term (acute) health risks:

Risk assessment: The short-term risk for anthrax (naturally acquired), rabies and Q-fever was low.

Medical implications: Naturally occurring anthrax (non-weaponized) is an acute disease that usually affects the skin, while inhalation anthrax has mild and non-specific initial symptoms among unimmunized individuals.

Symptoms of acute Q-fever, which may present one week to greater than one month after exposure, include fever, chills and weakness.

Rabies presents as an acute, viral encephalomyelitis and is almost invariably fatal.

Confidence in the risk assessment: Confidence in risk assessment is high.

6.6.2 Long-term (chronic) health risks:

Risk assessment: The long-term risk for Q-fever and rabies low.

Medical implications: Q-fever is generally an acute febrile disease. However, considerable variation in severity and duration may be seen; infections may be unapparent or present as a nonspecific undifferentiated febrile syndrome or as pneumonia. Q-fever should be considered in the differential diagnosis of an undifferentiated febrile syndrome when personnel mention a history of being near or in areas where animals were kept or had been kept.

The incubation period for rabies is typically 1–3 months, but may be more than one year in rare instances.

Confidence in the risk assessment: Confidence in risk assessment is high.

Return to Table 2

7 Venomous Animals/Insects

The species listed below have home ranges that overlap the country of Oman, and may present a health risk if encountered. Information was taken from US Army Public Health Command, Armed Forces Pest Management Board Living Hazards Database, and personal communication from previously deployed preventive medicine personnel. Little to no regional (within the country of Oman) animal range information was available. The below list should not be considered all inclusive; other venomous scorpions and snakes may be present in the region. See Section 10.3 for more information about pesticides and pest control measures.

7.1 Short-term (acute) health risk:

7.1.1 Spiders: Numerous species of spiders are found in Oman. The Black Widow Spider (*Latrodectus lugubris*) is the only known species whose bite presents a threat. Widow spider bites are mostly minor and even significant envenomation is unlikely to be lethal. Bite is usually felt as a "sting", with delayed (10+min) local pain, and sweating. More severe envenomation may produce regional pain, tender draining lymph nodes, nausea, hypertension, and malaise. Health risk was low (Low/Moderate/High/Extremely High).

7.1.2 Scorpions: Numerous species of scorpion are found in Oman. The majority of scorpions found in the region have stings that cause only short lived local effects, such as pain, without systemic effects. Serious envenomations may result in numbness, frothing at mouth, difficulty breathing, and convulsions. Various factors influence the severity of the envenomation to include health and age of patient, sting site, and size and age of scorpion. Most scorpion venom is neurotoxic with a mixture of other substances. If the patient is allergic to bee and wasp stings, extreme caution and care must be taken to prevent excessive morbidity and even possibly death. The following three scorpions are listed as present in Oman and have known detrimental health effects:

- *Androctonus amoreuxi* (Fat-tailed scorpion).
- *Hemiscorpius lepturus* (highly cytotoxic venom which can cause serious wounds, inflammation, blisters, and necrosis. No antivenom is currently available).
- *Hottentotta alticola* (Black scorpion)

Overall health risk from scorpions was low.

7.1.3 Snakes: Numerous species of snakes are found in Oman. A number of poisonous snakes, whose range incorporates Oman, could have been encountered to include cobras, pit vipers, and vipers. In Helmand Province, vipers were the most significant types of snakes that posed a health risk if encountered, namely Saw-scaled vipers which are numerous and aggressive if encountered, and possess a highly toxic venom. The following list is not an all inclusive list of vipers in the area, but rather those deemed most significant or potentially encountered.

- *Pseudocerastes persicus* (Persian Horned Viper): Reports of human envenomation are not uncommon in Oman, however, fatalities are uncommon as well.
- *Echis carinatus* (Saw-scaled Viper): Bites are typically moderate to severe, with potentially lethal envenoming, requiring urgent assessment and treatment, including IV fluids, IV antivenom and good wound care. Antivenom is key for the treatment of systemic envenoming.
- *Echis sochureki (Sochurek's Saw-scal*ed Viper): Bites are typically moderate to severe, with potentially lethal envenoming, requiring urgent assessment and treatment, including IV fluids, IV antivenom and good wound care. Antivenom is key for the treatment of systemic envenoming.
- *Macrovipera lebetina* (Levantine Viper): Bites may cause mild to severe local effects, including shock and coagulopathy.
- *Daboia russeli* (Russell's Viper): Venom is highly hemotoxic, and this snake has been known to cause severe envenomation and fatalities.
- *Eristocophis macmahonii* (Asian Sand Viper): Venom possesses a strong hemorrhagic activity. This snake is capable of causing serious envenomation and fatality.

Overall, the health risk associated with snakes was low.

7.2 Long-term (chronic) health risk:

No long-term health risks were identified based on available data.

Risk assessment: The long-term risk associated with snakes was low based on disease incident reporting from TRAB.

Medical implications: Long-term health effects resulting from interaction with snakes is Low Based on efficacy of control measure as evidenced by lack of disease(s) reported in various medical surveillance data bases e.g, TMDS, MERS, DRSi as per incident reporting from TRAB.

Confidence in the risk assessment: Confidence in risk assessment is high based on disease(s) incident reporting from TRAB.

Return to Table 2

8 Heat/Cold Stress

8.1 Site-Specific Conditions:

Oman's climate is hot and dry in the interior and humid along the coast. TRAB is located in southern Oman, Dhofar region, approximately 71 kilometers (km) north of Salalah (nearest coastal city). The Dhofar region's climate is dramatically different to the rest of Oman due to the effects of the monsoon rains which arrive during the summer months, creating humidity and moderate temperatures of around 86°F.

March-October temperatures range from 60 degrees F (Night) to triple digits (Day). November-February temperatures range from low 50 degrees F (Night) to low 80's (Day).

8.2 Heat

8.2.1 Heat Exposure Guidelines

The risk of heat injury is based on the Wet Bulb Globe Temperature Index as follows:
Low (80-84.9 °F)
Moderate (85-87.9°F)
High (88-89.9°F)
Extremely High (≥ 90°F)

8.2.2 Short (acute) and long-term (chronic) health risk:

Approach: No heat casualty, medical event reports involving heat injuries or heat stress monitoring data were available in the Defense Occupational and Environmental Health Readiness System or the Military Exposure Surveillance Library for any of the camps covered in this assessment. Accordingly, risk estimates are based strictly on existing climatologic data.

Risk Summary:

Short-term (acute) health risk: The short-term health risk of heat injury for un-acclimatized individuals (i.e. on site less than four weeks) from January-March was low. Health risk for persons with underlying health conditions may be elevated above these baselines, especially during May-September.

Long-term health risk: The long-term health risk was low.

Medical implications: Severity of heat injury can range from mild clinical signs such as clamminess, nausea, disorientation or headache to life threatening symptoms requiring hospitalization. Long-term medical implications from heat injuries are rare but can occur, especially from more serious injuries

such as heat stroke. Individuals with a history of heat injury, even when medical attention was not sought, are at increased risk for future heat injury; repeat heat injury may have increased severity.

Confidence in the risk assessment: Based on generally available information on climatic conditions and the absence of reported heat injuries, confidence in risk assessment is high. Individuals who experienced mild symptoms of heat injury may not have sought medical attention; this may lead to an underestimation of the risk.
Return to Table 2

8.3 Cold

8.3.1 Short (acute) and long-term (chronic) health risks*:*

Approach: No cold injury data were available in the Defense Occupational and Environmental Health Readiness System or the Military Exposure Surveillance Library for any of the camps covered in this assessment. Accordingly, risk estimates are based strictly on existing climatologic data.

Risk Summary: Even on warm days there can be a significant drop in temperature after sunset by as much as 40 °F. There is a risk of cold stress/injury when temperatures fall below 60 °F, which can occur from November to February. The health risk assessment for non-freezing cold injuries (chilblain, trench foot, and hypothermia) is Low based on historical temperature and precipitation data. Frostbite is unlikely to occur because temperatures rarely drop below freezing. As with heat stress/injuries, cold stress/injuries are largely dependent on operational and individual factors instead of environmental factors alone. With protective measures in place the health risk assessment is low for cold stress/injury; confidence in the health risk estimate is medium.

Medical implications: The cooling of body parts may result in various cold injuries - nonfreezing injuries, freezing injuries and hypothermia which is the most serious. Toes, fingers, ears and nose are at greatest risk because these areas do not have major muscles to produce heat. In addition, the body will preserve heat by favoring the internal organs and thus reducing the flow of blood to the extremities under cold conditions. The most severe cold injury is hypothermia which occurs from excessive loss of body heat and the consequent lowering of the body's core temperature.

Confidence in the risk assessment: Based on generally available information on climatic conditions and the absence of reported cold injuries, confidence in risk assessment is high. Individuals who experienced mild symptoms of cold injury may not have sought medical attention; this may lead to an underestimation of the risk.
Return to Table 2

9 Noise

9.1 Continuous

9.1.1 Exposure Guidelines:

The Services have established occupational and environmental exposure limits (OEEL) for continuous or intermittent noise at 85 decibels on the A-weighted scale (dbA.) The A-weighted scale of noise measurement is used because it mimics the human ear's response to sound. All Services require that individuals routinely exposed to noise levels greater than the OEL be enrolled in the hearing conservation program. Generally, routinely exposed is defined as when the TWA exceeds 84 dB(A) on average more than 2 days in any month.

9.1.2 Site Specific Conditions:

Sources of potential noise include flight line operations, associated with both fixed and rotary wing aircraft, tactical generators and various hand tools in maintenance shops. Due to the inherent noise hazard in flight line operations, personnel were required to wear dual hearing protection.

9.1.3 Short (acute) and long-term (chronic) health risk:

Approach: Knowledge of the Service hearing conservation programs and typical sound pressure level measurements associated with the various potential noise generating sources were used to complete the health risk assessment.

Risk Summary:

Short-term health risk: The short-term risk of noise induced hearing loss with the use of appropriate hearing protection use was low. Few exposed individuals are expected to have experienced noticeable short-term health effects such as annoyance, speech interference, fatigue and temporary hearing threshold shifts during deployment.

Long-term health risk: The long-term risk of noise induced hearing loss with appropriate hearing protection use is low.

Confidence in the Risk Assessment: Confidence in the health risk assessment is low. Hearing protection is readily available and generally worn by individuals with known occupational exposures across the Services. However, the limited availability of information about specific noise sources and enforcement of the use of personal protective equipment diminishes confidence. Noise dosimetry was not conducted on Industrial Hygiene shops in TRAB. BE will have to rely on home station noise surveillance readings.

9.2 Impulse

No information about potential sources of impulse noise (140 dbA) or greater) was available.

9.2.1 Short-term (acute) and Long-term (chronic) health risks:

Not evaluated: Insufficient data exist upon which to base a health risk assessment.
Return to Table 2

10 Unique Concerns

10.1 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. These process and hazards are identified and evaluated in DOEHRS for the corresponding work centers. 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.

Not evaluated: None - No data were available upon which to base a risk assessment specific to TRAB**.**

Risk Summary: None - No data were available upon which to base a risk assessment specific to TRAB**.**

Medical Implications: None - No data were available upon which to base a risk assessment specific to TRAB**.**

Confidence in the Risk Assessment: None - No data were available upon which to base a risk assessment specific to TRAB**.**

Return to Table 2

10.2 Potential Environmental Contamination Sources

In addition to environmental exposures already discussed, there may be specific occupational exposure pathways associated with aircraft, vehicle and site maintenance. Typical chemicals of concern associated with potential occupational exposures were petroleum, oils, and lubricants. No industrial hygiene data exist to document the significance of occupational exposures; however, there were typically procedures in place for storage, handling, use and disposal of hazardous materials which generally minimize health risk.

Approach: Based on 405 ECES Environmental, TRAB Environmental Conditions Report.

10.2.1 Short-term (acute) and Long-term (chronic) health risks: **Low**.

Risk Summary: None. No data were available upon which to base a risk assessment specific to TRAB.

Medical Implications: None - No data of were available upon which to base a risk assessment specific to TRAB**.**

Confidence in the risk assessment: Confidence in the risk assessment is **low**. Typical chemicals of concern associated with potential occupational exposures are petroleum, oils, and lubricants. These were generally present in relatively low volumes. Procedures for storage, handling, use and disposal of hazardous materials were in place throughout the theater of operations to minimize health risk.

10.3 Pesticides/Pest Control:

Both contract and military vector control personnel mitigated pests and vectors in accordance with mandated integrated pest management practices. The overwhelming majority of those efforts at TRAB were in the reduction of filth flies, rodents, and feral animals. Non-chemical measures such as exclusion measures and sanitation were first and primary efforts. Secondary measures included the use of targeted bait applications for flies and rodents, and various animal trapping methods. On-site or regional oversight was provided as available to ensure compliance with Theater, Navy, and DoD practices and regulations.

10.3.1 Short and Long-term (chronic) health risk

Approach: The Integrated Pest Management Plan for TRAB was reviewed for compliance with DoDI 4150.07 requirements. In addition, U. S. military entomologists who served at TRAB and the Navy Entomology Center of Excellence were consulted about their knowledge of pest management activities at these camps.

Risk Summary: None. No data were available/insufficient data exists.

Short-term health risk: No short-term health risk was identified based on available data.

Long-term health risk: No long-term health risk was identified based on available data.

Confidence in the risk assessment: Confidence in the risk assessment is **high**. The integrated pest management plan emphasizes non-chemical control over the use of chemical pesticides. The potential for camp residents to come in contact with improperly formulated insecticides is remote.
Return to Table 2

10.4 Asbestos and Lead-Based Paint

10.4.1 Site-Specific Conditions:

All structures occupied by U.S. personnel during the period were erected as new and therefore, there was no issue of exposure to potential sources of asbestos containing material (ACM) or peeling paint that could contain lead.

10.4.2 Short-term (acute) health risk:

Not evaluated: No data exist upon which to base a health risk assessment.

10.4.3 Long-term (chronic) health risk:

Not evaluated: No data exist upon which to base a health risk assessment.

10.5 Burn Pit

There are no burn pits on or near TRAB.

11 References[1]

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

2. DoDI 6055.05, Occupational and Environmental Health, 2008.

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

4. USAPHC TG230, June 2013 Revision.

5. DoD MESL Data Portal: https://mesl.apgea.army.mil/mesl/.Some of the data and reports used may be classified or otherwise have some restricted distribution.

6. Modification 12 to United States Central Command Individual Protection and Individual Unit Deployment Policy, 02 December 2013.

7. CDC. 2012. Morbidity and Mortality Weekly Report. Imported Human Rabies in a U.S. Army Soldier. May 4, 2012. 61(17); 302-305.

8. Armed Forces Pest Management Board: http://www.afpmb.org/content/venomous-animals-country#Oman. U.S. Army Garrison - Forest Glen, Silver Spring, MD.

9. Clinical Toxinology Resources: http://www.toxinology.com/. University of Adelaide, Australia.

10. Goldman RF. 2001. 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.

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

[1] NOTE. Data is currently assessed using the 2013 TG230. The general method involves an initial review of the data which eliminates all chemical substances not detected above 1-yr negligible MEGs. Those substances screened out are not considered acute or chronic health hazards so are not assessed further. For remaining substances, acute and chronic health effects are evaluated separately for air water (soil is only evaluated for long term risk). This is performed by deriving separate short-term and long term population exposure level and estimates (referred to as population exposure point concentrations (PEPC)) that are compared to MEGs derived for similar exposure durations. If less than or equal to negligible MEG the risk is Low. If levels are higher than negligible then there is a chemical-specific toxicity and exposure evaluation by appropriate SMEs, which includes comparison to any available marginal, critical or catastrophic MEGs. For drinking water 15 L/day MEGs are used for the screening while site specific 5-15 L/day are used for more detailed assessment. For nondrinking water (such as that used for personal hygiene or cooking) the 'consumption rate' is limited to 2 L/day (similar to the EPA) which is derived by multiplying the 5 L/day MEG by a factor of 2.5. This value is used to conservatively assess non drinking uses of water.

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 (Provisional) 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