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DEPARTMENT OF THE ARMY
US ARMY INSTITUTE OF PUBLIC HEALTH
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MCHB-IP-REH

MEMORANDUM FOR Headquarters, U.S. 8th Army Command (BG D. Conboy), PSC 303, Box 45, APO AP 96204

SUBJECT: Human Health Risk Assessment No. 39-DA-0ESM-11, Helipad and Area D/Land Farm Alleged Hazardous Material Disposal Sites, Camp Carroll, Teagu, South Korea, 15 June through 16 August 2011

A copy of the subject report is enclosed.

FOR THE DIRECTOR:

[redacted] b6

Encl

Portfolio Director, Health Risk Management

CF (w/encl):
HQDA (DASG-PPM-NC)
IMCOM-K (IMK-PWD-E)
USACE (CEHNC-CX-ES)
USAEC (IMAE-CD)
PHCR-Pacific (MCHB-AJ-THE)

USAPHC

U.S. ARMY PUBLIC HEALTH COMMAND

5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

HUMAN HEALTH RISK ASSESSMENT
NO. 39-DA-0ESM-11
HELIPAD AND AREA D/LAND FARM
ALLEGED HAZARDOUS MATERIAL DISPOSAL SITES
CAMP CARROLL
TEAGU, SOUTH KOREA
15 JUNE THROUGH 16 AUGUST 2011

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Preventive Medicine Survey: 40-5f1

CHPPM/PHC FORM 433-E (MCHB-CS-IP), SEP 10

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DEPARTMENT OF THE ARMY
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5158 BLACKHAWK ROAD
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MCHB-IP-REH

EXECUTIVE SUMMARY
HUMAN HEALTH RISK ASSESSMENT NO. 39-DA-0ESM-11
HELIPAD AND AREA D/LAND FARM
ALLEGED HAZARDOUS MATERIAL DISPOSAL SITES
CAMP CARROLL
TEAGU, SOUTH KOREA
15 JUNE THROUGH 16 AUGUST 2011

1. PURPOSE. This assessment was conducted to evaluate the validity of allegations that Agent Orange (Herbicide Orange) was buried on Camp Carroll, South Korea and to determine the human health risk from chemical residue in the soil and groundwater of the affected areas.

2. GENERAL. In May 2011, allegations surfaced that Soldiers buried drums of Agent Orange (Herbicide Orange) in the vicinity of the helipads on Camp Carroll, South Korea in 1978. A literature search of military documents showed that there was at least one incident involving the unauthorized burial of hazardous materials in the general area of the allegations. This human health risk assessment was performed to assess the potential for human health concerns while providing evidence to support or refute the allegations.

3. CONCLUSIONS.

a. Soil and groundwater data collected in the Phase I site (west end of the Helipad) does not indicate that Herbicide Orange was buried at or near this site.

b. The health risk evaluation performed for the Phase I site determined that exposure to this site by a hypothetical industrial worker, utility/grounds maintenance worker, construction worker, training Soldier, or adult resident would not result in a significant adverse health threat.

c. Soil and groundwater data collected in the Phase II site (Land Farm and Area D) does not indicate that Herbicide Orange was buried at or near this site.

d. The health risk evaluation performed for the Phase II site determined that exposure to this site by a hypothetical industrial worker, utility/grounds maintenance worker, construction worker, the training Soldier, or the hypothetical future adult resident would not result in a significant adverse health threat. All the calculated carcinogenic risks for this site are smaller than the health-based threshold of 1.0E-04 used by the U.S. Environmental Protection Agency (USEPA) to determine if any further action is warranted. The total noncarcinogenic risk (i.e., hazard index (HI)) for the hypothetical industrial worker and the hypothetical future adult resident slightly exceeded the threshold of unity used by the USEPA as guidance to determine if further action is warranted. The exceedance of the threshold was due to vapor intrusion of trichloroethene from the groundwater. The vapor intrusion model used assumptions of the construction of the building and the parameters of the underlying soil which most likely over estimates the transport of chemicals into the building, thus the small exceedance of the threshold should not be taken to indicate a health concern. It is important to note here that the adult resident receptor was included in this assessment for informational purposes only since this area is not being considered for future residential development. However, should the current and anticipated land use scenario change to future residential development, these results would indicate that the Phase II site should be considered for further evaluation of the vapor intrusion pathway.

e. Soil and groundwater data collected in the Phase IIB site (east end of the helipad) does not indicate that Herbicide Orange was buried at or near this site.

f. The health risk evaluation performed for the Phase IIB site determined that exposure to this site by a hypothetical industrial worker, utility/grounds maintenance worker, construction worker, the training Soldier, or the hypothetical future adult resident would not result in a significant adverse health threat. All the calculated carcinogenic risks for this site are smaller than the health-based threshold of 1.0E-04 used by the USEPA to determine if any further action is warranted. The total noncarcinogenic HI for all receptors does not exceed the threshold of unity used by the USEPA to determine if further action is warranted. Exposure to the Phase IIB site by the modeled receptors does not pose a significant adverse health risk to human health.

g. This health risk assessment must not be used as an absolute determination of the probability of health effects from the possible exposures at this site because of the limitations and assumptions inherent in risk assessment. The risk evaluation was focused on estimating potential environmental exposures to hypothetical receptors which is designed to represent a conservative (high-end) estimate of risks and may not represent an actual exposure or risk at the site. This assessment should only be used as guidance for making decisions about the site.

4. RECOMMENDATIONS. No recommendations are necessary.

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HUMAN HEALTH RISK ASSESSMENT NO. 39-DA-0ESM-11
HELIPAD AND AREA D/LAND FARM
ALLEGED HAZARDOUS MATERIAL DISPOSAL SITES
CAMP CARROLL
TEAGU, SOUTH KOREA
15 JUNE THROUGH 16 AUGUST 2011

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

2. PURPOSE. This assessment was conducted to evaluate the validity of allegations that Agent Orange (Herbicide Orange) was buried on Camp Carroll, South Korea and to determine the human health risk from chemical residue in the soil and groundwater of the affected areas.

3. AUTHORITY. Telephone conversation between BG David Conboy, U.S. 8th Army Command and [redacted]ublic Health Command Region-Pacific (PHCR-Pacific), 25 May 2011, subject: Request for Risk Assessment Assistance.

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4. GENERAL.

a. Background. In May 2011, allegations surfaced that Soldiers buried drums of Agent Orange (Herbicide Orange) in the vicinity of the helipads on Camp Carroll, South Korea in 1978. A literature search of military documents showed that there was at least one incident involving the unauthorized burial of hazardous materials in the general area of the allegations (U.S. Army Pacific Environmental Health Engineering Agency (USAPACEHEA, 1982). Previous investigations (USAPACEHEA, 1982 and 1983) indicate the following:

(1) Hazardous materials were improperly disposed of in an Area D burial site in March 1978. These materials were reported to be chemicals stored in Area 41 where the condition of the containers had deteriorated resulting in numerous leaks and spills.

(2) Chemical products from Area 41 were buried in Area D without authorization. On 16 February 1979 COL Elam, Commander, U.S. Army Material Support Command, directed that the buried material be removed, re-containerized, and properly disposed.

(3) Approximately 6,100 cubic feet of 188 types of various materials were removed from the Area D burial site from November 1979 through January 1980. The materials removed included numerous containers of pesticides (malathion, chlordane, DDT, lindane, Diazinon), acids, bases, various petroleum products, paints, cleaning

solvents, detergents, and varnishes. Some cross contamination occurred due to the deteriorated condition of the containers.

(4) The recovered chemicals were stored in a diked storage area until the repackaging materials containers were received. Repackaging started in May 1980 but was stopped in June 1980 because the repackaging containers received did not meet U.S. Department of Transportation requirements. In August 1980, U.S. Department of Transportation-approved containers were received and repackaging resumed.

(5) Documentation for the location and dates of the ultimate disposal of these materials could not be found. Records for the excavation and disposal of the contaminated soil from Area 41 could not be found.

b. Property Description and Environmental Setting.

(1) Camp Carroll. Camp Carroll (U.S. Army Corps of Engineers (USACE, 2011) is a U.S. Army installation located adjacent to the village of Waegwan in the south-central portion of Korea (Figure 1). Camp Carroll serves as the Headquarters, U.S. Army Material Support Command and functions as a staging ground for U.S. military operations on the Korean Peninsula. The primary mission of the base is to serve as a staging facility and a storage and maintenance depot. Urban areas bound Camp Carroll on the northwest, west, and southwest. Hilly, forested areas bound the base on the north and east. Agricultural fields (mostly rice paddies) border the camp on the northeast and the south. The Naktong River flows north-south approximately 0.5 kilometers west of Camp Carroll. The Land Farm and Area D sites are located on the central eastern installation boundary of Camp Carroll next to the H805 helipad. Figure 2 presents the locations of the Helipad, the Land Farm, and Area D.

(2) Helipad. The Camp Carroll Helipad consists of three landing pads connected by a system of runways adjacent to the Land Farm and Area D. It was reported that the western edge of the site was used for waste sludge burial in the 1980s (USACE, 1992). This area and an area west of the water treatment plant were used for disposal of sludge that was generated from oil/water separators associated with buildings 326 (engine testing facility), 327 (machine shop), 510 (electronics and communication equipment facility built over the site of a reported landfill), 665 (H-shop, heavy vehicle maintenance), and "possibly others."

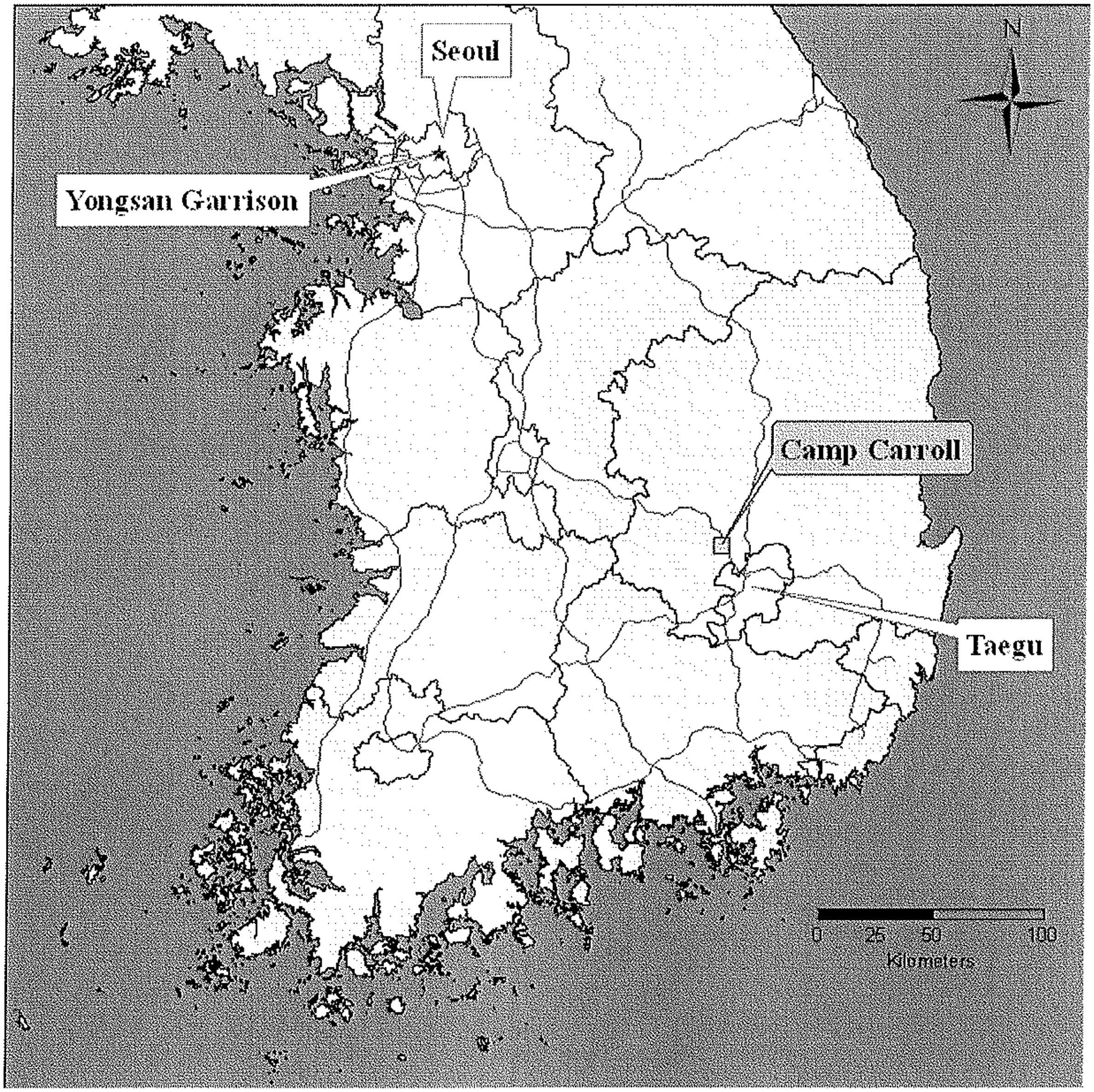

Figure 1. Location of Camp Carroll on the Korean Peninsula

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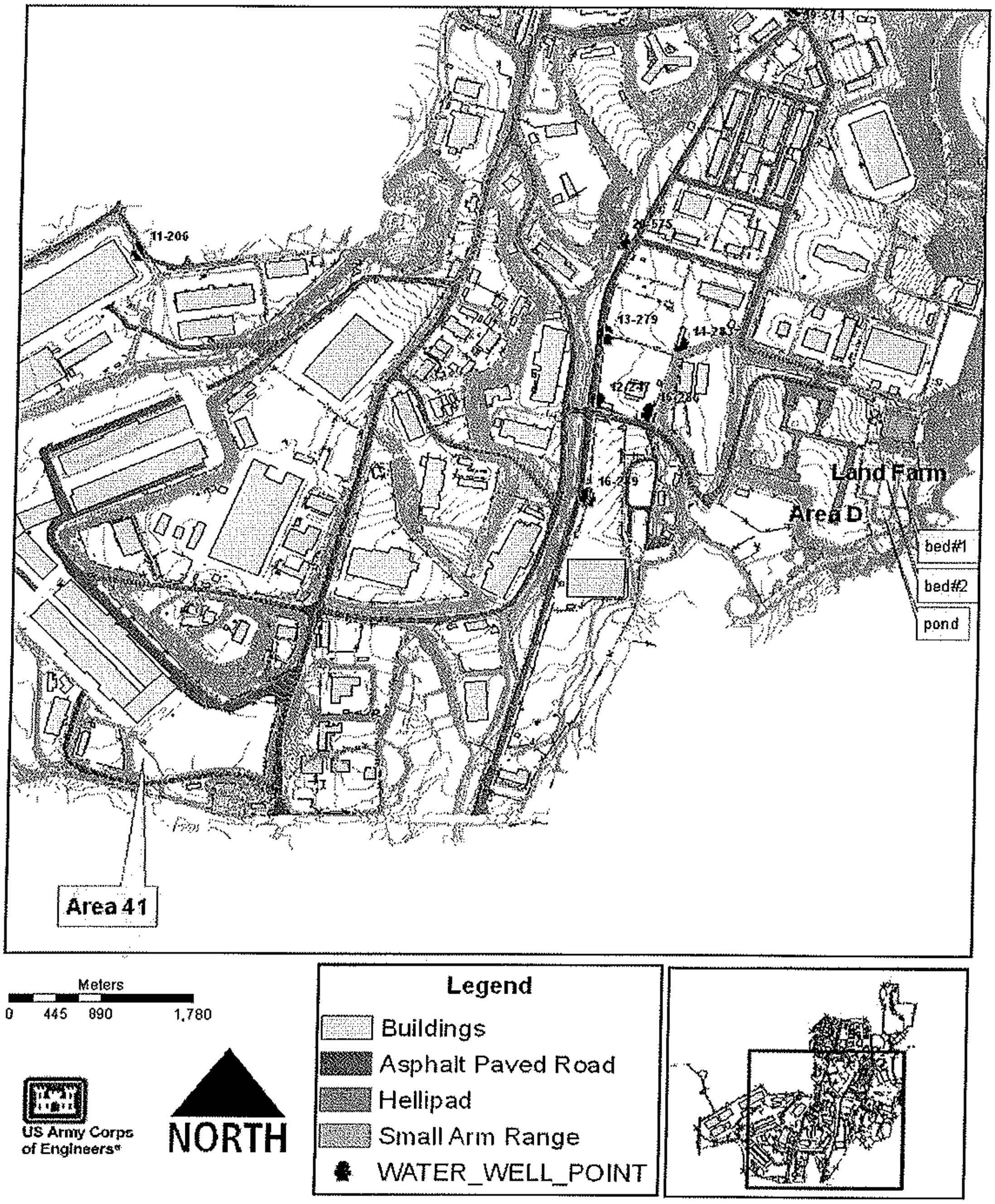

Figure 2. Locations of the Helipad, the Land Farm, and Area D on Camp Carroll

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(3) Land Farm. The Camp Carroll Land Farm consists of three engineered units for treatment of contaminated soil. Two of the units are treatment beds, referred to as Bed #1 at east and Bed #2 at west, and the third unit is a water retention pond. The dimensions of each treatment bed, which are bounded by a berm, are approximately 70 meters by 30 meters. The dimensions of the water retention pond are approximately 30 meters by 20 meters. The total Land Farm facility is approximately 9,100 square meters. Camp Carroll environmental Department of Public Works personnel suspect that contaminated soil and material from Area 41 were disposed of in the area now occupied by the Land Farm. Their suspicions are based on the fact that contaminated soil and waste materials, such as 1-gallon cans, were uncovered during the excavation and construction of Bed #1 in 1995 (northwest corner of Bed #1). The Land Farm is also located near to Area D.

(4) Area D.

(a) Area D is a former hazardous waste disposal area. Numerous hazardous materials were disposed of in this disposal area between the years of 1977 and 1982. Personnel interviews indicated that numerous drums of hazardous materials were transported to Area D from Area 41. The drums contained a variety of chemicals including pesticides (insecticides and herbicides), solvents, and over 100 other detected chemicals. The disposal area dimensions were approximately 150 meters by 75 meters in area and 6 to 9 meters deep. The 1992 Woodward-Clyde report reported that an open storage area supervisor stated that burning of materials occurred in this area (USACE, 1992).

(b) As previously stated, much of the disposal area material and surrounding soil was excavated between 1982 and 1983 and placed into 55-gallon drums (USAPACEHEA, 1982). The fate of the excavated drums is unknown. Despite the removal activity, residual amounts of contaminated material may have remained. No visual evidence of hazardous waste disposal, such as soil discoloration, dead vegetation, or hummocky terrain, was observed during a 1992 site inspection performed by a Woodward-Clyde Consultants field team (USACE, 1992).

c. <u>Summary of Previous Investigations</u>. The helipad site has not been previously investigated despite a 1992 historical report that identified a sludge burial site was located adjacent to the helipad (USACE, 1992). Two of the areas to be investigated (the Land Farm and Area D) have been previously evaluated for environmental conditions during an environmental site assessment (ESA) and preliminary site assessment (PSA) as follows.

- Land Farm:
  - ESA by the USACE Far East District (FED) in December 2004
  - Groundwater monitoring well construction at the Land Farm in 2007
  - Soil sampling to support of construction of treatment bed by the USACE FED in February 2008
  - Excavation of buried construction wastes, drums and cans during excavation for constructing a new treatment bed by the contractor (ECO Solutions, Inc) in March 2008

- Area D:
  - Historical Land Use and Background Survey by Woodward-Clyde in 1992
  - Site Investigation by Samsung in July 2004

(1) Land Farm.

(a) In 1992, monitoring well MW-23 was constructed by Woodward-Clyde personnel approximately 140 meters west of the Land Farm facility. A groundwater sample was collected from the well. No volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs) or organophosphorus (OP)-pesticides were detected in the groundwater sample collected from the well in 1992.

(b) In 2004, the ESA soil sampling results showed site soils were contaminated with VOCs (USACE, 2004). Most of the detected VOCs were solvent-related chemicals. VOC contamination was detected as deep as 6 to 8 meters below ground surface. In addition, several pesticide, metal, and dioxin/furan compounds were also detected in site soils. Arsenic was detected in one soil sample at a concentration greater than the U.S. Environmental Protection Agency (USEPA) guidance level for protection of groundwater. Preliminary findings indicate that VOC and arsenic contamination exist in site soils and the levels could contribute to the contamination of the underlying groundwater. Groundwater contamination could pose a threat to human health, because groundwater supply wells are used for Camp Carroll's potable water supply. It is important to note that this is not an actual exposure since Camp Carroll treats the groundwater before it enters the potable water system.

(c) In 2007, soil and groundwater were sampled and analyzed by the USACE FED to determine the level of chemicals potentially originating from the use of treatment facilities. Results showed there were no chemicals released into the environment from the treatment bed in use (USACE, 2008). However, soil sampling results showed that concentrations of VOCs were present, including tetrachloroethene (PCE) and trichloroethene (TCE) that exceeded USEPA Region 9 preliminary remedial goals

(PRGs) for residential soil and tap water. In addition, concentrations of organochlorinated (OC)-pesticides exceeded USEPA Region 9 PRGs for residential soil. Mixed total petroleum hydrocarbon (TPH) of JP-8, diesel, and oil was identified from one soil boring with the concentration of 10,000 milligrams per kilogram. Groundwater sampling results indicate that concentrations of VOCs including PCE and TCE exceeded USEPA PRGs for tap water. Concentrations of arsenic, lead, and OC-pesticides were detected in groundwater samples exceeding USEPA PRGs for tap water.

(d) In 2008, during soil excavation in support of a new treatment Bed #2, approximately 2,200 cubic meters of contaminated soils with various chemicals were excavated and stockpiled within the Land Farm facility. In association with the contaminated soil, buried materials were uncovered such as 55-gallon drums, 5-gallon cans, and construction debris. Most 55-gallon drums were empty and crushed. Despite the removal and excavation activities, residual amounts of contaminated material likely remained.

(2) Area D. In 2004, the Samsung Company conducted a site investigation at Area D, and reported that the soil contained numerous contaminants including TPH-gasoline (TPH-G), TPH-diesel (TPH-D), VOCs, SVOCs, pesticides, metals, and dioxins (USACE, 2004). Several soil contaminant concentrations exceeded USEPA Region 9 PRG screening criteria. Groundwater samples obtained from Area D monitoring wells contained concentrations of TPH-G and TPH-D, VOCs, SVOCs, pesticides, metals, and dioxins.

5. HERBICIDE ORANGE ALLEGATIONS.

a. In May 2011, former Soldiers were interviewed and alleged that they had taken part in the burial of hundreds of 55-gallon drums of Herbicide Orange and other chemicals in 1978. During these interviews, the former Soldiers named the possible locations of the alleged burial. Figure 3 shows these possible Camp Carroll locations.

b. While a search of the available records showed that an unauthorized burial of chemicals occurred during that approximate timeframe and some documentation contained a partial list of materials that might have been buried (USAPACEHEA, 1982 and 1983), none of the documents contained any reference to the existence of Herbicide Orange on Camp Carroll (USAPACEHEA, 1975). Additionally, the unauthorized burial was discovered in a short timeframe (approximately 2-4 years) and excavated for disposal.

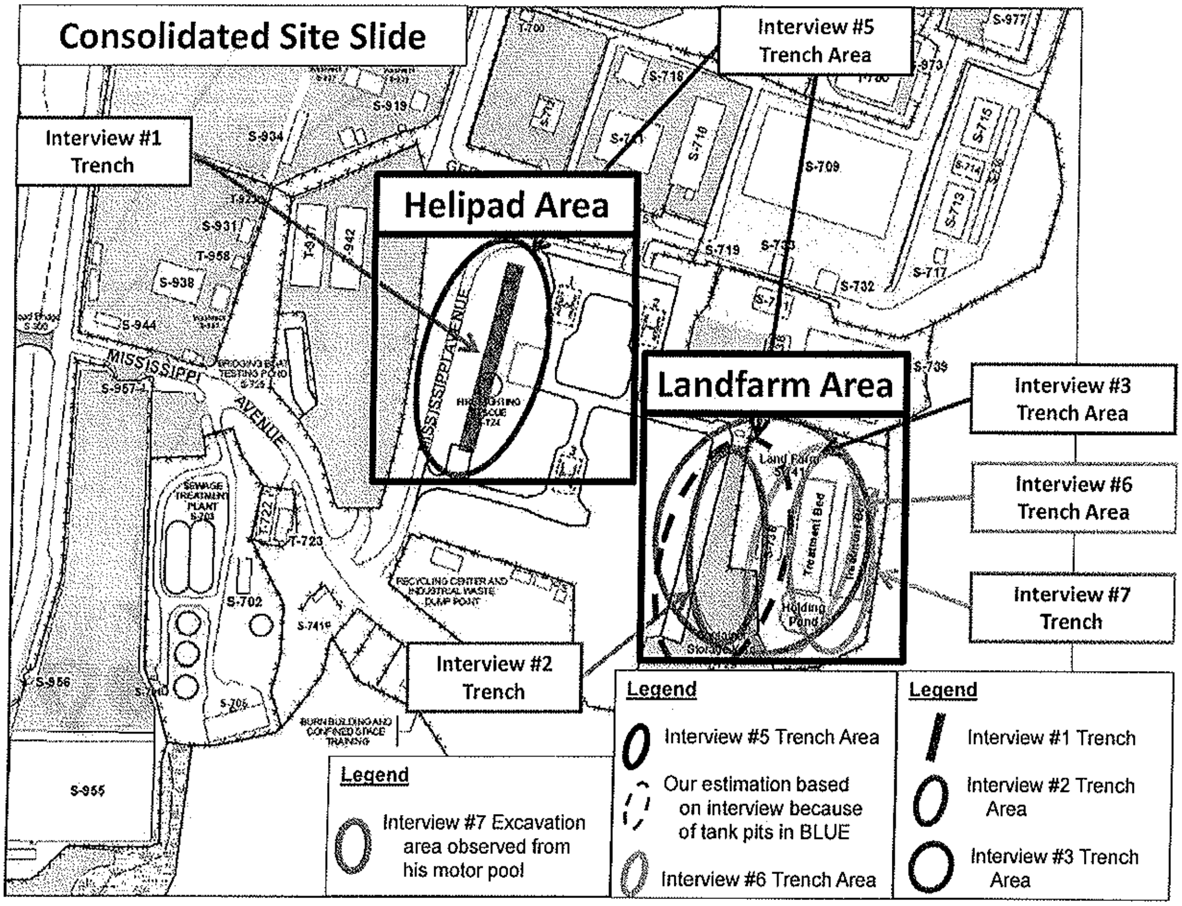

Figure 3. Possible Herbicide Orange Burial Locations on Camp Carroll Identified by the Former Soldiers

c. Agent Orange was a term coined by the media to refer to Herbicide Orange, one of the six tactical herbicides collectively referred to as Rainbow Herbicides. Herbicide Orange is a 50/50 mixture of the butyl esters of 2,4,5 trichlorophenoxyacetic acid (2,4,5-T) and 2,4 dichlorophenoxyacetic acid (2,4-D). While 2,4-D and 2,4,5-T were widely used agricultural herbicides, Herbicide Orange was manufactured specifically for the Department of Defense and used in Vietnam from 1965 to 1971. The use of Herbicide Orange was discontinued in 1971 after the 2,4,5-T constituent was discovered to be contaminated with 2,3,7,8 tetrachlorodibenzodioxin (TCDD). After 1971, stocks of Herbicide Orange were consolidated for disposal by incineration. All known supplies were confirmed incinerated by 1977 (Young, 2008 and 2006).

d. On the Korean peninsula, Herbicide Orange was used on the DMZ from 20 March 1968 to 1 July 1968. Supplies of Herbicide Orange, Herbicide Blue, and Monuron (Monuron is a commercially available pelletized herbicide) were obtained and provided to the Republic of Korea (ROK) Army for application. The ROK Army treated an area from the DMZ south tape to the civilian control line to reduce concealment and reduce infiltration from the north. Approximately 380 55-gallon drums of Herbicide Orange were used to treat 6,966 acres (Young, 2008). Reportedly, all supplies were exhausted before treating all of the desired area.

e. Since Herbicide Orange consisted of a specific and limited set of constituents, the investigation into the burial allegations can be focused on the analysis of soil and groundwater for 2,4-D, 2,4,5-T, and their breakdown products, and TCDD. Data for the risk assessment consisted of the analysis of soil and groundwater for a full range of environmentally significant chemicals as defined by the USEPA and with concurrence from the Ministry of Environment for the ROK. Appendix B contains the full data set.

f. Soil and groundwater sampling was performed by the USACE FED to determine the validity of this allegation and provide data for this human health evaluation. The sampling was performed in sections or phases which correspond to the specific sites named in the allegation: the western portion of the Camp Carroll helipad, defined as Phase I; the eastern portion of the Camp Carroll helipad, defined as Phase IIB; and the Land Farm/Area D area, defined as Phase II.

(1) Phase I.

(a) As a first field step, a geophysical survey was performed for each of the affected areas (SEKOGEO, 2011). Figure 4 shows the resulting anomalies from three geophysical procedures (Ground Penetrating Radar, Direct Current Resistivity, and Magnitometry). Soil borings were performed to provide an adequate database for investigating the allegation and calculating the human health risk assessment. Groundwater sampling data was provided from the monitoring results of nearby monitoring wells (B09-176, B09-177, and B09-178). Figure 5 shows the locations of the soil borings.

(b) While the data shows detections of several chemicals, the constituents of Herbicide Orange (2,4-D and 2,4,5-T) were not confirmed in any soil or groundwater sample. Initially, five groundwater samples were reported to contain low levels of 2,4,5-T but the detections were determined to be interferences upon confirmation testing (Appendix D). TCDD was found in low concentrations in 15 of 118 soil samples ranging from nondetect to 0.189 picograms per gram (pg/g). The spatial distribution of

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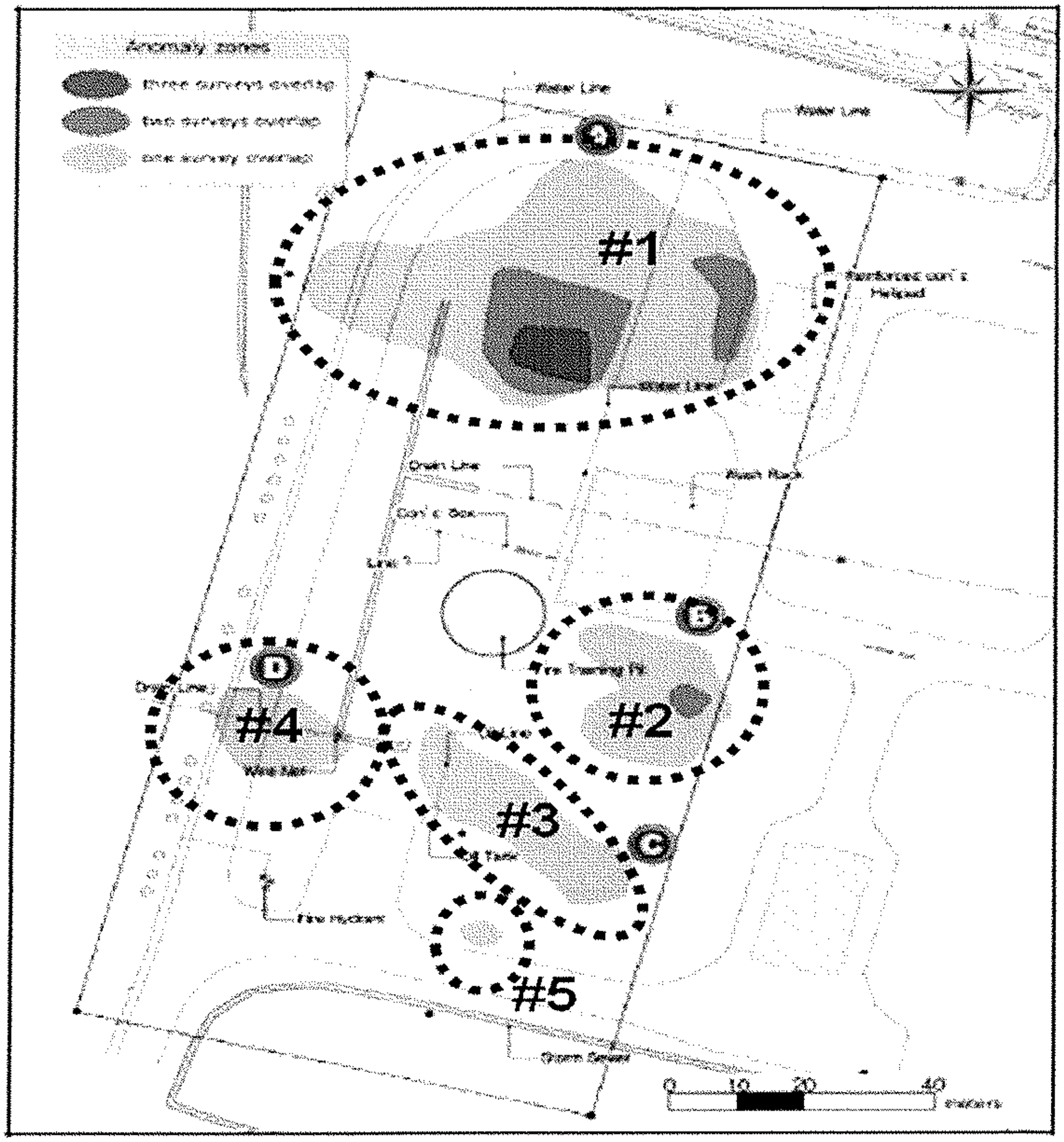

Figure 4. Final Interpretation of Subsurface Anomalies in Phase I (SEKOGEO, 2011)

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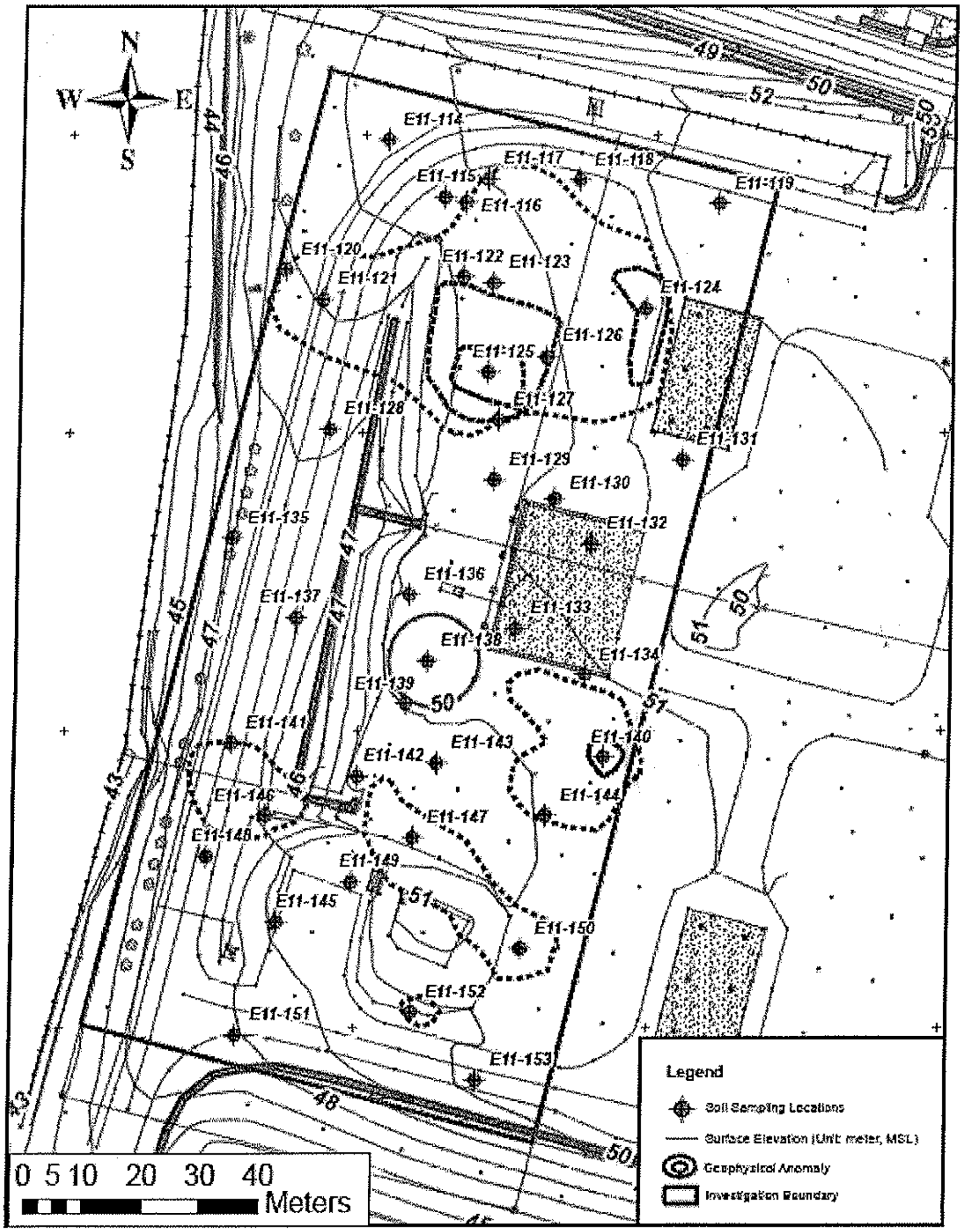

Figure 5. Soil Sampling Locations for Phase I Superimposed on the Geophysical Anomalies

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the TCDD detections shows a vertically and horizontally sporadic pattern not indicative of a plume. Such concentrations and distributions are indicative of background concentrations. These results are consistent with dioxin detections in other areas of Korea and other countries considered as ubiquitous (Hyeon et al., 2002).

(c) The historical record of a very limited use of Herbicide Orange on the Korean peninsula (DMZ) and the analytical results showing a lack of any concentration of the main ingredients of Herbicide Orange lead us to conclude that Herbicide Orange was not buried or used in the area of the Phase I site.

(2) Phase II/IIB.

(a) As with the Phase I site, the investigation of these sites began with a geophysical survey. Figure 6 shows the resulting anomalies from three geophysical procedures (ground penetrating radar, direct current resistivity, and magnitometry). These results were used to guide the locations of soil borings. Soil borings and soil sampling were performed to provide an adequate database for investigating the allegation and calculating the human health risk assessment. Groundwater sampling data were provided from the monitoring results of nearby monitoring wells (B09-193, B07-217, B07-218, B07-219, B07-220, B07-221, B07-222, B09-221, B03-467, B03-463, and B03-466 for the Phase II site; B09-176, B09-177, B09-178, B09-221, B03-364, B03-365, and B03-368 for the Phase IIB site). Figure 7 shows the locations for the Phase II/IIB soil borings and existing monitoring wells.

(b) While the data shows detections of several chemicals, the constituents of Herbicide Orange (2,4-D and 2,4,5-T) were not confirmed in any soil or groundwater sample collected in these phase sites. Three groundwater samples, collected from wells B03-463, B03-466 and B03-467, were initially reported to contain low levels of 2,4,5-T but the detections were determined to be interferences upon confirmation testing (Appendix D). Three soil samples were found to have TCDD levels greater than the reporting limit. These concentrations ranged from 0.502 pg/g (nanograms per kilogram) to 7.44 pg/g. Two of these detections were found in surface soils. The third detection (E11-171 [S3]) was found in a subsurface depth in a soil layer where the bore log indicated some fragments of waste (plywood, porcelain). The spatial distribution of the TCDD detections shows a vertically and horizontally sporadic pattern not indicative of a plume. With the exception of the results of the sample collected in the waste layer, such concentrations and distributions are indicative of background concentrations. These results are consistent with dioxin detections in other areas of Korea and other countries considered as ubiquitous (Hyeon et al., 2002).

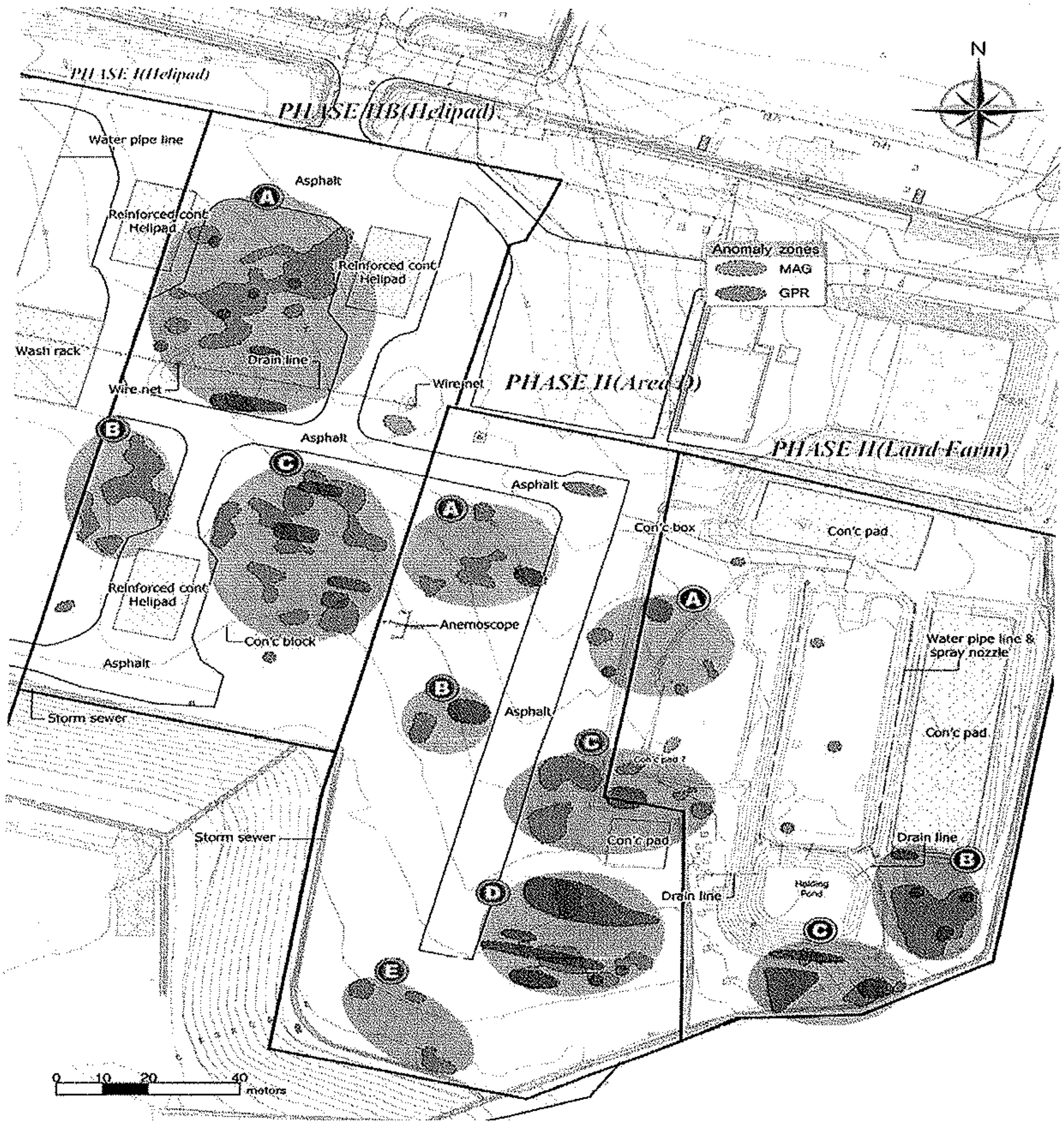

Figure 6. Geophysical Anomalies for the Phase II/IIB Sites

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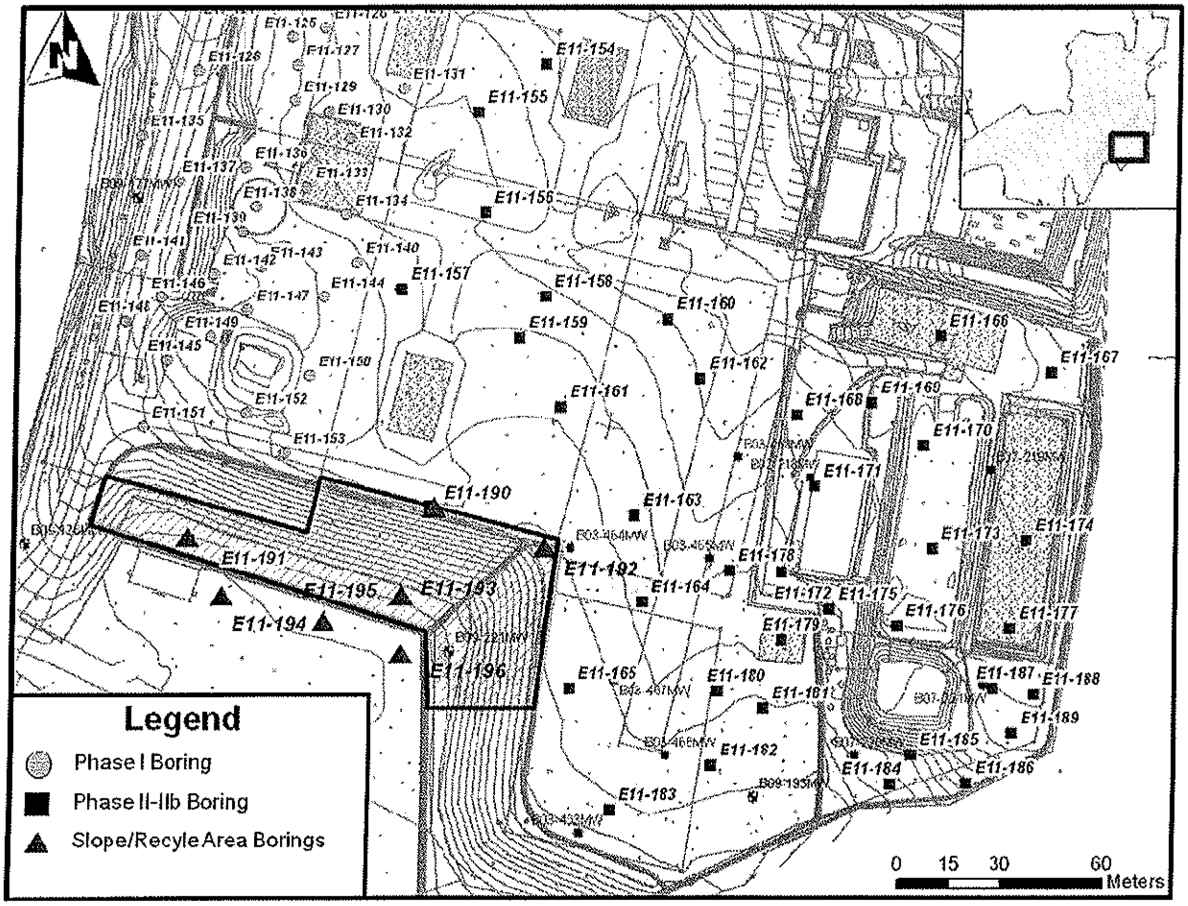

Figure 7. Locations of the Phase II/IIB Soil Borings and the Existing Monitoring Wells

(c) The historical record of a very limited use of Herbicide Orange on the Korean peninsula (DMZ) and the analytical results showing a lack of a concentration of the main ingredients of Herbicide Orange lead us to conclude the Herbicide Orange was not buried or used in the area of the Phase II/IIB sites.

6. HEALTH RISK ASSESSMENT.

a. These sites are being evaluated to determine whether a human health threat exists from residual contamination in surface and subsurface soil, groundwater, and drinking water. Former Soldiers have made allegations that the areas in question were used for burial of Herbicide Orange and other hazardous materials and wastes in 1978.

While records show that the Land Farm and Area D were used for waste burial, an unauthorized burial of materials was subsequently excavated and believed to be disposed of properly. The current effort is designed to determine whether Herbicide Orange residue can be found in the soil and groundwater at the sites and determine whether other operations at the sites have resulted in a human health concern. Based on the current and the possible future use of these sites, receptors that could be exposed to chemicals at these sites include:

(1) Industrial Workers in the Buildings Surrounding the Helipads. These are individuals that work in and around the buildings near the helipads for 250 days/year for their entire career (25 years). They are exposed to surface soils through incidental ingestion, dermal contact, and inhalation of soil particles and vapors. They are also exposed to chemicals in the drinking water and possible chemical vapors volatilizing through the floor from the groundwater.

(2) Utility/Grounds Maintenance Workers. These individuals maintain the utilities and grounds around the helipads for the warm seasons (125 days/year) for their entire career (25 years). They are exposed to surface soil (125 days/ year) and subsurface soil (50 days/year) through incidental ingestion, dermal contact, and inhalation of soil particles and vapors. They are also exposed to chemicals in the drinking water.

(3) Soldiers in Training Scenarios. These individuals are stationed at Camp Carroll for 5 years. The most protective assumption is that their entire exposure to the environment occurs at or near the investigation sites. They are exposed to surface soil (250 days/year) and subsurface soil (14 days/year) through incidental ingestion, dermal contact, and inhalation of soil particles and vapors. They are also exposed to chemicals in the drinking water and chemicals in the groundwater through incidental ingestion and dermal contact.

(4) Future Construction Workers. These individuals are engaged in building a structure at the investigation site for 9 months out of the year (190 days/year) for a single year. They are exposed to surface soil (190 days/year) and subsurface soil (50 days/year) through incidental ingestion, dermal contact, and inhalation of soil particles and vapors. They are also exposed to chemicals in the drinking water and chemicals in the groundwater through incidental ingestion and dermal contact.

(5) Residential Adult Receptor. This receptor was also evaluated to aid in the decision making. This is an individual that lives directly within the investigation site for 350 days/year for 30 years. This individual is exposed to surface soils through incidental ingestion, dermal contact, and inhalation of soil particles and vapors. This

individual is also exposed to chemicals in the drinking water and possible chemical vapors volatilizing through the floor from the groundwater.

b. Exposures at these sites include contact with the soil (such as, incidental ingestion, inhalation of fugitive dust, and dermal contact), drinking water (ingestion), and groundwater (incidental ingestion, vapor intrusion into buildings, and dermal contact). No surface water or sediment exists on this site; thus, these pathways were eliminated.

c. Using the methodology outlined by the USEPA, a risk assessment was performed for current and future users of the affected sites: the western portion of the Camp Carroll helipad, defined as Phase I; the eastern portion of the Camp Carroll helipad, defined as Phase IIB; and the Land Farm/Area D area, defined as Phase II. Site-specific sampling of the surface and subsurface soil was combined with groundwater monitoring and potable water monitoring data to define the extent of known and suspected contamination. The USEPA risk estimates represent a high-end estimate from exposure to a site. Most, if not all, of the parameters used in the calculations are inflated by safety factors to ensure that the values are protective of human health. As such, the estimates cannot be used as an absolute determination of a health effect to any specific individual since all receptors are hypothetical. The notation for risk is called scientific notation; 1E-06 means one (1) occurrence out of one million individuals under identical circumstances. The carcinogenic risk denotes a probability of the occurrence of cancer (not mortality). The noncarcinogenic risk of the hazard index (HI) is a ratio of the exposure concentration to the highest concentration that is believed to have no adverse health effect.

d. Figure 8 shows the boundaries of the areas used for the risk assessment. These areas are slightly modified from the definition of the Phases I, II, and IIB areas defined for the sampling portion of this human health risk assessment. This change was made to better align the risk assessment areas with areas of higher chemical concentrations. Appendix C contains the full text for the risk assessment.

e. Hypothetical users of the site consisted of: industrial workers, utility/grounds maintenance workers, construction workers, and Soldiers in field training. A hypothetical adult resident was also evaluated for informational purposes only.

(1) Phase I.

(a) The total Phase I site carcinogenic risk ranged from 3.1E-07 for the training Soldier to 3.5E-05 for the utility/grounds maintenance worker. The calculated risk for this site is smaller than the health-based criteria (i.e., 1E-04) used by the USEPA to determine if any further action is warranted.

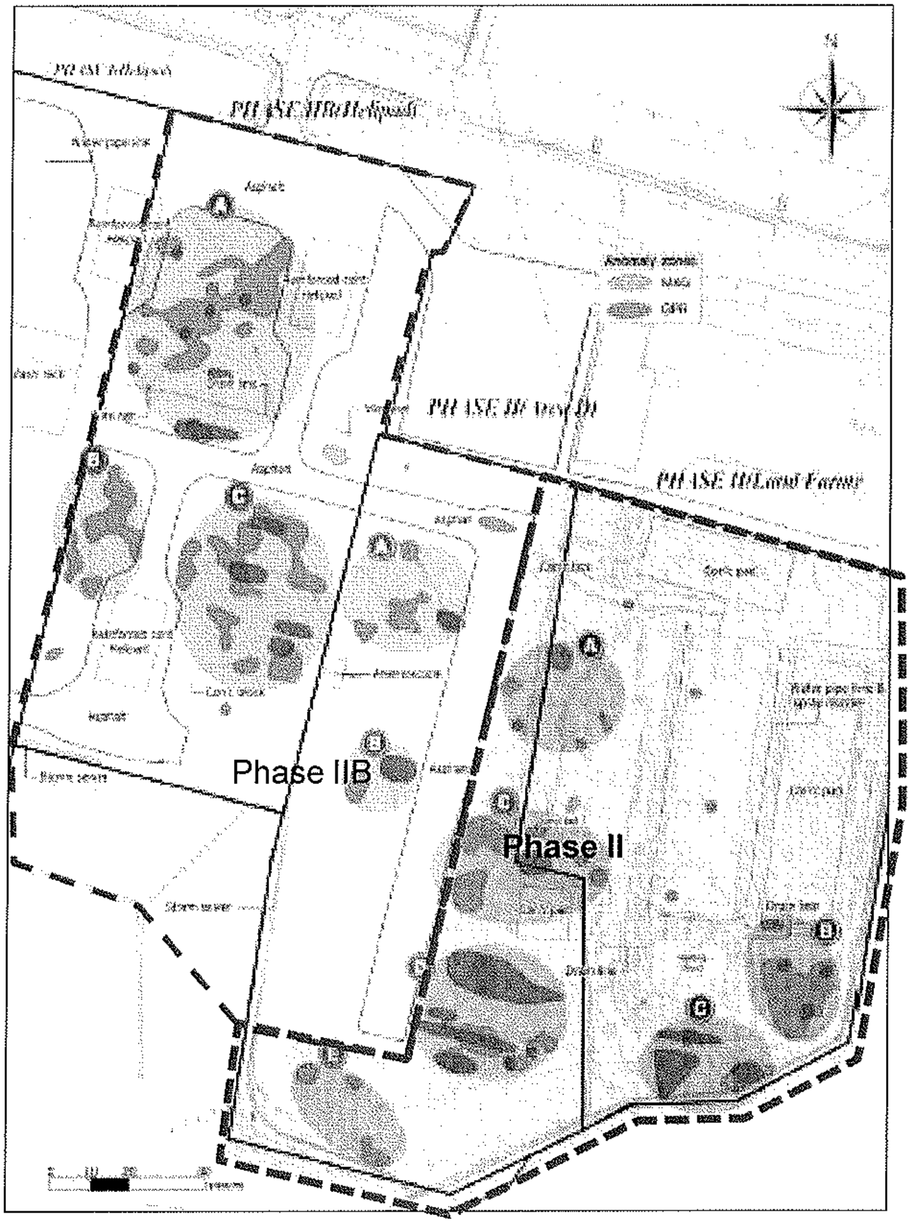

Figure 8. Areas Used for the Risk Assessment

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(b) The total Phase I site HI or noncarcinogenic risk ranged from 8.4E-05 for the industrial worker to 6.8E-02 for the utility/grounds maintenance worker. The calculated risk for this site does not exceed the health-based criteria (i.e., 1E+00 or Unity) used by the USEPA to determine if any further action is warranted.

(2) Phase II.

(a) The total Phase II site carcinogenic risk ranged from 3.8E-06 for the construction worker to 9.1E-05 for the utility worker. All the calculated carcinogenic risks for this site are smaller than the health-based threshold of 1.0E-04 used by the USEPA to determine if any further action is warranted.

(b) The total Phase II site HI or noncarcinogenic risk ranged from 1.8E+00 for the hypothetical adult resident to 2.2E-01 for the training Soldier. With the exception of the industrial worker and the hypothetical adult resident, the calculated noncarcinogenic risk for this site does not exceed the health-based criteria of unity (1) used by the USEPA as guidance to determine if any further action is warranted. The exceedance of the USEPA criteria for both receptors is due to vapor intrusion of trichloroethene in the groundwater. The vapor intrusion model used assumptions of the construction of the building and the parameters of the underlying soil which most likely over estimates the transport of chemicals into the building, thus the small exceedance of the threshold should not be taken to indicate a health concern. It is important to note here that the adult resident receptor was included in this assessment for informational purposes only since this area is not being considered for future residential development. However, should the current and anticipated land use scenario change to future residential development, these results would indicate that the Phase II site should be considered for further evaluation of the vapor intrusion pathway.

(3) Phase IIB.

(a) The total Phase IIB site carcinogenic risk ranged from 5.4E-06 for the construction worker to 9.0E-05 for the utility/grounds maintenance worker. All the calculated carcinogenic risks for this site are smaller than the health-based threshold of 1.0E-04 used by the USEPA to determine if any further action is warranted.

(b) The total Phase IIB site HI or noncarcinogenic risk ranged from 4.1E-01 for the industrial worker to 9.6E-01 for the construction worker. The calculated risk for this site does not exceed the health-based criteria of unity (1) used by the USEPA to determine if any further action is warranted.

7. CONCLUSIONS. This assessment must not be used as an absolute determination of the probability of health effects from the possible exposures at this site because of the limitations and assumptions inherent in risk assessment. The health risk evaluation was focused on estimating potential environmental exposures and may not represent an actual exposure or risk at the site. This assessment should only be used as guidance for making decisions about the site.

a. Phase I.

(1) Soil and groundwater data collected in the Phase I site (west end of the Helipad) does not indicate that Herbicide Orange was buried at or near this site.

(2) The health risk evaluation performed for the Phase I site determined that exposure to this site by a hypothetical industrial worker, utility/grounds maintenance worker, construction worker, training Soldier, or adult resident would not result in a significant adverse health threat.

b. Phase II.

(1) Soil and groundwater data collected in the Phase II site (east end of the Helipad) does not indicate that Herbicide Orange was buried at or near this site.

(2) The total Phase II site carcinogenic risk ranged from 3.8E-06 for the construction worker to 9.1E-05 for the utility worker. All the calculated carcinogenic risks for this site are smaller than the health-based threshold of 1.0E-04 used by the USEPA to determine if any further action is warranted.

(3) The total Phase II site HI or noncarcinogenic risk ranged from 1.8E+00 for the hypothetical adult resident to 2.2E-01 for the training Soldier. With the exception of the industrial worker and the hypothetical adult resident, the calculated noncarcinogenic risk for this site does not exceed the health-based criteria of unity (1) used by the USEPA to determine if any further action is warranted. The exceedance of the USEPA criteria for both receptors is due to vapor intrusion of trichloroethene in the groundwater. Should the future land use be changed to residential development, consideration should be given to further evaluation of the vapor intrusion pathway.

c. Phase IIB.

(1) Soil and groundwater data collected in the Phase IIB site (Land Farm and Area D) does not indicate that Herbicide Orange was buried at or near this site.

(2) The total Phase IIB site carcinogenic risk ranged from 5.4E-06 for the construction worker to 9.0E-05 for the utility/grounds maintenance worker. All the calculated carcinogenic risks for this site are smaller than the health-based threshold of 1.0E-04 used by the USEPA to determine if any further action is warranted.

(3) The total Phase IIB site HI or noncarcinogenic risk ranged from 4.1E-01 for the industrial worker to 9.6E-01 for the construction worker. The calculated risk for this site does not exceed the health-based criteria of unity (1) used by the USEPA to determine if any further action is warranted.

8. RECOMMENDATIONS. No recommendations are necessary.

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9. TECHNICAL ASSISTANCE. For further assistance, contact [redacted] Program Manager, Environmental Health Risk Assessment at co[redacted]ercial 410-436-2953, DSN 584-2953, or e-mail [redacted]il.

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Medical Officer
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Section Chief
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APPROVED:

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Program Manager
Environmental Health Risk Assessment

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APPENDIX A

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APPENDIX B

LABORATORY DATA

Technical_commette_report(7-13)
Water Test Results Cp Carroll 2011
11-032E_E2011-59 final phase I data report
Camp Carroll drinking water quality
Area D land farm water data 2011 RI
11-032E_E2011-62 final phase II IIB data

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DRINKING WATER QUALITY FOR CAMP CARROLL Finish water

Analytical Method & Chemical Parameter	Sample Collected		2010				2011				2012				2013			
			Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec
			1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Pesticides (525.2)	MDL (μg/l)	MCL (μg/l)																
alachlor*	0.2	2		<MDL														
atrazine	0.1	3		<MDL														
benzo [a] pyrene	0.02	0.2		<MDL														
chlordane	0.2	2		<MDL														
di (2-ethylhexyl) adipate	0.6	400		<MDL														
di (2-ethylhexyl) phtalate	0.6	6		<MDL														
endrin	0.02	2		<MDL														
heptachlor	0.04	0.4		<MDL														
heptachlorepoxide	0.02	0.2		<MDL														
hexachlorbenzene	0.1	1		<MDL														
hexachlorocyclopentadiene	0.1	50		<MDL														
lindane	0.02	0.2		<MDL														
methoxychlor	0.1	40		<MDL														
simazine	0.07	4		<MDL														
toxaphene	1	3		<MDL														
DBCP/EDB (504.1)	MDL (μg/l)	MCL (μg/l)																
dibromochloropropane (DBCP)	0.02	0.2					<MDL	<MDL										
ethylene dibromide (EDB)	0.01	0.05					<MDL	<MDL										
PCBs (508A)	MDL (μg/l)	MCL (μg/l)																
PCBs (as decachlorobiphenyl)	0.1	0.5		<MDL														
Herbicides (515.1)	MDL (μg/l)	MCL (μg/l)																
2,4,5-TP (silvex)	0.2	50		<MDL														
2,4-D	0.1	70		<MDL														
dalapon	0.2	200		<MDL														
dinoseb	0.2	7		<MDL														
pentachlorophenol	0.04	1		<MDL														
picloram	0.1	500		<MDL														
Carbamates (531.1)	MDL (μg/l)	MCL (μg/l)																
aldicarb	0.5	3					<MDL	<MDL										
aldicarb sulfone	0.8	3					<MDL	<MDL										
aldicarb sulfoxide	0.5	4					<MDL	<MDL										
carbofuran	0.9	40					<MDL	<MDL										
oxamyl (vydate)	2	200					<MDL	<MDL										
	MDL (μg/l)	MCL (μg/l)																
Glyphosate (547)	6	700					<MDL	<MDL										
Endothall (548.1)	9	100		<MDL														
Diquat (549.2)	0.4	20					<MDL											
Dioxin (1613)	0.000005	0.00003		<MDL														

Analytical Method & Chemical Parameter	Sample Collected		2010				2011				2012				2013			
			Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec
			1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
VOCs (524.2)	MDL (µg/l)	MCL (µg/l)																
1,1,1-trichloroethane	0.5	200	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
1,1,2-trichlorethane	0.5	5	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
1,1-dichlorethylene	0.5	7	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
1,2,4-trichlorobenzene	0.5	70	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
1,2-dichloroethane	0.5	5	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
1,2-dichloropropane	0.5	5	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
benzene	0.5	5	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
carbon tetrachloride	0.5	2	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
cis-1,2-dichloroethylene	0.5	70	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
dichloromethane	0.5	5	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
ethylbenzene	0.5	700	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
monochlorobenzene	0.5	100	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
o-dichlorobenzene	0.5	600	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
para-dichlorobenzene	0.5	75	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
styrene	0.5	100	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
tetrachloroethylene	0.5	5	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
toluene	0.5	1000	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
trans-1,2-dichloroethylene	0.5	100	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
trichloroethylene	0.5	5	0.7	1.6	1.1	0.8	0.9	0.8										
vinyl chloride	0.5	2	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
xylene (total)	0.5	10000	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL										
TTHMs (524.2)[1]	MDL (µg/l)	MCL (µg/l)																
WTP, Bldg #	0.5	80																
Site #1: S-80	0.5	80		9.4				9.3										
Site #2:	0.5	80																
Site #3:	0.5	80																
Site #4:	0.5	80																
HAA5 (552)[1]	MDL (µg/l)	MCL (µg/l)																
WTP, Bldg #	0.5	60																
Site #1: S-80	0.5	60			2.1			6										
Site #2:	0.5	60																
Site #3:	0.5	60																
Site #4:	0.5	60																
Asbestos (100.2)	MDL (Mf/l)	MCL (Mf/l)																
	n/a	7		<0.2														

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Analytical Method & Chemical Parameter	Sample Collected		2010				2011				2012				2013			
			Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec
			1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Metals (200.7/200.8*)	MDL (mg/l)	MCL (mg/l)																
antimony	n/a	0.006	<MDL					<MDL										
arsenic	n/a	0.05	<MDL					0.0014										
barium*	n/a	2	0.041					0.037										
beryllium	n/a	0.004	<MDL					<MDL										
cadmium	n/a	0.005	<MDL					<MDL										
chromium	n/a	0.1	<MDL					<MDL										
mercury	n/a	0.002	<MDL					0.00024										
nickel	n/a	0.1	<MDL					<MDL										
selenium	n/a	0.05	<MDL					<MDL										
sodium	n/a	Report only	22					21										
thallium	n/a	0.002	<MDL					<MDL										
Lead and Copper (200.8)	MDL (mg/l)	MCL (mg/l)																
# OF SAMPLES REQUIRED																		
90 Percentile lead	n/a	0.015																
90 Percentile copper	n/a	1.3																
Nitrate/Nitrite (300.0)	MDL (mg/l)	MCL (mg/l)																
Nitrate/Nitrite - Combined	0.5	10																
Nitrate	5	10	3.2				3.6											
Nitrite	0.5	1																
Fluoride (300.0)[2]	MDL (mg/l)	MCL (mg/l)																
	n/a	4	0.29				<0.25											
Cyanide (335.3)	MDL (mg/l)	MCL (mg/l)																
	n/a	0.2	<MDL				<MDL	<MDL										
Perchlorate (331)	MDL (mg/l)	MCL (mg/l)																
	n/a	4		1.5														
Radiologicals[3] (900/903.1/904.1/905/H_002)	MDL (pCi/l)	MCL (pCi/l)																
gross alpha and beta (900)	5	15																
gross alpha (900)	2	15						<1.3										
gross beta (900)	2	50						2.1										
Cesium-134 (901.1)	n/a	80						<1.3										
Cesium-137 (901.1)	n/a	200						<1.6										
Iodine-131	n/a	3						<3.9										

1 - Compliance for the TTHM 80 µg/l MCL and the HAA5 60 ug/l MCL is based on a distribuion system running annual average

2 - Fluoride MCL is based on recent promulated FGS standards (compliance by 20 Oct 13).

3- At the very minimum, gross alpha is required at the minimum and subsequent radiological analysis may be triggered based on gross alpha results. Gross beta required for surface water and GWUDI systems that serve a pop. >100,000

<MDL = Below Minimum Detection Limit. If there are detections for contaminants above their respective MDL, increased monitoring is triggered.

NT = Not Tested

n/a = not applicable

<AL = Below Action Level

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, FAR EAST DISTRICT
Unit #15546
APO AP 96205-5546

REPLY TO
ATTENTION OF:

SEP 09 2011

CEPOF-ED-G

MEMORANDUM FOR USFK Assistant Chief of Staff, Engineers, ATTN: Colonel Joseph F. Birchmeier, UNIT #15237, APO AP 96205-5237

SUBJECT: Final Test Results of Phase I (Helipad) Soil Samples, Cp Carroll, Korea (G&E 11-032E/E2011-59)

1. Enclosed are final test results for soil samples collected at Phase I (Helipad) Site, Cp Carroll. Soil sampling was conducted from 12 Jul to 18 Jul 2011 and a total of 118 samples were collected from 40 boreholes by the Geotechnical and Environmental Engineering Branch, US Army Corps of Engineers, Far East District (FED). The locations of boreholes are shown in Figure 1 and sample information, with sampling depth, is provided in Table 1.

2. The samples were tested by SGS North America located in Wilmington, NC, according to US EPA SW-846 Methods. The analytical parameters tested were dioxins and furans, chlorinated herbicides, organochlorine (OC) pesticides, organophosphorus (OP) pesticides, volatile organic compounds (VOC), semivolatile organic compounds (SVOC), and RCRA (Resource Conservation and Recovery Act) metals. Three (3) samples were tested by the US Army Public Health Command as duplicate analyses for quality assurance purposes. A total of 205 analytes were tested for each soil sample. Table 2 provides test method information for each analytical parameter.

3. Laboratory Findings

Summaries of test results for each analytical parameter are provided in Tables 3 through 9. The highlighted numbers indicate detections of contaminants. The summary tables presented in this memorandum indicate those parameters which were detected above the reporting limit or, at least, estimated to be above its reporting limit. The full laboratory reports are provided on compact disk (CD).

a. **Dioxin and Furan**: The chemical compound, 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), is one of the Agent Orange indicator compounds found in dioxin and furan congeners. The compound 2,3,7,8-TCDD was detected in 15 samples at the levels between 0.080 and 0.189 pg/g. The results for all 15 samples were less than reporting limit and EMPC-flagged (estimated maximum possible concentration). The EMPC flag means the results were calculated from a signal which did not meet the mass spectrum quality criteria, but was estimated as the maximum possible concentration under the assumption the signal is only originated from the analyte. None of the samples were detected for 2,3,7,8-TCDD at levels greater than reporting limits. Most of dioxin and furan congeners were found at levels between detection

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limits and reporting limits and are identified with the flag "J". OCDD was the most common dioxin found during sampling and was detected in 116 out of 118 samples tested. The maximum concentration was 524 pg/g at E11-150-S1 (0-0.5m depth). The toxic equivalence factor (TEF) of OCDD for human health risk is relatively lower (TEF=0.0003) than other dioxin congeners. Calculated toxic equivalent (TEQ) values ranged from 0.005 to 1.156 pg/g based on 2005 World Health Organization (WHO) evaluation.

b. **Chlorinated Herbicide**: No chlorinated herbicides were detected in any of the collected samples. Agent Orange-related chemicals in chlorinated herbicides are 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). The reporting limits of Agent Orange constituents range from 0.016 to 0.019 mg/kg for both of 2,4-D and 2,4,5-T.

c. **OC-Pesticide**: Analytes such as 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, alpha-BHC, delta-BHC, gamma-BHC (Lindane) and gamma-Chlordane were detected in 62 samples. Gamma-BHC has the highest concentration among the analytes and it was found at the concentration of 163,000 μg/kg in E11-118-S2 (0.5-2.0m depth).

d. **OP-Pesticide**: No OP-pesticides were detected in any of the collected samples.

e. **VOC**: A number of VOCs were detected in the collected samples. Tetrachloroethene (PCE) was detected in 25 samples out of a total of 118 samples tested and had the highest VOC concentration of 18,000 μg/kg at E11-119-S2 (0.6-2.0m depth). Trichloroethene (TCE) was detected in 3 samples and had the highest concentration of 186 μg/kg at the same borehole and depth. Benzene had the highest concentration of 117 μg/kg at E11-118-S3 (2.0-5.0m depth). Total xylenes had the highest concentration of 1683 μg/kg at E11-118-S2 (0.5-2.0m depth).

f. **SVOC**: A few SVOC analytes were detected at levels between detection limits and reporting limits.

g. **Metal**: Arsenic and lead were detected in 117 and 118 samples respectively. E11-135-S1 (0-0.5m depth) was found to have the highest concentration for both analytes; 39 mg/kg of arsenic, 138 mg/kg of lead. Mercury was detected at levels between detection limits and reporting limits, the maximum concentration was 0.0147 mg/kg at E11-134-S1 (0-0.5m depth).

4. Quality Control and Quality Assurance

a. **Data Validation**

Chemical data validation was conducted by US Army Corps of Engineers, Honolulu District using Automated Data Review (ADR) Version 8.2. Results for dioxin/furan analyses were evaluated in accordance with guidance provided in the *National Functional Guidelines for Chlorinated Dibenzo-p-Dioxins and Chlorinated Dibenzofurans*, OSWER 9240.1-51. Results for organic analyses and inorganic analyses were evaluated in accordance with *National Functional Guidelines for Superfund Organic Methods Data Review*, OSWER 9240.1-48 and *National Functional Guidelines for Inorganic Superfund Data Review*, OSWER 9240.1-51, respectively. Full data validation reports are included on compact disk (CD).

(1) Sample Preservation: All samples must be refrigerated at 4 ± 2°C from the time of receipt (time of collection when possible) until the time of extraction. All samples were received by the laboratory at temperatures between 1 °C and 6 °C. The temperature discrepancies are slight and should not affect the validity of the data.

(2) Holding Times: The maximum allowable holding time between sample collection and sample preparation or sample preparation and sample analysis depends on the analyte. All samples were prepared and analyzed within the allowable holding times specified by the appropriate method. There was no holding time discrepancy.

(3) Quality Control Samples: The Validation report summarized the evaluation of the performance of QC samples such as blanks, surrogate spikes, laboratory control samples, and matrix spike/matrix spike duplicates. The validation report includes identification of reported results which need to be qualified (flagged) due to quality control issues, and the reasons for the flags. For example, methylene chloride in VOC was detected in some laboratory blanks at concentration levels above reporting limits. Methylene chloride results of field samples were determined "not detected" depending on level of detection for this sample group. Hexachlrocyclopentadiene results in SVOC were unacceptably high at laboratory control samples in some sample groups. The hexachlrocyclopentadiene results were rejected for the sample groups. The rejected results were identified with the flag "R".

(4) Summary: Laboratory data packages were reviewed for preservation, holding times, blanks, surrogate spikes, laboratory control samples, and matrix spike/matrix spike duplicates. The evaluation for these parameters is considered to be a "Level 2b" Data Validation. The overall data validation showed that the data is generally of acceptable quality with some results for specific analytes being rejected or qualified as estimated/not detected.

b. **Duplicate Sample Results**

Field samples were collected as duplicates and used for performance evaluation and QA purposes. Duplicate sample results were evaluated based on EM 200-1-6 titled Chemical Quality Assurance for Hazardous, Toxic and Radioactive Waste Projects. The document identifies the criteria for comparing field QC and QA sample data. Based on those criteria, the concentration ratio between primary and duplicate samples should be within designated limits to be evaluated as "agreement" with each other. The acceptance criteria are as follows.

$0.33 \leq$ Ratio ≤ 3.00 when one result is less than reporting limit
$0.50 \leq$ Ratio ≤ 2.00 for metal
$0.20 \leq$ Ratio ≤ 5.00 for VOC
$0.25 \leq$ Ratio ≤ 4.00 for Dioxin, Herbicide, Pesticide, and SVOC

(1) Duplicate Samples in Primary Laboratory: Eleven (11) sets of duplicate samples were provided to the primary laboratory for blind duplicate analyses (primary and primary dup). Table 10 shows the results of samples to be compared and evaluated outcome determining whether the ratio is within "agreement" criteria or not. The table lists the analytes having at least one quantified (detected) result. Other analytes which are not included in the table had results "not detected" at both of the primary and primary dup samples, and they are considered as in "agreement" each other. Out of 11 sets of samples and 2255 analytes (205 analytes/sample), only 5 analytes showed "disagreement" between duplicate samples analyzed in the primary laboratory.

(2) Duplicate Samples between Primary and QA laboratories: Three (3) sets of duplicate samples were analyzed and compared between primary and QA laboratories. Comparison of the results and performance evaluation are provided in Table 11. The analytes that were not detected in both samples were omitted in this table. Out of 3 sets of samples and 615 analytes, 2 analytes showed "disagreement" as a result of the comparison of data between two different laboratories.

(3) The possible reason for the duplicate disagreement is considered to be due to non-homogeneity of the soil samples. Soil samples are homogenized when they are collected in two different containers at the site and also the laboratories homogenize soil samples prior to analyses. But there can be "hot spots" in a container that go into the sample aliquot and cause disparity between the results. The bis(2-ethylhexyl)phthalate disagreement could have come from a small piece of plastic present in one sample container and not the other or some other source of plastic. The data comparison showed pretty good performance and assured the quality of analyses.

b6

5. The POC for this matter is [redacted] at 721-7739.

b6

[redacted]

b6

Encl

Chief, Geotechnical and [redacted]mental
Engineering Branch

Table 1. Soil Sample Information for Phase I (Helipad) Site

Borehole	Sample ID	Depth (m)
E11-114	S1	0-0.5
E11-114	S2	0.5-2.0
E11-114	S3	2.0-5.0
E11-114	S4	5.0-8.4
E11-115	S1	0-0.5
E11-115	S2	0.5-2.0
E11-115	S3	2.0-5.0
E11-115	S4	5.0-9.4
E11-116	S1	0-0.5
E11-116	S2	0.5-2.0
E11-116	S3	2.0-5.0
E11-116	S4	5.0-9.7
E11-117	S1	0-0.5
E11-117	S2	0.5-2.0
E11-117	S3	2.0-5.0
E11-117	S4	5.0-10.0
E11-118	S1	0-0.5
E11-118	S2	0.5-2.0
E11-118	S3	2.0-5.0
E11-118	S4	5.0-8.9
E11-119	S1	0.1-0.6
E11-119	S2	0.6-2.0
E11-119	S3	2.0-5.0
E11-119	S4	5.0-7.9
E11-120	S1	0-0.5
E11-120	S2	0.5-2.0
E11-120	S3	2.0-3.3
E11-121	S1	0-0.5
E11-121	S2	0.5-2.7
E11-122	S1	0-0.5
E11-122	S2	0.5-2.0
E11-122	S3	2.0-5.0
E11-122	S4	5.0-9.3
E11-123	S1	0-0.5
E11-123	S2	0.5-2.0
E11-123	S3	2.0-5.0
E11-123	S4	5.0-7.7
E11-124	S1	0-0.5
E11-124	S2	0.5-2.0
E11-124	S3	2.0-5.0
E11-124	S4	5.0-7.35
E11-125	S1	0-0.5
E11-125	S2	0.5-1.56
E11-126	S1	0-0.5
E11-126	S2	0.5-1.83
E11-127	S1	0-0.5
E11-127	S2	0.5-2.32
E11-128	S1	0-0.5
E11-128	S2	0.5-3.2
E11-129	S1	0-0.76
E11-130	S1	0-1.22
E11-131	S1	0.12-0.5
E11-131	S2	0.5-1.7
E11-132	S1	0.1-0.6
E11-132	S2	0.6-3.0
E11-133	S1	0.15-0.65
E11-133	S2	0.65-2.46
E11-134	S1	0-0.5
E11-134	S2	0.5-1.51
E11-135	S1	0-0.5
E11-135	S2	0.5-2.0
E11-135	S3	2.0-5.0
E11-135	S4	5.0-7.65
E11-136	S1	0-0.5
E11-136	S2	0.5-3.2
E11-137	S1	0-0.5
E11-137	S2	0.5-2.0
E11-137	S3	2.0-5.0
E11-137	S4	5.0-6.75
E11-138	S1	0.4-0.9
E11-138	S2	0.9-2.22
E11-139	S1	0-0.5
E11-139	S2	0.5-2.0
E11-139	S3	2.0-3.66
E11-140	S1	0-0.5
E11-140	S2	0.5-2.0
E11-140	S3	2.0-3.0
E11-141	S1	0.3-0.8
E11-141	S2	0.8-2.3
E11-141	S3	2.3-5.3
E11-141	S4	5.3-7.2
E11-142	S1	0-0.5
E11-142	S2	0.5-2.0
E11-142	S3	2.0-4.73
E11-143	S1	0-0.5
E11-143	S2	0.5-2.0
E11-143	S3	2.0-3.55
E11-144	S1	0-0.5
E11-144	S2	0.5-1.52
E11-145	S1	0-0.5
E11-145	S2	0.5-2.0
E11-145	S3	2.0-5.0
E11-146	S1	0-0.5
E11-146	S2	0.5-2.0
E11-146	S3	2.0-4.85
E11-147	S1	0-0.5
E11-147	S2	0.5-1.97
E11-148	S1	0.3-0.8
E11-148	S2	0.8-2.3
E11-148	S3	2.3-5.8
E11-149	S1	0-0.5
E11-149	S2	0.5-2.0
E11-149	S3	2.0-3.6
E11-150	S1	0-0.5
E11-150	S2	0.5-2.0
E11-150	S3	2.0-5.0
E11-150	S4	5.0-7.0
E11-151	S1	0-0.5
E11-151	S2	0.5-2.0
E11-151	S3	2.0-5.0
E11-151	S4	5.0-7.85
E11-152	S1	0-0.5
E11-152	S2	0.5-2.0
E11-152	S3	2.0-5.0
E11-153	S1	0.3-0.8
E11-153	S2	0.8-2.3
E11-153	S3	2.3-5.3
E11-153	S4	5.3-10.0

Table 2. Soil Test Methods

Parameter	Number of Analytes	Method: Preparation / Analysis	Description
Dioxins and furans	17	3540C	Soxhlet Extraction
		8290A	High-resolution Gas Chromatography/High Resolution Mass Spectrometry (HRGC/HRMS)
Chlorinated herbicides	5	3541	Automated Soxhlet Extraction
		8151A	GC-MS Using Methylation Derivatization
OC pesticides	22	3541	Automated Soxhlet Extraction
		8081B	GC-Electron Capture Detector
OP pesticides	27	3546	Microwave Extraction
		8141B	GC-Flame Photometric Detector
VOCs	67	5035	Closed System Purge and Trap
		8260B	GC/MS
SVOCs	59	3541	Automated Soxhlet Extraction
		8270D	GC/MS
RCRA Metals (total)	8	3050B	Acid Digestion
		6010C	Inductively Coupled Plasma-Atomic Emission Spectrometry
		7471B mercury	Cold Vapor Technique