DEPARTMENT OF THE ARMY
US ARMY PUBLIC HEALTH COMMAND (PROVISIONAL)
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND MD 21010-5403

MCHB-TS-RDE

27 MAR 2010

MEMORANDUM FOR Office of the Command Surgeon (LTC (b) (6)), US Central Command, 7115 South Boundary Boulevard, MacDill Air Force Base, FL 33621-5101

SUBJECT: Deployment Occupational and Environmental Health Risk Characterization, Ambient Air Particulate Matter Samples, Kandahar, Afghanistan, 2-29 December 2009, U_AFG_KANDAHAR_CM_A10-25_20091229

1. The enclosed assessment details the occupational and environmental health (OEH) risk characterization for ambient air particulate matter samples collected by 2d Preventive Medicine Detachment personnel, Kandahar, Afghanistan, 2-29 December 2009. All 20 filters submitted are valid samples.

2. The OEH risk estimate for exposure to particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$) and analyzed metals in the ambient air at Kandahar, Afghanistan 2-29 December 2009 is **low**.

3. The OEH risk estimate for exposure to particulate matter less than 10 micrometers in diameter (PM_{10}) and analyzed metals in the ambient air at Kandahar, Afghanistan 2-29 December 2009 is **moderate** due to elevated levels of PM_{10}.

4. Exposure to the ambient air during this sampling event may have degraded unit readiness; periods with similar ambient conditions are expected to cause similar health effects.

FOR THE COMMANDER:

(b) (6)

Director, Health Risk Management

Encl

CF: (w/encl)
TF MED-SOUTH (Environmental Science Officer/LT (b) (6)
JSC-A (Environmental Science Officer/LT (b) (6)
30th MEDCOM (Liaison Officer/LTC (b) (6)
30th MEDCOM (Environmental Science Officer/LTC (b) (6)
(CONT)

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CF: (w/encl) (CONT)
CJTF-82 (Command Surgeon Office/CPT [redacted]
ARCENT (Command Surgeon Office/MAJ [redacted]
ARCENT (Force Health Protection Officer/LTC [redacted]
USAFSAM (LtCol [redacted]
CFLCC/USA 3d MDSC (MAJ [redacted]
NMCPHC (Expeditionary Preventive Medicine/Mr. [redacted]
MARFORCOM (Force Environmental Health Officer/ LT [redacted]
PHCR-Europe (MCHB-AE-EE/CPT [redacted]

U.S. Army Public Health Command
(Provisional)

USAPHC

DEPLOYMENT OCCUPATIONAL AND ENVIRONMENTAL
HEALTH RISK CHARACTERIZATION
AMBIENT AIR PARTICULATE MATTER SAMPLES
KANDAHAR, AFGHANISTAN
2-29 DECEMBER 2009
U_AFG_KANDAHAR_CM_A10-25_20091229

Preventive Medicine Survey: 40-5f1

DEPLOYMENT OCCUPATIONAL AND ENVIRONMENTAL
HEALTH RISK CHARACTERIZATION
AMBIENT AIR PARTICULATE MATTER SAMPLES
KANDAHAR, AFGHANISTAN
2-29 DECEMBER 2009
U_AFG_KANDAHAR_CM_A10-25_20091229

1. REFERENCES. See Appendix A for a list of references.

2. PURPOSE AND SCOPE. This occupational and environmental health (OEH) risk characterization addresses the analytical results for ambient air particulate matter (PM) less than 10 micrometers in diameter (PM_{10}), $PM_{2.5}$, and metals samples collected on 2-29 December 2009 at Kandahar, Afghanistan in accordance with U.S. Department of Defense medical surveillance requirements. All 20 filters submitted are valid samples. This sample set was assessed using the methodology described in Appendix B. This report should not be considered a complete assessment of the overall OEH hazards to which troops may be exposed at Kandahar, Afghanistan.

3. BACKGROUND AND EXPOSURE ASSUMPTIONS. Ambient air PM_{10}, $PM_{2.5,}$ and associated metals samples were collected at the board walk, burn pit, South park, and morale welfare and recreation (MWR) building at Kandahar, Afghanistan, 2-29 December 2009. There is an active burn pit nearby. Rain was reported during 8, 17, and 29 December 2009. All personnel are expected to remain at this location for approximately 1 year. A conservative (protective) assumption used in this characterization is that all personnel inhale the ambient air 24 hours/day for 365 days (1 year). In addition, it is assumed that control measures and/or personal protective equipment are not used.

4. SAMPLE COLLECTION AND ANALYSIS.

a. Sample Collection. This ambient air PM_{10}, $PM_{2.5,}$ and associated metals sample set was collected using the Deployable Particulate Sampler (DPS) apparatus. Eight PM_{10} with associated metals and 12 $PM_{2.5}$ with associated metals samples were collected. Appendix C presents an information summary of the PM filters submitted by 2d Preventive Medicine Detachment personnel. (DPS™ is a trademark of SKC, Inc.)

b. Laboratory Analysis. The U.S. Army Public Health Command (Provisional) (USAPHC (Prov)), formerly U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), laboratory weighs the ambient air PM filters to determine PM

mass and calculate a concentration. The USAPHC (Prov) laboratory analyzes the filters to determine metals concentrations. Metals detected above the laboratory reportable limit were compared to military exposure guidelines (MEGs) published in USACHPPM Technical Guide (TG) 230, while $PM_{2.5}$ or PM_{10} concentrations were assessed using the methodology described in Appendix B. Appendix C shows an information summary of the filters assessed in this report. Appendix D shows a sample results summary table. Appendices E through L show complete analytical results.

5. HAZARD IDENTIFICATION.

a. Particulate Matter. Since PM was measured at a concentration above the Air Quality Index good range, PM is identified as a potential health threat requiring further assessment. Air particulates include 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. Airborne particulates can include dust, silica, soil, metals, organic compounds, allergens, and compounds, such as, nitrates or sulfates formed by condensation or transformation of combustion exhaust. Particulate chemical composition and size vary considerably depending on the source.

b. Metals. No metals were found at concentrations greater than their respective MEGs. Therefore, the OEH risk estimate for exposure to metals in the ambient air at this location is considered **low**.

6. HAZARD ASSESSMENT.

a. Hazard Severity.

(1) The average concentration of $PM_{2.5}$ was 139 micrograms per cubic meter ($\mu g/m^3$). This concentration falls within the range of concentrations believed to pose significant health concerns to susceptible groups, which in the military can include asthmatics or persons with pre-existing cardiopulmonary disease. Otherwise, generally healthy troops may have some eye, nasal, or throat irritation causing little or no impact on unit readiness. Therefore, the hazard severity is considered negligible.

(2) The average concentration of PM_{10} was 325 $\mu g/m^3$. This concentration falls within the range of concentrations believed to pose significant health concerns to susceptible groups, which in the military can include asthmatics or persons with pre-existing cardiopulmonary disease. Otherwise, generally healthy troops may have some eye, nasal, or throat irritation causing little or no impact on unit readiness. Therefore, the hazard severity is considered negligible.

b. Hazard Probability.

(1) The hazard probability reflects the likelihood that the exposures at the location are represented by the concentrations used to determine the hazard severity. Although the average $PM_{2.5}$ sample concentration was within the negligible severity range, it is important to examine the individual samples to determine whether the average concentration is dominated by outliers or if it is representative of a typical exposure. The probability that the severity of a hazard is negligible is based on a comparison of individual sample concentrations to the $PM_{2.5}$ 24-hour National Ambient Air Quality Standards (NAAQS) of 35 µg/m^3. During this sampling event, the range of $PM_{2.5}$ sample concentrations was 16-891 µg/m^3, and eight of twelve (67 percent) of the samples were above 35 µg/m^3; therefore, the probability that personnel in the sampled areas will be exposed to $PM_{2.5}$ greater than 35 µg/m^3 is considered likely.

(2) The hazard probability reflects the likelihood that the exposures at the location are represented by the concentrations used to determine the hazard severity. Although the average PM_{10} sample concentration was within the negligible severity range, it is important to examine the individual samples to determine whether the average concentration is dominated by outliers or if it is representative of a typical exposure. The probability that the severity of a hazard is negligible is based on a comparison of individual sample concentrations to the PM_{10} 24-hour NAAQS of 150 µg/m^3. During this sampling event, the range of PM_{10} sample concentrations was 101-716 µg/m^3, and seven of eight (88 percent) samples were above 150 µg/m^3; therefore, the probability that personnel in the sampled area(s) will be exposed to PM_{10} greater than 150 µg/m^3 is considered frequent.

c. Risk Estimate and Confidence. Table 1 summarizes the risk estimate for each identified hazard.

Table 1. Risk Estimate Summary for Exposure to PM and Metals in Ambient Air, Kandahar, Afghanistan, 2-29 December 2009

Parameter	Hazard Severity	Hazard Probability	Hazard-Specific Risk Estimate	Confidence
PM_{10}	Negligible	Frequent	MODERATE	MEDIUM
$PM_{2.5}$	Negligible	Likely	LOW	
Metals	No parameters detected above a MEG		LOW	

7. CONCLUSION.

a. The OEH risk estimate for exposure to $PM_{2.5}$ and analyzed metals in ambient air at Kandahar, Afghanistan, 2-29 December 2009 is **low**.

b. The OEH risk estimate for exposure to PM_{10} and analyzed metals in ambient air at Kandahar, Afghanistan, 2-29 December 2009 is **moderate** due to elevated levels of PM_{10}.

c. Exposure to the ambient air during this sampling event may have degraded unit readiness; periods with similar ambient conditions are expected to cause similar health effects.

8. RECOMMENDATIONS AND NOTES.

a. Recommendations.

(1) Collect PM samples from Kandahar, Afghanistan at least once every 6 days (if possible) for the deployment duration (or as long as possible) to better characterize the ambient air PM and metals exposures.

(2) Restrict outdoor physical activities where possible during periods of visibly high particulate levels.

(3) Inform preventive medicine and medical personnel of potential health effects resulting from exposures to the measured levels of ambient PM and associated heavy metals. Disease Non-Battle Injury (DNBI) rates of respiratory diseases, particularly asthma, should be followed and assessed during periods of high PM levels. If elevated DNBI respiratory illness rates (that is, above two standard deviations), or an increase in the incidence or severity of asthma, are noted during periods of high PM levels, ensure appropriate medical surveillance-related items are documents. If assistance and/or information are needed on environmental health effects and/or medical implications from exposure to PM and associated heavy metals, please contact the USAPHC (Prov) Environmental Medicine Program at commercial (b) (6) .

b. Notes.

(1) This OEH risk assessment is specific to the exposure assumptions identified above and the sample results assessed in this report. If the assumed exposure scenario changes or additional information is available, provide the updated information so the risk estimate can be reassessed. If additional samples from this site and/or area are collected, a new OEH risk assessment will be completed.

(2) As part of a Comprehensive Military Medical Surveillance Program, required by Department of Defense Directive 6490.02E and Department of Defense Instruction 6490.03, this report has been submitted to the Deployment Occupational and Environmental Health Surveillance (DOEHS)-Data Portal. You can view this and other archived DOEHS data at https://doehrswww.apgea.army.mil/doehrs-oehs/. If you have additional DOEHS data for Kandahar, Afghanistan it can also be submitted via this Web site.

9. POINTS OF CONTACT. The USAPHC (Prov) points of contact for this assessment are Ms. (b) (6) and Mr. (b) (6). Ms. (b) (6) may be contacted at e-mail (b) (6), and Mr. (b) (6) may be contacted at e-mail (b) (6), or DSN (b) (6) or commercial (b) (6).

(b) (6)

Environmental Scientist
Deployment Environmental Surveillance Program

Approved by:

(b) (6)

MAJ, MS
Program Manager
Deployment Environmental Surveillance

APPENDIX A

REFERENCES

1. Department of Defense Directive (DODD) 6490.02E, Comprehensive Health Surveillance, 21 October 2004.

2. Department of Defense Instruction (DODI) 6490.03, Deployment Health, 11 August 2006.

3. Department of the Army, Field Manual (FM) 5-19, Composite Risk Management, 21 August 2006.

4. U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) Technical Guide (TG) 230, Chemical Exposure Guidelines for Deployed Military Personnel, Version 1.3, May 2003 with the January 2004 addendum.

5. Memorandum, USACHPPM (MCHB-TS-RDE), 27 April 2007, Subject: Deployment Operational Risk Characterization Method for Particulate Matter.

APPENDIX B

METHODOLOGY

B-1. SCOPE OF RISK ASSESSMENTS. The U.S. Army Public Health Command (Provisional) (USAPHC (Prov)), formerly U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), Deployment Environmental Surveillance Program (DESP) characterizes deployment occupational and environmental health (OEH) risks which may impact mission capability (that is, operational risks). Each characterization is performed using risk management doctrine (Field Manual (FM) 5-19), and the relatively conservative (protective) assumptions and methods provided in the USACHPPM Technical Guide (TG) 230, to facilitate decision making that can minimize the likelihood of significant risks. A risk estimate is generated for each sample or sample set sent to the USAPHC (Prov) laboratory for analysis. These risk estimates are provided to preventive medicine personnel with information about potential operational risks and associated health effects. Samples received are generally limited in time, area, and media. Therefore, any risk characterization based on a sample or sample set should not be considered a complete characterization of the overall OEH hazards to which troops may be exposed at a location.

B-2. RISK ASSESSMENT METHODOLOGY.

a. General. The USACHPPM TG 230 methodology (identification of the hazard(s), assessment of the hazard severity and probability, and determination of a risk estimate and confidence level), military exposure guidelines (MEGs), and National Ambient Air Quality Standards (NAAQS) are used to characterize the risk from identified OEH hazards. Each component of the methodology is described in more detail below.

b. Hazard Identification.

(1) Hazard Definition. For the purpose of conducting these risk assessments, an OEH hazard is any biological, chemical, or physical parameter detected in a medium by field testing or laboratory analysis. The detected parameter could pose a health threat if personnel are exposed to it at levels greater than its respective MEG.

(2) Screening the Hazards.

(a) General. The purpose of screening the hazards is to focus the risk assessment on the most important/credible health threats. Concentrations of identified hazards are screened against the long-term (1-year) MEGs. The 1-year MEGs

represent exposure concentrations at or below which no significant health effects (including delayed or chronic disease or significant increased risk of cancer) are anticipated even after 1 year of continuous daily exposures. For exposures that are known to be brief or intermittent (such as, 24 hours, less than 2 weeks, etc.), short-term MEGs can be used (when available).

(b) Ambient Air Particulate Matter. Particulate matter (PM) is one of six air pollutants for which the U.S. Environmental Protection Agency (USEPA) has promulgated NAAQS in the interest of protecting public health. In addition, the USEPA developed the Air Quality Index (AQI) to communicate daily air quality to the public using six descriptive categories ranging from “good” to “hazardous.” The AQI categories for PM are based on concentration ranges grouped according to health concern severity. The USAPHC (Prov) uses the AQI categories to characterize the operational risk from PM. The PM sample concentrations are screened against the upper bound of the AQI good air quality concentration range. If any PM sample concentration is above this threshold, PM is identified as a hazard.

(3) Hazards that are Not Credible Health Threats. If concentrations of identified hazards are below the screening MEGs, it can be assumed that they do not pose a health threat. In these cases, a hazard assessment is not conducted and the estimated risk from exposure to these hazards is assumed to be low.

(4) Hazards that are Credible Health Threats. If concentrations of identified hazards are above the screening MEGs, they are considered credible health threats, and a hazard assessment is conducted for each one.

c. Hazard Assessment.

(1) Hazard Severity.

(a) General. When concentrations of an OEH hazard are greater than the screening MEG, the severity of the health threat associated with the hazard must be estimated. Determine whether the concentration of the hazard also exceeds short-term guidelines. Significant health and/or mission impacts may be anticipated when both long- and short-term guidelines are exceeded. Many OEH hazards with long-term guidelines have no parallel short-term guidelines. In such cases, professional judgment is necessary to estimate the hazard severity. Estimating the hazard severity involves determining the proportion of individuals within the population of interest that will experience effects and the severity of the effects. In practice, this can be difficult due to the limited and variable toxicological and epidemiological data available for most OEH hazards. Conclusions about the hazard severity must be made with an understanding

of the limitations of currently available data used to develop the MEGs and the risk assessment process in general.

(b) Multiple Samples. The average concentration of the OEH hazard is compared to the short- and long-term MEGs to determine hazard severity for sample sets where samples are collected on different days or multiple samples are collected on the same day from the same source.

(c) Ambient Air Particulate Matter. Hazard severity is determined by comparing the average PM concentration for a specific location and timeframe to PM concentration ranges identified as either negligible or marginal. This process is described in more detail in Appendix A, reference 5. Negligible concentration levels correspond to mild respiratory effects among generally healthy troops, with more significant effects among sensitive persons, such as asthmatics or those with existing cardiopulmonary disease. Marginal concentration levels are expected to pose more significant health effects among healthy personnel, and those with pre-existing sensitivities.

(2) Hazard Probability.

(a) General. The hazard probability represents the likelihood that individuals within a population of interest during a specified time period will actually be exposed to concentrations of an OEH hazard that are greater than a MEG. The MEGs were developed using certain conservative exposure assumptions that may not reflect actual exposure conditions. The primary factors in estimating the hazard probability are how closely actual exposure conditions match those used to develop the MEG, and what proportion of the population of interest will be exposed to the hazard.

(b) Ambient Air Particulate Matter. Hazard probability is based on the frequency that anticipated exposures are above a threshold that is representative of the hazard severity category. This process is described in more detail in Appendix A, reference 5. However, using USACHPPM TG 230 methodology and reference 4 to estimate the hazard probability for PM when a small number of samples are collected or numbers of days that are sampled often results in a risk estimate that is not consistent with actual exposure outcomes. Until a more refined assessment method can be published in USACHPPM TG 230, the method the USAPHC (Prov) DESP uses to characterize the risk from PM deviates slightly from USACHPPM TG 230 and reference 4. When less than four samples are collected or number of days are sampled and received for risk characterization, a hazard probability is not estimated; the hazard severity determines the risk estimate. A negligible severity represents a low risk and a marginal severity represents a moderate risk.

(3) Risk Estimate.

(a) The estimated hazard severity and probability levels are used with the Risk Assessment Matrix published in USACHPPM TG 230 and FM 5-19 to provide a risk estimate for exposure to each OEH hazard identified as a credible health threat. Therefore, communication of operational risks from OEH hazards can be made in the same context as other operational risks. The risk estimate is based on the highest estimated risk for the OEH hazards identified. Each level of operational risk has a defined mission impact and unit status description.

(b) Each risk estimate is specific to exposure assumptions derived from information on the field data sheets, communication with the collecting unit, and the associated sample results. If the assumed exposure scenario changes, additional/updated information should be provided so the risk estimate can be reassessed.

(c) If additional samples from Kandahar, Afghanistan and source are collected, a new risk estimate will be generated based upon exposure scenario information provided with the samples.

(4) Confidence. A confidence level is assigned to each risk estimate. The degree of confidence is particularly important when determining possible courses of action. The confidence level should integrate uncertainties associated with the hazard severity and probability determinations. Typical areas of uncertainty include: sampling or field data quality; actual exposure conditions and comparability to the exposure assumptions used to develop the MEGs or other comparison level; expected symptoms of exposure, including consideration of exposure to multiple hazards; and whether the predicted health outcome is plausible, given weight of evidence or real-world experiences. In general, confidence in risk estimates is usually low to medium.

APPENDIX C

INFORMATION SUMMARY
AMBIENT AIR PARTICULATE MATTER SAMPLES
KANDAHAR, AFGHANISTAN
2-29 DECEMBER 2009

DOEHRS Sample ID	Field/Local Sample ID	Site	Start Date/Time	Filter ID
00001S0W	AFG KANDAH 09336 PM25DPS	Board Walk	2009/12/02 1514	47-08-0963
00001S10	AFG KANDAH 09342 PM10DPS	Board Walk	2009/12/08 1422	47-08-0969
00001S11	AFG KANDAH 09336 PM25DPS	Burn Pit	2009/12/02 1426	47-08-0996
00001S14	AFG KANDAH 09342 PM10DPS	Burn Pit	2009/12/08 1324	47-08-0971
00001S15	AFG KANDAH 09356 PM10DPS	Burn Pit	2009/12/12 1302	47-08-0997
00001S17	AFG KANDAH 09342 PM10DPS	South Park	2009/12/08 1343	47-08-0967
00001S1E	AFG KANDAH 09349 PM25DPS	South Park	2009/12/15 1328	47-08-0974
00001S1K	AFG KANDAH 09356 PM10DPS	South Park	2009/12/22 1406	47-08-0966
00001S1L	AFG KANDAH 09336 PM25DPS	South Park	2009/12/02 1441	47-08-0955
00001S56	AFG KANDAH 09342 PM10DPS	MWR	2009/12/08 1400	47-08-0965
00001S57	AFG KANDH 09336 PM25DPS	MWR	2009/12/02 1500	47-08-0956
00001S58	AFG KANDAH 09349 PM25DPS	MWR	2009/12/15 1342	47-08-0973
00001S5M	AFG KANDAH 09356 PM10DPS	MWR	2009/12/22 1336	47-08-0957
00001S5S	AFG KANDAH 09363 PM25DPS	South Park	2009/12/29 1325	47-09-2412
00001S5T	AFG KANDAH 09363 PM25DPS	Board Walk	2009/12/29 1403	47-09-2414
00001S5U	AFG KANDAH 09363 PM25DPS	Burn Pit	2009/12/29 1312	47-09-2411

Deployment OEH Risk Characterization, Ambient Air PM Samples, Kandahar, Afghanistan, 2-29 Dec 09, U_AFG_KANDAHAR_CM_A10-25_20091229

DOEHRS Sample ID	Field/Local Sample ID	Site	Start Date/Time	Filter ID
00001S5X	AFG KANDAH 09363 PM25DPS	MWR	2009/12/29 1340	47-09-2413
00001S5Z	AFG KANDAH 09349 PM25DPS	Board Walk	2009/12/15 1356	47-09-2528
00001S60	AFG KANDAH 09356 PM10DPS	Board Walk	2009/12/22 1426	47-09-2529
00001S6C	AFG KANDAH 09351 PM25DPS	Burn Pit	2009/12/17 1354	47-09-2530

LEGEND:
DOEHRS Sample ID = Defense Occupational and Environmental Health Readiness System Sample Identification Number
MWR = morale welfare and recreation

APPENDIX D

RESULTS SUMMARY
AMBIENT AIR PARTICULATE MATTER SAMPLES
KANDAHAR, AFGHANISTAN
2-29 DECEMBER 2009

Parameter[1]	Units	Concentration		Valid Samples		USACHPPM TG 230 Military Exposure Guidelines[2] 1-year	
		Maximum	Average	#	# > Laboratory Reporting Limit	# > MEG	MEG
PM_{10}	$\mu g/m^3$	715	325	8	8	8	50
$PM_{2.5}$	$\mu g/m^3$	891	139	12	12	12	15

[1] Highlighted values indicate the parameter was detected at a concentration above a MEG.
[2] This table was created from DOEHRS on 5 March 2010. The MEGs in DOEHRS are current as of June 2009.

LEGEND:
$\mu g/m^3$ = micrograms per cubic meter
USACHPPM = U.S. Center for Health Promotion and Preventive Medicine
TG = technical guide
MEGs = military exposure guidelines
PM_{10} = particulate matter less than 10 micrometers in diameter
$PM_{2.5}$ = particulate matter less than 2.5 micrometers in diameter

APPENDIX E

ANALYTICAL SAMPLE RESULTS
AMBIENT AIR PARTICULATE MATTER SAMPLES
KANDAHAR, AFGHANISTAN
8-12 DECEMBER 2009

DOEHRS Sample ID			00001S10	00001S14	00001S15	00001S17
Field/Local Sample ID			AFG KANDAH 09342 PM10DPS	AFG KANDAH 09342 PM10DPS	AFG KANDAH 09356 PM10DPS	AFG KANDAH 09342 PM10DPS
Site			Board Walk	Burn Pit	Burn Pit	South Park
Start Date/Time			2009/12/08 1422	2009/12/08 1324	2009/12/12 1302	2009/12/08 1343
Parameter	Class	Units	Concentration[1,2]			
Antimony	Metals	$\mu g/m^3$	< 0.00033711	< 0.00033387	< 0.00034722	< 0.00033387
Arsenic	Metals	$\mu g/m^3$	< 0.00033711	< 0.00033387	< 0.00034722	< 0.00033387
Beryllium	Metals	$\mu g/m^3$	< 0.00016855	< 0.00016693	< 0.00017361	< 0.00016693
Cadmium	Metals	$\mu g/m^3$	< 0.000033711	0.000060096	< 0.000034722	< 0.000033387
Chromium	Metals	$\mu g/m^3$	0.00047869	< 0.00016693	< 0.00017361	< 0.00016693
Lead	Metals	$\mu g/m^3$	< 0.00033711	< 0.00033387	0.00090278	< 0.00033387
Manganese	Metals	$\mu g/m^3$	0.0028991	0.00073451	0.00069444	0.00066774
Nickel	Metals	$\mu g/m^3$	0.0016181	< 0.00033387	< 0.00034722	< 0.00033387
PM_{10}		$\mu g/m^3$	716	178	415	164
Vanadium	Metals	$\mu g/m^3$	< 0.00033711	< 0.00033387	< 0.00034722	< 0.00033387
Zinc	Metals	$\mu g/m^3$	< 0.0033711	< 0.0033387	< 0.0034722	< 0.0033387

[1]< X.XX = Below laboratory reporting limit (X.XX)
[2]Laboratory reporting limit is parameter and sample specific
LEGEND:
DOEHRS Sample ID = Deployment Occupational and Environmental Health Readiness System Sample Identification Number
$\mu g/m^3$ = micrograms per cubic meter
PM_{10} = particulate matter less than 2.5 micrometers in diameter

APPENDIX F

ANALYTICAL SAMPLE RESULTS
AMBIENT AIR PARTICULATE MATTER SAMPLES
KANDAHAR, AFGHANISTAN
8-22 DECEMBER 2009

DOEHRS Sample ID			00001S1K	00001S56	00001S5M	00001S60
Field/Local Sample ID			AFG KANDAH 09356 PM10DPS	AFG KANDAH 09342 PM10DPS	AFG KANDAH 09356 PM10DPS	AFG KANDAH 09356 PM10DPS
Site			South Park	MWR	MWR	Board Walk
Start Date/Time			2009/12/22 1406	2009/12/08 1400	2009/12/22 1336	2009/12/22 1426
Parameter	Class	Units	Concentration[1,2]			
Antimony	Metals	µg/m^3	< 0.00034722	< 0.00033875	< 0.00034722	< 0.00034722
Arsenic	Metals	µg/m^3	< 0.00034722	< 0.00033875	< 0.00034722	< 0.00034722
Beryllium	Metals	µg/m^3	< 0.00017361	< 0.00016938	< 0.00017361	< 0.00017361
Cadmium	Metals	µg/m^3	< 0.000034722	< 0.000033875	< 0.000034722	< 0.000034722
Chromium	Metals	µg/m^3	0.00022917	0.00027778	0.00022917	0.00027083
Lead	Metals	µg/m^3	< 0.00034722	< 0.00033875	< 0.00034722	< 0.00034722
Manganese	Metals	µg/m^3	< 0.00069444	0.00088076	0.0017361	0.0013889
Nickel	Metals	µg/m^3	< 0.00034722	< 0.00033875	< 0.00034722	< 0.00034722
PM_{10}		µg/m^3	101	210	450	363
Vanadium	Metals	µg/m^3	< 0.00034722	< 0.00033875	< 0.00034722	< 0.00034722
Zinc	Metals	µg/m^3	< 0.0034722	< 0.0033875	< 0.0034722	< 0.0034722

[1]< X.XX = Below laboratory reporting limit (X.XX)
[2]Laboratory reporting limit is parameter and sample specific
LEGEND:
DOEHRS Sample ID = Deployment Occupational and Environmental Health Readiness System Sample Identification Number
µg/m^3 = micrograms per cubic meter MWR = morale welfare and recreation
PM_{10} = particulate matter less than 10 micrometers in diameter

APPENDIX G

ANALYTICAL SAMPLE RESULTS
AMBIENT AIR PARTICULATE MATTER SAMPLES
KANDAHAR, AFGHANISTAN
2-15 DECEMBER 2009

DOEHRS Sample ID			00001S0W	00001S11	00001S1E	00001S1L	00001S57	00001S58
Field/Local Sample ID			AFG KANDAH 09336 PM25DPS	AFG KANDAH 09336 PM25DPS	AFG KANDAH 09349 PM25DPS	AFG KANDAH 09336 PM25DPS	AFG KANDH 09336 PM25DPS	AFG KANDAH 09349 PM25DPS
Site			Board Walk	Burn Pit	South Park	South Park	MWR	MWR
Start Date/Time			2009/12/02 1514	2009/12/02 1426	2009/12/15 1328	2009/12/02 1441	2009/12/02 1500	2009/12/15 1342
Parameter	Class	Units	Concentration[1,2]					
Antimony	Metals	µg/m^3	< 0.00033711	< 0.00030063	< 0.00034361	< 0.00033548	< 0.00033548	< 0.00035073
Arsenic	Metals	µg/m^3	< 0.00033711	< 0.00030063	< 0.00034361	< 0.00033548	< 0.00033548	< 0.00035073
Beryllium	Metals	µg/m^3	< 0.00016855	< 0.00015031	< 0.00017181	< 0.00016774	< 0.00016774	< 0.00017536
Cadmium	Metals	µg/m^3	< 0.000033711	< 0.000030063	< 0.000034361	< 0.000033548	< 0.000033548	< 0.000035073
Chromium	Metals	µg/m^3	< 0.00016855	< 0.00015031	< 0.00017181	0.00018116	< 0.00016774	0.00021044
Lead	Metals	µg/m^3	< 0.00033711	0.00033069	< 0.00034361	< 0.00033548	< 0.00033548	< 0.00035073
Manganese	Metals	µg/m^3	< 0.00067422	< 0.00060125	< 0.00068723	< 0.00067096	< 0.00067096	< 0.00070146
Nickel	Metals	µg/m^3	< 0.00033711	< 0.00030063	< 0.00034361	< 0.00033548	< 0.00033548	< 0.00035073
$PM_{2.5}$		µg/m^3	71	158	94	95	108	98
Vanadium	Metals	µg/m^3	< 0.00033711	< 0.00030063	< 0.00034361	< 0.00033548	< 0.00033548	< 0.00035073
Zinc	Metals	µg/m^3	< 0.0033711	< 0.0030063	< 0.0034361	< 0.0033548	< 0.0033548	< 0.0035073

[1]< X.XX = Below laboratory reporting limit (X.XX)
[2]Laboratory reporting limit is parameter and sample specific
LEGEND:
DOEHRS Sample ID = Deployment Occupational and Environmental Health Readiness System Sample Identification Number
µg/m^3 = micrograms per cubic meter MWR = morale welfare and recreation
$PM_{2.5}$ = particulate matter less than 2.5 micrometers in diameter

APPENDIX H

ANALYTICAL SAMPLE RESULTS
AMBIENT AIR PARTICULATE MATTER SAMPLES
KANDAHAR, AFGHANISTAN
15-29 DECEMBER 2009

DOEHRS Sample ID			00001S5S	00001S5T	00001S5U	00001S5X	00001S5Z	00001S6C
Field/Local Sample ID			AFG KANDAH 09363 PM25DPS	AFG KANDAH 09363 PM25DPS	AFG KANDAH 09363 PM25DPS	AFG KANDAH 09363 PM25DPS	AFG KANDAH 09349 PM25DPS	AFG KANDAH 09351 PM25DPS
Site			South Park	Board Walk	Burn Pit	MWR	Board Walk	Burn Pit
Start Date/Time			2009/12/29 1325	2009/12/29 1403	2009/12/29 1312	2009/12/29 1340	2009/12/15 1356	2009/12/17 1354
Parameter	Class	Units	Concentration[1,2]					
Antimony	Metals	µg/m^3	< 0.00034549	< 0.00034378	< 0.00035251	< 0.00034041	< 0.00033387	0.00089829
Arsenic	Metals	µg/m^3	< 0.00034549	< 0.00034378	< 0.00035251	< 0.00034041	< 0.00033387	< 0.00034549
Beryllium	Metals	µg/m^3	< 0.00017275	< 0.00017189	< 0.00017625	< 0.00017021	< 0.00016693	< 0.00017275
Cadmium	Metals	µg/m^3	< 0.000034549	< 0.000034378	< 0.000035251	< 0.000034041	< 0.000033387	0.00053897
Chromium	Metals	µg/m^3	< 0.00017275	< 0.00017189	< 0.00017625	0.00017702	< 0.00016693	0.00018657
Lead	Metals	µg/m^3	< 0.00034549	< 0.00034378	< 0.00035251	< 0.00034041	< 0.00033387	0.002073
Manganese	Metals	µg/m^3	< 0.00069099	< 0.00068757	< 0.00070502	< 0.00068083	< 0.00066774	< 0.00069099
Nickel	Metals	µg/m^3	< 0.00034549	< 0.00034378	< 0.00035251	< 0.00034041	< 0.00033387	< 0.00034549
$PM_{2.5}$		µg/m^3	16	22	22	16	76	891
Vanadium	Metals	µg/m^3	< 0.00034549	< 0.00034378	< 0.00035251	< 0.00034041	< 0.00033387	< 0.00034549
Zinc	Metals	µg/m^3	< 0.0034549	< 0.0034378	< 0.0035251	< 0.0034041	< 0.0033387	< 0.0034549

[1]< X.XX = Below laboratory reporting limit (X.XX)
[2]Laboratory reporting limit is parameter and sample specific
LEGEND:
DOEHRS Sample ID = Deployment Occupational and Environmental Health Readiness System Sample Identification Number
µg/m^3 = micrograms per cubic meter
$PM_{2.5}$ = particulate matter less than 2.5 micrometers in diameter MWR = morale welfare and recreation