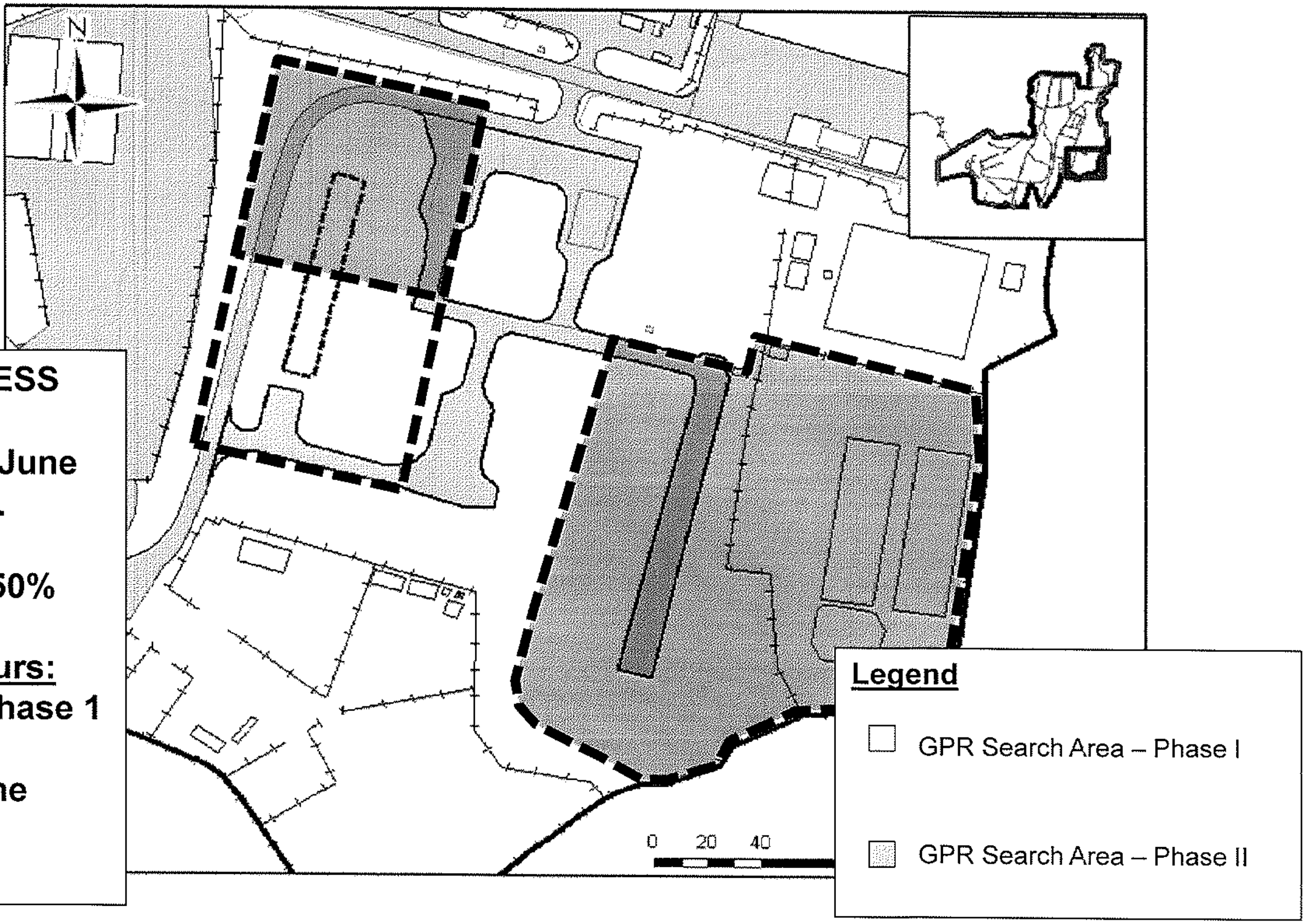
11901 Samuel, Garden Grove, CA 92840-2546

TESTING & EVALUATION

GPR Survey Areas



PROGRESS

__Planned:__ 8 June completion.

__Executed:__ 50%

__Next 24 Hours:__ Continue Phase 1

__Issues:__ None

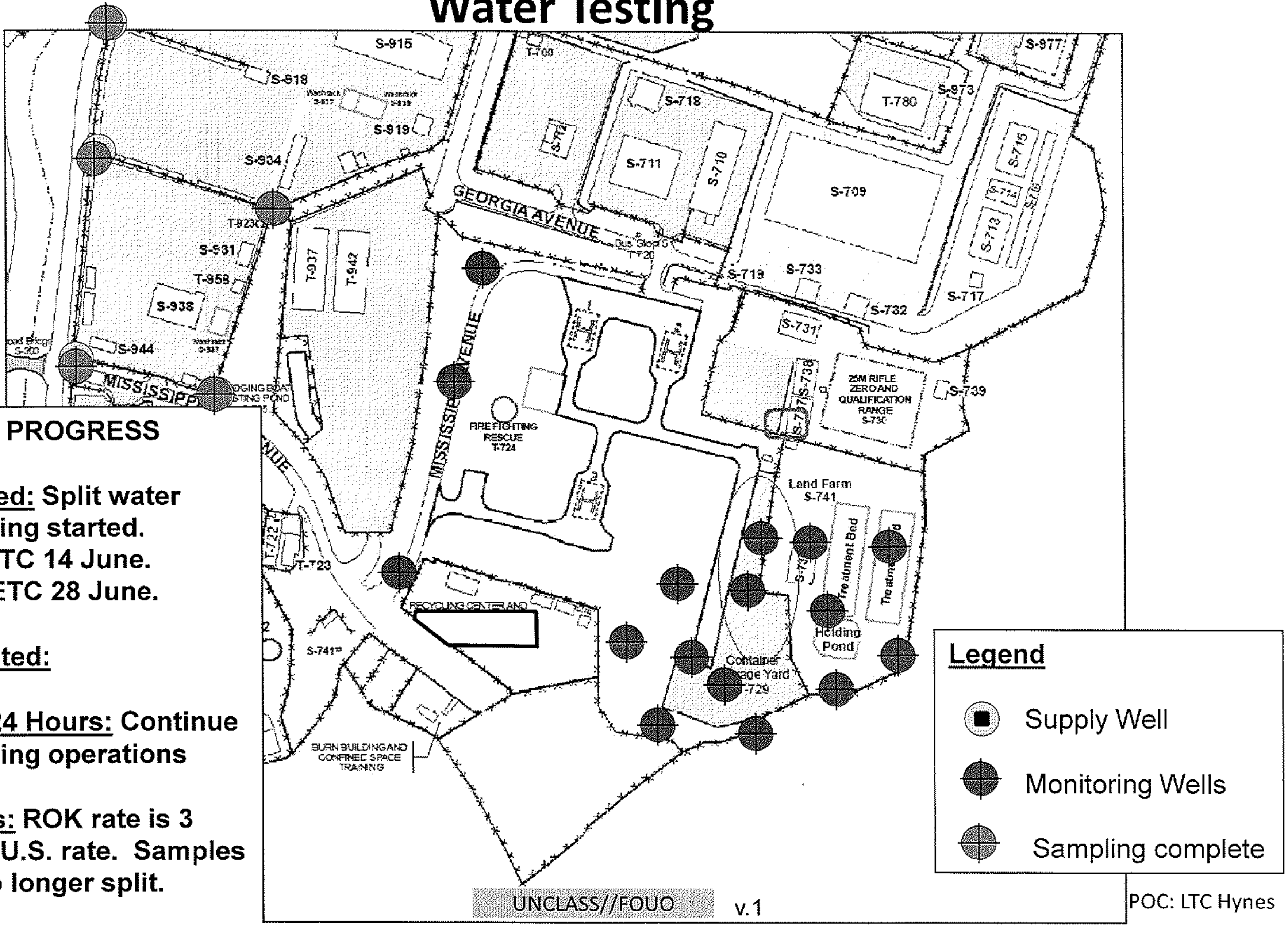
402

POC: LTC Hynes

as of 8 Jun 11

TESTING & EVALUATION

Water Testing



PROGRESS

<u>Planned:</u> Split water sampling started. U.S. ETC 14 June. ROK ETC 28 June.

<u>Executed:</u>

<u>Next 24 Hours:</u> Continue sampling operations

<u>Issues:</u> ROK rate is 3 times U.S. rate. Samples are no longer split.

 v.1

POC: LTC Hynes

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Consolidated Interview Update

1. When did you arrive at Camp Carroll, when did you leave?
2. What was your unit, rank, duty position?

USFK Employee	Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
I was Assigned to Camp Walker Oct/Nov 1979 to Nov/Dec 1980.	February 1978 thru February 1979	Arrived October/December 1978. Departed October/November 1980	January 1978 to January 1979. Stayed entire year, did not take leave.	Late December 1978 thru Early December 1979	COL Bishop was not stationed at Camp Carroll – he did visit in 1978	1968 - 2001	I was assigned to Camp Walker Dec1981 to Dec 1983.
SFC, NCO In Charge of LB Detachment, Daegu, Korea	D Company, 802nd Platoon, Spec 4, MOS 62L-20 (Heavy Equipment Operator)	1LT and CPT, OIC of LB Det (Prev Med), Daegu, Korea	802d Engineering Bn, D Co, E-4, 62L (equipment operator)	802d Engineering Bn, D Co, 802nd Platoon, E-1 to E-3, Truck Driver	CDR Pacific Envi Engineering Health Agency, Japan	DPW/20th SPT Grp truck driver and equipment operator	LB Detachment, 5th PMU, Daegu, Korea, CPT, Commander

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Consolidated Interview Update

3. Do you remember your chain of command? (Platoon leader, company commander….up to highest rank)

USFK Employee	Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
CO – CPT [redacted] b6	SL – [redacted] b6 PL - 2LT [redacted] b6 CO: CPT [redacted] b6 1SG: [redacted] b6 Doesn't recall any higher ranked officers	SL: Sgt. [redacted] b6 PL: LT [redacted] b6 CO: CPT [redacted] b6	SL: [redacted] b6 PSG: SFC [redacted] b6 1SG: [redacted] b6 CO: CPT [redacted] b6 Doesn't recall any higher ranked officers	CO – COL Daniel Berliner

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The following had no input to this question: Mr. [redacted] b6 Mr. [redacted] b6 Mr. [redacted] b6

Consolidated Interview Update

4. Please describe what was disposed of at Camp Carroll? And when?

USFK Employee	Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
Not sure of what or when items were disposed. CPT [redacted] b6 and a crew of 10-12 worked for a number of months to recover the items buried in the trench. USFK Employee was present when BG Pendleton directed CPT [redacted] b6 to remove the items. CPT [redacted] never mentioned any herbicides being found. Samples were taken and sent to Japan for testing USFK Employee left Daegu for a new assignment at HQ 5th Preventive Medicine Seoul in December 1979, before testing and final disposal was completed. Left Korea in Summer 1980, CPT [redacted] was still in Daegu b6	a. Disposal took place between Spring 1978 (April/May) and Fall 1978 b. Material was in 55 gallon drums and delivered by truck	Not sure when disposed (not involved with disposal). The outgoing officer in charge told Mr. [redacted] b6 (incoming officer in charge) chemicals were buried at Camp Carroll. A couple of months after arriving, Mr. [redacted] b6 asked the engineer in the area about the burial of any chemicals. There was a pregnant pause then the engineer said 'let me get back to you'. Mr. [redacted] b6 then met with the deputy commander. Inquiry stopped there. After a week, Mr. [redacted] said things started happening b6 - List of drum chemicals provided - Destruction certificate produced - Location was found - BG Pendleton asked what needed to be done - [redacted] b6 said they needed removed - Pendleton said OK - A DAC from Pine Bluff (couldn't remember name) and [redacted] b6 put together a plan, included protective gear and heavy equipment. -10-12 GI's started hand excavation -Trench was several hundred feet long - Pallets neatly stacked 3-4 pallets wide and 2 high - Set up temporary containment area - Sandbags and rubberized protection - Pulled drums out and put them in the containment area - Wore respirators, eye protection, rubber gloves, coveralls, and tox boots.	a. Mr. [redacted] b6 was asked by Sgt. [redacted] b6 to place some spent, rusted, concertina wire in trench. Mr. [redacted] b6 was not present during any other burial activities; however, Sgt. [redacted] b6 indicated that the trench was built to dispose of used motor oil. Scuttlebutt on post was that Agent Orange was buried there.	55 Gallon drums	Not sure of what or when items were disposed as this was before my time; however, my predecessor, CPT [redacted] b6 and a crew of 10-12 worked for a number of months to recover the items buried in a trench in Area D. In my talks with him, CPT [redacted] b6 never mentioned any herbicides; he said most were solvents, some acids and bases, some POL oils, and small amount of pesticides. He told me that there were drums in fairly good shape.

The following had no input to this question: Mr. [redacted] b6 Mr. [redacted] b6

Consolidated Interview Update

5. Please describe what it looked like, where it was located, what the area looked like.

USFK Employee	Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
Did not see any drums that had orange markings or bright yellow bands on the frequent visits to the site to consult with CPT [redacted] b6 about the work, [redacted] b6 was doing and other unit missions. CPT [redacted] b6 spent much of his time at Camp Carroll. As NCOIC of the PM Detachment USFK Employee took over the supervision of daily mission activities for Preventive Medicine from south of Taejon to Busan ROK.	- Lots of writing on drums in bright yellow or orange - Bright yellow or orange bands on the drums -Some said 'for province of Viet Nam' -- 4 drums to a skid - Air Force delivered additional drums to the area - OD Green 55 gallon drums (looked brand new) - Same type of markings as described in 'b' above	a. Dirt area – not much vegetation in the area. Small, sloped hill. Trench was cut into hillside. Excavation/recovery of drums was at one end using front end loader and hand tools. b. Couldn't describe soil type…just regular soil. c. [redacted] b6 not 100% sure of location, but believes it was near fence line (within a couple hundred feet)(Area D did not come to mind)	Mr. [redacted] b6 was one of several equipment operators who excavated the trench. Length was ¾ to 1 city block or roughly 100-yards. Width of 290 scrapper. Depth 10-12 feet. Area were trench was constructed, sloped downward towards the east.	a. Drums were picked up at warehouse – Mr. [redacted] b6 referred to warehouse as "War Surplus Area" b. Drums - All were OD Green - Orange stripes on the drums - Most drums were leaking - Writing on drums: 1. 1967-1968 for Republic of Viet Nam 2. Agent Orange painted in yellow	In 198?, I was asked to verify the ultimate disposal of the excavated wastes at Camp Carroll. I walked the locations were I was told the drums had been dug up (Area D) uphill and up from the helipad and observed what seemed to be recent excavation work. I also walked another smaller area where I would told there may have been buried chemicals, near Bldg 580. This area was denuded of grass, but I was told there had been a fire there earlier; there was no obvious evidence of recent digging. I also visited Area 41 (the subject of main concern at the beginning); there were deteriorating and leaking drums and ground contamination. There was no evidence that these drums were the one which had been dug up from Area D.

The following had no input to this question: Mr. [redacted] b6 Mr. [redacted] b6

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Consolidated Interview Update

6. Can you point out where it was disposed? Did it have a special name? Are you aware of the reason why it was disposed?

USFK Employee	Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6 [redacted] b6
See Maps, Do not recall any special name for the area. Someone told the CMD to get rid of the items from inventory.	See maps	a. Mr. [redacted] b6 wasn't 100% sure of the area, but did point to an area at the current Land Farm as the likely area. No recall of any special name. No recall on why disposed.	a. After reviewing Mr. House's photographs and the maps provided by COL Degidio, Mr. [redacted] b6 indicated he thought the trench was located west of the helipads, in the general area indentified by Mr. House. See attached maps which depict the area identified by Mr. [redacted] b6 Mr. [redacted] b6 clearly remembers 2 water pits (1 small, 1 large) for tank water proof tests. The distance from the water pits to the trench was roughly 150 yds. See attached maps which depict the area identified by Mr. [redacted] b6	a. Truck loads were taken to trench b. No special name for the disposal area c. Told they were moving the barrels because they were damaged or leaking	See map, I was told it was "Area D" with a small burial site "near Bldg 580". I was told the chemicals were similar to those at Area 41 in 1981 (solvents, oils, pesticides, etc.).

The following had no input to this question: Mr. [redacted] b6 Mr. [redacted] b6

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Consolidated Interview Update

7. How long did the transportation and disposal take?

Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6
a. Ditch was surveyed – someone brought into area to survey b. Ditch was dug w/ramps on either end - About 1-1/2 semi-trailers wide - Approximately ¾ city block long (including ramps) - About 30 feet deep - Original intent was to back dump trucks into the trench and dump the loads - Sides were unstable so drums were dumped into the ditch from the berm - Water was present at approximately 3-4' in depth at bottom of ditch	a. Does not know.	Unaware. Mr. [redacted] b6 stated that during PT runs he would run by a storage area containing 55-gallon, OD Green drums. The storage area was located in the Depot area. The drums were stacked on their sides, pyramid style, 6-feet high. See attached maps which depict the drum storage area identified by Mr. [redacted] b6	a. Transportation took approximately 4 days b. Ditch was dug w/ramps on either end - Approximately ¾ city block long including ramps (about 300 feet) - About 15 feet deep - Original intent was to back dump trucks into the trench and dump the loads 1. First load was driven into the trench – dumped – and truck drove out other side 2. Loads after that for next 3-4 days were backed into the trench then dumped 3. After 3-4 days, sides of trench were unstable – trucked backed as far as possible, dumped drums, drums were rolled rest of the way into the trench 4. Drums were not on pallets nor were they neatly stacked in the trench Trench was wet, but unsure if from underground water seepage or from rain – heavy rain early in the disposal process. Approximately 3-4" standing water.

409

The following had no input to this question: USFK Employee, Mr. [redacted] b6 Mr. [redacted] b6 and Dr. [redacted] b6

Consolidated Interview Update

8. How much was disposed? In same location?

Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6
a. Approximately 200-250 drums over initial 10 day disposal period b. Ditch was filled with drums and capped as the disposal progressed occurred c. Initial disposal occurred over approximately 10 days at a rate of 2-3 loads a day d. Ditch remained open for approximately 6 months with occasional disposal	a. Does not know.	Unaware. However, when asked by Mr. [redacted] b6 how many drums sitting upright could be placed in the trench he built, Mr. [redacted] b6 indicated, no more than 2 high.	a. 150-200 drums total b. 2 drives took 10-12 loads each to the trench - Dump truck tock 20-30 barrels each - Flat beds took 10-15 barrels each - Beds were lined with rubber pad/liner c. Initial disposal occurred over approximately 3-4 days

410

The following had no input to this question: USFK Employee, Mr. [redacted] b6 Mr. [redacted] b6 and Dr. [redacted] b6

Consolidated Interview Update

9. Where did the containers originally come from?

Mr. Stephen House b6	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
a. PFC [redacted] Truck Driver and SGT [redacted] b6 [redacted] b6 Truck Driver drove the drums into the dump site. Mr. House does not know where they came from.	a. Mr. [redacted] thought that b6 some of the containers came frcm a pesticide shop (Site 41 did not ring any bells). Many not known	Mr. [redacted] stated that during b6 PT runs he would run by a storage area containing 55-gallon, OD Green drums. The storage area was located in the Depot area. The drums stacked on their sides, pyramid style, 6-feet high. See attached maps which depict the drum storage area b6 identified by Mr. [redacted] Mr. [redacted] noticed during a PT run b6 (subsequent to the building of the trench), that the drums were no longer present in the storage area. He also noticed that the trench was filled in.	a. War Surplus Area (Area 41) - Drivers were escorted anytime they went to this area to pick up drums	I was told there had been in Area 41, but were removed for burial. From the nature of the materials in Area 41 in 1981, most were from shops (e.g., solvents, oils, waste acids and bases, a few pesticides).

4////

The following had no input to this question: USFK Employee, Mr. [redacted] Mr. [redacted]
b6 b6

Consolidated Interview Update

10. Where were they stored prior to disposal? Did it have a special name? Any other locations where they were stored?

Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
a. Mr. House did not know	a. See above.	See attached maps which depict the drum storage area identified by Mr. [redacted] b6	a. War Surplus Area b. Area 41 c. No known	In 1981, I was told they had been in Area 41.

412

The following had no input to this question: USFK Employee, Mr. [redacted] b6 Mr. [redacted] b6

Consolidated Interview Update

11. What was the condition in storage?

Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
a. Mr. House did not know	a. Does not know.	He didn't recall the condition of the drums. While on post, he observed flatbed trucks loaded with drums. The flatbeds were lined with rubber sheets. Mr. [redacted] b6 did not see the drums being placed in the trench.	a. Drums were damaged and/or leaking	I do not know; however, in 1981 there were deteriorating drums in Area 41 with subsequent soil contamination. Yet, CPT [redacted] b6 told me the drums he excavated were intact and not leaking.

413

The following had no input to this question: USFK Employee, Mr. [redacted] b6 Mr. [redacted] b6

Consolidated Interview Update

12. How were they moved?

Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
a. Flatbed truck	a. Does not know.	While on post, he observed flatbed trucks loaded with drums and flatbed was lined with rubber sheets.	a. Dump truck and Flatbed truck	I do not know.

414

The following had no input to this question: USFK Employee, Mr [redacted] b6 Mr. [redacted] b6

Consolidated Interview Update

13. Who was involved with the transportation and disposal?

Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
a. Truck Drivers: [redacted] b6 b6 [redacted] and Frederick Wright b. Heavy equipment operators: Stephen House and [redacted] b6 b6 b6 - Mr. [redacted] became ill and was medivac'd out of the area	a. Does not know.	Mr. Stephen House and Mr. [redacted] were the b6 equipment operators and Mr. [redacted] and Mr. [redacted] were the truck drivers. b6 b6	a. Truck Drivers: [redacted] b6 [redacted] and [redacted] b6 b6 b. Heavy equipment operators: Stephen House and [redacted] b6 b6	I do not know.

415

The following had no input to this question: USFK Employee, Mr. [redacted] b6 and Mr. [redacted] b6

Consolidated Interview Update

14. Describe the containers (all the same, any markings)?

Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
a. Does not know.	Couldn't tell if they had any colored bands, or couldn't read writing on drums. He described the drums located in the storage area and on the flatbed trucks as 55-gal, OD Green, steel drums.	I do not know.

416

The following had no input to this question: USFK Employee, Mr. House, Mr. [redacted] Mr [redacted] Mr. [redacted] and Mr. [redacted]
b6 b6 b6 b6

Consolidated Interview Update

14a. What where they made of?

USFK Employee	Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6 b6
Pails and other small containers were metal – small containers contained: Lindane; malathion; technical grade DDT; diazanon; paint; greases; oils; POL; and adhesives. A lot of 55 gallon drums.	Steel 55 gallon drums	Removed from excavation - steel drums painted OD Green – did not see Herbicide Orange (or any other herbicide type) markings on any of the drums – his point of reference is drums of Herbicide Orange he saw while working at Eglin AFB, Florida. Pails and other small containers were metal – small containers contained: Lindane; Malathion; technical grade DDT; Diazanon; paint; greases; oils; POL; and adhesives. Possibly some off-color drums.	55-gallon, steel OD Green drums.	Steel 55 gallon drums	I do not directly know; I was told 55-gallon steel drums. However, in 1981, chemicals in Area 41 were in plastic, steel, and glass containers.

417

The following had no input to this cuestion: Mr.[redacted] Mr.[redacted]and Mr.[redacted]
b6 b6 b6

Consolidated Interview Update

14b. If leaking, what did the substance(s) look like/ smell like?

USFK Employee	Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
Chemical smell, some smelled like Malathion.	Smelled similar to creosote and/or ether – strong chemical smell.	Chemical smells	No odors during trench excavation. Was at trench site after nearly covered, and did not recall any smells or anything unusual about the site.	Smelled sweet and not pleasant.	I do not know.

4/18

The following had no input to this question: Mr [redacted] b6 Mr. [redacted] b6 and Mr. [redacted] b6

Consolidated Interview Update

14c. If leaking, what percentage of the containers do you think were leaking? Where was it leaking? How much was leaking from the containers?

USFK Employee	Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
Some were crushed or dented, some were rusted a bit and others were in near to new condition.	Doesn't recall	Some crushing had occurred, but many were in tact. Some leaking and degradation of containers, as well.	Unaware.	Most were leaking.	I do not know; however, in 1981, perhaps 10% of the drums and containers in Area 41 were leaking.

419

The following had no input to this cuestion: Mr. [redacted] b6, Mr. [redacted] b6 and Mr. [redacted] b6

Consolidated Interview Update

14d. If leaking, what did you do with the material that leaked both during transportation and disposal?

USFK Employee	Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6 b6
Soil was removed and containerized for disposal.	Doesn't recall	Excavated impacted soil placed in drums.	Mr. [redacted] b6 was not involved in the transportaticn and disposal of crums.	Doesn't recall	I do not know.

420

The following had no input to this question: Mr. [redacted] b6, Mr. [redacted] b6 and Mr. [redacted] b6

Consolidated Interview Update

15a. Length of trench, width, and depth of burial.

USFK Employee	Mr. Stephen House	Mr. [redacted] b6 b6	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6 b6	Dr. [redacted] b6 b6
Length - About 300 feet long, Width – About 15 feet wide, Height – 15-25 feet.	Length - About 300 feet long, Width – About 15 feet wide, Height – 15-25 feet.	¾ city block long 1-1/2 semi trailers wide 30 feet	Length - About 300 feet long, Width – About 15 feet wide, Height – 15-25 feet.	Wasn't involved in any disposal of drums. Mr. [redacted] b6 was ordered to build a trench. Length of trench built was ¾ to 1 city block or roughly 100-yards. Width of 290 scrapper. Depth 10-12 feet.	¾ city block long, 1-1/2 semi trailers wide, 15 feet	The obviously excavated area in 1981 was about 300 feet long by about 30 feet wide. I was told that the excavation had gone 20-30 feet beyond the last drum in every direction. I have no knowledge of the depth.

421

The following had no input to this question: Mr. [redacted] b6 and Mr. [redacted] b6

Consolidated Interview Update

15b. Were they still leaking?

Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
Yes and some were crushed in the disposal process	No knowledge.	Yes – most were leaking	I have no knowledge.

422

The following had no input to this question: USFK Employee, Mr. [redacted] b6, Mr. [redacted] b6, Mr. [redacted] b6 and Mr. [redacted] b6

Consolidated Interview Update

15c. How where the containers arranged in the trench?

USFK Employee	Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6 b6
Drums were on pallets and neatly stacked 2 pallets high.	Dumped into the trench – no specific arrangement	Drums were on pallets and neatly stacked 2 pallets high	Doesn't have firsthand knowledge, however, he remembers hearing that the drums were stack 2-high and thinks they were set in the trench with a loader and not dumped.	Dumped either directly into trench after driving or backing into it or dumped at entrance to the trench and rolled into trench.	I have no direct knowledge, but was told by CPT [redacted] that there were neatly b6 arranged on pallets, 2 tiers high.

423

The following had no input to this question: Mr. [redacted] Mr. [redacted] and Mr. [redacted]
b6 b6 b6

Consolidated Interview Update

15d. What type of soil was excavated? What did you do with the excavated soil?

Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
After breaking through initial cap of hard soil, soil consisted of pea gravel and sand. Excavated soil was for berm and used to back fill trench after drums were dumped.	Excavated impacted soil drummed and stored onsite in contained area.	Sandy soil. Excavated soil was placed on side of trench using scrapper.	Was not involved in the excavation, but soil was sandy and unstable	In 1981, the soil in Area D was sandy to gravely without grass cover and with evidence of recent excavation. I have no other knowledge.

424

The following had no input to this question: USFK Employee, Mr. [redacted] b6, Mr. [redacted] b6 and Mr. [redacted] b6

Consolidated Interview Update

15e. How did you cover?

Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
See above	Trench was filled in after drums/etc. were removed because of safety reasons – too deep. Confirmation soil samples collected/analyzed from bottom of excavation.	Unaware. Mr. [redacted] b6 was not involved with the covering of the trench.	Not involved with covering the trench	In 1981, the trench had been filled in with local soil, but had no grass yet.

425

The following had no input to this question: USFK Employee, Mr. [redacted] b6, Mr. [redacted] b6 and Mr. [redacted] b6

Consolidated Interview Update

15f. Were you there long enough to notice if any vegetation grew back?

Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
No	Not applicable.	No noticeable dead vegetation in the area. Lots of scrub grass. Also remembers that ringed-tailed pheasants were in the area.	Area never had vegetation – it was always bare dirt	In 1981, there was still no grass cover over the trench area.

426

The following had no input to this question: USFK Employee, Mr. [redacted] b6, Mr. [redacted] b6 and Mr. [redacted] b6

Consolidated Interview Update

16. Are you aware if the containers were removed after they were buried?

Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
No	Not applicable.	No	No.	In 1981, I was told by CPT [redacted] b6 and my staff who were involved in the excavation that all containers were removed from Area D, but there were no records of transport or ultimate disposal. I was told there may be a few still buried near Bldg. 580.

427

The following had no input to this question: USFK Employee, Mr. [redacted] Mr. [redacted] and Mr. [redacted]
b6 b6 b6

Consolidated Interview Update

17. Other notes from the interview:

USFK Employee	Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
USFK Employee did not visit the site daily maybe every week or so for 30 minutes. Recalls the Colonel Robert E, Lees, QM CDR USAG Busan was a investigating officer and spent several days talking to [redacted] about what was found and how the recovery was done.	a. Mr. House stated he received some chemical burns on his legs from kick-up of dirt while compacting back-fill of ditch b. Mr. House stated he discovered ditch had not been completely back-filled in Fall 1978. He noticed thick yellow foam leaching from open end of ditch into soil and crossing road. He also noticed dead birds and grass in the affected areas. He reported through his chain of command as was directed to close the ditch. Closing ditch took approximately ½ day. c. Mr. House also reported suspect area between helipads (see map). The soil looked discolored.	a. Took about 6 months to get it all containers removed from disposal area. b. Excavation was started with front end loader. c. Equipment operators were from Camp Carroll. d. After drums were reached, excavation continued with hand tools e. Pallets, once exposed, were moved with rough terrain fork lifts f. Close to 300 items (319 sticks in his mind as the number of containers) - 55 gallon drums (est. (300) 55-gal drums) - Other items - 5, 10, 15 gallon pails - Condition of containers - some leakage, but many of the drums were in good condition. -Did not encounter any fuel pods or semi-trailer in trench.	a. Mr. [redacted] noticed the trench had been nearly filled with exception to the north side of the trench. b. Mr. [redacted] was asked by Sgt. [redacted] to place some spent, rusted, concertina wire in an open end of the trench (north end of trench). During the placement of the wire in the trench, Mr. [redacted] observed 2 jeeps and a Crown Victoria sedan entering the gate. MPs approached Mr. [redacted] asking "Are you aware of what's buried there". Mr. [redacted] said "yes" and the MPs left the site. c. Mr. [redacted] asked if the south gate (gate leading into helipads area) has moved since the 1970's. This gate and water pits were his reference for the location of the trench he excavated.	a. After leaving Korea, Mr. [redacted] was stationed for 3 years at Aberdeen Proving Ground, MD. His job was driving shuttle bus between APG, MD and Walter Reed Army Medical Center (WRAMC), Washington, DC. On one of his shuttle runs, Mr. [redacted] saw Mr. [redacted] (other driver during the disposal). Mr. [redacted] said he was being treated at WRAMC for in injuries to his feet he received during the disposal. According to Messrs House and [redacted] there is no mention of Mr. [redacted] being treated at WRAMC for anything. Mr. [redacted] recalls 2 helipads, not 3. Mr. [redacted] recalls taking some surplus dirt from trench area to bridge they were building. This is similar to Mr. House's recollection.	COL Biship was the Commander of the Pacific Env. Eng. Health Agency (part of current day Public Health Command). His unit was comprised of: 9 military, 3 civilians, and 1 Korean LN. While stationed at Camp Zama, Japan from 1977-1980, COL Bishop visited Camp Carroll in 1978 (prior to MAJ [redacted] being there). COL Bishop said no chemicals from Korea were burned on the incinerator ship Vulcanus. COL Bishop's unit was in charge of testing chemicals and soil taken from trench at Camp Carroll. He dispatched CPT [redacted] (now living in Tyrone, GA) to the site.	There may have been other chemicals buried near Bldg 580. I was also told, but could not confirm, that medical x-ray films had also been buried at Camp Carroll – location not specified or could be located in 1981. Any developed films would have had the silver halides reduced to silver and contained in the gelatin matrix; however, if they were expired films and unprocessed, they might contain soluble silver halides.

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Consolidated Interview Update

17. Other notes from the interview:

Mr. Stephen House	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6
Fumes coming from the soil caused burning in throat. He reported having several chest X-rays as a result of this exposure. He reported having several chest X-rays as a result of this exposure. d. Mr. House reported that in addition to the barrels, a trailer with bright yellow barrels with a tarp on it along with two old fuel pod trailers were buried at the site.	- Started sampling liquids from containers in the Fall of 1979: 1. Used pipettes and disposable paddles 2. Sent for environmental testing in Japan – COL Ron Bishop was commander of lab in Japan – he may still be consultant with Health Sciences Academy (AMEDD C&S?) 3. Difficult unknowns liquids were sent to Edgewood Arsenal for further testing. 4. Trench was left open while testing was being done. g. Expanded search to confirm nothing further buried. h. When [redacted] PCS's in Fall 1980, the drums which were stored onsite in an contained area were still there. i	d. He was enrolled in class 7 of the NCO academy , 1978. e. He doesn't recall any helipads being near the trench he built or any special names for the area. f. Mr. [redacted] operated the equipment to build the trench. It took no more than a week to build. It was completed in the Fall 1978. Doesn't recall wearing any special protective gear during construction of the trench. g. Did not observe water in the bottom of the trench. h. No discoloration of soil was observed or odors. i. When asked, Mr. [redacted] did recall a fence being nearby the trench.	Mr. [redacted] does not recall any drums in outdoor storage. Said there could have been drums in outdoor storage, but he's not sure. Mr. [redacted] believes trench was partially filled after their disposal ended, but part of it remained open to allow other units to dump barrels into it. Mr. [redacted] was in the ditch moving the barrels as they were dumped – Mr. [redacted] believes this is how Mr. [redacted] was injured. Mr. [redacted] was on profile for injury and wore white tennis shoes. Mr. [redacted]s unaware of Mr. [redacted] being medevac'd out of Camp Carroll. Mr. [redacted] believes the people working the War Surplus Warehouse were Korean Nationals.	CPT [redacted] area of expertise while in Korea was in water and waste water area. COL Bishop does not believe CPT [redacted] was involved with the excavation of the site, only in testing material from the site. The lab in Japan had only basic equipment for testing. According to COL Bishop, the items they could identify were not out of the ordinary – no herbicides were found. The unknown items were sent to the Aberdeen Proving Ground, MD for testing. COL Bishop does not recall any herbicides found in this testing either.

Consolidated Interview Update

17. Other notes from the interview:

Mr. [redacted] b6	Mr. [redacted] b6	Mr. [redacted] b6
i. Delay in excavated containers disposal to allow time to identify contents and arrange transportation j. Excavated soil (drums) and excavated drums possibly went to Utah or Nevada (Mr [redacted] b6 thinks Utah makes the most sense) k. Mr. [redacted] b6 wasn't 100% sure of the location of the trench but did point to an area at the current Land farm as the likely area.	i. Mr. [redacted] b6 heard that Mr. [redacted] b6 was on profile "wearing tennis shoes" because chemicals were spilled on his feet. He also had heard that Mr. House had chemicals spilled on his lower legs. He doesn't recall Mr. [redacted] b6 being evacuated from Camp Carroll.	COL Bishop said the common practice for disposing of chemicals in the 1970s was to dig a trench, place items to be disposed of in trench, back fill trench with soil removed to create the trench, compact the area and spread rest of soil around. To clean up a dump site, soil was removed and placed on impermeable tarp. Items from trench were removed, soil was analyzed to determine proper way to dispose. Contaminated dirt is usually incinerated.

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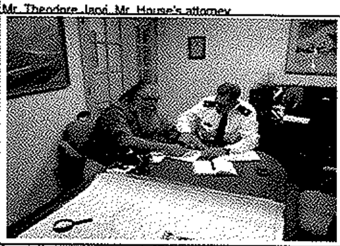
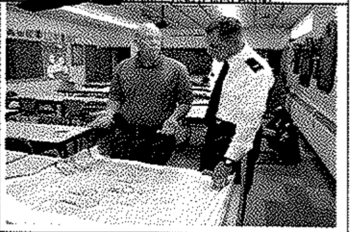
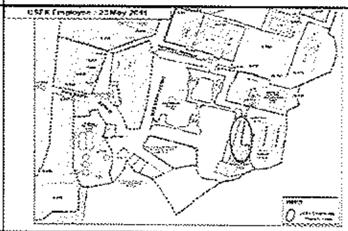
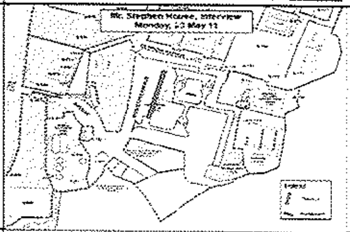
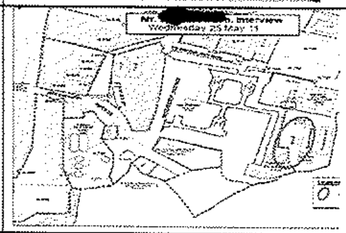
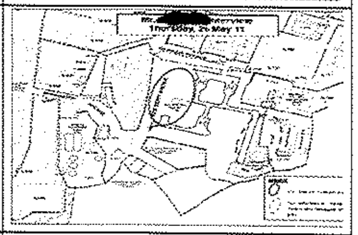
Questions	USFK Employee	Mr. Stephen House	MAJ (Ret) [redacted]	Mr. [redacted]
Interview date		Monday, 23 May 11	Wednesday, 25 May 11	Thursday, 26 May 11
Attendees:		Army Reps: -COL Donald Degidio, IMCOM Korea -Mr. [redacted] USAEC -Ms. [redacted] IMCOM Public Affairs – Environmental Branch Veteran Reps: Mr. Steven House Mr. Theodore Jarvi, Mr. House's attorney	Army Reps: -COL Donald Degidio, IMCOM Korea -Mr. [redacted] USAEC -Ms. [redacted] IMCOM Public Affairs – Environmental Branch Veteran Reps: Mr. [redacted] (MAJ, USA, Ret) (currently employed with Bechtel at Bluegrass AD Demil Program)	Army Reps: -COL Donald Degidio, IMCOM Korea -Mr. [redacted] USAEC -Ms. [redacted], IMCOM Public Affairs – Environmental Branch Veteran Reps: Mr. [redacted] Mr. [redacted] brother, also retired Army)
	Photo Not Available			
				
1. When did you arrive at Camp Carroll, when did you leave?	I was Assigned to Camp Walker oct nov 1979 to Nov - Dec 1980	February 1978 thru February 1979	Arrived October/December 1978. Departed October/November 1980	January 1978 to January 1979. Stayed entire year, did not take leave.
2. What was your unit, rank, duty position?	a. LB Detachment (Preventative Medicine) b. SFC c. NCO In Charge of LB Detachment, Daegu, Korea d. USFK Employee was from Preventative Medicine – he was stationed in Camp Walker Daegu, but travelled all over	D Company, 802nd Platoon, Spec 4, MOS 62L-20 (Heavy Equipment Operator)	a. LB Detachment (Preventative Medicine) b. 1LT and CPT c. Officer In Charge of LB Detachment, Daegu, Korea d. [redacted] was from Preventative Medicine – he was stationed in Camp Walker, Daegu, but travelled all over	802nd Engineering Battalion, D Company, E4, 62 Lima (equipment operator)
3. Do you remember your chain of command? (Platoon ldr, company commander….up to highest rank)	Cdr Capt [redacted]	a. Squad Leader – [redacted] b. Platoon leader - 2LT [redacted] c. CPT [redacted], Company Commander d. Top Sgt [redacted] e. Doesn't recall any higher ranked officers	NA	Squad Ldr - Sgt. [redacted]; Platoon Ldr - LT [redacted] Company Commander – CPT [redacted]
4. Please describe what was disposed of at Camp Carroll? And when?	Not sure what or when items were disposed of. Capt [redacted] nd a crew of 10-12 worked for a number of months to recover the items baried in the trench USFK Employee was present when BG Pendleton directed Cpt [redacted] to remove the items. CPT [redacted] never mentioned any herbicides being found. Samples were taken and sent to Japan for testing USFK Employee left Daegu for a new assigenmnt at HQ 5th Preventive Medicine Seoul in December 1979. Befor testing and final disposal was completed. Left Korea in Summer 1980, Cpt [redacted] was still in Daegu	a. Disposal took place between Spring 1978 (April/May) and Fall 1978 b. Material was in 55 gallon drums and delivered by truck	Not sure when disposed (not involved with disposal). The outgoing officer in charge told Mr [redacted] (incoming officer in charge) chemicals were buried at Camp Carroll. A couple of months after arriving, Mr. [redacted] asked the engineer in the area about the burial of any chemicals. There was a pregnant pause then the engineer said 'let me get back to you'. Mr. [redacted] then met with the deputy commander. Inquiry stopped there. After a week, Mr. [redacted] said things started happening - List of drum chemicals provided -Destruction certificate produced - Location was found - BG Pendleton asked what needed to be done [redacted] said they needed removed - Pendleton said OK - A DAC from Pine Bluff (couldn't remember name) and [redacted] put together a plan, included protective gear and heavy equipment. -10-12 GI's started hand excavation -Trench was several hundred feet long - Pallets neatly stacked 3-4 pallets wide and 2 high - Set up temporary containment area - Sandbags and rubberized protection -	a. Mr. [redacted] was asked by Sgt. [redacted] to place some spent, rusted, concertina wire in trench. Mr [redacted] was not present during any other burial activities; however, Sgt. [redacted] indicated that the trench was built to dispose of used motor oil. Scuttlebutt on post was that Agent Orange was buried there.

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Questions	USFK Employee	Mr. Stephen House[redacted]	MAJ (Ret) [redacted]	Mr. [redacted]
Interview date		Monday, 23 May 11	Wednesday, 25 May 11	Thursday, 26 May 11
5. Please describe what it looked like, where it was located, what the area looked like.	Did not see any drums that had orange markings or bright yellow bands. On the frequent visits to the site to consult with Cpt[redacted] about the work [redacted] was doing and other unit missions. Cpt[redacted] spent much of his time at Camp Carroll. As NCOIC of the PM Detachment USFK Employee took over the supervision of daily mission activities for Preventive Medicine from south of Taejon to Busan RoK.	a. Drums – color OD Green - Lots of writing on drums in bright yellow or orange - Bright yellow or orange bands on the drums - Some said 'for province of Viet Nam' b. 4 drums to a skid c. Air Force delivered additional drums to the area - OD Green 55 gallon drums (looked brand new) - Same type of markings as described in 'b' above	a. Dirt area – not much vegetation in the area. Small, sloped hill. Trench was cut into hillside. Excavation/recovery of drums was at one end using front end loader and hand tools. b. Couldn't describe soil type…just regular soil. c. Rowden not 100% sure of location, but believes it was near fence line (within a couple hundred feet)(Area D did not come to mind)	Mr.[redacted] was one of several equipment operators who excavated the trench. Length was ¾ to 1 city block or roughly 100-yards. Width of 290 scrapper. Depth 10-12 feet.Area were trench was constructed, sloped downward towards the east.
6. Can you point out where it was disposed? Did it have a special name? Are you aware of the reason why it was disposed?	See Maps, Do not recall any special name for the area. Someone told the Cmd to get rid of the items from inventory.	See maps	a. Mr[redacted] wasn't 100% sure of the area, but did point to an area at the current Land Farm as the likely area. No recall of any special name. No recall on why disposed.	a. After reviewing Mr. House's photographs and the maps provided by COL Degidio, Mr.[redacted] indicated he thought the trench was located west of the helipads, in the general area indentified by Mr. House. See attached maps which depict the area identified by Mr.[redacted] Mr.[redacted] clearly remembers 2 water pits (1 small, 1 large) for tank water proof tests. The distance from the water pits to the trench was roughly 150 yds. See attached maps which depict the
7. How long did the transportation and disposal take?	Unknown	a. Ditch was surveyed – someone brought in to area to survey b. Ditch was dug w/ramps on either end - About 1-1.2 semi-trailers wide - Approximately ¾ city block long (including ramps) - About 30 feet deep - Original intent was to back dump trucks into the trench and dump the loads - Sides were unstable so drums were dumped into the ditch from the berm - Water was present at approximately 3-4' in depth at bottom of ditch	a. Does not know.	Unaware. Mr.[redacted] stated that during PT runs he would run by a storage area containing 55-gallon, OD Green drums. The storage area was located in the Depot area. The drums were stacked on their sides, pyramid style, 6-feet high. See attached maps which depict the drum storage area identified by Mr[redacted]
8. How much was disposed? In same location?	Unknown	a. Approximately 200-250 drums over initial 10 day disposal period b. Ditch was filled with drums and capped as the disposal progressed occurred c. Initial disposal occurred over approximately 10 days at a rate of 2-3 loads a day d. Ditch remained open for approximately 6 months with occasional disposal	a. Does not know.	Unaware.However, when asked by Mr[redacted] how many drums sitting upright could be placed in the trench he built, Mr[redacted] indicated, no more than 2 high.
9. Where did the containers originally come from?	Unkonwn	a. PFC[redacted] Truck Driver and SGT[redacted] Truck Driver drove the drums into the dump site. Mr. House does not know where they came from.	a. Mr[redacted] thought that some of the containers came from a pesticide shop (Site 41 did not ring any bells). Many not known	Mr.[redacted] stated that during PT runs he would run by a storage area containing 55-gallon, OD Green drums. The storage area was located in the Depot area. The drums stacked on their sides, pyramid style, 6-feet high. See attached maps which depict the drum storage area identified by Mr[redacted] Mr.[redacted] noticed during a PT run (subsequent to the building of the trench), that the drums were no longer present in the storage area. He also noticed that the trench
10. Where were they stored prior to disposal? Did it have a special name? Any other locations where they were stored?	Unknown	a. Mr. House did not know	a. See above.	See attached maps which depict the drum storage area identified by Mr.[redacted].
11. What was the condition in storage?	unknown	a. Mr. House did not know	a. Does not know.	He didn't recall the condition of the drums.While on post, he observed flatbed trucks loaded with drums. The flatbeds were lined with rubber sheets. Mr.[redacted] did not see the drums being placed in the trench.
12. How were they moved?	Unknown	a. Flatbed truck	a. Does not know.	While on post, he observed flatbed trucks loaded with drums and flatbed was lined with rubber sheets.
13. Who was involved with the transportation and disposal?	Unknown	a. Truck Drivers:[redacted] and [redacted] b. Heavy equipment operators. Stephen House and [redacted] - Mr[redacted] became ill and was medivac'd out of the area - Mr. House continued disposing of the barrels.	a. Does not know.	Mr. Stephen House and Mr.[redacted] were the equipment operators and Mr.[redacted] and Mr[redacted] were the truck drivers.
14. Describe the containers (all the same, any markings)?	Unknown		a. Does not know.	Couldn't tell if they had any colored bands, or couldn't reac writing on drums. He described the drums located in the storage area and on the flatbed trucks as 55-gal, OD Green, steel drums.

Questions	USFK Employee	Mr. Stephen House	MAJ (Ret) [redacted]	Mr. [redacted]
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a. What where they made of?	Pails and other small containers were metal – small containers contained: Lindane; malathion; technical grade DDT; diazanon; paint; greases; oils; POL; and adhesives. A lot of 55 gallon drums	Steel 55 gallon drums	Removed from excavation - steel drums painted OD Green – did not see Herbicide Orange (or any other herbicide type) markings on any of the drums – his point of reference is drums of Herbicide Orange he saw while working at Eglin AFB, Florida. Pails and other small containers were metal – small containers contained: Lindane; malathion; technical grade DDT; diazanon; paint; greases; oils; POL; and adhesives. Possibly some off-color drums	55-gallon, steel OD Green drums.
b. If leaking, what did the substance(s) look like/ smell like?	Chemical smell, some smelled like malathion	Smelled similar to creosote and/or ether – strong chemical smell	Chemical smells	No odors during trench excavation. Was at trench site after nearly covered, and did not recall any smells or anything unusual about the site.
c. If leaking, what percentage of the containers do you think were leaking? Where was it leaking? How much was	Some were crushed or dented, some were rusted a bit and others were in near to new condition	Doesn't recall	Some crushing had occurred, but many were in tact. Some leaking and degradation of containers, as well	Unaware.
d. If leaking, what did you do with the material that leaked both during transportation and disposal?	Soil was removed and containerized for disposal	Doesn't recall	Excavated impacted soil placed in drums.	Mr[redacted] was not involved in the transportation and disposal of drums.
15. Describe how you disposed of the containers?				
a. Length of trench, width, and depth of burial.	Length - About 300 feet long, Width – About 15 feet wide, Height – 15-25 feet.	¾ city block long 1-1/2 semi trailers wide 30 feet	Length - About 300 feet long, Width – About 15 feet wide, Height – 15-25 feet.	Wasn't involved in any disposal of drums. M[redacted] was ordered to build a trench. Length of trench built was ¾ to 1 city block or roughly 100-yards. Width of 290 scrapper. Depth 10-12 feet.
b. Were they still leaking?	Not applicable	Yes and some were crushed in the disposal process	Not applicable.	No knowledge.
c. How where the containers arranged in the trench?	Drums were on pallets and neatly stacked 2 pallets high	Dumped into the trench – no specific arrangement	Drums were on pallets and neatly stacked 2 pallets high	Doesn't have firsthand knowledge, however, he remembers hearing that the drums were stack 2-high and thinks they were set in the trench with a loader and not dumped.
d. What type of soil was excavated? What did you do with the excavated soil?	Unknown	After breaking through initial cap of hard soil, soil consisted of pea gravel and sand. Excavated soil was for berm and used to back fill trench after drums were dumped	Excavated impacted soil drummed and stored onsite in contained area.	Sandy soil. Excavated soil was placed on side of trench using scapper.
e. How did you cover?	Not applicable	See above	Trench was filled in after drums/etc. were removed because of safety reasons – too deep. Confirmation soil samples collected/analyzed from bottom of excavation	Unaware. M[redacted] was not involved with the covering of the trench.
f. Were you there long enough to notice if any vegetation grew back?	Not applicable	No	Not applicable.	No noticeable dead vegetation in the area. Lots of scrub grass. Also remembers that ringed-tailed pheasants were in the area.
16. Are you aware if the containers were removed after they were buried?	Not applicable	No	Not applicable.	No.
17. Other notes from the interview:	USFK Employee did not visit the site daily maybe every week or so for 30 minutes. Recalls the Colonel Robert E. Lees, CM CDR USAG Busan was a investigating officer and spent several days talking t[redacted] about what was found and how the recovery was done.	a. Mr. House stated he received some chemical burns on his legs from kick-up of dirt while compacting back-fill of ditch b. Mr. House stated he discovered ditch had not been completely back-filled in Fall 1978. He noticed thick yellow foam leaching from open end of ditch into soil and crossing road. He also noticed dead birds and grass in the affected areas. He reported through his chain of command as was directed to close the ditch. Closing ditch took approximately ½ day. c. Mr. House also reported suspect area between helipads (see map). The soil looked discolored. Fumes coming from the soil caused burning in throat. He reported having several chest X-rays as a result of this exposure. d. Mr. House reported that in addition to the barrels, a trailer with bright yellow barrels with a tarp on it along with two old fuel pod trailers were buried at the site.	a. Took about 6 months to get it all containers removed from disposal area. b. Excavation was started with front end loader. c. Equipment operators were from Camp Carroll. d. After drums were reached, excavation continued with hand tools e. Pallets, once exposed, were moved with rough terrain fork lifts f. Close to 300 items (319 sticks in his mind as the number of containers) - 55 gallon drums (est. (300) 55-gal drums) - Other items - 5, 10, 15 gallon pails - Condition of containers - some leakage, but many of the drums were in good condition. - Did not encounter any fuel pods or semi-trailer in trench. - Started sampling liquids from containers in the Fall of 1979: 1. Used pipettes and disposable paddles 2. Sent for environmental testing in Japan – COL Ron Bishop was commander of lab in Japan – he may still be consultant with Health Sciences Academy (AMEDD C&S?) 3. Difficult unknowns liquids were sent to Edgewood Arsenal for further testing. 4. Trench was left open while testing was being done. g. Expanded search to confirm nothing further buried. h. Whe[redacted] PCS's in Fall 1980, the drums which were stored onsite in an contained area were still there. i. Delay in excavated containers disposal to allow time to	a. Mr.[redacted] noticed the trench had been nearly filled with exception to the north side of the trench. b. Mr[redacted] was asked by Sgt[redacted] to place some spent, rusted, concertina wire in an open end of the trench (north end of trench). During the placement of the wire in the trench, Mr[redacted] observed 2 jeeps and a [redacted] Victoria sedan entering the gate. MPs approached M[redacted] asking "Are you aware of what's buried there". Mr[redacted] said "yes" and the MPs left the site. c. Mr[redacted] asked if the south gate (gate leading into helipads area) has moved since the 1970's. This gate and water pits were his reference for the location of the trench he excavated. d. He was enrolled in class 7 of the NCO academy , 1978. e. He doesn't recall any helipads being near the trench he built or any special names for the area. f. Mr[redacted] operated the equipment to build the trench. It took no more than a week to build. It was completed in the Fall 1978. Doesn't recall wearing any special protective gear during construction of the trench. g. Did not observe water in the bottom of the trench. h. No discoloration of soil was observed or odors. i. When asked, Mr.[redacted] did recall a fence being nearby the trench. j. Mr.[redacted] heard that Mr.[redacted] was on profile "wearing tennis shoes" because chemicals were spilled on his feet. He also had heard that Mr. House had chemicals spilled on his

Questions	USFK Employee	Mr. Stephen House	MAJ (Ret) [redacted] b6	Mr. [redacted] b6
Interview date		Monday, 23 May 11	Wednesday, 25 May 11	Thursday, 26 May 11
			identify contents and arrange transportation j. Excavated soil (drums) and excavated drums possibly went to Utah or Nevada (M[redacted] b6 thinks Utah makes the most sense) k. Mr. [redacted] b6 wasn't 100% sure of the location of the trench but did point to an area at the current Land farm as the likely area.	lower legs. He doesn't recall Mr. [redacted] b6 being evacuated from Camp Carroll.

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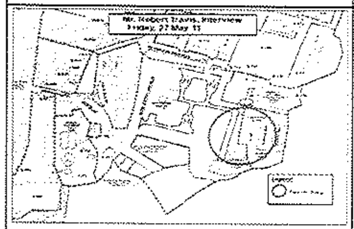
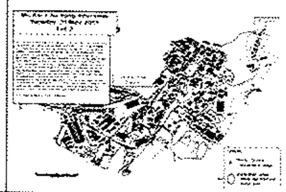
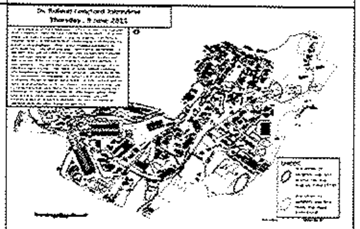
Answers

Mr. [redacted] b6	COL (Ret) [redacted] b6	Mr. [redacted] b6	Dr. [redacted] (LTC Ret) b6
Friday, 27 May 11	Saturday, 28 May 11	Tuesday, 31 May 11	Thursday, 9 June 11
Army Reps: -Mr. [redacted] USAEC -Ms. [redacted] IMCOM Public Affairs – Environmental Branch b6 Veteran Reps: Mr [redacted] b6	Army Reps: -COL Donald Degidio, IMCOM Korea -Mr. [redacted] USAEC -Ms. [redacted] IMCOM Public Affairs – Environmental Branch Veteran Reps: COL (R) [redacted] b6	Army Reps: -COL Donald Degidio, IMCOM Korea	Army Reps: -COL Donald Degidio, IMCCM Korea
Photo Not Available			Photo Forthcoming
	Not Applicable		
Late December 1978 thru Early December 1979	COL Bishop was not stationed at Camp Carroll – he did visit in 1978	1958 to 2001	I was assigned to Camp Walker Dec1981 to Dec 1983
a. D Company, 802nd Platoon b. Pvt when arrived – promoted to PFC while in Korea c. Truck Driver	a. Pacific Environmental Engineering Health Agency, Japan b. Major c. Commander of above unit	KWB-5703, Truck Driver for DPW then 20th SPT Grp	LB Detachment, 5th PMU, Daegu, Korea, CPT, Commander
a. Squad Leader - [redacted] b6 b. Platoon Sgt - [redacted] b6 c. First Sgt - [redacted] d. Company Commander [redacted] b6 e. Doesn't recall any higher ranked officers	Not Applicable		CO - COL Daniel Berliner
55 Gallon drums	Not Applicable	40-50 55 gallon drums. 20-30 5 gallon cans, 20-30 glass jars at both the fire station site and BOQ area.	Not sure of what or when items were disposed as this was before my time; however, my predecessor, CPT [redacted] b6 and a crew of 10-12 worked for a number of months to recover the items buried in a trench in Area D. In my talks with him, CPT [redacted] b6 never mentioned any herbicides; he said most were solvents, some acids and bases, some POL oils, and small amount of pesticides. He told me that there were drums in fairly good shape.

Answers

Mr. [redacted] b6	COL (Ret) [redacted] b6	Mr. [redacted] b6	Dr [redacted] (LTC Ret)
Friday, 27 May 11	Saturday, 28 May 11	Tuesday, 31 May 11	Thursday, 9 June 11 b6
a. Drums were picked up at warehouse – Mr. [redacted] referred to warehouse as "War Surplus Area" b6 b. Drums - All were OD Green - Orange stripes on the drums - Most drums were leaking - Writing on drums: 1. 1967-1968 for Republic of Viet Nam 2. Agent Orange painted in yellow	Not Applicable		In 1981, I was asked to verify the ultimate disposal of the excavated wastes at Camp Carroll. I walked the locations were I was told the drums had been dug up (Area D) uphill and up from the helipad and observed what seemed to be recent excavation work. I also walked another smaller area where I would told there may have been buried chemicals, near Bldg 580. This area was denuded of grass, but I was told there had been a fire there earlier; there was no obvious evidence of recent digging. I also visited Area 41 (the subject of main concern at the beginning); there were deteriorating and leaking drums and ground contamination. There was no evidence that these drums were the one which had been dug
a. Truck loads were taken to trench b. No special name for the disposal area c. Told they were moving the barrels because they were damaged or leaking	Not Applicable		See map, I was told it was "Area D" with a small burial site "near Bldg 580". I was told the chemicals were similar to those at Area 41 in 1981 (solvents, oils, pesticides, etc.).
a. Transportation took approximately 4 days b. Ditch was dug w/ramps on either end - Approximately ¾ city block long including ramps (about 300 feet) - About 15 feet deep - Original intent was to back dump trucks into the trench and dump the loads 1. First load was driven into the trench – dumped – and truck drove out other side 2. Loads after that for next 3-4 days were backed into the trench then dumped 3. After 3-4 days, sides of trench were unstable – trucked backed as far as possible, dumped drums, drums were rolled rest of the way into the trench 4. Drums were not on pallets nor were they neatly stacked in the trench Trench was wet, but unsure if from underground water seepage or from rain – heavy rain early in the disposal	Not Applicable		
a. 150-200 drums total b. 2 drives took 10-12 loads each to the trench - Dump truck took 20-30 barrels each - Flat beds took 10-15 barrels each - Beds were lined with rubber pad/liner c. Initial disposal occurred over approximately 3-4 days	Not Applicable		
a. War Surplus Area (Area 41) - Drivers were escorted anytime they went to this area to pick up drums	Not Applicable		I was told there had been in Area 41, but were removed for burial. From the nature of the materials in Area 41 in 1981, most were from shops (e.g., solvents, oils, waste acids and bases, a few pesticides).
a. War Surplus Area b. Area 41 c. No known	Not Applicable		In 1981, I was told they had been in Area 41.
a. Drums were damaged and/or leaking	Not Applicable		I do not know; however, in 1981 there were deteriorating drums in Area 41 with subsecuent soil contamination. Yet, CPT [redacted] told me the drums he excavated were intact and not leaking. b6
a. Dump truck and Flatbed truck	Not Applicable		I do not know.
a. Truck Drivers: [redacted] b6 and [redacted] b6 b. Heavy equipment operators: Stephen House and [redacted] b6 b6	Not Applicable		I do not know.
	Not Applicable		I do not know.

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Answers

Mr. [redacted] b6	COL (Ret) [redacted] b6	Mr. [redacted] b6	Dr. [redacted] b6
Friday, 27 May 11	Saturday, 28 May 11	Tuesday, 31 May 11	Thursday, 9 June 11
Steel 55 gallon drums			I do not directly know; I was told 55-gallon steel drums. However, in 1981, chemicals in Area 41 were in plastic, steel, and glass containers.
Smelled sweet and not pleasant			I do not know.
Most were leaking			I do not know; however, in 1981, perhaps 10% of the drums and containers in Area 41 were leaking.
Doesn't recall			I do not know.
	Not Applicable		
¾ city block long, 1-1/2 semi trailers wide, 15 feet			The obviously excavated area in 1981 was about 300 feet long by about 30 feet wide. I was told that the excavation had gone 20-30 feet beyond the last drum in every direction. I have no knowledge of the depth.
Yes – most were leaking			I have no knowledge.
Dumped either directly into trench after driving or backing into it or dumped at entrance to the trench and rolled into trench.			I have no direct knowledge, but was told by CPT [redacted] that there were neatly arranged on pallets, 2 tiers high. b6
Was not involved in the excavation, but soil was sandy and unstable			In 1981, the soil in Area D was sandy to gravely without grass cover and with evidence of recent excavation. I have no other knowledge
Not involved with covering the trench			In 1981, the trench had been filled in with local soil, but had no grass yet.
Area never had vegetation – it was always bare dirt			In 1981, there was still no grass cover over the trench area.
No.	Not Applicable		In 1981, I was told by CPT [redacted] and my staff who were involved in the excavation that all containers were removed from Area D, but there were no records of transport or ultimate disposal. I was told there may be a few still buried near Bldg. 580.
a. After leaving Korea, Mr. [redacted] was stationed for 3 years at Aberdeen Proving Ground, MD. His job was driving shuttle bus between APG, MD and Walter Reed Army Medical Center (WRAMC), Washington, DC. On one of his shuttle runs, Mr. [redacted] saw Mr. [redacted] (other driver during the disposal). Mr. [redacted] said he was being treated at WRAMC for in injuries to his feet he received during the disposal. According to Messrs House and [redacted] there is no mention of Mr. [redacted] being treated at WRAMC for anything. Mr. [redacted] recalls 2 helipads, not 3. Mr. [redacted] recalls taking some surplus dirt from trench area to bridge they were building. This is similar to Mr. House's recollection. Mr. [redacted] does not recall any drums in outdoor storage. Said there could have been drums in outdoor storage, but he's not sure. Mr. [redacted] believes trench was partially filled after their disposal ended, but part of it remained open to allow other units to dump barrels into it. Mr. [redacted] was in the ditch moving the barrels as they were dumped – Mr. [redacted] believes this is how Mr. [redacted] was injured. Mr. [redacted] was on profile for injury and wore white tennis shoes. Mr. [redacted] unaware of Mr. [redacted] being medevac'd out of Camp Carroll. Mr. [redacted] believes the people working the War Surplus Warehouse were Korean Nationals.	COL [redacted] was the Commander of the Pacific Env. Eng. Health Agency (part of current day Public Health Command). His unit was comprised of: 9 military, 3 civilians, and 1 Korean LN. While stationed at Camp Zama, Japan from 1977-1980, COL [redacted] visited Camp Carroll in 1978 (prior to MAJ [redacted] being there). COL [redacted] said no chemicals from Korea were burned on the incinerator ship Vulcanus. COL [redacted] unit was in charge of testing chemicals and soil taken from trench at Camp Carroll. He dispatched CPT [redacted] (now living in Tyrone, GA) to the site. CPT [redacted] area of expertise while in Korea [redacted] water and waste water area. COL [redacted] does not believe CPT [redacted] was involved with the excavation of the site, only in testing material from the site. The lab in Japan had only basic equipment for testing. According to COL [redacted] the items they could identify were not out of the ordinary – no herbicides were found. The unknown items were sent to the Aberdeen Proving Ground, MD for testing. COL [redacted] does not recall any herbicides found in this testing either. COL [redacted] said the common practice for		There may have been other chemicals buried near Bldg 580. I was also told, but could not confirm, that medical x-ray films had also been buried at Camp Carroll – location not specified or could be located in 1981. Any developed films would have had the silver halides reduced to silver and contained in the gelatin matrix; however, if they were expired films and unprocessed, they might contain soluble silver halides.

Answers

Mr. [redacted] b6	COL (Ret) [redacted] b6	Mr. [redacted] b6	Dr. [redacted] (LTC Ret) b6
Friday, 27 May 11	Saturday, 28 May 11	Tuesday, 31 May 11	Thursday, 9 June 11
	disposing of chemicals in the 1970s was to dig a trench, place items to be disposed of in trench, back fill trench with soil removed to create the trench, compact the area and spread rest of soil around. To clean up a dump site, soil was removed and placed on impermeable tarp. Items from trench were removed, soil was analyzed to determine proper way to dispose.		

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Buddy STATEMENT

TO WHOM IT MAY CONCERN:

I [redacted] SR. GIVE THIS TESTAMENT 66 OF MY OWN FREE WILL.

I SERVED IN THE U.S. ARMY FROM AUG. 12, 1976 TO AUG. 11, 1980. DURING MY DUTY I WAS SENT TO KOREA IN AUGUST OF 1978. MY CAPACITY IN DELTA COMPANY, 802ND ENGINEER BATTALION WAS GENERAL HEAVY CONSTRUCTION MACHINE OPERATOR. I OPERATED AN EARTH AUGER, SCRAPER, DOZER, BACKHOE, AND DURING THE INCIDENT IN QUESTION, A BUCKET LOADER.

DURING MY DUTY I REMEMBER OPERATING A BUCKET LOADER PULLING UP TO THE BACK OF A TRUCK WHILE OTHER SOLDIERS LOADED THEM INTO MY BUCKET. I THEN DROVE TO AN ALREADY EXCAVATED SITE AND PUT THE BARRELS IN IT.

SOMETIME LATER I CAME DOWN WITH AN ILLNESS THAT AFFECTED MY BACK AND LOWER EXTREMITIES. THE CLINIC ON POST SENT ME TO THE MAIN HOSPITAL AT SEOUL WHERE THEY TREATED ME WITH EXPIERMENTAL DRUGS FOR AN ILLNESS THEY DIDN'T KNOW WHAT I HAD. AT FIRST I COULDN'T WALK BUT MY ILLNESS SUBSIDED SLIGHTLY AND I WAS ABLE TO WALK WITH CRUTCHES. THE HOSPITAL SENT ME BACK TO MY UNIT WHERE MY CAPACITY WAS LIKE A MEDICAL HOLDOVER. MY COMPANY PUT ME IN THE NBC ROOM WHERE I DIDN'T DO ANYTHING BUT WAS OUT OF THE WAY.

CSS 226 66 1495

buddy stmt

MY CONDITION DIDN'T GET MUCH BETTER SO THE CLINIC ON POST SENT ME BACK TO THE HOSPITAL AT SEOUL. THE HOSPITAL MEDIVACED TO WALTER REED HOSPITAL IN WASHINGTON D.C. AFTER SERVING ONLY 9 MONTHS IN SOUTH KOREA.

WALTER REED TREATED ME WITH WHAT THEY CALLED EXPIERMENTAL DRUGS BECAUSE THE DOCTORS SAID THEY REALLY DIDN'T KNOW WHAT WAS WRONG WITH ME.

AFTER SOME TIME I PROGRESSED FROM CRUTCHES TO A CANE AND THEN WAS ABLE TO GET AROUND WITHOUT AN AID. WALTER REED SAID THEY COULDN'T HELP ME ANY MORE SO I WAS SENT TO MY NEXT DUTY STATION FT BRAGG. I TRIED TO GET STATIONED AT FT. DEVENS, MASS., BUT WHEN FT. DEVENS CONTACTED WALTER REED, THE HOSPITAL HAD NO RECORDS OF ME BEING THERE.

AT FT. BRAGG N.C., I SERVED THE REST OF MY DUTY ALL THE TIME WITH A HEALTH PROFILE THAT SAID I DIDN'T HAVE TO DO ANY PHYSICAL ACTIVITY AND HAD TO WEAR TENNIS SHOES, NOT ARMY BOOTS, AS THE BOOTS CAUSED PHYSICAL PAIN ON MY FEET.

I ETS'ED FROM FT. BRAGG IN AUG OF 1980 AND TO THIS DAY CARRY MY MYSTERIOUS ILLNESS THAT I MAINLY FEEL IN MY BACK AND FEET. WHEN AT FT. BRAGG I WANTED MY MEDICAL RECORDS AND WAS TOLD THEY WERE "LOST."

[redacted] b6 10/5/07

DECATUR IL. 62526

440 [redacted] b6 ESS [redacted] b6

STATE OF ILLINOIS
COUNTY OF MACON

SIGNED BEFORE ME ON OCTOBER 6, 2007 BY STEPHEN F. HOUSE AND

[redacted] b6

SEAL

OFFICIAL SEAL
JUDITH A WILHELM
NOTARY PUBLIC - STATE OF ILLINOIS
MY COMMISSION EXPIRES:05/10/08

[redacted] b6

Stephen F. House
STEPHEN F. HOUSE

[redacted] b6

441 CSS [redacted] b6

[redacted] b6
Colonel, US Army (Retired)
607 Comanche Drive
Allen, Texas 75013

March 3, 2008

Department of Veteran's Affairs

REFERENCE: Claim for Service Connection by Stephen House

The purpose of this letter is to provide evidence that may prove relevant to the claim for service connection of disabilities of Stephen House.

From August 8, 1978 to March 16, 1979, I served as Commander of D Company, 802nd Engineer Battalion. This unit was stationed at Camp Carroll in Waegan, South Korea. This Camp was an active Army depot facility and was near the much larger City of Taegu. The unit was an engineer construction company that had one horizontal equipment platoon and two vertical construction platoons. The "horizontal" platoon did earthwork with heavy construction equipment like D-8 bulldozers, scrapers, various size bucket loaders, back hoes, asphalt paving equipment, and concrete placement equipment. The "vertical" platoons had carpenters, electricians, and plumbers that were capable of constructing everything from concrete building foundations to the finished buildings that sat on the concrete foundations.

The unit was continuously tasked to perform both horizontal and vertical construction projects all over the southern portions of South Korea from Camp Carroll south to the coast in Pusan.

I recall in the spring of 1979 that we were tasked to excavate a large ditch on post in what was called Area D. This area was a ridgeline where helicopters landed. The company used both scrapers and bulldozers to excavate the large ditch. Stephen House, then Specialist House, was among those in the heavy equipment platoon that helped in this excavation. While I never personally visited the site, I clearly remember seeing the equipment in the distance on the ridge excavating the ditch.

I may have completed my assignment in the company before the ditch was ever used for disposal purposes, I can't be sure. I do not recall ever being told what was going to be buried in the excavation or personally sending any soldiers to the site after it was constructed. As we had many projects from Camp Carroll to Pusan, it is possible materials were buried while I was away visiting a remote construction site. However, if materials were to be buried, it is credible that Specialist House could have been involved in those operations as he operated the type equipment that would be used in such operations.

[redacted] b6

CSS-[redacted] b6 442

buddy stmt

If the Department of Veteran's Affairs wishes to ask me anything further about my recollections, they may feel free to contact me at by mail at the above address or by calling me at any of the following phone numbers.
Home: [redacted] Work: [redacted]
b6 b6

Sincerely,

[redacted] b6

Colonel, US Army (Retired)

443 CSS [redacted] b6

T/c with [redacted] public works director of Allen, TX.
b6

He denies that he has any more information than that which he included in his letter. I mentioned that we thought he might have more to say if subpoenaed, but he said that was not the case. He was emphatic on that point.

He remembers that more than one "slit trench" was dug and that another agency, which he could not remember, was responsible for what went in the trenches. He said that the only people who would know what went in those trenches were the people who put the material in, and the people who covered it up. He was not present went anything was dumped in the trenches and he doesn't know what went in the trenches. He shipped out before the trench project was completed.

He had high praise for Steven House and held him in high regard as a person who would do anything for his superiors in the Army. Without being asked, he reiterated that he had never been asked to make anything up by Mr. House.

b6
Mr. [redacted] currently is service connected and 70% disabled with bladder cancer, is a retired O-6 (Colonel) who has had service in the Army Corps of Engineers. He is quite outspoken and willing to add or contribute anything else that he knows.

[redacted] b6

OFFICIAL SEAL
STATE OF WEST VIRGINIA
NOTARY PUBLIC
[redacted] b6
BB&T
1605 HARRIS HIGHWAY
PARKERSBURG, WV 26101
My Commission Expires July 3, 2016

PAGE ONE

10. 20. 06.

Subject: CAMP CARROLL
WAEGWAN SOUTH KOREA
DELTA COMPANY
802ND ENGINEER BATTALION
(COMBAT) (HEAVY)
EARTH MOVING Platoon
1978

I [redacted] b6, hereby swear to the following events, in the late spring early summer of 1978, of events under order while stationed at the above Army Depot.

In the spring we were told of a "move" that we to be a part of. For two weeks we fell out for formation in our Nuclear Biological Chemical suits, with gas mask, and were tested on proper wear, each day.

At this time, after apr. 2wks, it was raining, and we were ordered not to wear our NBC gear, due to the rain. We left our motorpool with our 20 ton Dump trks and went to the part of the post, known as the war surplus area.

[redacted] 66

OFFICIAL SEAL
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NOTARY PUBLIC
[redacted] 66
BB&T
1605 HARRIS HIGHWAY
PARKERSBURG, WV 26101
My Commission Expires July 3, 2016

Page Two

We proceeded to a brick building, which had a loading dock of a concrete front. In this building was appry. 250 barrels, which were olive drab green, 55 galon, with an orange stripe and yellow lettering, which read - Chemical, AGENOT, TYPE: ORANGE, dated 1967 and read for the Republic of Viet Nam.

These barrels, were leaking and rusted, and we were told to hand move them into the back of the dump trucks, which we had backed up to the dock, with the tail gate, chained, in the down/open position.

These barrels were then transported across the post/depot to an old airfeld, in which the previous two weeks, we had dug a hole, appry. 150 yds long, 25 to 30 feet wide, and 25 to 30 feet in depth.

We then dumped these barrels in the hole, until all 250 barrels had been moved. The hole stayed open for about six months, at which time there were outside units from within Korea, that dumped other barrels and equipment, both day and night.

446

[redacted] b6

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NOTARY PUBLIC
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1605 HARRIS HIGHWAY
PARKERSBURG, WV 26101
My Commission Expires July 3, 2018

Many of us, within weeks, developed skin rashes, consisting of red colored, odd size, gauites shaped raised bumps.

I left Korea in December of 1978, at was stationed at Aberdeen Proving Ground Maryland, where I became the main bus driver to Walter Reed Army Hospital in Washington, D.C.

At this time, I went to an Army Doctor, name unknown, rank of Captain and told Him what I had participated in. He looked at me has if I was nuts, but issued me a Selsun brown Shampoo, which I used for several months. The rash did clear up, but does reappear in hot muggy weather.

I also swear the Steven F. Moose who was also in my platoon as a Spc 4th class, participated in this move as a driver, bucket, and forklift operator.

We also stood in line together, during the NBC training at this time, and noticed the some soldiers had white filters, and some had orange filters in our gas mask. This when questioned was never answered.

[redacted] b6

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[redacted] b6
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1605 HARRIS HIGHWAY
PARKERSBURG, WV 26101
My Commission Expires July 3, 2016

page Four

I had access to my medical records from this time, throughout my time at Aberdeen Proving Ground MD, and also while stationed at Manheim FRG, for three years, and turned them in at Fort Campbell KY, around January 1985. Upon ETS in March of 1985, I was told by Ft. Campbell Military personnel and the hospital, that they had no records of my medical files, and that they had been lost.

[redacted] b6

10.20.06.

[redacted] b6
Parkersburg WV. 26101

ph. home. [redacted] b6
cell. [redacted] b6

DEPARTMENT OF THE ARMY
FAR EAST DISTRICT, CORPS OF ENGINEERS
UNIT #15546
APO AP 96205-0610

REPLY TO
ATTENTION OF:

CEPOF-ED-MS (415-10f) 7 December 1992

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Final Report for Baseline Groundwater Investigation, Camp Carroll, Korea

1. The Final Report for the subject project was completed on 19 November 1992 and received in Korea on 3 December 1992. Copies of this final report are transmitted for your use as shown on the distribution list below.

2. This report includes a memorandum for record by the government project manager as a preface. Our proposals for the next step in site investigations for three sites were provided to EANC-T-EH-C by memorandum dated 8 September 1992.

3. The Point of Contact for this report is Mr. [redacted] b6 Special Projects Section, at DSN [redacted] b6

FOR THE COMMANDER:

Encls (See Dist)

[redacted] b6
Acting Chief, Engineering Division

DISTRIBUTION:
Commander, 19th Support Command, Assistant Chief of Staff, Engineer, ATTN: EANC-EN (Col Goring), Unit No. 15015, APO AP 96218-0171 (2 Copies)
USFK/EUSA Assistant Chief of Staff, Engineer, ATTN: FKEN-E (Dr [redacted] b6, Unit No. 15237 APO AP 96205-0010 (2 Copies)
Commander, US Army Material Support Center-Korea, ATTN: EANC-MSC-DS (Col Block), Unit No. 15384, APO AP 96260-0286 (2 Copies)
Installation Manager, 20th Support Group, ATTN: EANC-T-EH-C (Mr [redacted] b6, Unit #15499, APO AP 96260-0565 (2 Copies)
CEPOD-ED-ME (Mr. [redacted]) b6

FINAL REPORT

CAMP CARROLL
BASELINE GROUNDWATER
INVESTIGATION

Prepared for

U.S. Army Engineer Division
Pacific Ocean Division
CEPOD-ED-ME
Building 223
Fort Shafter, Hawaii 96858-5440

November 19, 1992

Prepared by

Woodward-Clyde Consultants
Three Waterfront Plaza, Suite 480
500 Ala Moana Boulevard
Honolulu, Hawaii 96813

451

DEPARTMENT OF THE ARMY
PACIFIC OCEAN DIVISION, CORPS OF ENGINEERS
FORT SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF

CEPOD-ED-ME

19 November 1992

MEMORANDUM FOR RECORD

SUBJECT: Preface to Camp Carroll Baseline Groundwater Investigation

1. Monitoring wells installed for this study were secured with locking caps. The keys for the locking caps were given to both the Camp Carroll Directorate of Engineering and Housing (DEH) and the U.S. Army Corps of Engineers, Far East District (FED). The wells may be resampled at any time and could be incorporated into an overall monitoring program to document changes in contaminant levels. Should any wellhead be damaged or broken, immediate repair or well closure is imperative. An open monitoring well is a conduit by which surface contaminants or spills may travel to the aquifer.

2. A variety of alternative remedies are available for removing the sources of contamination and more are being developed every year. Some alternatives which are feasible in some cases may be inappropriate for remediating others. It was beyond the scope of the current project to suggest remedial action for either the individual sites or the installation as a whole. In order to plan an effective strategy for remediating contamination, a great deal of site specific information is needed. This information will necessarily be developed in future phases of investigation before remedial action can take place.

3. Subsurface contamination is typically difficult and expensive to isolate if the source is not known. Once contamination is detected, it must be more fully characterized (both by the different kinds contaminants and the shape of the plume in three dimensions) if decisions are to be made concerning what kinds of remediation steps might be taken. Camp Carroll is especially difficult since the bedrock is extensively fractured making it possible for contaminants to travel through the cracks substantial distances away from the source. A well which intersects such a fracture might show considerable contamination while one not far away from the fracture could be relatively clean.

4. Once the size and nature of contamination is well understood, various mitigation or remediation options will be proposed. One of the more popular methods of treatment of contaminated groundwater has been "pump and treat". The pump and treat method pumps contaminated groundwater from the aquifer, removes the contaminant(s), and reinjects the water. While pump and treat has been popular, it has not been without its drawbacks. The primary disappointment has been that while large amounts of contaminants are frequently recovered initially, it becomes increasingly difficult to reach and maintain the low level health based goals.

5. An example of how pump and treat might be complicated by buried contamination was described by EPA hydrologists (*"Basics of Pump-and-Treat Groundwater Remediation Technology"; U.S. Environmental Protection Agency. Robert S. Kerr Environmental Research Laboratory: Ada OK, March 1990; EPA-600/8-90/003*). They estimated that it would take 120 (one hundred and twenty) years for 30 liters (approximately 8 gallons) of TCE (from 1 m^3 of contaminated soil) to fully dissolve into the groundwater flowing at 0.1 ft/day. This means that a small amount of contaminant can slowly enter the groundwater system, "reinfecting" the aquifer

CEPOD-ED-ME
SUBJECT: Addendum to Camp Carroll Baseline Groundwater Investigation

6. The analytical work on the samples included the routine drinking water parameters for all monitoring wells. In addition to these parameters, the perimeter and SB3 groundwater samples were analyzed for semivolatile compounds (Method 8270). Some of these samples showed trace levels of diethyl phthalate, a plasticizer and common artifact (from either the sampling or sample preparation process). In addition to the standard semivolatile analytes listed in the laboratory reports, chromatograms were examined for other compounds. Most of the samples did not have any significant additional compounds. MW 14 had some low level contamination by some long chain and branched hydrocarbons (probably from petroleum), but only SB 3 showed extensive contamination by semivolatile compounds.

7. Mass spectral data from SB3 was examined in detail by both the contract laboratory and the COE. Unfortunately very few of the compounds in this groundwater sample could be identified. Those which could be identified included dimethyl tetrasulfide, ethanethioic acid, ethylthiopropanoic acid, and phosphorodithioic acid ester (all breakdown products of malathion), some indole compounds, and some long chain hydrocarbons. It is probable that many of the compounds were degradation products of the contaminants dumped in the area (malathion, petroleum, and other wastes).

8. Considering all of the above, this report together with the Historical Report (*"Historical Land Use and Background Survey Report, Camp Carroll, Korea"; Woodward Clyde Consultants, Honolulu, HI.*) should be considered to represent a first step in identifying the potential sources of environmental contamination at Camp Carroll. Future work may be directed towards studying all potential sources in more detail, or intensively attacking one or more of the sites which have already been identified.

[redacted] b6
Chemist, Environmental Branch

Three Waterfront Plaza
Suite 480
500 Ala Moana Boulevard
Honolulu, HI 96813
(808) 531-5462
Fax: (808) 531-6164

Woodward-Clyde Consultants

November 19, 1992
91C0499H

Mr. [redacted] b6
U.S. Army Corps of Engineers
Pacific Ocean Division
CEPOD-ED-ME, Bldg. 223
Ft. Shafter, HI 96858-5440

Subject: Delivery Order No. 0029
Contract No. DACA83-90-D-0023
Submittal of Final Report
Camp Carroll Baseline Groundwater Investigation

Dear Mr. [redacted]

In accordance with our contract for the subject project, we are pleased to submit fifteen (15) copies of the final report entitled *Camp Carroll Baseline Groundwater Investigation*. This report is submitted in accordance with the Scope of Work entitled "Revised Scope of Work for Monitoring Wells, Soil and Groundwater Sampling, Camp Carroll, Korea," dated September 19, 1991, and revised December 18, 1991.

If you have any questions or comments regarding the report, please call me at [redacted]

Sincerely

[redacted] b6

S.R. [redacted] b6 PhD
Project Scientist

Attachment

TABLE OF CONTENTS
CAMP CARROLL BASELINE GROUNDWATER INVESTIGATION

LIST OF TABLES

LIST OF FIGURES

1.0

INTRODUCTION

1.1 EXECUTIVE SUMMARY

A total of sixteen monitoring wells were installed at the U.S. Army facility at Camp Carroll, Republic of Korea between March 13 and April 17, 1992 to establish baseline information on the nature, extent and levels of contamination within groundwater underlying the base. Monitoring wells were installed in areas located just down-gradient from potential source areas of contamination identified in an earlier historical review of hazardous waste usage at the base (WCC, 1992a). Fifteen monitoring wells installed during this study along with an addition three wells installed during the Building 644 Contaminant Investigation (WCC, 1992b) were developed and purged. Water samples were collected from these wells after water quality parameters had stabilized. Water samples were also collected from ten drinking water supply wells located on the base.

Fifteen of eighteen monitoring wells sampled contained detectible levels of one or more chlorinated hydrocarbons. Eight of ten water supply wells sampled contained detectible levels of chlorinated hydrocarbons. Only two of the eighteen monitoring wells sampled contained detectible levels of aromatic hydrocarbons while none of the water supply wells sampled contained detectible levels of these compounds. Detectible levels of lead (>3 parts per billion) were measured in seven of the fifteen monitoring wells installed during this baseline survey while five of these wells contained detectible levels of zinc (>20 ppb).

Geologic logs of the borings drilled during this investigation revealed that Camp Carroll is underlain by granitic gneiss bedrock which constitutes the primary groundwater aquifer. Those areas of the base where bedrock is overlain by large amounts of fill and alluvial material often have shallow groundwater lenses perched on buried, low permeability clay horizons.

Pumping tests were conducted on two water supply wells located on the base (Wells 2-89 and 12-289) while utilizing nearby monitoring wells and water supply wells as observation points for drawdown measurements. Drawdown and recovery characteristics observed during these pumping tests are consistent with water movement through the aquifer via a combination of porous media flow and fracture flow. Analysis of the drawdown curves with analytical solutions based on porous media flow yielded transmissivity values for the aquifer between 500 to 3000 square feet per day. Assuming an effective aquifer thickness of 250 feet, hydraulic conductivity (K) values for the granitic gneiss range from 2 to 12 feet/day. Storativity values measured during these pump tests ranged from 0.006 to 0.04, which are low values for typical unconfined aquifer systems. Bail and slug tests performed on monitoring wells installed during this investigation yielded similar hydraulic conductivity values, ranging from 0.015 to 5 feet/day. Measured hydraulic conductivity values tended to decrease in monitoring wells screened at deeper depths within the granitic gneiss bedrock.

The following report summarizes the baseline investigation conducted by Woodward-Clyde Consultants (WCC) at Camp Carroll between March 13 and April 17, 1992. Topics addressed in this report include a discussion of the rationale for locating the installed monitoring wells, the geology encountered during drilling, methods of installation, development and purging of monitoring wells, hydraulic testing of the aquifer underlying the base, interpretation of chemical analyses of collected groundwater samples, a discussion of laboratory quality assurance and quality control (QA/QC), and recommendations for additional remedial work on the base.

The work was performed in accordance with the scope of work entitled "Revised Scope of Work for Monitoring Wells, Soil and Groundwater Sampling, Camp Carroll, Korea," dated September 19, 1991, prepared under U.S. Army Engineering District, Honolulu Contract No. DACA 83-90-D-0023, Delivery Order Number 0029.

This project was requested and funded by the 19th Support Command based in Taegu, South Korea. Mr. [redacted] of the Military Division, Environmental Branch, U. S. Army

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Corps of Engineers was the Project Manager for this project. The drilling equipment and personnel were provided by the Far East District of the U. S. Army Corps of Engineers based in Seoul, South Korea.

1.2 PURPOSE AND OBJECTIVE

The purpose of this investigation was to determine the overall groundwater quality within the aquifer systems underlying the Camp Carroll. The need for this study was prompted by the discovery of elevated levels of chlorinated hydrocarbons (trichloroethylene and tetrachloroethylene) in water supply wells located on the base.

Monitoring wells were installed in this study using a Jaswell drill rig equipped with a Conair 250 psi compressor. The selection of drilling locations was based largely on the results of a historical land use and background survey report (WCC, 1992a) which identified potential source areas of contamination on the base where improper disposal and use of hazardous materials may have occurred. Hydraulic testing of the aquifer was performed by slug and pumping tests conducted on both installed monitoring wells and the existing water supply wells. Groundwater samples collected from the installed monitoring wells and the existing pumping wells were analyzed by Pacific Environmental Laboratory and by NET Pacific, Inc.

1.3 SCOPE OF WORK

Major work tasks outlined in the scope of work are described below:

a. **Prepare Safety Plan.** The Contractor shall prepare and submit a safety plan to the Contracting Officer's Representative (COR) for review and approval. No field work may be performed until the safety plan is reviewed and approved by the COR. All work shall be performed according to the approved plan. The safety plan must be administered by a qualified safety and health professional and shall comply with all federal, state, and local health and safety requirements including the Occupational Safety and Health Administrations requirements (29 CFR 1910 and 1926), the U. S. Environmental Protection Agency's hazardous waste requirements (40 CFR 260-270), the U. S. Army Corps of Engineers' Safety and Health Requirements Manual (EM 385-1-1), and the U. S. Army Material Command's Safety Manual, AMCR 385-100.

b. **Prepare Plan for Installation of Monitoring Wells.** Based on the hydrological and historical land use information, prepare a plan for the installation of monitoring wells. Using information gathered during the historical search, the contractor shall propose a minimum of 12 locations for monitoring wells to be used for determining the groundwater quality, gradient and migration of contaminants at the base and near its boundaries.

c. **Supervise Installation of Monitoring wells and Collect Groundwater Samples.** Upon approval by the Government Contract Monitor (GCM) of the plan described in Paragraph b above, the Contractor shall supervise the drilling of borings to at least 10 feet below the water table, or until bedrock is encountered. Prior to any drilling, the Contractor shall tone the area to determine if any underground utilities, pipelines, etc. exist. Detailed requirements concerning installation of monitoring wells are found in Attachment 4 of the Scope of Work. The Contractor shall collect two soil samples while installing each monitoring well. Soil samples shall be collected for chemical analyses by the Government, and QA samples shall be shipped back to the QA laboratory. The Contractor shall supervise the installation of the monitoring wells for a period of 19 workdays.

d. **Prepare Report Summarizing All Work Items.** The Contractor shall prepare a detailed report summarizing all of the work item actions defined by this scope of work. The report shall also include survey data, a general site map, piezometric surface map, and a location map including elevations. The report shall include recommendations for site remediation or further study.

1.4 SITE LOCATION AND PHYSIOGRAPHY

The U. S. Army Installation at Camp Carroll is located adjacent to the village of Waegwan in the south-central portion of the Republic of Korea (Figure 1). The western edge of the installation is bounded by urban development while hilly forested areas bound the base on the north and east perimeter. Rice is grown in agricultural fields situated along the southern border of the base.

Figure 2 is a topographic map of the Waegwan area before construction of the base (exact date of the map is unknown). The approximate boundaries of Camp Carroll today are superimposed for reference. The hatched areas on the map indicate areas of rice cultivation. This is consistent with comments made by Mr. [redacted] (driller with FED) who stated that much of the land on which the base was built had been previously used in the cultivation of rice. As a result of this agricultural usage, the valley floors and surrounding hillslopes had been extensively terraced into individual rice patty plots.

As can be seen on the topographic map, the base is built around a discontinuous, north-south trending ridgeline which splits the base into eastern and western halves. Extensive regrading has occurred throughout the base to produce level lots suitable for the large warehouses constructed at Camp Carroll. For instance, the hillslope behind Building 644 had been truncated and regraded to produce the flat area which currently exists between Buildings 644 and 645 (WCC, 1992b). In the two valleys located in the central and western portions of the base, the original terraced terrain has been levelled by the addition of up to 20 feet of fill material (Mr [redacted] personal communication).

1.5 REGIONAL GEOLOGIC AND HYDROGEOLOGIC SETTING

The basement rock underlying Camp Carroll is composed of Precambrian granitic gneiss (Geologic Map of Korea, 1:50000, 1974). Siliceous dikes intrude the granitic gneiss in this area in a random manner without any single dominant regional trend. In the northern part of the town of Waegwan, thin beds of quartzite, calc-schist and limestone are found intercalated within the granitic gneiss.

Geologic logs of eleven water wells located in the southern half of Camp Carroll (Wells 1-87, 2-89, 6-167, 8-188, 10-205, 11-206, 12-247, 13-279, 14-283, 15-286, 16-289 and well files available at U.S. Army Corps of Engineers, Far East District (FED) in Seoul indicate that bedrock in this part of the base is largely composed of granitic gneiss and granodiorite. Figure 3 shows the location of the water supply wells on the base. The upper 100 to 200 feet of bedrock is weathered, with the degree of weathering decreasing with depth. Calcareous-schist and limestone were encountered near the bottoms of some of the deeper wells. The overburden in the vicinity of these wells varies from about 20 to 40 feet in thickness and ranges in composition from silty clays to gravel-rich sandy silts.

The granitic gneiss bedrock underlying Camp Carroll has low primary porosity due to the tight intergranular packing within the rock matrix. As a result of this low primary porosity, fractures which cut the gneiss probably contribute to the storage and transmittal of water through the aquifer (secondary porosity). The uppermost, more extensively weathered portion of the granitic gneiss may be somewhat more permeable and probably yields the majority of water to the wells. The alluvial overburden is moderately permeable but is generally not exploited by these deep water wells. Shallow perched water is not exploited since the upper 30 to 100 feet of these wells are typically cased off. The water wells drilled on the base are typically drilled to depths of 200 to 350 feet to maximize the number of potential water-transmitting joints and fractures which the well may encounter. Specific capacities for these wells are generally low, with an average of 0.9 gallons per minute/foot drawdown measured in pump tests performed shortly after drilling and development of these wells by FED personnel (pump test data available in well files at Seoul FED).

1.6 HISTORY OF ACTIVITIES AT THE SITE

The groundwater pumped from water supply wells at Camp Carroll has been periodically analyzed for inorganic constituents over the past 15 years by personnel based at Seoul FED. Table 1 summarizes the analytical results. Groundwater contamination by halogenated hydrocarbons was first discovered in the drinking water supply for Camp Carroll during sampling conducted by the 5th Preventative Medicine Unit in August 1990. Elevated levels of trichloroethylene (~50 parts per billion) were detected in several wells on the base. No documentation of these analyses could be found except for an analysis of water sampled from the water treatment plant which contained 18 ppb trichloroethylene (result listed in table compiled by EUSA Environmental Programs Office). This initial sampling was followed by more regular sampling of the water supply wells the following year during the months of June, August, September, December 1991 and January 1992. Table 2 lists the results of these sampling efforts and the round of sampling conducted in April 1992 during this study. The chlorinated solvents trichloroethylene and tetrachloroethylene exceeded the drinking water standards and were the dominant contaminants of concern identified in these initial rounds of sampling.

In August 1991, military and civilian personnel at the base were notified of the presence of trichlorethylene in the water supply and its potential health hazard. Contaminated wells were shut down and potable water was trucked in from Camp Walker. As a result of these events, the U. S. Army Corp of Engineers initiated a contract with WCC on September 9, 1991 to do a three-part environmental study of Camp Carroll: an historical land use and background survey, a study to determine the nature and extent of contamination in the vicinity of Building 644, and a baseline groundwater survey of the base.

The historical land use survey (WCC, 1992a) identified a number of facilities and operations which may have potentially contributed to surface and subsurface contamination within Camp Carroll. These areas included motorpool and maintenance areas, drum storage areas, equipment and vehicle cleaning operations, and historical landfill sites. Other potential sources of contamination on the base included the numerous aboveground and underground fuel storage tanks and the oil/water separators associated with maintenance buildings throughout the base. Hazardous waste routinely used on the base included petroleum, synthetic and mixed oils, battery acid and various types of solvents. Figure 4 shows the annual quantities of oil, solvents and acids disposed from various facilities throughout the base in 1991.

In the vicinity of Building 644, an estimated 26,500 cubic feet of soil contaminated with malathion, trichlorethylene and tetrachloroethylene were delimited (WCC, 1992b). The underlying groundwater in this area was contaminated with the same suite of compounds. Probable migration of contamination occurred from the original area of soil contamination to groundwater which is pumped by a drinking water well located approximately 400 feet down-gradient from the soil contamination site.

2.0
FIELD INVESTIGATION

2.1 INTRODUCTION

The baseline investigation was designed to estimate the hydraulic gradient and the nature and extent of groundwater contamination underlying Camp Carroll. The following sections outline the work performed to achieve the Scope of Work objectives.

2.2 HEALTH AND SAFETY PLAN AND RECORDS

A health and safety plan was prepared prior to the initiation of field work. The plan discussed the anticipated hazards associated with the project and outlined site-specific health and safety requirements as well as general health and safety requirements to be followed during completion of the project. The document also discussed emergency procedures to be followed by the Site Safety Officer and identified the responsible project personnel. A complete health and safety plan was submitted to CEPOD.

A health and safety briefing was conducted for the drillers at the base camp established in the building located just southwest of Building 938 on March 16, 1992. Mr. [redacted] b6 WCC's Site Safety Officer, discussed the specific work hazards and actions to be taken to avoid injury and illness with the drilling crew. Personal protective equipment available on the site during work included coated tyvek suits with hood and booties, gloves, respirators equipped with organic vapor cartridges, and steel-toed boots. Tyvek suits and gloves were discarded during breaks in work such as during the lunch break and at the end of the day.

Air monitoring with a Model PI-101 HNu and a Gas Tech Combustible Gas Indicator was performed at least hourly during drilling operations to determine the need to don respiratory protection gear. (The HNu, equipped with both a 10.2 and 11.7 eV lamp, has a recommended operating temperature range of -10°C to 40°C and can properly function under relative humidity conditions of up to 90%.) The breathing zone and air space above the soil cuttings were typically monitored. The air space above the auger when the cutting rod was removed was also monitored and is recorded on the boring logs (Attachment 4) under open hole gas readings. Air monitoring information was recorded in a field logbook by Mr. [redacted] During the duration of the project, the drill crew upgraded to Level C only once when organic vapors were detected at concentration levels in excess of acceptable action levels set forth in the Health and Safety plan. Additional details of the Health and Safety Plan can be found in Attachment 3 which includes a copy of the Safety Completion Report for the project and field notes made by the Site Safety Officer.

2.3 MOBILIZATION AND SITE PREPARATION

A base camp was established in the concrete storage building located just southwest from Building 938. This area was fenced off and secured. Entry was limited to those individuals having a key to the padlock on the only gate leading into the property. All field supplies were stored in this building. A staging and decontamination area for the drill rig was established adjacent to this building on the low side of the parking lot area. Five-millimeter thick visquine was laid down on the asphalt surface and a perimeter berm was constructed using 4 by 4 inch lengths of lumber. A wooden ramp was placed against the perimeter berm to allow the drill rig to back into the decontamination area. A steam cleaner was placed adjacent to the decontamination facility. Water was supplied from a nearby fire hydrant. Excess steam cleaner water used to decontaminate the drill rig was allowed to evaporate within the containment area.

A map showing the locations of where intrusive activity was planned was given to the Directorate of Engineering and Housing (DEH) so that these areas could be checked for the presence of underground utilities. Additional utility maps located at the Signal Brigade (Building 902) were reviewed prior to the initiation of drilling. The specific points of drilling were also toned with a Metrotech Model 480 Pipe and Cable Locator.

The drilling sites were closed off to through traffic by stringing yellow caution tape between wooden traffic barriers surrounding the drill rig. Wooden signs labelled "Dangerous Keep Away" in both English and Hangul (Korean) were placed around the perimeter of the drill site.

2.4 CRITERIA FOR LOCATING MONITORING WELLS

A historical land use and activity survey of Camp Carroll (WCC, 1992a) identified potential areas of contamination on the base. Based on the historical land use information gathered and on the limited amount of hydrological information available for the base, a Work Plan was generated on January 10, 1992 providing locations of monitoring wells which would provide data for evaluating groundwater quality, gradient and migration of contaminants within the base and near the base boundaries. Twelve locations were recommended by WCC as priority sites with an additional seven alternative sites also included in the Work Plan.

Table 3 provides rationale for the specific locations chosen for the monitoring wells during the Historical Land Use Survey (WCC, 1992a). Some sites, such as the BEQ #2 Landfill, were discovered during the field portion of this baseline survey and were thus not included in the original work plan list. In general, monitoring wells were installed in locations estimated to be hydraulically down-gradient from potential source areas. Drilling was conducted along the periphery of suspected contaminated areas to avoid contaminating the drill rig. Figure 5 plots the location of monitoring wells locations with the major potential contamination source areas identified in the historical land use survey (WCC, 1992a).

2.5 DRILLING OPERATIONS AND MONITORING WELL INSTALLATION AND DEVELOPMENT

A total of sixteen monitoring wells were installed throughout the base during this investigation. A Jaswell truck-mounted air rotary drill rig equipped with a 250-pound per square inch (psi) air compressor was used with 6-inch and 8-inch percussion carbide drill bits. In borings where soft material was encountered in the shallow subsurface, an 8-inch diameter hole was drilled and casing installed. At the depth where competent material was encountered, the cutting bit was changed to a 6-inch bit for the remainder of the drilling. In borings where competent material (granitic gneiss) was encountered within the first five feet or so, the entire boring was drilled with the 6-inch drill bit and no casing was placed down the hole. Visquine was laid down around the immediate vicinity of the drilling operation to contain the potentially contaminated cuttings. While drilling through the granitic gneiss bedrock, it was often difficult to accurately determine the depth at which the water table was encountered. As a result, some wells may have been drilled to depths in excess of ten feet below the static water table. In later borings, the water levels were allowed to equilibrate in the boring prior to installation of the monitoring well to assure that the slotted well casing intersected the water table.

Fifteen to twenty-five foot lengths of two-inch threaded polyvinyl chloride (PVC) pipe were placed inside the boring so that the upper portion of the 0.020-inch slotted pipe was three to five feet above the water table. Because the graded silica sand available in Korea was finer than the slot size, an inert filter sock was placed over the slotted pipe casing of the well to minimize entry of sand into the casing. The graded sand was slowly packed around the annular space surrounding the casing with a tremmie pipe to minimize the possibility of bridging of the sand pack at a higher level in the well. The sand pack was pored to a depth of about 1 to 2 feet above the top of the slotted interval. A powdered bentonite seal of 3 to 5 feet thickness was then placed above the sand and hydrated. The remainder of the hole was filled with Portland cement to within 1 foot of the surface. After the cement set, a protective Christy box was cemented in place. Construction details for the various wells installed can be found in the boring logs in Attachment 4.

Slotted well casings on the following wells intercepted the static water levels, measured on 4/16/92: MW-14, MW-15s, MW-17, MW-18, MW-20, MW-22, MW-24, MW-25, SB-3, SB-6 and SB-11. Laboratory analyses determined on water samples collected from these wells will reflect a composite of compounds in any immiscible product floating on the water table (if present) and dissolved compounds in the groundwater.

The following monitoring wells screened intervals were installed below the water table: MW-12B, MW-13, MW-15, MW-16, MW-19, MW-21 and MW-23. The analytical data determined on water samples collected from these wells will reflect only dissolved compounds in the groundwater.

The individual monitoring wells were developed by bailing five times the volume of water within the well under static conditions. The majority of wells were bailed with dedicated bailers. Monitoring wells with water levels within 10 feet of the ground surface were developed with flexible polypropylene tubing connected to a suction pump. Development of individual wells was typically done over several days due to the relatively large amounts of water which needed to be removed from most wells. This repeated bailing typically removed much of the fine grained material which had entered the well during installation. Development water was placed in dedicated 55 gallon drums.

Water quality measurements were periodically made on water samples after specific volumes of water had been removed during development to determine whether the chemical composition of the water in the well had stabilized. Parameters monitored included the water temperature, pH, salinity and specific conductance. These measurements have been tabulated in Table 4.

2.6 ELEVATION SURVEY OF MONITORING WELLS AND EXISTING WELLS

The elevations of the sixteen monitoring wells installed during this investigation were surveyed by Mr. [redacted] and Mr. [redacted] of the U.S. Army Corps, Far East District. Well elevations were referenced to various benchmarks located around the base. A notch was placed in the top of the PVC casing of each well. Elevations of these notches were measured. The elevations of individual monitoring wells installed during this study can be found in the upper right hand corner of the boring logs (Attachment 4). Specific site location maps for the individual wells can be found in Attachment 5.

2.7 GROUNDWATER SAMPLING

Fifteen of the sixteen monitoring wells installed during this study were sampled for groundwater. The sixteenth monitoring well, MW-26, became dry after installation and a water sample could not be collected. Three of the monitoring wells installed during the Building 644 study were also sampled (SB-3, SB-6, SB-11). Water samples were also collected from ten drinking water wells at Camp Carroll. Dedicated Teflon and polypropylene bailers were used to collect water samples from the installed monitoring wells for analysis. Water supply wells were sampled from attached spigots after a minimum of 100 gallons had been pumped. The monitoring wells were sampled on April 13, 1992 and April 14, 1992 while the water supply wells were sampled on April 15, 1992. Water samples were collected in 40 milliliter volatile organic analyte (VOA) vials, 250 ml Nalgene plastic bottles, and 1 liter flint glass bottles. No preservatives were added to any of the sample containers.

SITE GEOLOGY AND HYDROLOGY

3.1 LOCAL GEOLOGY

Geologic logs were recorded for the eighteen borings drilled during this investigation. Boring logs can be found in Attachment 4. The depths of the borings ranged from 5 to 85 feet depth. Granitic gneiss was encountered as bedrock in all the borings drilled on the base. This granitic gneiss bedrock was overlain by 2 to 30 feet of fill and colluvium throughout the base. Borings situated within the valley floors located typically had the greatest thickness of fill and colluvial material, while borings situated on the ridgeline which bisects the base had relatively shallow accumulations of fill and colluvium. The only exception to this were the lithologies encountered in monitoring well MW-22, where 30 feet of fill material was encountered atop a ridgeline in the northeastern corner of the base. This relatively large thickness of fill material represents the depth of a landfill excavation which was once located at this site. Borings situated on the lower slopes of the ridgeline typically had intermediate thicknesses of fill and colluvium.

The relatively thick accumulations of fill encountered in the valley floors are consistent with the large alteration of the natural topography which occurred during construction of the base. According to Mr. [redacted], the land on which the base sits was formerly heavily terraced rice paddies. Rice paddies were typically constructed by placing a layer of clay in the areas of rice cultivation to pond diverted stream water and direct rainfall within the rice paddy area. Construction of Camp Carroll altered the original topography by filling of the terraced areas, especially in the valley down which American Avenue runs. This is depicted on Figures 6 and 7, which show cross sections along and across this valley, and were developed using geologic information collected in this study. The buried clay horizons of the former rice paddies produce localized perched conditions within the shallow subsurface in these portions of the base.

3.2 REGIONAL AND LOCAL GROUNDWATER ELEVATIONS

A synoptic set of groundwater levels was measured on April 16, 1992 for all monitoring wells installed at Camp Carroll during this investigation and during the Building 644 investigation.

Figure 8 shows the measured water levels in the various monitoring wells located around the base. Figure 9 includes partially to fully recovered water levels measured at the base water supply wells during this study and the baseline study, in addition to the monitoring well measurements. The actual date of measurement is included on the figure. The water levels measured in the base water supply wells are generally much lower than those measured in nearby shallower monitoring wells installed during this study. The cluster of wells centered around Building 938 (Wells 12-247, 13-279, 14-283 and 15-286) typically had measured water levels 30 feet lower than levels measured in nearby shallow monitoring wells such as MW-18 and MW-24. Likewise, the water level measured in pumping well 6-167 was about 35 feet lower than the water level measured in nearby monitoring well MW-20.

These differences in measured water levels may either reflect the presence of distinct shallow and deep aquifer systems in these two areas, or may simply reflect a large vertical head gradient within a single aquifer. The water supply wells on the base are typically cased over the first 40 to 100 feet to minimize the potential for contamination from the surface. Thus, the water levels in these wells reflect the hydrostatic pressures present within a deeper portion of the aquifer system. The presence of downward vertical head gradients is evident in the relative head difference measured in the nested monitoring wells MW-15 and MW-15s, which were screened over depth intervals of 54 to 74 feet and 35 to 45 feet below grade respectively. No geologic discontinuities were observed during drilling, and the screened intervals of each well are located within material of similar lithology (granitic gneiss). The static head measured on April 16, 1992 in MW-15 was 114.05 feet and in MW-15s was 119.87 feet above mean sea level. This head difference of 5.82 feet exists over a vertical distance of 24 feet between the midpoints of the screened intervals of the two wells yielding a downward gradient of 0.24 ft/ft. Based on these large measured vertical head gradients in this nested set of monitoring wells, the difference in water levels in the monitoring wells and the base water supply wells is most likely attributable to large, natural downward vertical head gradients present within the granitic gneiss underlying the base.

The overall groundwater flow direction underneath the base (Figure 10) is to the south to southwest, consistent with the trend of the two main valleys on the base. The north-south trending ridgeline which parallels Nebraska Avenue probably acts as a groundwater divide for groundwater flow underneath the base. The direction of groundwater migration is towards the southwest in portions of the base to the east of this divide and to the southeast in portions of the base east of this divide. The high water level measured in MW-16 to the west of the main groundwater divide may be due to local perching of groundwater. The ridgeline which borders the northeastern corner of the base probably also acts as a groundwater divide. Thus, groundwater is moving in a southwesterly direction in the eastern portion of the base. Figure 10 shows the general groundwater flow direction underneath the base along with the approximate location of the groundwater divide which bisects the base.

Groundwater elevations in the shallow monitoring wells are irregular in the vicinity of the cluster of pumping wells located near the current base fuel point (near Building 938). In particular, the water level measured in MW-18 was lower than the levels measured in MW-24 and MW-17 which were located down the valley to the south. This irregularity in water levels may partially reflect the fact that MW-18 had not achieved its true static water level. During development of this well by bailing, this monitoring well could easily be bailed dry due to the slow recovery rate in the well. Alternatively, this non-uniformity in gradient may reflect the natural variability in shallow groundwater tables in this valley as a result of the regrading of the original terraced topography with fill to produce a flat valley surface. Buried rice patty terraces containing clay floors could produce irregular water levels due to local perching of groundwater atop these relatively impermeable layers.

Small scale differences in shallow water tables were evident in excavations made for the installation of two new oil/water separators which were being built on the northwest and southwest corners of Building 915. These excavations were roughly 80 feet apart and both were dug 10 feet below grade. Water filled the northern excavation up to a depth of 3.5 feet above the bottom of the excavation. This water level was apparently a static level since continuous pumpage of the excavation was required during installation of the oil/water separator. No water entered the excavation at the southwestern corner of the building. Thus the shallow water table underlying this building dropped a minimum of 3.5 feet over a lateral distance of 80 feet. Because of these local discontinuities in the shallow water tables in the valley areas which had been regraded, the water levels in Figure 8 can only be used to determine the general hydraulic gradient underneath the base, and local variations probably occur.

The water levels measured in the water supply wells located in the western corner of the base decreased rapidly towards the southwest. This flow direction is consistent with groundwater flowing towards the Naktong River which flows through the town of Waegwan. The elevation of the river in the vicinity of Waegwan is 21 feet. If it is assumed that no structural or geologic discontinuities occur between the western half of Camp Carroll and the Waegwan river, a water table elevation of 21 feet represents a constant head boundary to which all water levels ultimately converge within the basin. Groundwater flowing through the eastern half of Camp Carroll may intersect the Tongjon-chon river which runs to the south of the base at an elevation of roughly 85 feet (Figure 2).

3.3 AQUIFER CHARACTERISTICS

The hydraulic characteristics of the aquifer underlying Camp Carroll were estimated by performing slug and bail tests on the monitoring wells installed during this study and by conducting pumping tests which utilized the existing water supply wells on the base. Drawdown characteristics observed during these pumping tests indicate that the aquifer material does not behave as a simple porous media where water moves uniformly through pore channels between soil grains of the aquifer matrix. Because of the indurated nature of the granitic gneiss which constitutes the aquifer, groundwater probably moves through both the intergranular pore space of the matrix (the granitic gneiss) as well as through a permeable network of connected, open fractures (e.g., joints and bedding plane openings) which crisscross the matrix. Fracture flow can lead to long, contorted flow paths and relatively rapid flow velocities in comparison to those velocities estimated for the indurated bedrock.

In a dual-porosity medium such as this, the mass transport of contaminants may be controlled by molecular diffusion between relatively mobile water in the fractures and static water in the pore space of the matrix. Diffusive transport of contaminants from the fractures into the intergranular pore space of the matrix is driven by the concentration gradient between the fracture and the matrix. If the diffusion rates are fast relative to the fracture groundwater velocity, transport effects may be predicted by considering the system to be an equivalent porous medium (EPM). In addition, the groundwater flow within a fractured system can be adequately characterized as an EPM when the interfracture spacings are small in comparison to the scale of the system being studied and when there is some interconnection between the fractures. Darcy's law, pump drawdown and recovery tests, and Bouwer and Rice's (1976) interpretation of slug tests have all been applied successfully to such systems (Barker and Black, 1983; Gerhart, 1984). For the following analysis of the slug and pumping test data collected at Camp Carroll, it is assumed that the aquifer underlying the base can be treated as an EPM.

Hydraulic conductivity, K, of the aquifer was estimated at fifteen monitoring wells using bail and slug tests. The bail and slug tests were conducted after the monitoring wells had been developed. The equipment used to perform the bail tests consisted of a 5 psi Druck pressure transducer attached to a Campbell data logger and a 5-foot long, 1-inch thick stainless steel rod which was used to displace water in the well during the test. The data logger was programmed to monitor pressure fluctuations at one second intervals and to record the time when these fluctuations exceeded 0.01 feet in magnitude. The pressure transducer was placed between 8 to 13 feet below the water table and the resulting pressure head noted in the field book. The stainless steel rod was then lowered into the well until its entire length was submerged. In wells where the slotted well casing did not intersect the groundwater table, this resulted in an increase in measured pressure as the water level in the well rose due to the displacement of water by the rod. Monitoring of the ensuing decline in water level constitutes a slug test (since the water level response is equivalent to that which would occur if a slug of water had been introduced down the well). Monitoring wells MW-12, MW-13, MW-15, MW-19, MW-21, MW-23 were subjected to slug tests.

The majority of the monitoring wells were constructed during this investigation so that the screened interval intersected the water table. In these wells, slug testing could not be performed to determine aquifer properties because the water table elevation or head inside the well casing could not be controlled during the slug test into the overlying unsaturated zone. Thus, the conductivity values derived from slug tests in those wells where the water table intersects the screened interval are probably not valid.

The decline in pressure head in the well was monitored after insertion of the steel rod until the water level had recovered to within 5% of the initial level (the static water level). At that time, the stainless steel rod was quickly removed from the well and the ensuing recovery in water level in the well was recorded. This constitutes a bail test since it is equivalent to instantaneously removing a known volume of water from the well (equal to the volume of the rod). The resulting rise in water level is then monitored until the equilibrium water level is reached. This bail test is applicable for determining conductivities in wells screened either at or below the water table. During this investigation, one to three sets of slug and bail tests were conducted on each well, depending on the time required for the water levels to recover.

Slug and bail test data were analyzed using the technique derived by Bouwer and Rice (1976). This technique is applicable to completely or partially penetrating wells in unconfined aquifers.

The theory underlying the technique is presented in Bouwer and Rice (1976). Only equations used in applying the technique are presented here.

Geometry and symbols of a well in an unconfined aquifer are shown on Figure 11. Referring to Figure 11, L is the height of the portion of well through which water enters, H is the head in the aquifer, D is the saturated thickness of the aquifer above a lower impermeable boundary, r_c is the radius of the portion of the well where water level change occurs, r_w is the radial distance between the undisturbed aquifer and the well center, and y is the vertical distance between water level in the well and the equilibrium water table in the aquifer. The terms L, H, D, r_c, r_w, and y are expressed in units of length.

Bouwer and Rice (1976) used an electrical analog model with various well and aquifer geometries to develop curves for three coefficients as a function of L/r_w (Figure 12). Coefficients A, B, and for the case where D = H, C, are dimensionless coefficients determined graphically from Figure 12 and used to calculate $\ln(Re/r_w)$ by the equation (equation 8 in Bouwer and Rice (1976))

$$\ln(Re/r_w) = \left((1.1/(\ln(H/r_w)) + ((A + B \times \ln(D\text{-}H)/r_w) / (L/r_w) \right)^{-1} \qquad [1]$$

where Re is the effective radius, or the equivalent radial distance, over which the head loss y is dissipated in the flow system.

The relation between time and residual drawdown (y), measured during the slug tests is also used in the analysis. Figures 13a, b and c show plots of residual drawdown versus time for the fifteen wells tested. The slope of the straight-line portion of each plot is of interest. The time required for the water levels to recover in both the slug and recovery tests (the range of the x-axis) is a useful qualitative indicator of the conductivity of the matrix. Long recovery times are associated with low conductivities while short recovery times are associated with high conductivities. Extending that slope to the y-axis yields a graphical estimate of y_o (the y intercept on the plot). Values of t and y are arbitrarily selected from the straight-line portion of each plot. Those values, the graphical estimate of y_o, and the value of $\ln(Re/r_w)$ calculated from equation 1 are used to calculate K by the equation (equation 5 in Bouwer and Rice (1976)).

$$K = \left((r_c^2 \times \ln(Re/r_w)/2L) (1/t)\ln(y_o/y_t) \right) \qquad [2]$$

For the fifteen monitor wells tested, L was equal to the length of the saturated screened opening, D was assigned a value of 250 feet, and r_c is the inside radius of the casing if the water level is above the perforated or otherwise open portion of the well. For those wells where water levels rise within the perforated section of the well, allowance should be made for the porosity outside the well casing if the hydraulic conductivity of the surrounding sand pack or developed zone is much higher than that of the aquifer. In that case, the porosity in the permeable zone must be included in the cross-sectional area of the well. A porosity of 30% was assumed for the well pack in those wells in which the water table intersected the screened interval. The parameter r_w was estimated as 0.25 feet, which is equivalent to the radius of the 6-inch cutting bit used to drill the deeper portions of each boring. The entire radius of the boring was used in the calculation on the assumption that the sand pack material is much more permeable than the surrounding aquifer material.

The parameters used to calculate conductivities for the monitoring wells on the base are compiled in Table 5. Calculated hydraulic conductivity values ranged from 0.015 to 5 feet/day. In order to determine the sensitivity of the calculation of K to the choice of r_w and D, the K of MW-12 was calculated with r_w equal to 0.086 foot (rather than 0.25 feet) and D values of 100 and 400 feet (rather than the 250 feet value chosen). The effect of decreasing r_w from 0.25 foot to 0.086 foot (the radius of the piezometer) was to increase the calculated K by about 60 percent. Varying the effective thickness of the aquifer from 100 to 400 feet led to hydraulic conductivity values 5% and 6% greater and lesser respectively than the value calculated using the estimated value of 250 feet.

Figure 14 shows the general decrease in calculated hydraulic conductivity values in monitoring wells installed at deeper depths within the granitic gneiss aquifer. For instance, the nested piezometers MW-15s and MW-15 had measured conductivity values of 7.8 and 0.14 feet/day respectively which is consistent with the overall decrease in hydraulic conductivities measured in other monitoring wells. This measured decrease suggests that the uppermost, more heavily weathered portion of the granitic gneiss aquifer, is generally more permeable than the underlying, less weathered portion of the aquifer. Mr. [redacted] (FED driller) stated that the maximum depth from which water can be efficiently removed from the granitic gneiss bedrock underlying Camp Carroll is 300 feet. The effective base of the aquifer is not marked by a lithologic boundary and probably results from the systematic decrease in effective permeability of the granitic gneiss bedrock with depth.

A pumping test was conducted on water supply well 2-89 between March 20 and March 25, 1992 using wells SB-6 and SB-11 as observation wells. Well 2-89 was pumped over a 42-hour period between March 20 to March 22, 1992. Pumping from the well was cyclic rather than continuous over this time. As the water level decreased below a certain level in the pumping well, the pump automatically turned off until the water rose to a specified level in the well, at which time the pump turned back on. Thus, the pump rate utilized in the calculations was an averaged rate calculated by recording the total quantity of water pumped during the duration of the pumping portion of the test. The resulting averaged pumping rate was 16.4 gallons per minute.

The steep hydraulic gradient between the pumping well and the two observation wells and the non-uniformity in depth of the screened intervals of the pumping well and the observation wells further complicated interpretation of the data. Since the majority of analytical solutions for pumping tests rely on the Dupuit assumptions and the absence of significant vertical gradients within the flow field, the drawdown/recovery data are not readily amenable to quantitative analysis. The graphs (Figure 15b) are useful, however, for gaining a qualitative sense of the influence that a pumping well has on the surrounding water table. A relatively low pumping volume of roughly 16 gallons per minute induced drawdown of roughly 1 foot in the observation well 95 feet away (SB-6) and a drawdown of roughly 0.5 feet in a monitoring well roughly 200 feet away within two days of the onset of pumping. The water levels in the two monitoring wells were still declining when the pump was turned off so the equilibrium drawdown levels for this pumping rate are not known. The ultimate effect of these water level changes is an increased hydraulic gradient towards the pumping well which can lead in turn to more rapid migration of contaminants from the Building 644 area towards pumping well 2-89.

A pumping test was also conducted using water supply well 12-247 as the pumping well and water supply well 13-279 as the observation well. Monitoring well MW-24 and water supply well 15-286 were also periodically monitored with an electric sounder water tape during the pump test. This pumping well also cycled on and off during the pumping test. The pre-pumping hydraulic gradient between the pumping and observation wells was relatively flat in this area. Pumping was started on April 6, 1992 and stopped on April 9, 1992 over a total time period of 73 hours. Recovery rates were monitored over the following 50 hours. An average pumping rate of 60 gallons per minute was maintained during the pump test. The shallow monitoring well (MW-24), located 250 feet from the pumping well, showed no significant drawdown during the pump test. The water supply well 13-279, located 373 feet from the pumping well, had a total drawdown of about 1 foot. This behavior suggests that the shallow monitoring well intersects a shallow perched water body, which is not in direct hydraulic connection within the deeper aquifer exploited by the water supply wells.

Aquifer parameters were estimated from the pumping test data using the semilog method derived by Cooper and Jacob (1946). Because pumping was cyclical rather than constant, only recovery data from pumping tests were analyzed. Transmissivity (T) and storativity (S) values can be estimated for the aquifer by measuring the drawdown over one log cycle of time and the time intercept (t_o) where the drawdown line intercepts the zero drawdown axis on a semi-log time drawdown graph. For a confined or unconfined aquifer, the transmissivity is equal to the hydraulic conductivity divided by the height of the water table above the effective bottom of the aquifer and the storativity (which is termed the specific yield in unconfined systems) is defined as the volume of water that the aquifer releases from storage per unit surface area of aquifer per unit decline in the water table. The values of T and S are calculated using the following equations:

$$T = (2.3 \times Q) / (4 \times \pi \times \Delta h) \qquad (3)$$

$$S = (2.25 \times T \times t_o) / (r^2) \qquad (4)$$

where Q is the pumping rate, Δh is the drawdown over one log cycle of time, t_o is the time intercept on the semi-log plot and r is the distance between the pumping and observation wells. The drawdown was calculated from the slope on the earliest portion of the recovery plots. The resultant calculated T values ranged between 500 to 3000 ft^2/day. If an effective aquifer thickness of 250 feet is assumed, these values yield estimates for the hydraulic conductivity between 2 to 12 feet/day. These values overlap the range in conductivity values calculated based on the bail and slug tests (range 0.015 to 5 feet/day) conducted on the monitoring wells.

The storativity values measured during these pump tests ranged from 0.006 to 0.04. This range is intermediate between typical storage values for confined aquifers (0.005 to 0.00005) and for unconfined aquifers (0.01 to 0.30). These low values for the unconfined aquifer underlying Camp Carroll probably reflect the low primary permeability of the granitic gneiss matrix since the earliest portion of the recovery response (which probably reflects porous media flow into the well) was used to determine the drawdown over one log cycle of time value.

The velocity of contaminant migration in the groundwater at Camp Carroll can be grossly estimated from observations made of the extent of contamination present in the Building 644 area. The halogenated hydrocarbons trichloroethylene and tetrachloroethylene have migrated about 850 feet from the presumed major source area of contamination located near the southern end of Building 644. This migration distance assumes that the head of the plume is located halfway between Well 2-89 (where contamination was observed) and Well 8-188 (where only minor contamination was observed). The contaminants are thought to have been dumped at the Building 644 site somewhere around 1963 or 1964 (WCC, 1992b). This yields an estimated average contaminant velocity (v_s) of 0.09 feet/day. The average hydraulic gradient (i) is relatively steep in this area (~0.11). The effective porosity of the aquifer is difficult to estimate since it depends on the volume of fractures within the granitic gneiss rather than the actual porosity of the rock matrix. Freeze and Cherry (1979) give a range in porosity values between 0 to 10 percent for fractured crystalline rock.

Extensive trace tests have been performed at the Borden Landfill site in Canada to estimate the degree of retardation resulting from solute adsorption to the aquifer matrix (Roberts et al., 1986). The retardation coefficient (groundwater velocity divided by solute velocity, $v_g/v_s = R$) was determined for tetrachloroethylene and four other organic solutes in the unconfined sand aquifer at this site. Tetrachloroethylene had a mean retardation factor of 3.3 in this tracer study. Typical retardation values for trichloroethylene range from 1.6 to 2.6 and for 1,2-dichloroethylene range from 1.2 to 2.5 (Mackay, 1986). Thus the rate of solute movement within a sandy aquifer will be on the order of 1.2 to 3.3 times slower than the average linear groundwater velocity. An estimate for the effective hydraulic conductivity of the aquifer can be made using the following relation:

$$K = (v_g \times n) / i \qquad (5)$$

The average linear groundwater velocity (v_g) is estimated to be roughly 0.27 feet/day assuming a retardation factor of 3 for the solutes. Using values of 0.11 for the hydraulic gradient and 0.10 for the effective porosity, a conductivity value of 0.25 foot/day is obtained. This value is similar to conductivity values measured in slug and bail tests conducted in monitoring wells SB-6 and SB-11, which are located at the Building 644 site, but is about an order of magnitude less than the average conductivity values measured by bail (average K = 2 foot/day) and pumping tests (average K = 6 foot/day) on wells from throughout the base. This lower conductivity value based on the observed migration distance of the contaminants apparently reflects locally low permeabilities of the aquifer matrix in the Building 644 area.

4.0
CHEMICAL DATA QA/QC REVIEW

4.1 SAMPLE INFORMATION AND CHEMICAL ANALYSES

One soil sample and 30 water samples were collected between April 13 and 15, 1992. The samples were packed into coolers with blue ice and sent under chain-of-custody via U.S. Express Mail to the analytical laboratories. The water samples were collected from 15 newly installed monitoring wells, 3 monitoring wells installed in November of 1991, 10 existing water supply wells, and 2 surface water sites. The samples were analyzed for halogenated volatile organics, aromatic volatile organics, volatile and semivolatile petroleum hydrocarbons (quantitated using gasoline and diesel, respectively), selected metals (As, Ba, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn), organophosphorus pesticides, phosphorus, nitrate, and sulfate, and a screen for semivolatile compounds. Table 6 identifies the EPA methods used. The analyses were completed by Pacific Environmental Laboratory and NET Laboratory. The laboratory data, included as Attachment 6, were submitted to a thorough QA/QC review. The review included the following:

- Holding Time Review - Check that analysis was performed within the recommended holding times.
- Blank Review - Review trip and method blanks for evidence of potential contaminants.
- Spike Review - Review matrix and blank spike recoveries and matrix spike duplicate relative percent differences as a check for analytical precision and accuracy.
- Duplicate Review - Review duplicate analyses for agreement of results as a check for analytical and sampling precision.
- Elevated Detection Limits - Review analytical results to check for effects of elevated detection limits.
- Surrogate Recoveries - Review surrogate recoveries for matrix interferences and acceptance within limits of acceptability.

Each of the above QA/QC checks are described in detail in this section and are included in Tables 6 through 12.

4.2 SAMPLE HOLDING TIMES

Most analytical methods used for this study have an associated prescribed holding time that is the maximum amount of time after collection that a sample may be held prior to extraction and/or analysis. Sample integrity becomes questionable for samples extracted and/or analyzed outside of the holding times owing to physical and chemical changes to the sample, such as degradation or volatilization. The holding times for all analyses conducted were reviewed and are shown in Table 7.

The recommended holding time for EPA Method 8010 (halogenated volatile organics) and 8020 (aromatic volatile organics) is 14 days from the date of collection. The recommended holding time for EPA Methods 6010/7000 is 6 months from date of collection, with the exception of Method 7470 for mercury analysis, which is 28 days from date of collection. The recommended holding time for modified EPA Method 8015 (volatile and semivolatile petroleum hydrocarbons) is 14 days from date of collection. The recommended holding time for EPA Method 8270 is 14 days from date of collection. All of the samples were analyzed for these compounds within the prescribed holding time. Analysis for phosphorus, nitrate, and sulfate by EPA Method 365.2, Standard Method 424F, and EPA Method 375.4 were completed within recommended holding times. The recommended holding time for EPA Method 8140 (organophosphorus pesticides) is 7 days until extraction and 40 days until analysis. Because the soil samples were extracted 13 to 14 days after collection, the chemical results for organophosphorus pesticides (malathion) should be viewed as estimates.

4.3 TRIP AND LABORATORY BLANKS

Blank samples are analyzed in order to check for potential sample contamination. Information regarding the source of contamination may also be gained by analyzing a variety of blanks prepared at several points during sample collection and analysis. Table 8 summarizes the results of the trip and laboratory blank samples.

Two trip blanks of bottled water accompanied the samples from the field back to the analytical laboratory. These aqueous samples were analyzed by EPA Methods 8010/8020 for volatile halogenated and aromatic compounds. The analytical results indicated that no contamination of samples occurred as a result of field work, transport, or laboratory handling.

Laboratory (Method) blanks were run each day for each analytical method to indicate potential sources of contamination from laboratory sources. No target analytes were detected in any of the blank analysis conducted (8270, 8010, 8020, mod. 8015, NPS, 8140).

4.4 MATRIX SPIKE AND MATRIX SPIKE DUPLICATE REVIEW

Matrix spikes are performed in order to evaluate the efficiency of the sample extraction and analysis procedures and are necessary since matrix interference (that is, interferences from the sample matrix - water or soil) may have widely varying impacts on the accuracy and precision of the extraction and analysis. The matrix spike is prepared by the addition of known quantities of target analytes to a sample. The sample is extracted and analyzed. The results of the analysis are compared with the known additions and a blank spike recovery is calculated. The recoveries indicate the accuracy of the extraction and analysis procedures. Additionally, the matrix spike gives an indication of possible matrix effects on target compounds. Typically, matrix spikes are performed in duplicate in order to also evaluate the precision of the methods. Matrix spike recoveries are reviewed to check that they are within an acceptable range. However, the acceptable ranges vary widely according to analytical method and matrix.

Table 9 lists the recoveries found in the Matrix Spike and Matrix Spike Duplicate samples. A review of the data indicated that the spike recoveries were generally within acceptable limits. The noted exceptions were considered acceptable because the laboratory spikes the sample with the full list of target compounds and, at most, only one to three of the target analytes exhibited recoveries outside acceptable range. Because most of the matrix and blank spike recoveries were within the limits of acceptability established for this project, the isolated instance of recoveries outside limits do not adversely affect the quality of the data set. The laboratory accuracy can thus be considered acceptable. In addition, the matrix spike duplicate results were reviewed to evaluate the precision of the analyses. The Relative Percent Differences (RPDs) were calculated for positive results. The calculated RPDs listed in Table D are an indication of acceptable laboratory precision.

RPD = [(Result 1 - Result 2)/(Average of Result 1 and Result 2)] x 100

4.5 DUPLICATE REVIEW

Selected samples were extracted and analyzed twice to serve as laboratory duplicates. A review of the duplicate analysis results was completed as a check for analytical and sampling precision. Table 10 lists the sample number, analytical method and calculated RPD. The RPDs are all <10%, which is an indication of good laboratory precision.

4.6 ELEVATED DETECTION LIMITS

Detection limits for target analytes may sometimes be elevated due to sample size limitations or to dilutions necessary to counter matrix interference effects or to bring target analyte concentrations to within calibration linear range. Results reported as below an elevated detection limit must be noted. Table 11 shows expected detection limits and those samples and analytical methods for which the detection limits were elevated. Detection limits were sometimes elevated due to insufficient sample supplied to the laboratory and sometimes due to dilution to bring target analyte concentrations with the detection range of the target analytes. For these samples with elevated detection limits, results of "not detected" should be interpreted with care.

4.7 SURROGATE RECOVERIES

Surrogates are added to each sample to monitor the effect of the matrix on the accuracy of the analysis of that sample. Results are reported in terms of percent recovery. Not all analytical methods require the use of surrogate spikes. For this project, surrogates were used in samples analyzed by EPA Method 625/8270 for semivolatiles. The surrogate recovery ranges are listed on Table 12. Generally, the recoveries were within the limits of acceptability established by the laboratory, indicating acceptable laboratory performance. Only one to three of the target analytes exhibited recoveries outside acceptable range despite the laboratory spiking the samples with the full list of target compounds. Since most of the surrogates were within acceptable recovery limits, the few instances of recoveries outside the limits do not adversely affect the quality of the data set. The laboratory accuracy can thus be considered acceptable.

4.8 COMPARISON OF ANALYTICAL RESULTS FROM QA LAB (NET) AND ANALYTICAL LAB (PEL)

Four of the groundwater samples were split and sent to an external QA laboratory as a check for analytical laboratory accuracy. The four water samples submitted were MW-22, MW-23, SB-3, and PW-12. The QA laboratory, National Environmental Testing (NET), Inc., analyzed these samples using Method 8010/8020 (BTXE), Method 6010/700 (metals), and Method 8140 (malathion). Table 14 compares the positive (non -ND) results from the analytical laboratories. For most of the analyses, there is good agreement between the two laboratories. A discussion of the few inconsistencies observed for specific samples follows. The sample that had the most inconsistencies, SB-3, was highly contaminated with organic solvents making quantification of lower levels of contaminants difficult.

Sample PW-12 was submitted for 8010 analysis to both laboratories. Results for most halogenated organic solvent compounds gave similar results. The QA laboratory (NET) reported ND for trans 1,2-dichloroethylene whereas Pacific reported 37 ug/L for 1,2-dichloroethylene. This difference is due to PEL's reporting peaks representing both the cis and trans isomers as a single component. PEL laboratory submitted their primary and confirmation data sheets and chromatograms which show that the compound present at 37 ug/L is the cis isomer of 1,2-dichloroethylene.

Sample MW-22 was submitted for 8010 analysis to both laboratories. Results for all compounds agreed except for methylene chloride. This compound was detected at 23 ug/L by Pacific and was not detected by the QA laboratory (NET), with both labs reporting a detection limit of 10 ug/L. In reviewing the NET data, a small amount of methylene chloride was seen near the detection limit and was therefore reported as "below the quantitation limit". However, in the confirmation analysis by NET, there is a small amount of methylene chloride present between 10 and 50 ug/L. Although this compound cannot be quantitated definitively in this sample, it is present at a low level.

Sample SB-3 was submitted for 8020 analysis to both laboratories. The analytical data for toluene results are greatly disparate (ND by PEL and 4,300 ug/L by NET). For the confirmation analysis, PEL re-analyzed the sample using a different chromatography column to confirm the absence of toluene. Since the internal standard retention times were similar for the sample and standard, the absence of toluene was confirmed. There was a large peak present indicative of a different unsaturated compound near where the toluene peak would have been if present. The compound detected by NET at 4,300 ug/L was probably not toluene. The confirmation run for the standard solution and the diluted sample showed similar retention times for the internal standard but somewhat different retention times for the "toluene". The not detected result for toluene reported by PEL is probably correct, despite the QA laboratory's report of toluene at a high concentration.

Sample SB-3 was submitted for 8010 analysis to both laboratories. The analytical data for methylene chloride results are greatly disparate (130 ug/L by PEL and ND by NET). A review of the primary and confirmation analyses by NET revealed that they missed the detection of this compound in this sample. The chromatogram indicates methylene chloride at approximately 55 ug/L, which is similar to the result from Pacific (130 ug/L).

5.0
FINDINGS AND DISCUSSION

5.1 EXTENT OF GROUNDWATER CONTAMINATION

Chemical analyses of water sampled over a three-day period from the network of monitoring and water supply wells at Camp Carroll provided data for estimating the extent of groundwater contamination beneath the site. A total of ten water supply wells and eighteen monitoring wells were sampled between April 13 and April 15, 1992. The most common contaminants measured in the water samples were the chlorinated solvents trichlorethylene, tetrachloroethylene and 1,2-dichloroethylene. Detectible levels of chlorinated solvents (detection limit usually ≤ 1 ppb) were measured in fifteen of the eighteen monitoring wells installed and in eight of the ten water supply wells sampled. Analysis for heavy metals in the fifteen monitoring wells installed and sampled during this baseline study showed detectible levels (≥3 ppb) of lead in seven wells and of zinc (>20 ppb) in five monitoring wells. BTEX compounds were observed in only two of eighteen monitoring wells sampled on the base. Table 13 lists the analytical data for the water samples collected from the monitoring wells and from the water supply wells on the base during this investigation.

The measured concentrations of the commonly encountered groundwater contaminants (trichlorethylene, tetrachloroethylene, 1,2-dichloroethylene, nitrate and lead) are displayed spatially on Figures 16 through 20. These figures indicate that contamination exists down-gradient from potential source areas identified in the earlier historical report (WCC, 1992a). The absence of contamination in a monitoring well located adjacent to a potential source area does not necessarily indicate that groundwater contamination from this source did not occur. For instance, the absence of contamination in MW-23 does not conclusively prove that contaminant leaching to groundwater from the previous landfill which existed nearby (Area D) did not occur. The exact location of this landfill site was based solely on anecdotal information from long-term base personnel. Numerous monitoring wells may be required to locate groundwater contamination emanating from such a site, particularly if the contaminant plume from this source was elongate and narrow in dimension. The fact that detectible levels of chlorinated solvents were detected in so many wells suggests that contamination is widespread throughout the base. Contamination observed in a monitoring well located down-gradient from a suspected source area may alternatively have originated from another source area and migrated here via advection in the groundwater system or by surface transport and infiltration through the run-off ditch system which runs throughout the base. Elevated levels of nitrate observed in some of the monitoring wells (Figure 19) can originate from off-base sources such as fertilizer applied on agricultural land adjacent to the base.

The detection of low levels of trichloroethylene in the two nested monitoring wells (MW-15 and MW-15s) suggests that dispersion of contamination in the vertical direction has occurred within the aquifer. Downward migration of the zone of contamination within the granitic gneiss aquifer is probably caused primarily by the downward-directed hydraulic gradients measured within the aquifer and secondarily by the density contrast between the chlorinated solvents and water. Thus, migration of miscible compounds within the groundwater system underlying source areas at Camp Carroll moves both horizontally (perpendicular to the static pressure head gradient) and downward (proportional to the vertical head gradient).

Detectible levels of lead in MW-21, MW-18 and MW-24 (Figure 20) may be related to gasoline leakage from nearby fuel storage tanks. The lead levels observed in MW-17 may have originated from the maintenance activity conducted in nearby Building 326. The levels in MW-14 and MW-22 may have resulted from contaminant leaching from nearby landfill sites. Alternatively, the elevated heavy metal results (Pb and Zn) may be an artifact from water samples that were not filtered prior to analysis. For some samples, suspended granitic gneiss material may have contributed greatly to the measured metal levels since the entire sample was digested (both water and suspended sediment) prior to analysis. The suspended granitic material probably has relatively high levels of metals such as Pb and Zn; thus, only a small amount of co-digested suspended material could result in detectible concentrations of these elements.

Monitoring wells and pumping wells located near the down-gradient boundaries of the base contained little or no contamination. In fact, the two water supply wells (10-205 and 11-206) situated along the western boundary of the base have the highest measured nitrate and sulfate levels of all analyzed pumping wells (Table 1). Well 11-206 also contained 9 ppb trichlorethylene in water samples collected during this study. These wells exploit groundwater originating largely from the urban areas to the northwest of the base. Thus, on-base migration of contamination from the adjacent town of Waegwan may have occurred to a limited extent near the western boundaries of the base. The lack of significant contamination in the monitoring wells and water supply wells located along the southern perimeter of the base suggest that little or no off-base migration of groundwater contamination is occurring into the surrounding community in those areas monitored.

5.2 POTENTIAL SOURCE AREAS OF OBSERVED CONTAMINATION

The areas where contaminants were observed in the groundwater system (Figures 16 to 20) can be compared with Figures 4 and 5 which depict the volumes of hazardous materials used at the major facilities at Camp Carroll and the potential source areas identified in the Historical Land Use Survey (WCC, 1992a). Table 15 compares the contaminant levels observed in monitoring wells located adjacent to or down-gradient of potential source areas on Camp Carroll. The elevated levels of trichloroethylene, tetrachloroethylene and 1,2- dichloroethene detected in monitoring wells SB-3, SB-6 and SB-11 probably originated from the area of soil contamination delimited in the Building 644 study (WCC, 1992b). The elevated levels of trichlorethylene observed in MW-17 may have originated either from the reported solvent dumping area located in front of Building 375 or from the Building 326 facility where large quantities of solvent are routinely used in rebuilding and cleaning tank and truck engines. These two areas are also likely sources for the contamination encountered in the nearby cluster of water supply wells in the area (12-247, 13-279, 14-283, 15-286). The presence of 70 ppb 1,2-dichloroethane and 4700 ppb of 1,1,1-trichloroethane in MW-19 may be attributable to the reported dumping of rinsewater containing residual solvent, chromic acid, phosphate and oil at this site (WCC, 1992a). The low levels of trichloroethylene measured in MW-15s and MW-15 probably originated from the Building 665 H-Shop facility which is predominately used for the maintenance of heavy vehicles such as trucks and tanks. The chlorinated hydrocarbons observed in MW-22 very likely originated from the adjacent BEQ #2 Landfill site since this area is isolated from the remainder of the base and no other activities are known to have occurred here. The low levels of chlorinated hydrocarbons detected in MW-14 may have originated from Area 41 or from vehicle cleaning activity conducted in and around the wash rack area and Building 658. Strong hydrocarbon odors were encountered during drilling in the old cannibalization area (Area CC, WCC 1992a). Respirator protection was required while drilling at the BEQ #2 Landfill site when a strong solvent odor was encountered in the shallow subsurface. Visual evidence of groundwater contamination was observed in the drainage canal adjacent to the base Heat Plant. Spring discharge entering the eastern edge of the concrete lined drainage canal had a distinct hydrocarbon sheen. This contamination apparently originated from leaking pipes connected to two aboveground fuel tanks removed from the site sometime during the 1980's. A water sample (HP-S) taken from this spring, however, contained levels of TPH, TCE and PCE below the detection limit.

This baseline study was intended to verify the presence of groundwater contamination in the vicinity of suspected source areas. Field studies designed to delineate the extent and volume of contaminant plumes emanating from a given point source require a dense three-dimensional array of monitoring points. For example, studies on contaminant transport conducted in aquifers composed of sandy material have utilized up to 66 wells to adequately define the shape and volume of a plume of contaminated groundwater (LeBlanc, 1984). Plumes in sandy aquifers tend to be long, narrow and relatively thin in shape (Anderson, 1987). This type of plume is comparatively easy to remediate. In a fracture flow system such as the basal aquifer which underlies Camp Carroll, an even denser array of monitoring points may be required to define the shape of a contaminant plume due to the complex and spatially variable nature of the fracture system through which the bulk of contaminant transport occurs. The resulting contaminant distributions in the fractured media often contain numerous irregularities (Hewetson et al., 1985). This type of plume is often difficult to remediate. Additional data are required before remedial actions can be planned and undertaken for individual sites at Camp Carroll.

5.3 SUGGESTED REMEDIAL ACTION

At the present time, the wells at Camp Carroll containing the highest levels of contaminants have been shut down and base personnel advised not to drink the tap water on the base. Several alternatives can be pursued to remediate this situation. These remediation measures include drilling new, deeper wells, purchasing water from another water service, and pursuing remedial actions consisting of various treatment alternatives.

The technology exists for treating the contaminated groundwater at Camp Carroll to control pollutant migration within the underlying aquifer; however, due to the apparently wide extent of groundwater contamination at the base and the correspondingly high costs and long times for the required cleanup procedures, other less costly and more expedient alternatives should first be pursued.

Treatment of the groundwater pumped from the water supply wells on the base is one viable alternative. Two of the most applicable treatment technologies for removal of volatile organic compounds in the groundwater are air stripping and activated carbon adsorption. The contaminated water may be treated for direct use or treated and recharged back into the aquifer to achieve restoration and cleanup of the aquifer.

Air stripping is an efficient method of removing volatile organic compounds with relatively high Henry's law constants (>10^{-3} atm m^3/mole) from groundwater. The three dominant contaminant species at Camp Carroll (TCE, PCE, 1,2-DCE) all have relatively high Henry's law constants, which makes air stripping amenable. The efficiency of the air stripping process depends on the relative ease by which the volatile components can be transferred from the aqueous phase to the gas phase. Mass transfer coefficients are determined from a pilot plant study conducted at the site and an acceptable clean-up level chosen based on levels designated by the appropriate regulatory agency. Air-to-water ratios and packing materials used are additional important considerations in the design of a full-scale system. A site-specific pilot study is recommended prior to design of the full-scale system because the mass transfer coefficients are dependent on the bulk chemical composition of the treated groundwater. The average daily quantity of water treated at the water treatment plant is 600,000 gallons. An air stripping system consisting of a tower diameter of approximately 5 to 8 feet and a tower height of 25 to 30 feet with 20 feet of packing material would be required to treat this volume of water.

Pilot studies are also normally conducted prior to establishing a full scale carbon adsorption treatment system. The most critical element in a carbon pilot study is the establishment of the carbon exhaustion rate as a function of the retention time. This parameter is determined by monitoring the quantity of organic material removed at different retention times in the carbon column. The object is to determine a retention time which will yield the highest carbon adsorption loading rate and the lowest carbon exhaustion rate. The ability of activated carbon to remove low molecular weight contaminants such as TCE and PCE is dependent on the overall water quality of the treated water. In areas of generally good water quality, activated carbon has been shown to be effective. In poorer quality waters, the low molecular weight contaminant compounds can be desorbed from the carbon by preferential adsorption of naturally occurring higher molecular weight compounds. Thus, it is important to conduct a pilot feasibility study so that any potential interferences (such as other organics adsorbing to action sites in the activated carbon) can be identified and mitigated. Multiple carbon units (4-6) of 6-foot diameter and 8-foot height would probably be required to treat the volume of water pumped at the base.

The most effective corrective measure which could be pursued at the present time to ultimately remove the contaminants within the aquifer underlying Camp Carroll would be to remove the sources of contamination within the soil. The major potential sources of contamination thus far identified which could be remediated include the BEQ #2 Landfill site, Area D, the Building 644 site, the solvent dumping site adjacent to Building 379, the landfill site within Area GG, Area 41 and the heat plant area. Site characterization studies should be conducted at these sites in order to delimit the nature and extent of contamination in the subsurface. The approximate location and size of these areas can be found on Figure 5 of the Historical Land Use Survey (WCC, 1992a). The Building 644 study (WCC, 1992b) is an example of how such a characterization study can be conducted. Other potential source areas such as the H-Shop complex and Building 326 could also be investigated although contamination may not emanate from a single point source in these areas. By removing the contaminated soil from these source areas from around the base, the concentration of contaminants in the groundwater system underneath the base would eventually decline as a result of dilution and chemical degradation of the contaminants.

In summary, a three step approach is recommended for responding to the contamination discovered in the water supply wells at Camp Carroll. The first step involves ensuring a safe drinking water supply for the base. This can be achieved by obtaining the required water from an alternative source (truck water in, tap into Waegwan's water supply system, drill new, deeper screened wells at Camp Carroll) or by treating water pumped from the existing network of water supply wells on the base. For the later alternative, installation of either an air stripping unit or a carbon adsorption treatment system in the vicinity of the existing water treatment plant is recommended. The second step involves remediation of known areas of soil contamination at Camp Carroll which likely contribute to contamination of the groundwater. Remediation may involve excavation and removal of the contaminated soil from the base. Alternatively, in-situ treatment by either accelerated biological degradation (bio-remediation) or by mechanical methods such as vapor extraction may be effective, depending on the nature and extent of soil contamination at the individual source areas. The third step involves investigating areas where extensive soil contamination is suspected. Additional site characterization studies should be conducted to determine the nature and extent of soil and groundwater contamination in these suspected areas. The results of these studies would guide additional clean-up efforts at those sites where remediation is warranted.

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ATTACHMENT 1

FIGURES 1 THROUGH 20

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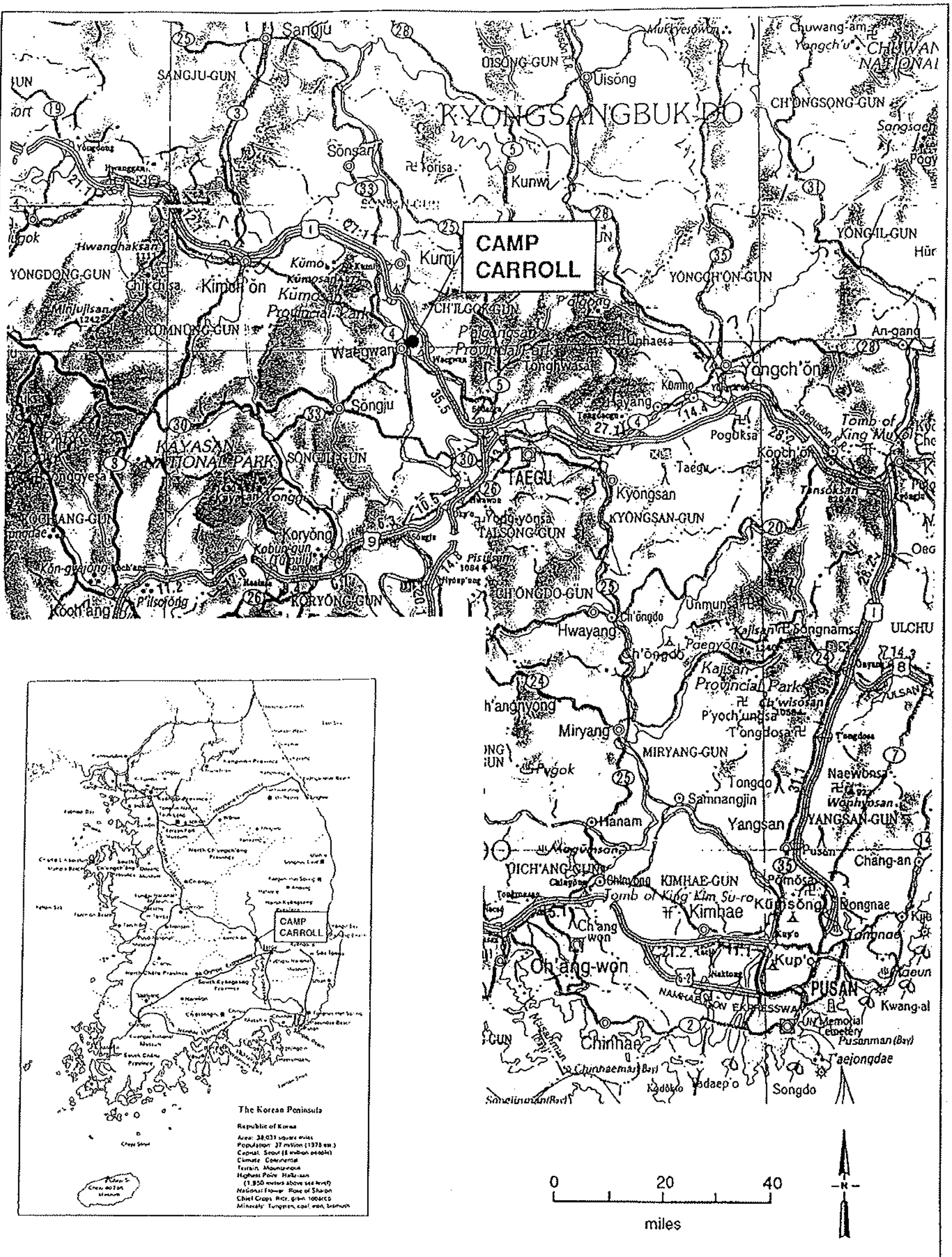
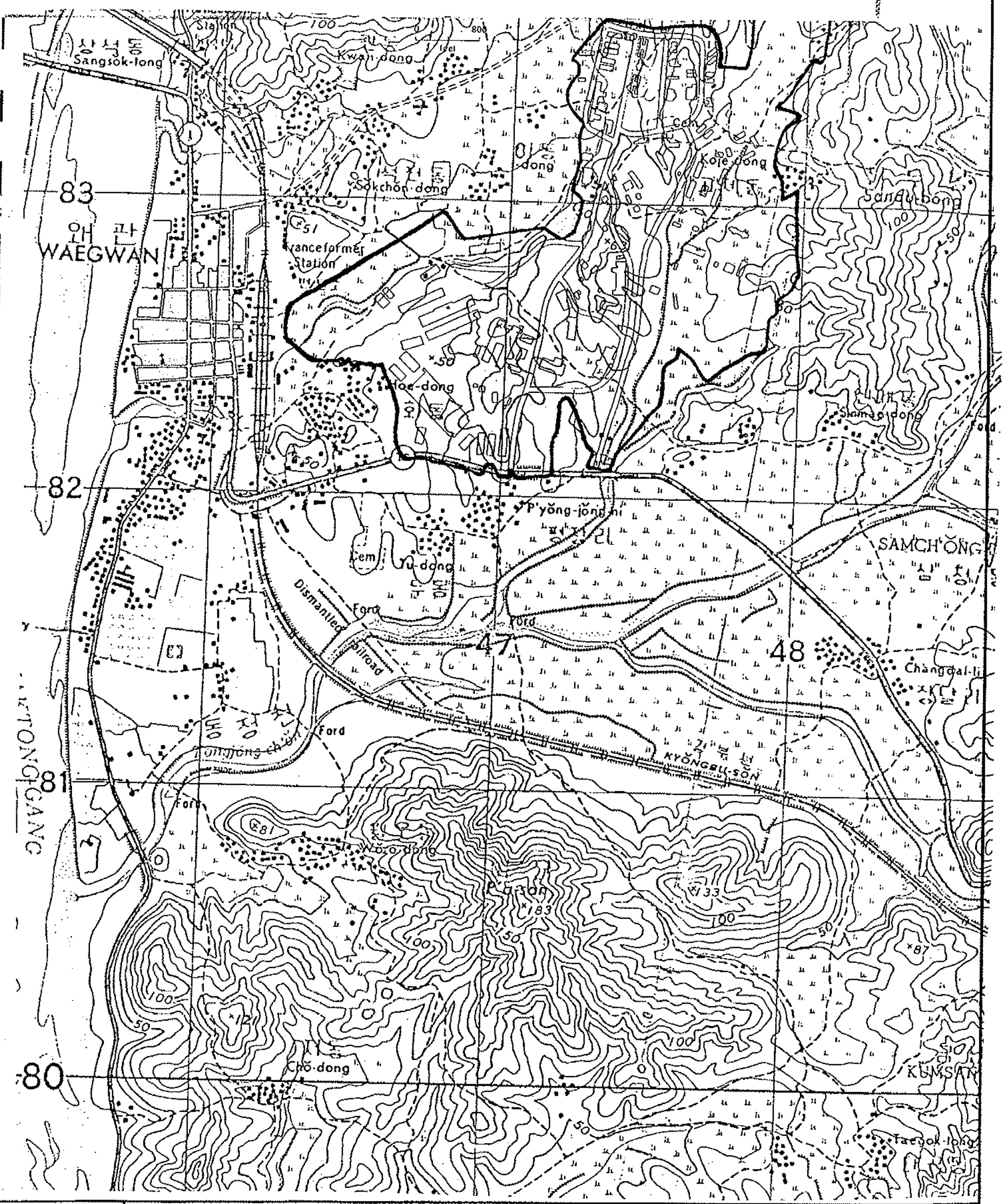
LIST OF FIGURES



Project No. 91C0499H	Camp Carroll	GENERAL SITE LOCATION MAP	Figure 1
Woodward-Clyde Consultants			



Project No. 91C0499H	Camp Carroll, Korea	PRE-DEVELOPMENT TOPOGRAPHIC MAP	Figure 2
WOODWARD-CLYDE CONSULTANTS			

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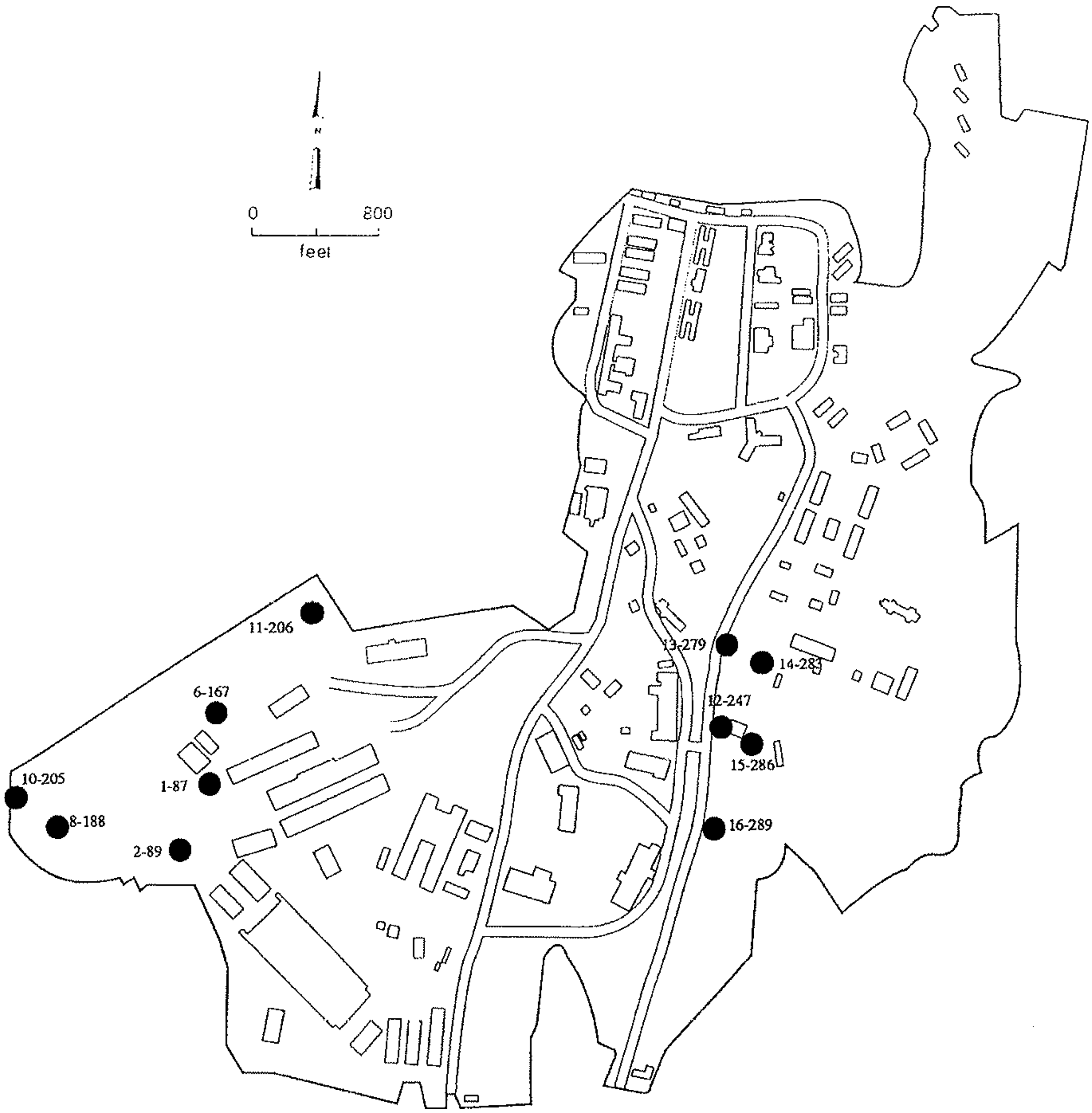

Project No. 91C0499H	Camp Carroll, Korea	Pumping Wells on Camp Carroll	Figure 3
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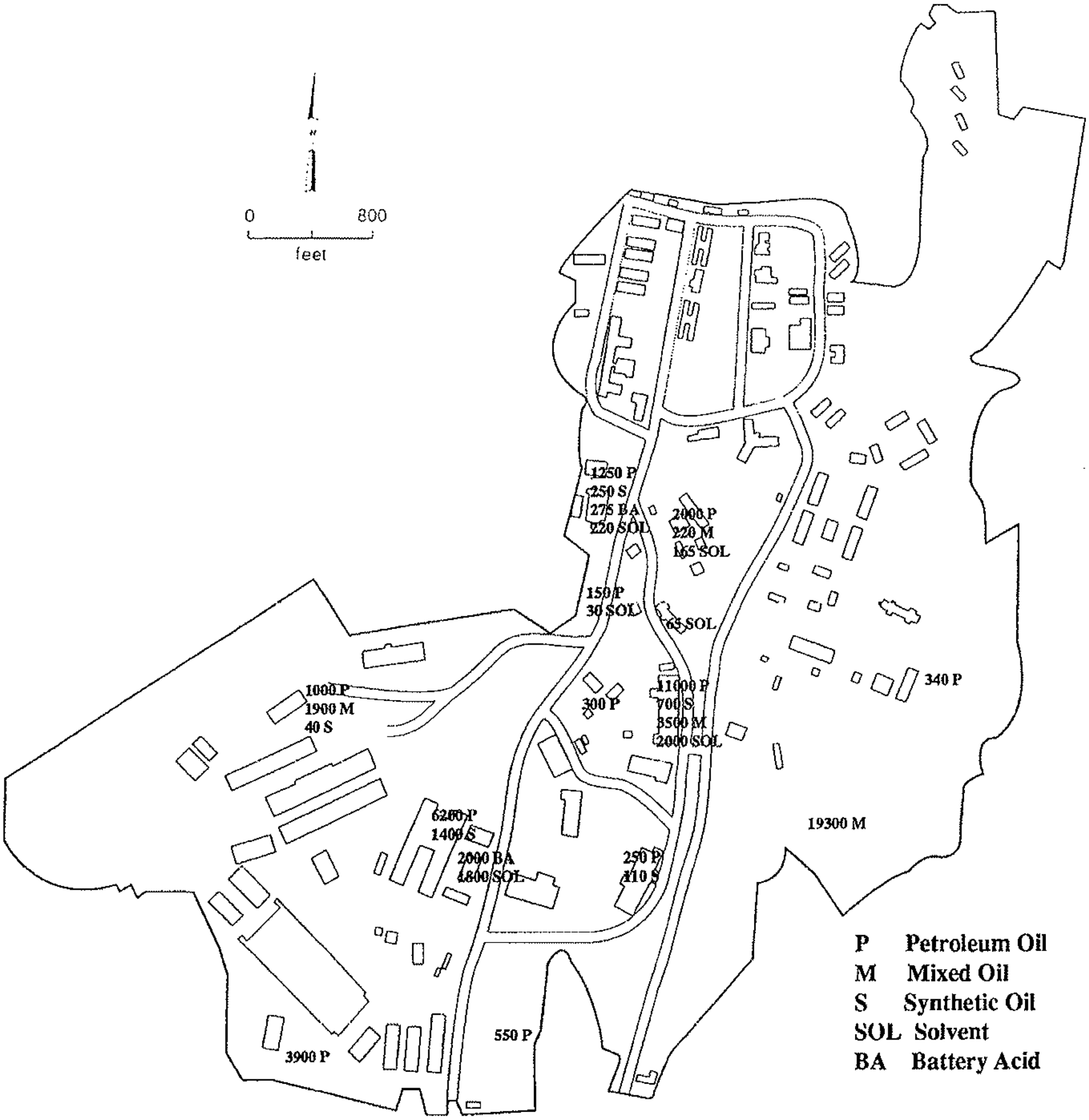

Project No. 91C0499H	Camp Carroll, Korea	Quantities of Hazardous Waste Disposed from Various Facilities in 1991 (Gallons)	Figure 4
WOODWARD-CLYDE CONSULTANTS			

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