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RESOURCE CONSERVATION AND RECOVERY ACT PART B HAZARDOUS WASTE FACILITY PERMIT APPLICATION VOLUME 4 OF 4 APPENDICES L8-L9 FOR ATLANTIC FLEET WEAPONS TRAINING FACILITY NAVAL ACTIVITY PUERTO RICO
6/28/1993
ENVIRONMENT AND SAFETY DESIGNS, INC

AFWTF Vieques Island 93-4

RCRA PART B
HAZARDOUS WASTE FACILITY
PERMIT APPLICATION
VOLUME IV, APPENDICES L8 - L9

for

ATLANTIC FLEET WEAPONS TRAINING FACILITY
VIEQUES ISLAND, PUERTO RICO

Prepared for

ATLANTIC DIVISION
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JUNE 28, 1993

APPENDIX L-8

U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY
PHASE 5: SUMMARY OF AMC OPEN BURNING/OPEN DETONATION GROUNDS EVALUATIONS
MARCH 1981-1985

Steve / Roy
Info.

UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY

ABERDEEN PROVING GROUND, MD 21010-5422

PHASE 5
HAZARDOUS WASTE STUDY NO. 37-26-0593-86
SUMMARY OF AMC OPEN-BURNING/OPEN-DETONATION
GROUNDS EVALUATIONS
MARCH 1981 - MARCH 1985

AEHA

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DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

HSHB-ES-H

4 February 1986

SUBJECT: Phase 5, Hazardous Waste Study No. 37-26-0593-86, Summary of AMC Open-Burning/Open-Detonation Grounds Evaluations, March 1981 - March 1985

Commander
US Army Materiel Command
ATTN: AMCSG
5001 Eisenhower Avenue
Alexandria, VA 22333-0001

EXECUTIVE SUMMARY

1. The purpose and a summary of the recommendations of the enclosed report follow:

a. Purpose. To summarize the results of previous soil investigations at open-burning/open-detonation (OB/OD) sites, and to offer recommendations for the proper operation and management, siting, and design of OB/OD facilities. To provide necessary data to support development of an OB/OD Permit Writers' Guide.

b. Recommendations. To ensure good environmental engineering practices the following recommendations are made: develop a policy statement for OB/OD operational practices; develop a policy statement incorporating OB/OD site selection guidelines; close, relocate, or upgrade OB/OD facilities located in regulatory flood plain hazards; use burning pans or other containment systems for OB of pyrotechnic, explosive, and propellant wastes; utilize data presented in this report for site closure plans; initiate a research program to determine chemical toxicity of OB/OD soils; and present the data contained in this report to the US Environmental Protection Agency for use in completion of the Resource Conservation and Recovery Act Part B Permit Writers' Guidance Manual for OB/OD Facilities, and to other Department of Defense activities which perform OB/OD operations.

2. Additional copies of this report are enclosed for mailing to HQDA(DAEN-ZCF-U), HQDA (DAEN-ZCE), and Commandant, Academy of Health Sciences (HSHA-IPM).

FOR THE COMMANDER:

Encl

KARL J. DAUBEL
Colonel, MS
Director, Environmental Quality

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Cdr, Iowa AAP (2 cy) (w/encl)
Cdr, Lake City AAP (2 cy) (w/encl)
Cdr, Louisiana AAP (2 cy) (w/encl)
Cdr, Newport AAP (2 cy) (w/encl)
Cdr, Radford AAP (2 cy) (w/encl)
Cdr, Seneca AD (2 cy) (w/encl)
Cdr, Sierra AD (2 cy) (w/encl)
Cdr, Tooele AD (2 cy) (w/encl)
Cdr, Volunteer AAP (2 cy) (w/encl)
Cdr, MEDDAC, Ft Campbell (PVNTMED Svc) (2 cy) (w/encl)
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Cdr, MEDDAC, LAMC (PVNTMED Svc) (2 cy) (w/encl)
Cdr, DDEAMC (PVNTMED Svc) (w/encl)
Cdr, WRAMC (PVNTMED Svc) (w/encl)
Cdr, BAMC (PVNTMED Svc) (w/encl)
Cdr, USATHAMA (AMXTH-TE) (w/encl)
Cdr, USAEHA Fld Spt Actv, Ft Meade (w/encl)
Cdr, USAEHA Fld Spt Actv, Ft McPherson (w/encl)
Cdr, USAEHA Fld Spt Actv, FAMC (w/encl)

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DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

HSHB-ES-H

PHASE 5
HAZARDOUS WASTE STUDY NO. 37-26-0593-86
SUMMARY OF AMC OPEN-BURNING/OPEN-DETONATION GROUNDS EVALUATIONS
MARCH 1981 - MARCH 1985

1. AUTHORITY. Letter, HSHB-ES-H, this Agency, 15 July 1985, subject: USAEHA Phase 5 of AMC OB/OD Grounds Evaluation, USAEHA Project No. 37-26-0593-85.

2. REFERENCES. See Appendix A for a listing of references.

3. PURPOSES.

a. To summarize the results of previous soil investigations at OB/OD sites, and to evaluate the lateral and vertical extent of contamination at these sites.

b. To offer recommendations for the proper operation and management, siting, and design of OB/OD facilities.

c. To provide necessary data to support development of an RCRA Part B Permit Writers' Guidance Manual for OB/OD Facilities.

4. GENERAL.

a. Abbreviations and Definitions. See Appendix B for a listing of abbreviations and definitions of terms used in this report.

b. Acknowledgments. See Appendix C for acknowledgments of the project officers who performed the site investigations and other related projects in support of this report.

c. Background of DOD OB/OD Operations.

(1) The OB/OD operations are conducted at numerous facilities throughout DOD. However, based on original project plans, all site investigations performed in support of this report were conducted at Army installations in AMC. As such, all references to specific locations and facilities apply to AMC installations. Due to the inherent similarities of AMC OB/OD facilities with those OB/OD sites elsewhere in DOD, it is hoped that this report can have universal application throughout DOD.

(2) Each year the AMC installations generate thousands of tons of PEP wastes. These wastes include off-specification explosives, explosive residues, PEP materials which have failed quality assurance tests, and unserviceable and obsolete PEP and munitions items, along with ancillary but integral munitions components. Other related wastes may include items which have become contaminated by contact with PEP during their production, storage, handling, or transportation. Additional wastes, not normally considered explosive, that must also be disposed of, include laboratory chemicals such as ethers, peroxides, picric acid, and chloropicrin, to mention a few. Substantial quantities of propellants and munitions wastes are also generated through routine troop operations and training exercises.

(3) Currently, OB and OD of PEP and PEP-contaminated wastes are the safest and most effective means of destroying many items, decontaminating large metals process parts, and reducing combustible portions of the waste to smaller, manageable volumes. The Army has developed an EWI and a CWP which can theoretically incinerate of PEP and PEP-contaminated wastes. Unfortunately, these incineration units are marginally effective and can actually be net waste producers. Moreover, due to the size and infrequent small quantities of waste requiring controlled combustion treatments, an EWI or CWP is often impractical. The OB/OD methods are clearly the safest and most effective means available for treatment of PEP wastes. It becomes obvious that the Army must keep OB and OD as viable options for thermal treatment of the family of PEP wastes.

d. Project Approach and Phasing Strategy. This study was structured into five phases in order to fulfill project purposes.

(1) Phase 1. The first phase, initiated in March 1981, consisted of an extensive literature review and evaluation of information on the subsurface conditions at 36 AMC installations with OB/OD grounds at various levels of activity. This initial subsurface data evaluation was performed in order to rank installations both geohydrologically and geographically for actual onsite investigations under Phase 2. Environmental factors or guides used in this preliminary evaluation were general site selection indicators, geologic units, soils, ground and surface waters, and climatology. Seven installations were initially eliminated from any Phase 2 consideration due to floodplain location under guidance issued by EPA on 12 January 1981 (Location Standards). Three other installations were also eliminated due to either existing contamination studies by other agencies or a lack of active OB/OD facilities. The remaining 26 installations were ranked in terms of high, medium, and low potential to contaminate ground or surface waters and were advanced to Phase 2 for onsite residue and soil sampling. Phase 1 was completed in March 1982.

(2) Phase 2.

(a) This phase, commencing in August 1981, comprised the onsite visits to 26 AMC installations to collect samples of residues and soils to a depth of 18 inches, as an initial screening. Sampling at OB facilities

included collection of surface residues and soils by manual methods and collection of subsurface soils via remote drilling. Sampling at OD sites was restricted, for safety reasons, to surface sampling, due to the possible encounter with a variety of unexploded ordnance. All drilling was performed with a trailer-mounted, remote-control drill rig.

(b) In May 1983, the original list of 26 installations was expanded to 36 (see Table 1) at AMC request. Twelve of these installations were chosen for the Phase 4 investigations as summarized in Appendices D through O. The increase in the number of installations slated for sampling resulted from a change in the EPA floodplain ruling in addition to changes in command priorities. A total of 1,541 samples was collected and analyzed for 14 chemical parameters, resulting in a total of 21,574 separate chemical analyses. Analysis for the eight RCRA TEP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) was performed according to standard EPA (EP Toxicity) methods in reference 9. Analysis for the six explosives (RDX, HMX, TNT, tetryl, 2,6-DNT, and 2,4-DNT) was performed according to methodology contained in reference 10.

TABLE 1. AMC INSTALLATIONS EVALUATED DURING PHASE 2

AMCCOM	DESCOM	TECOM	MICOM
Badger AAP	Anniston Ad	Dugway PG	Redstone Ars
Hawthorne AAP	Letterkenny Ad	Jefferson PG	
Holston AAP	Lexington-Bluegrass AD	White Sands Missile Range	
Indiana AAP	Navajo DA	Yuma PG	
Iowa AAP	Pueblo DA		
Kansas AAP	Red River AD		
Lake City AAP	Savanna ADA		
Lone Star AAP	Seneca AD		
Longhorn AAP	Sierra AD		
Louisiana AAP	Tooele AD		
McAlester AAP	Umatilla DA		
Milan AAP	Ft Wingate DA		
Newport AAP			
Picatinna Ars			
Radford AAP			
Ravenna AAP			
Sunflower AAP			
Twin Cities AAP			
Volunteer AAP			

(3) Phase 3. This phase consisted of a summary and interpretation of the data collected during the Phase 2 surface soil investigations, published as reference 13. A listing of the conclusions and recommendations of the Phase 3 report are provided in Appendix P. A summary of analytical data on the Phase 2 OB/OD field studies is provided in Table 2. Each numerical entry in Table 2 represents the cumulative average of percents for TEP metals and explosives in OB and OD operations. The percents for TEP metals include all data values from the ND through the RCRA TEP metal limits interval, likewise, for explosives, the percents include all data

values from the ND through 1,000 µg/g interval. The first two columns in Table 2 show the overall AMC picture for TEP metals and explosives by major subordinate commands.

TABLE 2. AMC SUMMARY OF ANALYTICAL RESULTS FOR TEP METALS* AND EXPLOSIVES†

	Overall AMC		Open Burning		Open Detonation	
	TEP Metals (%)	Explosives (%)	TEP Metals (%)	Explosives (%)	TEP Metals (%)	Explosives (%)
AMCCOM	98.7	97.6	97.9	97.3	99.9	98.3
DESCOM	99.4	99.8	99.2	99.7	99.5	100
TECOM	99.2	100	99.1	100	99.4	100
ARRADCOM ‡	97.6	99.5	95.3	99.4	100	100
MICOM	100	99.7	100	99.6	100	100
TOTAL AMC	99.0	98.7	98.6	98.4	99.7	99.3

* Percentage of data below RCRA TEP limits.
† Percentage of data below 1,000 µg/g limit.
‡ Results from Picatinny Arsenal which is now in AMCCOM.
Note: Appropriate units for TEP metals is mg/L and for explosives is µg/g.

(4) Phase 4. This phase involved the detailed subsurface investigations into the extent of metals and explosives migration as indicated as possible problem areas from Phase 2. Table 3 lists the installations studied during Phase 4. A total of 599 samples was collected and analyzed for 14 chemical parameters, resulting in a total of 8,386 separate chemical analyses.

TABLE 3. AMC INSTALLATIONS EVALUATED DURING PHASE 4

AMCCOM	DESCOM
Badger AAP	Seneca AD
Holston AAP	Sierra AD
Indiana AAP	Tooele AD
Iowa AAP	
Lake City AAP	
Louisiana AAP	
Newport AAP	
Radford AAP	
Volunteer AAP	

(5) Phase 5. This report is the summary and interpretation of all analytical data collected in Phase 2 (surface soil sampling) and Phase 4 (subsurface soil sampling).

e. Regulations.

(1) Thermal Treatment. The OB/OD is regulated as a thermal treatment process under 40 CFR 265. Under the general facility requirements of this regulation, installations must have developed a series of plans applicable to OB/OD facilities and operations, such as waste analysis, inspection, contingency, training, and closure plans with any attendant recordkeeping. Facilities must also comply with specific quantity-distance relationships which closely parallel those already in use within the DOD community. There are presently no 40 CFR 264 regulations for OB/OD facilities. It is expected, however, that EPA will promulgate standards for these facilities under a Subpart "x" some time in 1987. These standards will include rather general requirements which will apply to all interim status facilities for which final standards (40 CFR 264) have not been promulgated. This Agency will be preparing a RCRA Part B Permit Writers' Guidance Manual for OB/OD facilities for use by regulatory officials. Data contained in this report will be utilized in completing the Permit Writers' Guide. Additionally, information contained in reference 14, a ground-water monitoring study at OB/OD sites, and an on-going OB/OD air pollution study at Tooele AD, and a research report concerning migration of contaminants in soil contained in reference 11 will be used in preparing this Guide.

(2) OB/OD as Hazardous Waste Treatment. The OB/OD process also meets the definition of hazardous waste treatment. The regulations prohibit the open burning of hazardous waste as a treatment method. However, an exemption is granted for the OB/OD of waste PEP which cannot be safely disposed by other means (40 CFR 265.382). This exemption is only from the prohibition on OB and does not in any way exempt the facility or its operators from compliance with all other applicable regulations for treaters, storers, and disposers of hazardous wastes. The OB/OD process is also subject to regulations under the Clean Air Act (reference 1) and may require waivers or permits under existing State air pollution regulations.

(3) Reactivity Definition. The regulations promulgated under RCRA (references 3 through 7) set forth standards and guidance for the "cradle to grave" management of hazardous wastes. Under these regulations, one of the criteria for designating a waste hazardous is reactivity, which is defined to include wastes which may detonate from strong initiation or when heated under confinement, and specifically includes "forbidden," "Class A," and "Class B" explosives as specified by DOT in 49 CFR 173 (reference 8). Forbidden explosives can include some PEP wastes.

(4) Reactivity Testing. According to the definition of hazardous waste, residues from hazardous waste treatment operations are themselves considered to be hazardous until proven otherwise. Since the original PEP wastes are hazardous by characteristic of reactivity, the residues must also

be considered reactive. During the study period, officially approved reactivity tests were unavailable. Therefore, for the purposes of this study, 1,000 µg/g (0.1 percent) of explosives was defined as an arbitrary minimum concentration guideline below which OB/OD residues would probably not be reactive. Recently, however, some EPA regions and some State regulatory agencies have accepted the US Department of Interior Bureau of Mines reactivity test. This test consists of two independent experiments called the Gap Test and the Internal Ignition Test. These tests are detailed in Appendix Q. This Agency has developed a program in which 65 soil samples from 10 installations contaminated by various levels of explosives have been tested for reactivity using this Bureau of Mines test. These results have shown that soils containing explosives in concentrations exceeding 30,000 µg/g (3 percent) are not reactive. In fact, reactivity tests on all of these soil samples have been negative. A summary of OB/OD soils samples submitted for reactivity testing is contained in Table 4. This implies that the 1,000 µg/g guideline chosen for this report is a conservative yet suitable level to utilize. This statement is also supported by the experience and opinion of the ammunition plant community. The only possible exception for using this guideline might be for styphnate- or azide-containing explosives.

TABLE 4. SUMMARY OF OB/OD SOILS SUBMITTED FOR REACTIVITY TESTING *

EXPLOSIVE	# DETECTED	MINIMUM OF DETECTED VALUES (ug/g)	MAXIMUM VALUE (ug/g)	MEDIAN OF DETECTED VALUES (ug/g)	AVERAGE OF DETECTED VALUES (ug/g)
HMX	19	1.8	16900.0	39.5	2707.9
RDX	26	1.4	14300.0	20.4	966.1
TETRYL	1	--	--	12.4	12.4
TNT	46	1.6	15100.0	49.2	1432.7
2,4-DNT	28	1.1	312.0	11.8	53.3
2,6-DNT	8	4.5	24.0	6.0	9.2
SUM OF EXPLOSIVE CONCENTRATIONS	65	1.8	31222.6	59.2	2217.0

* Reactivity tests, using Bureau of Mines procedures, on all 65 samples were negative. Only samples with detectable concentrations of any explosive were included in this summary.

(5) Metals. Since many PEP wastes also contain toxic heavy metals, there is also the potential for some of these metallic elements to be released from the waste to the environment via leaching in acidic soils or through air dispersal. The residues and soils were, therefore, analyzed for TEP metals. Additionally, the State of California places limits on the total concentrations of the metals on the TEP list. These standards, called TTCL's, are 10 times the Federal TEP limits. Therefore, for samples collected from Sierra AD, located in California, samples were analyzed for total as well as TEP metals concentrations.

(6) Ground-water Contamination. The principal thrust of Federal hazardous waste regulations is the protection of ground and surface waters. Hazardous waste disposal sites are required to have installed a ground-water monitoring system which can measure the impact of the facility on the uppermost aquifer. Since heavy metals and PEP wastes could migrate to ground and/or surface waters, the analytical results of this and other similar studies, coupled with a knowledge of site geohydrology, can give a preliminary indication of the subsurface pollution potential of the OB/OD facilities.

(7) Toxicity Considerations. The RCRA regulations require OB/OD operators to perform TEP metals and reactivity tests on residues and potentially contaminated soils to determine if these wastes are hazardous. However, the Army has also performed some limited toxicity testing on these wastes. This testing was required for samples collected at Sierra AD, located in California, because toxicity is one of the hazardous waste characteristics in the State of California regulations. All Sierra AD samples were less toxic than the 500 mg/L threshold value in 96-hour LC50 tests established in these regulations. Therefore, these wastes were not considered to be toxic by the California definition. A second group of toxicity tests were performed by this Agency on ash and residues resulting from the OB of M-15 propellants. The results of these tests indicated that the toxicity of the propellant ash was many times greater than that expected based on the literature toxicity values of the ash constituents. Additional toxicity testing is required in order to provide a more complete discussion of the toxicities of OB/OD residues and contaminated soils.

f. Sampling Methodologies and Strategies.

(1) Background.

(a) The OB facilities typically encountered at the OB sites include large burn pads, clusters of small burn pads, burn trenches, flashing piles or pits, and burn cages.

(b) At most OB facilities, residues are in the form of either discrete piles of ash or merely veneers of ash dispersed over the soil. The color of the ash usually ranges from white to black, with occasional reds. In terms of texture, the ash appears in a variety of forms from light flakes to solid char and often is seen as a crumbly, granular "cake,"

residue/soil matrix. However, in many areas the intense burning action has altered the immediate subsurface soil structure to the point where it is difficult to clearly determine where residue stops and soil begins. Unfortunately, there is a lack of data on how the physical soil characteristics can change from the repeated burning actions, combined with the infusion of a variety of organic compounds.

(c) Due to the inherent operational differences between OB and OD, OD sites usually have neither discrete residue piles nor always visible veneers of ash to sample. The detonation/deflagration process tends to more completely combust, vaporize, or aerosolize the explosive and metal components, leaving only minute and generally nonvisible traces in the resultant craters and surrounding soils.

(d) While the goal of the onsite visits was to gather samples which were as representative as possible, the primary consideration in sampling had to be the safety of the study team. This Agency's remote control drill rig was selected as the best overall method of OB sample retrieval to protect personnel from potential flash burns and explosions. The determination to use a remote-control rig rather than bulky and heavy stationary devices was the consensus of opinion among USAEHA, AMCCOM and DESCOM representatives and safety personnel during the establishment of this project.

(2) Phase 2. Phase 2 sampling methodologies were detailed in reference 9. These procedures are duplicated in Appendix R of this report.

(3) Phase 4.

(a) The majority of the samples collected during the Phase 4 investigations were taken from depths in excess of 18 inches. The primary method used for collection of these samples was the 4-inch-diameter, hollow-stem augering system which greatly reduces the possibility of contamination between soil horizons. However, some samples had to be collected from the auger cuttings pile at the surface. This was necessary in situations where the Shelby tube placed within the auger deformed due to the presence of stones in the soil, therefore, not allowing collection of an appropriate sample. The typical strategy used in determining sampling depths was to collect an initial sample at a depth of 1-1/2 to 2 feet, with subsequent samples collected every 5 feet or change of strata. Drilling was generally terminated upon interception of ground water or refusal. A small number of samples were also collected from the top 18 inches of soil. The procedures used to collect these surface soil samples were the same as those utilized during the Phase 2 studies (see Appendix Q).

(b) At most installations, wherever possible, sampling sites were chosen which duplicated those utilized during the Phase 2 evaluations. Specific sampling locations at these sites were determined based on site-specific geologic and hydrologic considerations. At most installations, several boreholes were sited directly within the OB site. Other boreholes

were located in the immediate vicinity of the site to determine the extent of lateral migration of contaminants, if any. Additionally, at some installations, boreholes were sited farther away from the OB site to further characterize the lateral migration of contaminants. Finally, sediment samples were collected from drainage ditches and swales at a number of installations to ascertain whether lateral contaminant migration was occurring as a result of surface runoff events.

(c) No samples were collected from OD sites as part of the Phase 4 evaluations. Because of the inherent possibility of unexploded ordnance being buried a considerable depth below the surface following OD activities, it was felt that the threat to the safety of drill rig operators at these sites was too great to justify collecting subsurface samples.

g. Analytical Detection Limits and Methodologies. Detection limits and methodologies for each of the parameters included in this study are provided in Table 5.

TABLE 5. ANALYTICAL DETECTION LIMITS AND METHODOLOGIES.

Parameter	Units	Detection Limit	Methodology
TEP Metals			
Silver	mg/L	0.5	Extraction per
Arsenic	mg/L	0.5	40 CFR 261, analysis
Barium	mg/L	10.0	by atomic absorption
Cadmium	mg/L	0.1	described in reference 9
Chromium	mg/L	0.5	
Mercury	mg/L	0.02	
Lead	mg/L	0.5	
Selenium	mg/L	0.1	
Total Metals			
Silver	µg/g	12.5	Acid digestion
Arsenic	µg/g	5.0	followed by atomic
Barium	µg/g	150	absorption described in
Cadmium	µg/g	0.50	reference 9
Chromium	µg/g	0.025	
Mercury	µg/g	0.1	
Lead	µg/g	0.001	
Selenium	µg/g	2.5	
Explosives			
RDX	µg/g	1.0	HPLC method described
HMX	µg/g	1.0	in reference 10
TNT	µg/g	1.0	
Tetryl	µg/g	5.0	
2,6-DNT	µg/g	1.0	
2,4-DNT	µg/g	1.0	
Reactivity	--	--	Bureau of Mines method described in Appendix Q

5. SUMMARY AND INTERPRETATION OF PHASE 2 AND PHASE 4 ANALYTICAL RESULTS.

a. Background. The following discussion strictly deals with the OB/OD sites from which both surface and subsurface analytical soils results were obtained. As a result, no OD sites are included in this summary since subsurface sampling was not accomplished at these facilities. The OB sites meeting this sampling criterion, and therefore discussed below, are located at the 12 AMC installations shown in the Figure.

b. Soil Investigation Appendices. Discussions of the OB soil investigations at each of the 12 installations are contained in Appendices D through O of this report. The format of each appendix is very similar. Brief background information is provided in each appendix concerning pertinent environmental setting considerations, an overview of the OB grounds, and sampling methodologies and locations. Subsequently, analytical results are interpreted through the use of tables, showing results for each parameter as well as providing summaries, and bar graphs portraying data summaries. Samples were grouped into six categories: 0-6 inches, 6-18 inches, 18 inches to 5 feet, 5-10 feet, 10-20 feet, and greater than 20 feet. Additionally, samples collected at some installations were divided into two groups, those collected within or immediately nearby the OB sites, and those collected farther away from the sites. Sediment samples collected from drainage ditches were placed in this latter category. Brief summaries of each of the appendices is provided below.

c. Summaries of Investigations at Individual Installations.

(1) Badger AAP (Appendix D). Significant soils contamination was detected at the site but was limited to the top 18 inches of soil. The primary contaminants were lead, 2,6-DNT and 2,4-DNT.

(2) Holston AAP (Appendix E). Significant soils contamination was detected at the site but was limited to the top 18 inches of soil. Trace levels of contaminants were migrating vertically down to saturated zones. Lateral migration of contaminants with the ground water was predicted. At least a portion of the contamination could have been due to spillage and runoff of unburnt compounds. The primary contaminants were RDX and HMX.

(3) Indiana AAP (Appendix F). Significant soils contamination was detected at the site but was limited to the top 18 inches of soil. Little if any horizontal migration of contaminants was observed. The primary contaminant was lead. The high lead levels were attributable to the past practice of burning polyester powder bags containing thin lead liners.

(4) Iowa AAP (Appendix G). Significant soils contamination was detected at the site but was limited to the top 18 inches of soil. No vertical migration of contaminants was found. Significant horizontal migration of contaminants in the surface soils in conjunction with runoff from precipitation events was detected. The primary contaminants were TNT, RDX, HMX, and barium.

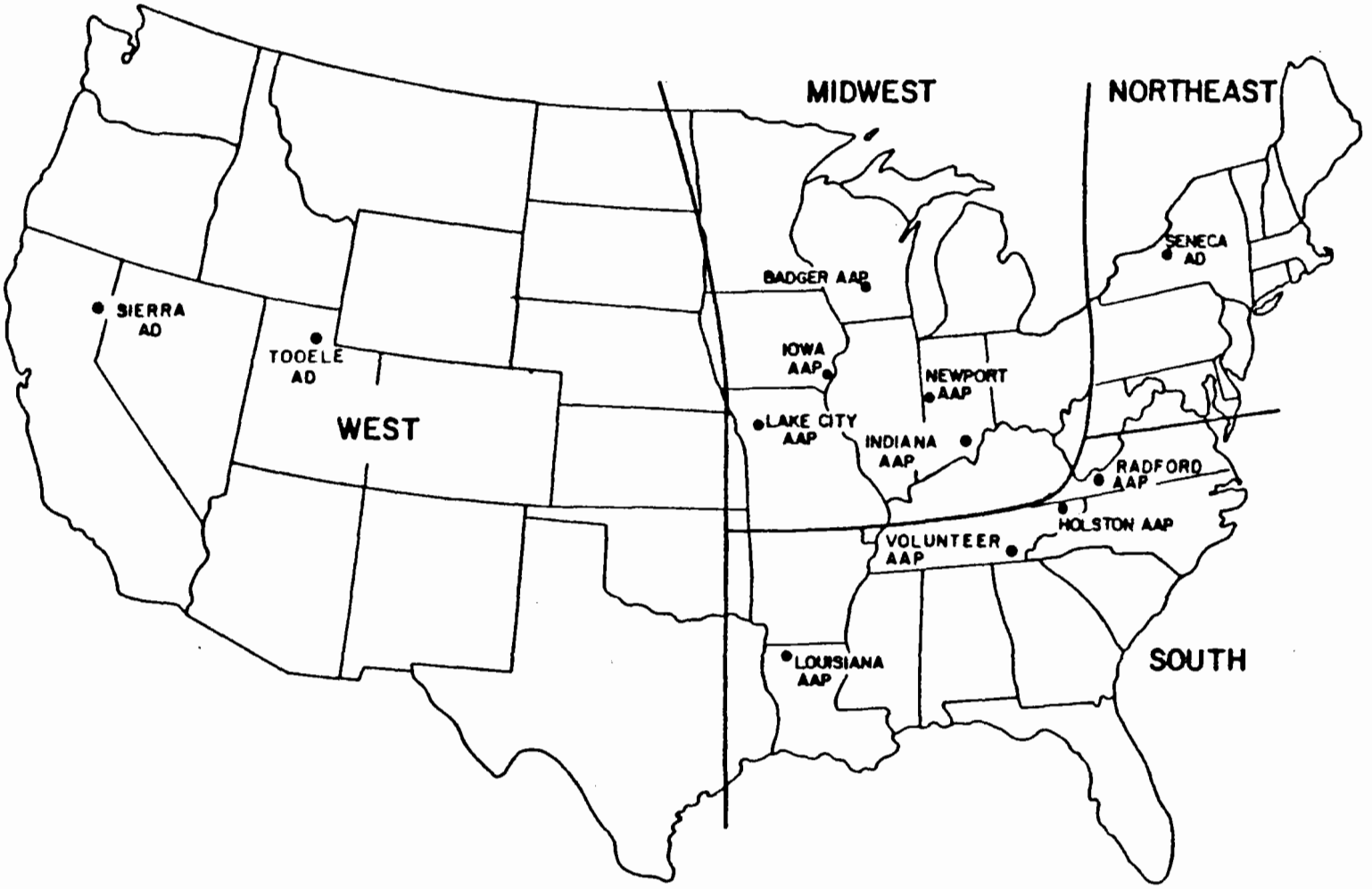

FIGURE. LOCATION OF INSTALLATIONS INCLUDED IN PHASE 4 STUDY

(5) Lake City AAP (Appendix H). Samples were only collected from inactive OB sites. Contamination at these locations was minimal. Insignificant horizontal or vertical contamination was detected. However, erosion of contaminated surface soils is a potential problem at the active OB site at Lake City AAP.

(6) Louisiana AAP (Appendix I). Significant soils contamination was detected at the site but was limited to the top 18 inches of soil. Significant contamination also exists immediately downgradient of the site in the top 18 inches of soil. This contamination is most likely due to contaminated runoff leaking from the OB site catchment basin. The primary contaminants were TNT, RDX, and HMX.

(7) Newport AAP (Appendix J). Contamination attributable to OB operations was minimal.

(8) Radford AAP (Appendix K). Significant soils contamination was detected at the site but was limited to the top 18 inches of soil. The potential exists for contaminated surface soils to be transported laterally from the site via surface runoff. The primary contaminants were TNT, 2,4-DNT, and lead.

(9) Seneca AD (Appendix L). Significant soils contamination was detected at one of three sampled OB facilities. This contamination which occurred down to the ground-water table (last depth sampled), was partially due to the existence of a buried OB site which was found 4 feet beneath the existing OB pad. Lateral migration of contaminants using the ground water as a transport medium was possible due to the shallow ground-water table in the area. Contamination at the other sites was not considered to be significant. Horizontal migration of contaminants due to surface runoff was not significant. The primary contaminants were lead and barium.

(10) Sierra AD (Appendix M). Significant soils contamination was detected in the top 6 inches of soils at the bases of the burning trenches. Past OB practices in conjunction with runoff problems increased the possibility for contaminants to leach from burning residues. The primary contaminants were lead and barium.

(11) Tooele AD (Appendix N). Soils contamination at the OB site is minimal.

(12) Volunteer AAP (Appendix O). Significant soils contamination probably exists at the OB site. This statement cannot be made conclusively, because only a limited number of samples were collected from the soils near the surface, and these samples contained a wide range of concentrations of contaminants. What contamination is present is limited to the top 18 inches. Lateral surface migration of contaminants can be expected in conjunction with runoff events. The primary contaminants were TNT, 2,6-DNT, and 2,4-DNT.

d. Interpretation of Results. A summary of the findings at the individual installations is contained in Table 6.

(1) Extent of Contamination.

(a) Significant soils contamination was detected at the OB sites of 9 of the 12 installations included in the summary. Soils at many of these sites contained concentrations of TEP metals which exceeded the applicable limits. Therefore, these soils were hazardous wastes. However, this contamination was limited to the top 18 inches of soils at seven of these sites and only the top 6 inches at an eighth installation. Significant contamination at greater depths was only detected at one installation (Seneca AD). The contamination at this facility at depths exceeding 18 inches was primarily due to a buried OB pad which was found 4 feet below the existing site.

(b) Lateral subsurface migration of contaminants was confirmed at one installation (Louisiana AAP), with contaminants limited to the top 18 inches. This contamination was primarily due to leakage from a catchment basin and not from migration of contaminants from OB operations. Additionally, sampling at Holston AAP and Seneca AD suggested that contaminants could migrate laterally in low levels with ground water.

(c) Significant contamination was detected at greater depths at one installation, Seneca AD. Although some vertical migration of contaminants was occurring at this site, this contamination was primarily due to the buried OB pad discovered at the site. Minimal migration was detected at Holston AAP. Vertical migration was also determined to be possible at Sierra AD as a result of runoff considerations.

(d) Runoff-related surface contamination was detected at three installations, and was estimated to be possible at two other locations. Migration of contaminants in this scenario primarily occurs in surface soils along drainage channels. In some locations, the potential exists for significant contamination of downgradient soils and/or surface waters through this avenue.

(2) Most Frequently Detected Significant Contaminants.

(a) Metals. "Significant" with respect to metals contaminaton was defined as exceeding the applicable TEP limit in more than one sample, or detected in concentrations approaching these limits in several samples. Significant levels of TEP lead were detected at five installations. Soils from three installations contained TEP barium in concentrations considered to be significant.

(b) Explosives. "Significant" with respect to explosives contamination was defined as exceeding the 1,000 µg/g limit in more than one sample, or detected in concent rations approaching this limit in many samples. Significant concentrations of TNT were found in soils collected from four installations. Three explosives, 2,4-DNT, RDX, and HMX, were considered to be significant at three installations. Finally, 2,6-DNT was found in significant levels at two installations.

TABLE 6. SUMMARY OF FINDINGS

INSTALLATION	SIGNIFICANT CONTAMINANTS TEP METALS	EXPLOSIVES	CONTAMINATION AT-SITE	LATERAL MIGRATION	VERTICAL MIGRATION	RUNOFF-RELATED	EXCESS PRECIPITATION (inches)	RELATIVE SOILS PERMEABILITY	DEPTH TO GROUND WATER (feet)
AMCCOM									
BADGER AAP	Pb	2,6-DNT 2,4-DNT	Yes, Top 18"	?	No	No	2	High	83-111
HOLSTON AAP	--	RDX HMX	Yes, Top 18"	Possible	Minimal, to Ground Water	No	12	Low	8-15
INDIANA AAP	Pb	--	Yes, Top 18"	No	No	No	8	Low	100-200
IOWA AAP	Ba	TNT RDX HMX	Yes, Top 18"	No	No	Yes	0	Low	4-17
LAKE CITY AAP	--	--	Minimal	No	No	Possible	0	Low	6-19
LOUISIANA AAP	--	TNT RDX HMX	Yes, Top 18"	Top 18"	No	No	1	High	2-24
NEWPORT AAP	--	--	Minimal	No	No	No	5	Low	5-15
RADFORD AAP	Pb	TNT 2,4-DNT	Yes, Top 18"	No	No	Possible	6	Medium	15-18
VOLUNTEER AAP	--	TNT 2,6-DNT 2,4-DNT	Probably, Top 18"	No	No	Yes	17	Low	120
DESCOM									
SENECA AD	Pb Ba	--	Yes	Possible	Yes, Down to Ground water	No	3	Low	3-6
SIERRA AD	Pb Ba	--	Yes, Top 6"	No	Possible	Yes	-33	Low	18-20
TOOELE AD	--	--	Minimal	No	No	No	-27	Medium	>200

e. Factors Affecting Migration of Contaminants. In general, contamination at the studied sites was not very severe. However, several possible factors which could affect the migration of contaminants are listed for each installation in Table 6. Two observations can be drawn from this data. First, the only two installations where vertical migration of contaminants was detected and lateral migration was possible have very shallow ground water and significant excess precipitation. At installations with deeper ground-water tables, the possibility exists that sufficient dilution, adsorption, biodegradation, or chemical degradation of the contaminants is occurring before the contaminants can reach the ground water. At Installations without considerable excess precipitation, there is not a sufficient driving force to cause migration of contaminants. The second observation is that runoff-related problems are of primary concern at installations with soils having low permeability. At these locations, the soils are sufficiently impermeable that runoff, rather than infiltration, occurs during and after precipitation events. The design of the OB facility and the topography of the site are also critical factors in determining whether these runoff problems will occur.

6. DISCUSSION OF OB SITE OPERATIONS. The Phase 3 report, reference 13, recommended that an extensive list of "good and poor" OB/OD operational practices be adopted. These practices are duplicated in Appendix S. Some of the more important operational practices include minimizing the volume of waste to be burned by segregation, only burning PEP or PEP-contaminated wastes, not burning or disposing of liquids at the OB sites, controlling runon/runoff using diversion and drainage systems, performing OB activities in pans, collecting residues after each OB operation and testing them for hazardous waste characteristics, storing residues (pending test results) in RCRA-permitted storage facilities, and disposing of hazardous residues in RCRA-permitted hazardous waste facilities. This listing is still felt to be appropriate for current OB/OD operations. Additionally, AMCCOM delineated what it felt to be acceptable open burning practices in reference 12. The acceptable operational practices listed in this latter reference are contained in the Phase 3 list.

7. SITING OB/OD FACILITIES. The Phase 3 report, reference 13, contained a list of factors involved in OB/OD site selection. This list is duplicated in Appendix T. This listing is still felt to be appropriate for current OB/OD operations. One point to stress is that the OB facilities at Holston AAP and Radford AAP are located within 100-year floodplains. These facilities can be relocated, sites can be raised above the flood level, or facilities can be designed so that all wastes and contaminants are removed prior to the advance of flood waters. Siting facilities under these circumstances can obviously lead to significant environmental impacts if not properly addressed. Additionally, 40 CFR 265.382 (reference 7) of the RCRA regulations specifies the minimum distance from OB/OD operations to the property of others, as a function of the pounds of waste explosives treated.

8. DESIGN OF OB/OD FACILITIES.

a. OB Facilities.

(1) In a soon to be published policy statement, AMC will be requiring that OB of PEP wastes be conducted in containment systems. The AMCCOM has proposed and is utilizing a simplistic design consisting of a trough made of reinforced stainless steel and lined with firebrick. The trough is approximately 2-feet high by 4-feet wide by 10-feet long but can vary in size or in multiples to suit needs. The box is raised off the ground via pipes to permit ground inspection. The intent of this design is to preclude all ground contact, thereby lessening the chance for contamination from surface runoff or through infiltration of soils. Once the PEP wastes are burned, the residue will be collected, tested, and disposed of accordingly. Several installations have also devised a portable, wheeled top for the pans which can be easily rolled over the pan after a burn to keep out rain until the pan is cleaned.

(2) A sizable workload also exists for large PEP-contaminated items, intended for flashing, for public salvage or final disposal. Sections of pipe, vessels, and other items peculiar to ammunition production and commercial items (to include over-the-road trailers) contaminated with explosives must be disposed of. The OB burn pans obviously have size/quantity limitations. Other equipment to contain and burn these bulk PEP-contaminated wastes are currently under consideration.

b. OD Facilities. Several experimental OD procedures are being tested to treat these extremely dangerous and sensitive ordnance.

9. FUTURE CONSIDERATIONS.

a. Importance of Phase 5 Data. The summaries and interpretations made in this report are based upon analytical data from samples collected strictly from OB sites which have been in operation for many years. Typically, these operations have used antiquated practices based on few, if any environmental considerations. Some of the practices which have had the most severe potential environmental impact have included conducting burning operations directly on existing surface soils, treating or disposing of wastes at the site which are not contaminated by explosives (including disposing of liquid wastes), and not providing adequate runon/runoff control. However, despite all of these omissions or inadequacies, the data presented in this report indicates that soils contamination at the vast majority of the sites is limited to the top 18 inches of soil, with little if any lateral or vertical migration of contaminants. In comparison, future OB operations for PEP wastes will be performed using environmentally-sound practices. The most important of these practices will be the use of OB pans which contain OB residues. By design, these pans minimize the possibility of contaminants reaching the soils of the immediate area, and migrating from the OB site. Therefore, the data and interpretations presented in this report should be utilized to assess the environmental impact of past OB activities rather than of future activities.

b. OB Site Closure. As discussed above, the data presented in this report can be utilized to determine the environmental impact of past OB activities. Therefore, the Phase 5 data, as well as the supporting data in the field survey reports, can be utilized in the RCRA-regulated closure of these old sites.

c. OD Site Data Versus OB Site Data.

(1) All of the facilities discussed in this report conducted OB operations. Therefore, the interpretations contained herein do not necessarily apply to OD operations. Phase 2 sampling results showed that OB operations created greater levels of contamination in surface soils than did OD operations. This is due to the inherent nature of OD activities, in which a substantial portion of the residual explosives and metals are either forced into the subsoils, or propelled away from the immediate vicinity of the OD site. The major portion of these residuals consists of large metal fragments or unexploded ordnance. These materials can be, and have been, easily removed from the surface soils. As such, little contamination is left behind at the OD site. However, the potential exists for small but very concentrated pockets of contamination to be created in the subsoils beneath the site. Chunks of unexploded explosives or small metal shards would create a more significant environmental impact than would unexploded ordnances or large pieces of shrapnel, although any of these materials represent a potential impact. Therefore, it could be concluded that although the surface contamination at OD sites is less than that detected at OB sites, the subsurface contamination, in the form of small but concentrated "hot spots," exist at OD facilities.

(2) It should be noted that the majority of OD operations are conducted in arid or semiarid locations in the western half of the country. There are three major factors at these locations which act to minimize the migration of contaminants at these sites. These factors are having considerable excess of evaporation over precipitation, soils that are alkaline in nature, and ground water located a great distance below the ground surface. These same factors could act to minimize contaminant migration at OB sites as well.

10. CONCLUSIONS.

a. Significant soils contamination was detected at the OB sites of 9 of the 12 installations included in this summary. However, this contamination was limited to the top 18 inches of soils at eight of these sites. Contamination at greater depths at the ninth installation was primarily due to the presence of a buried OB pad at the existing site.

b. At the only OB site where lateral subsurface migration of contaminants was confirmed, this contamination was not due to OB operations. Lateral migration of contaminants with ground water was possible at two other sites.

c. Vertical migration of contaminants was detected at two OB sites and considered to be possible at a third site.

d. Runoff-related surface contamination was present or possible at OB facilities located at 5 of 12 installations sampled. In some locations, the potential exists for significant contamination of downgradient soils and/or surface waters through this avenue.

e. The TEP metals most frequently detected at OB sites in significant concentrations were lead and barium.

f. The explosives most frequently detected at OB sites in significant concentrations were, in order of decreasing frequency of detection, TNT, 2,4-DNT, RDX, HMX, and 2,6-DNT.

g. The only two installations where vertical migration of contaminants was detected and lateral migration was possible have very shallow ground water and significant excess precipitation. Contamination could be less of a problem at installations with ground water at greater depths due to dilution, adsorption, and degradation, and at installaions without excess precipitation due to the lack of a driving force to cause contaminant migration.

h. Runoff-related contamination problems are of primary concern at installations with soils having low permeabilities. The design of the OB facility and the topography of the site are also critical factors in determining whether runoff problems will occur.

i. The extensive list of "good and poor" OB/OD operational practices, presented in Appendix S, can be used to prevent or minimize health and environmental impacts. The most important of these practices include only burning PEP wastes, not burning liquids, controlling runon/runoff, using burning pans, collecting residues after each operation and testing them for hazardous waste characteristics, and storing and disposing of residues properly.

j. The OB/OD site selection guidelines, presented in Appendix T, can be used to relocate or select new OB/OD sites to minimize impacts to human health and environment. Facilities located within 100-year floodplains pose potentially severe environmental risks.

k. The state-of-the-art OB facility design using burning pans will prevent or minimize environmental contamination.

l. The data and interpretations presented in this report can be utilized to assess the environmental impact of past OB activities rather than of future activities.

m. The data presented in this report, as well as the supporting data in the field survey reports, can be utilized in the RCRA-regulated closure of the old OB sites.

n. Although surface contamination at OD sites is less than that detected at OB sites, the OD sites are predicted to have subsurface contamination, in the form of small but concentrated "hot spots," which is worse than the contamination found at the OB sites. However, environmental conditions at most OD locations act to minimize contaminant migration.

o. Only limited toxicity testing of OB/OD residues and contaminated soils has been conducted.

p. Based on the results of the Bureau of Mines reactivity test, it is unlikely that the concentrations of explosives detected in OB/OD soils are reactive. However, it must be stressed that no reactivity tests have received official regulatory approval.

q. The data contained in this report is suitable for use by the EPA as background information to complete the RCRA Part B Permit Writers' Guidance Manual for OB/OD Facilities.

11. RECOMMENDATIONS. The following recommendations are based on good environmental engineering practices.

a. Develop a policy statement for OB/OD operations incorporating the "good and poor" operational practices listed in Appendix S.

b. Develop a policy statement concerning the use of the OB/OD site selection guidelines, patterned after the factors involved in site selection contained in Appendix T, for establishing or relocating OB/OD facilities.

c. Close, relocate, or upgrade those OB/OD facilities located in regulatory flood hazard areas.

d. Use burning pans or other containment systems for OB of PEP wastes rather than conducting OB operations directly on the soil surface.

e. Utilize the data presented in this report, as well as the supporting data in the field survey reports, to aid the development of OB site closure plans.

f. Initiate a research program to determine the chemical toxicity of OB/OD soils.

g. Present the data contained in this report to the EPA for use as background information in completion of the RCRA Part B Permit Writers' Guidance Manual for OB/OD Facilities, and other Department of Defense activities which perform OB/OD operations.

12. TECHNICAL ASSISTANCE. Requests for services should be directed through appropriate command channels of the requesting activity to the Commander, US Army Environmental Hygiene Agency, ATTN: HSHB-ES, Aberdeen Proving Ground, MD 21010-5422, with an information copy furnished the Commander, US Army Health Services Command, ATTN: HSCL-P, Fort Sam Houston, TX 78234-6000. The point of contact for OB/OD-related projects at this Agency is Mr. Michael E. Resch, P.E., AUTOVON 584-3651, commercial (301) 671-3651.

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APPENDIX A

REFERENCES

1. Public Law 95-95, 7 August 1977, Clean Air Act Amendments of 1977.

2. Public Law 96-510, 11 December 1980, Comprehensive Environmental Response, Compensation and Liability Act of 1980.

3. Title 40, Code of Federal Regulations (CFR), 1985 rev, Part 260, Hazardous Waste Management System: General.

4. Title 40, CFR, 1985 rev, Part 261, Identification and Listing of Hazardous Waste.

5. Title 40, CFR, 1985 rev, Part 262, Standards Applicable to Generators of Hazardous Waste.

6. Title 40, CFR, 1985 rev, Part 264, Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.

7. Title 40, CFR, 1985 rev, Part 265, Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.

8. Title 49, CFR, 1985 rev, Part 173, Shippers - General Requirements for Shipments and Packagings.

9. "Test Methods for Evaluating Solid Waste," SW-846, 2d ed, EPA, Office of Solid Waste, Washington, DC.

10. "High Performance Liquid Chromatographic Analysis of Explosives in Soils," USAEHA Methods; R. Bongiovanni, CPT, MSC; L. D. Clark; and C. E. Podolak, Aberdeen Proving Ground, MD.

11. US Army Toxic and Hazardous Materials Agency, "Evaluation of Critical Parameters Affecting Contaminant Migration Through Soils," Volume I, July 1985, Aberdeen Proving Ground, MD.

12. Letter, HQ AMCCOM, AMSMC-IS, 6 May 1985, subject: Environmental Management of Hazardous Waste Burning Grounds.

13. Letter, USAEHA, HSHB-ES-H/WP, 28 September 1984, subject: Phase 3, Hazardous Waste Study No. 37-26-0147-84, Summary of AMC Open-Burning/ Open-Detonation Ground Evaluations, November 1981 - September 1983.

14. Letter, USAEHA, HSHB-ES-G, 28 October 1985, subject: Ground-water Monitoring Study No. 38-26-0457-85, AMC Open-Burning/Open-Detonation Facilities, February 1984 - March 1985.

Phase 5, Hazardous Waste Study No. 37-26-0593-86, Mar 81 - Mar 85

15. Letter, USAEHA, HSHB-ES-E/WP, 28 July 1983, subject: Phase 2, Hazardous Waste Management Special Study No. 39-26-0147-83, DARCOM Open-Burning/Open-Detonation Grounds Evaluation, Badger Army Ammunition Plant, Baraboo, Wisconsin, 19-30 April 1982.

16. Letter, USAEHA, HSHB-ES-G/WP, 22 February 1985, subject: Hazardous Waste Study No. 37-26-0339-85, Phase 4 of AMC Open-Burning/Open-Detonation Grounds Evaluation, Investigation of Soil Contamination at the Open-Burning Ground, Badger Army Ammunition Plant, Baraboo, Wisconsin, 8-15 May 1984.

17. Letter, USAEHA, HSHB-ES-E/WP, 23 January 1984, subject: Phase 2, Hazardous Waste Management Special Study No. 37-26-0147-84, DARCOM Open-Burning/Open-Detonation Grounds Evaluation, Holston Army Ammunition Plant, Kingsport, Tennessee, 16-17 June 1983.

18. Letter, USAEHA, HSHB-ES-E, 3 July 1985, subject: Hazardous Waste Study No. 37-26-0512-85, Phase 4 of AMC Open-Burning/Open-Detonation Grounds Evaluation, Investigation of Soil Contamination at the Open-Burning Grounds, Holston Army Ammunition Plant, Kingsport, Tennessee, 5-16 November 1984.

19. Letter, USAEHA, HSHB-ES-H, 6 September 1983, subject: Phase 2, Hazardous Waste Management Special Study No. 39-26-0147-83, DARCOM Open-Burning/Open-Detonation Grounds Evaluation, Indiana Army Ammunition Plant, Charlestown, Indiana, 22 February - 4 March 1982.

20. Letter, USAEHA, HSHB-ES-H/WP, 12 September 1984, subject: Hazardous Waste Study No. 37-26-0338-84, Phase 4 of AMC Open-Burning/Open-Detonation Grounds Evaluation, Investigation of Soil Contamination at the Open-Burning Grounds, Indiana Army Ammunition Plant, Charlestown, Indiana, 27 September - 3 October 1983.

21. Letter, USAEHA, HSHB-ES-E/WP, 29 August 1983, subject: Phase 2, Hazardous Waste Management Special Study No. 39-26-0147-83, DARCOM Open-Burning/Open-Detonation Grounds Evaluation, Iowa Army Ammunition Plant, Middletown, Iowa, 20-22 April 1982.

22. Letter, USAEHA, HSHB-ES-E/WP, 21 December 1984, subject: Hazardous Waste Study No. 37-26-0338-85, Phase 4 of AMC Open-Burning/Open-Detonation Grounds Evaluation, Investigation of Soil Contamination at the Open-Burning Grounds, Iowa Army Ammunition Plant, Middletown, Iowa, 30 April - 4 May 1984.

23. Letter, USAEHA, HSHB-ES-E/WP, 2 July 1984, subject: Hazardous Waste Study No. 37-26-0322-84, Determination of the Extent of Explosives and Heavy Metals Contamination at the Open-Burning Grounds, Lake City Army Ammunition Plant, Independence, Missouri, 24-29 August 1983.

24. Letter, USAEHA, HSHB-ES-E, 17 May 1983, subject: Phase 2, Hazardous Waste Management Special Study No. 39-26-0147-83, DARCOM Open-Burning/Open-Detonation Grounds Evaluation, Louisiana Army Ammunition Plant, Shreveport, Louisiana, 11-12 August 1981.

Phase 5, Hazardous Waste Study No. 37-26-0593-86, Mar 81 - Mar 85

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26. Letter, USAEHA, HSHB-ES-H/WP, 1 September 1983, subject: Phase 2, Hazardous Waste Management Special Study No. 39-26-0147-83, DARCOM Open-Burning/Open-Detonation Grounds Evaluation, Newport Army Ammunition Plant, Newport, Indiana, 22 February - 4 March 1982.

27. Letter, USAEHA, HSHB-ES-H/WP, 19 March 1984, subject: Hazardous Waste Special Study No. 37-26-0326-84, Investigation of Soil Contamination at the Open-Burning Ground, Newport Army Ammunition Plant, Newport, Indiana, 5-11 October 1983.

28. Letter, USAEHA, HSHB-ES-E/WP, 27 January 1984, subject: Phase 2, Hazardous Waste Management Special Study No. 37-26-0147-84, DARCOM Open-Burning/Open-Detonation Grounds Evaluation, Radford Army Ammunition Plant, Radford, Virginia, 14-15 June 1983.

29. Letter, USAEHA, HSHB-ES-H, 26 June 1985, subject: Hazardous Waste Study No. 37-26-0480-85, Phase 4 of AMC Open-Burning/Open-Detonation Grounds Evaluation, Investigation of Soil Contamination at the Open-Burning Grounds, Radford Army Ammunition Plant, Radford, Virginia, 22-26 October 1984.

30. Letter, USAEHA, HSHB-ES-H/WP, 14 September 1983, subject: Phase 2, Hazardous Waste Management Special Study No. 39-26-0147-83, DARCOM Open-Burning/Open-Detonation Grounds Evaluation, Seneca Army Depot, Seneca, New York, 2-13 May 1982.

31. Letter, USAEHA, HSHB-ES-E/WP, 8 March 1985, subject: Hazardous Waste Study No. 37-26-0479-85, Phase 4 of AMC Open-Burning/Open-Detonation Grounds Evaluation, Investigation of Soil Contamination at the Open-Burning Grounds, Seneca Army Depot, Romulus, New York, 13-19 August 1984.

32. Letter, USAEHA, HSHB-ES-E/WP, 7 July 1983, subject: Phase 2, Hazardous Waste Management Special Study No. 39-26-0147-83, DARCOM Open-Burning/Open-Detonation Grounds Evaluation, Sierra Army Depot, Herlong, California, 13-15 October 1981.

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34. Letter, USAEHA, HSHB-ES-T/WP, 6 January 1983, subject: Phase 2, Hazardous Waste Management Special Study No. 39-26-0147-83, DARCOM Open-Burning/Open-Detonation Grounds Evaluation, Tooele Army Depot, Tooele, Utah.

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35. Letter, USAEHA, HSHB-ES-E/WP, 1 March 1985, subject: Hazardous Waste Study No. 37-26-0462-85, Phase 4 of AMC Open-Burning/Open-Detonation Grounds Evaluation, Investigation of Soil Contamination at the Open-Burning Grounds, Tooele Army Depot, Tooele, Utah, 27 July - 10 August 1984.

36. Letter, USAEHA, HSHB-ES-H/WP, 4 August 1983, subject: Phase 2, Hazardous Waste Management Special Study No. 39-26-0147-83, DARCOM Open-Burning/Open-Detonation Grounds Evaluation, Volunteer Army Ammunition Plant, Chatanooga, Tennessee, 22 February - 4 March 1982.

37. Letter, USAEHA, HSHB-ES-E/WP, 9 August 1984, subject: Hazardous Waste Study No. 37-26-0340-84, Investigation of Soil Contamination at the Open-Burning Grounds, Volunteer Army Ammunition Plant, Chattanooga, Tennessee, 4-9 November 1983.

APPENDIX B

ABBREVIATIONS AND DEFINITIONS

AAP	Army Ammunition Plant
AD	Army Depot
AEC	Atomic Energy Commission
AMC	US Army Materiel Command
AMCCOM	US Army Armament, Munitions and Chemical Command
CFR	Code of Federal Regulations
CWP	contaminated waste processor
DA	Depot Activity
deflagration	A rapid chemical reaction in which the output of heat is sufficient to enable the reaction to proceed and be accelerated without input of heat from another source. Deflagration is a surface phenomenon, with reaction products flowing away from unreacted material at subsonic velocity. The effect of a true deflagration under confinement is an explosion. Confinement of deflagration may cause transition to detonation.
detonation	A chemical reaction within a substance in which the transformation proceeds through the material faster than the speed of sound and produces a shock wave which is originally of supersonic velocity.
DESCOM	US Army Depot Systems Command
disposal	The discharge, deposit, injection, dumping, spilling, leaking or placing of any solid waste or hazardous waste into or on any land or water so that such solid or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground waters.
DNT	dinitrotoluene
DOD	Department of Defense
DOT	Department of Transportation
EPA	US Environmental Protection Agency
EP Toxicity	An extraction test to evaluate the leachability of eight different metals from a hazardous waste. These metals are arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), silver (Ag), and selenium (Se). Synonymous with TEP.
EWI	explosive waste incinerator
facility	All contiguous land and structures, other appurtenances, and improvements on the land used for treating, storing, or disposing of hazardous waste. For permitting purposes, a facility may consist of an entire installation or any part or combination of parts of that installation where treatment, storage, or disposal operations are located (see OB grounds, OB area, and OD area).
ground water	water below the surface in a zone of saturation
HMX	cyclotetramethylenetetranitramine

HPCL	High Pressure Liquid Chromatography
leachate	any liquid, included suspended components in the liquid, that has percolated through or drained from hazardous waste.
LC50	concentration of a contaminant which is lethal to 50 percent of the organisms used in the toxicity test.
MSL	mean sea level
ND	not detected
OB	open burning- the combustion of any material without the following characteristics: (1) Control of combustion air (2) Containment of combustion reaction in an enclosed device. (3) Control of gaseous combustion product emissions. This definition includes open detonation.
OB area	That area or portion of the facility where open burning operations are conducted. Synonymous with OB grounds
OB grounds	Synonymous with OB area
OD	open detonation- the detonation of any material without control of airborne emissions
OD area	That area or portion of the facility where open detonation operations are conducted
PCB	polychlorinated biphenyl
PEP	pyrotechnics, explosives, and propellants
RCRA	Resource Conservation and Recovery Act of 1976
reactivity	A characteristic of solid waste whereby the waste is: (1) Capable of detonation or explosion if subjected to a strong initiating source or if heated under confinement (2) Readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure
RDX	cyclotrimethylenetrinitramine
TECOM	US Army Test and Evaluation Command
TEP	Toxic Extraction Procedure. Synonymous with EP Toxicity
TNT	trinitrotoluene
treatment	Any method, technique, or process design to change the chemical, physical, or biological character or composition of any hazardous waste so as to recover energy or material resource from the waste, or to render such waste nonhazardous, or less hazardous, or safer to transport
TTCL	total threshold concentration limit
USAEHA	US Army Environmental Hygiene Agency
USATHAMA	US Army Toxic and Hazardous Materials Agency

APPENDIX C

ACKNOWLEDGEMENTS

The first four phases of this OB/OD project were performed under the direction of Mr. Edward L. Newell, JR. Mr. Newell completed the Phase 3 summary report which formed the basis for a significant portion of this Phase 5 document. Additionally, he completed numerous Phase 2 and Phase 4 field investigations. Other project officers performing studies in support of this report, as well as the investigations they performed, are listed below. Finally, Ms. Tracy Nelson completed the numerous tables and graphs contained in Appendices D through O and provided invaluable assistance in putting the finishing touches on this report.

Matthew W. Andrews, JR	Badger AAP Phase 2, Iowa AAP Phase 2
John W. Bauer	Ground-water OB/OD Report
Keith B. Hoddinott	Holston AAP Phase 4, Tooele AD Phase 4
CPT Richard L. Kussman, P.E.	Holston AAP Phase 2, Radford AAP Phase 2
Edward L. Newell, JR	Indiana AAP Phase 2 and Phase 4, Newport AAP Phase 2 and Phase 4 Radford AAP Phase 4, Seneca AD Phase 2, Volunteer AAP Phase 2
CPT Joseph A. Sandrin	Sierra AD Phase 2, Tooele AD Phase 2
CPT Joe R. Schroeder	Seneca AD Phase 4
CPT David A. Sheets	Badger AAP Phase 4, Sierra AD Phase 4, Volunteer AAP Phase 4
William P. Smithson	Lake City Phase 4
CPT Jeffery C. Springer	Iowa AAP Phase 4, Louisiana AAP Phase 4
Kenneth E. Wiggans	Louisiana AAP Phase 2

APPENDIX D

SUMMARY OF OB SOIL INVESTIGATIONS AT BADGER ARMY AMMUNITION PLANT BARABOO, WISCONSIN

1. ENVIRONMENTAL SETTING.

a. General Physiography and Stratigraphy.

(1) Regional. Badger AAP, located in Merrimac and Sumpter townships, Sauk County, Wisconsin, lies in the Eastern Lake section of the Central Lowland Physiographic Province. The eastern two-thirds of the installation were under the direct influence of glacial ice, giving rise to undulating topography, characterized by knob-and-kettle-type features. The glacial deposits in these areas are a combination of stratified outwash deposits and glacial till. The western third of the installation is a flat, gravel outwash plain which is underlain by stratified sand and gravel, containing minor silt and clay layers. The bedrock beneath Badger AAP is characterized by Precambrian metamorphic rock and Upper Cambrian to Ordovician sandstones, shales, and dolomites.

(2) Local. The subsoils beneath the OB ground consist of at least 240 feet of unconsolidated, stratified outwash sand and gravel. Windblown deposits of silts (loess) cover the sand and gravel and are from 2 to 10 feet thick. A thin veneer of an organic-enriched topsoil has developed on the loess. The topsoil consists of a black to brown clay silt, containing traces of fine to medium sand.

b. Ground Water. There are two major aquifers underlying Badger AAP. The upper sand and gravel, or outwash, aquifer and the underlying sandstone aquifer. The outwash aquifer exhibits water-table conditions throughout the area. The depth to ground water in this aquifer's below-ground surface ranges between 83 to 111 feet. The sandstone aquifer is also under watertable conditions throughout the majority of the plant area and is hydraulically connected to the upper outwash aquifer. In some areas, however, the aquifer is overlain by relatively impermeable glacial till and influenced by semiconfined conditions. Beneath the sandstone aquifer are impermeable Precambrian granites and quartzites which mark the lower limit of ground-water movement. Ground-water flow is primarily to the south with the Wisconsin River being the primary influence on the ground-water flow direction.

c. Precipitation and Evaporation. The mean annual precipitation in the Badger AAP area is approximately 31 inches. The mean annual lake evaporation in this vicinity is approximately 29 inches.

2. OVERVIEW OF BURNING GROUND AND CONTAMINATED WASTE AREA.

a. The burning ground was located in the southwest section of Badger AAP. It consisted of two pads, each 100 feet by 50 feet, and three shallow

refuse pits, each with a diameter of approximately 40 feet. See Figure D-1 for a map of the burning ground. The burning pads had been used for the open-burning of bulk propellants and smokeless powder. The refuse pits had been used for the open-burning of containers in which explosive materials were delivered and stored. Since the closure of the burning ground in 1983, the refuse pits had been lined with plastic, filled with propellants, covered with soil, and seeded.

b. The contaminated waste area was located approximately 500 feet northeast of the burning ground. As shown in Figure D-1, the waste area consisted of three large open pits 50 to 75 feet in diameter and 15 to 20 feet deep, and a large burn area.

3. BURNING GROUND SITE EVALUATIONS.

a. Phase 2 Sampling Methodologies and Locations. See Appendix A, reference 15, for a detailed discussion of this investigation. Phase 2 sampling was conducted on 26-28 April 1982. A total of 18 soil samples were collected from eight sites at burning pad number one, and 15 samples were collected at eight sites at burning pad number 2. Additionally, one sample was collected at each of the three refuse pits. Samples were composited for the following depths-0 to 6 inches, 6 to 18 inches, and 18 to 30 inches.

b. Phase 4 Sampling Methodologies and Locations. See Appendix A, reference 16, for a detailed discussion of this investigation. Phase 4 sampling was conducted on 8-15 May 1984.

(1) Twelve bore holes were drilled on the burning ground and contaminated waste area to a maximum depth of 50 feet. See Figure D-1 for the location of these boreholes. Eleven of the twelve borings were drilled in the burning ground area. Three of these were located directly on the two burn pads to determine vertical migration of explosives and metals. Another four bore holes were drilled within 100 ft east and west of the burning pads. The four remaining borings in the burning ground area were located in the vicinity of the three former refuse pits. Drilling into these pits was not permitted by the installation since they had been lined with plastic and filled with soil contaminated with propellants. Therefore, the bore holes were chosen at least 10 feet off the pits to avoid contact with the propellants or the liners. The last hole was drilled in the center of the contaminated waste area to detect contamination from previous burning.

(2) The sampling frequency used during this study was to take an initial sample from the surface to 2 feet and then additional samples at approximately 5, 10, 20, 30, 40, and 50 feet. As a result, a total of 57 samples were collected for use in the Phase 5 report. Fifty feet was chosen as the depth limit, based on a combination of the capabilities of the drill rig and extensive literature on the geology and ground water in the area. The type of samples consisted of 2-inch Shelby tubes and 1-quart glass jars.

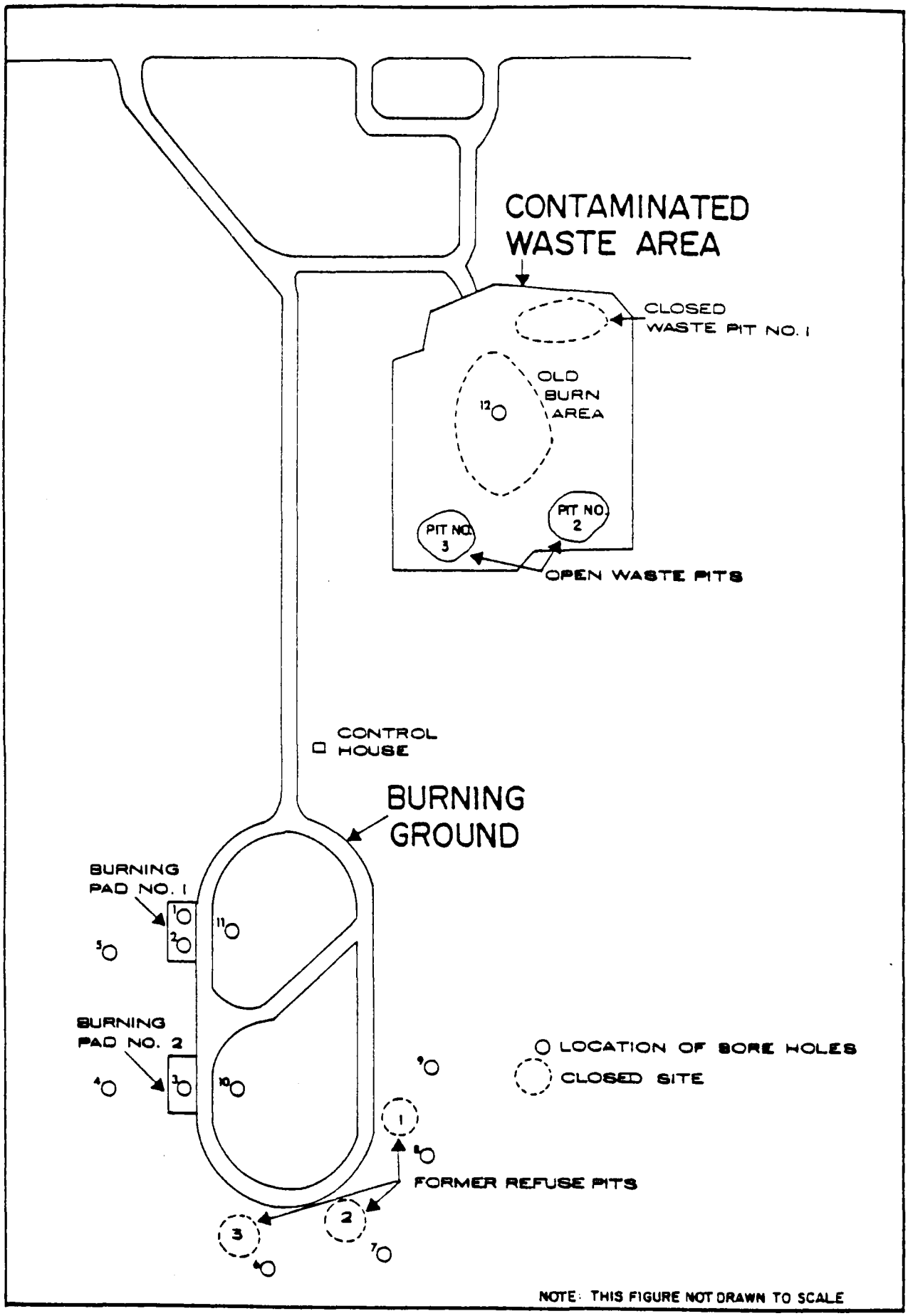


FIGURE D-1. CONTAMINATED WASTE AREA AND BURNING GROUND, BADGER AAP

The jar samples were collected from 2-inch and 3-inch split-spoon sampling devices. Both Shelby tubes and the split-spoon samplers provided undisturbed soil samples; therefore, virtually no cross contamination was possible. A few samples were also collected from auger cuttings. This was done only when the other methods were not feasible due to the rocky subsoil.

c. Analytical Results of Sampling Investigations. Analytical results are summarized in Tables D-1 through D-11, and Figures D-2 and D-3.

(1) Metals. Lead was the only metal detected above the TEP limit, and then only in the 0- to 6-inch samples. A total of 32 percent of these samples contained lead above the TEP limit. Lead was also the only metal detected below the TEP limit. This element was detected in one sample collected from the 6 to 18 inch level.

(2) Explosives. The only explosives found in concentrations greater than the 1,000 µg/g reactivity guideline were 2,6-DNT and 2,4-DNT. For both of these explosives, one 0- to 6-inch sample and two 6- to 18-inch samples exceeded the guideline. In addition, one 2,4-DNT sample in the 18 inch to 5-foot interval exceeded the guideline. These two compounds were also the explosives which were most often detected below the guideline. Overall, the frequency of detection for the explosives decreased from 84 percent in the 0- to 6-inch samples, to only 17 percent in the samples collected at the greatest depths. It should be noted that only trace levels were detected in samples collected from depths greater than 5 feet.

d. Site Operations. No observations of incorrect or abnormal site operations were made.

4. CONCLUSIONS.

a. As shown in Table D-11, 37 percent of soil samples collected from the top 6 inches and 7 percent of samples, both from the 6- to 18-inch interval and the 1-inch to 5-feet level, exceeded applicable limits or guidelines. No samples collected at lower depths exceeded any criteria. The frequency of detection of contaminants at levels less than their criteria approached zero as sampling depth increased.

b. Significant soils contamination at the site is limited to the top 18 inches of subsoil.

c. The primary contaminants were lead, 2,6-DNT, and 2,4-DNT.

TABLE D-1 INSTALLATION: BADGER AAP

CONTAMINANT: EACH METAL EXCEPT PB

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	19	100	0	0	100	0	0	19	100
6-18"	27	100	0	0	100	0	0	27	100
18"-5'	14	100	0	0	100	0	0	14	100
5-10'	10	100	0	0	100	0	0	10	100
10-20'	11	100	0	0	100	0	0	11	100
20'+	12	100	0	0	100	0	0	12	100

TABLE D-2 INSTALLATION: BADGER AAP

CONTAMINANT: PB

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	9	47	4	21	68	6	32	19	100
6-18"	26	96	1	4	100	0	0	27	100
18"-5'	14	100	0	0	100	0	0	14	100
5-10'	10	100	0	0	100	0	0	10	100
10-20'	11	100	0	0	100	0	0	11	100
20'+	12	100	0	0	100	0	0	12	100

TABLE D-3 INSTALLATION: BADGER AAP

CONTAMINANT: HMX

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	16	94	1	6	100	0	0	17	100
6-18"	25	93	2	7	100	0	0	27	100
18"-5'	14	100	0	0	100	0	0	14	100
5-10'	9	90	1	10	100	0	0	10	100
10-20'	9	82	2	18	100	0	0	11	100
20'+	11	92	1	8	100	0	0	12	100

TABLE D-4 INSTALLATION: BADGER AAP

CONTAMINANT: RDX

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	17	100	0	0	100	0	0	17	100
6-18"	26	96	1	4	100	0	0	27	100
18"-5'	13	93	1	7	100	0	0	14	100
5-10'	9	90	1	10	100	0	0	10	100
10-20'	11	100	0	0	100	0	0	11	100
20'+	12	100	0	0	100	0	0	12	100

TABLE D-5 INSTALLATION: BADGER AAP

CONTAMINANT: TETRYL

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	17	100	0	0	100	0	0	17	100
6-18"	27	100	0	0	100	0	0	27	100
18"-5'	14	100	0	0	100	0	0	14	100
5-10'	10	100	0	0	100	0	0	10	100
10-20'	11	100	0	0	100	0	0	11	100
20'+	12	100	0	0	100	0	0	12	100

TABLE D-6 INSTALLATION: BADGER AAP

CONTAMINANT: TNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	14	82	3	18	100	0	0	17	100
6-18"	26	96	1	4	100	0	0	27	100
18"-5'	13	93	1	7	100	0	0	14	100
5-10'	9	90	1	10	100	0	0	10	100
10-20'	9	82	2	18	100	0	0	11	100
20'+	12	100	0	0	100	0	0	12	100

TABLE D-7 INSTALLATION: BADGER AAP

CONTAMINANT: 2,6-DNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	8	47	8	47	94	1	6	17	100
6-18"	19	70	6	22	93	2	7	27	100
18"-5'	13	93	1	7	100	0	0	14	100
5-10'	10	100	0	0	100	0	0	10	100
10-20'	11	100	0	0	100	0	0	11	100
20'+	12	100	0	0	100	0	0	12	100

TABLE D-8 INSTALLATION: BADGER AAP

CONTAMINANT: 2,4-DNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	3	18	13	76	94	1	6	17	100
6-18"	9	33	16	59	93	2	7	27	100
18"-5'	8	57	5	36	93	1	7	14	100
5-10'	8	80	2	20	100	0	0	10	100
10-20'	7	64	4	36	100	0	0	11	100
20'+	11	92	1	8	100	0	0	12	100

TABLE D-9 INSTALLATION: BADGER AAP

CONTAMINANT: SUM OF EXPLOSIVES DATA

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	75	74	25	25	98	2	2	102	100
6-18"	132	81	26	16	98	4	2	162	100
18"-5'	75	89	8	10	99	1	1	84	100
5-10'	55	92	5	8	100	0	0	60	100
10-20'	58	88	8	12	100	0	0	66	100
20'+	70	97	2	3	100	0	0	72	100

TABLE D-10 INSTALLATION: BADGER AAP

CONTAMINANT: SUM OF METALS DATA

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	142	93	4	3	96	6	4	152	100
6-18"	215	100	1	0	100	0	0	216	100
18"-5'	112	100	0	0	100	0	0	112	100
5-10'	80	100	0	0	100	0	0	80	100
10-20'	88	100	0	0	100	0	0	88	100
20'+	96	100	0	0	100	0	0	96	100

TABLE D-11 INSTALLATION: BADGER AAP

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	> TEP LIMIT OR GUIDELINE #	> TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	3	16	9	47	63	7	37	19	100
6-18"	7	26	18	67	93	2	7	27	100
18"-5'	7	50	6	43	93	1	7	14	100
5-10'	7	70	3	30	100	0	0	10	100
10-20'	6	55	5	45	100	0	0	11	100
20'+	10	83	2	17	100	0	0	12	100

Figure D-2.

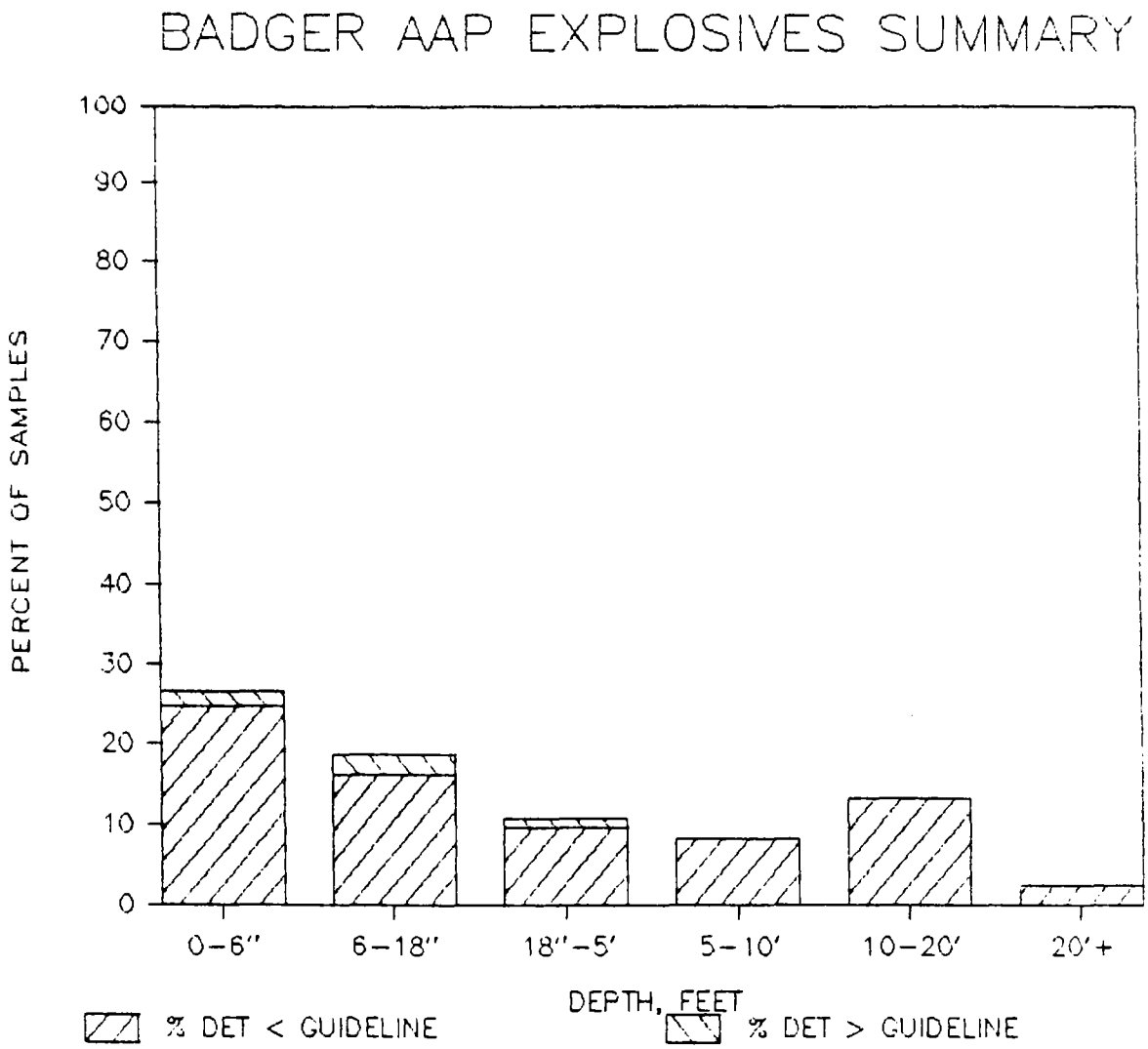
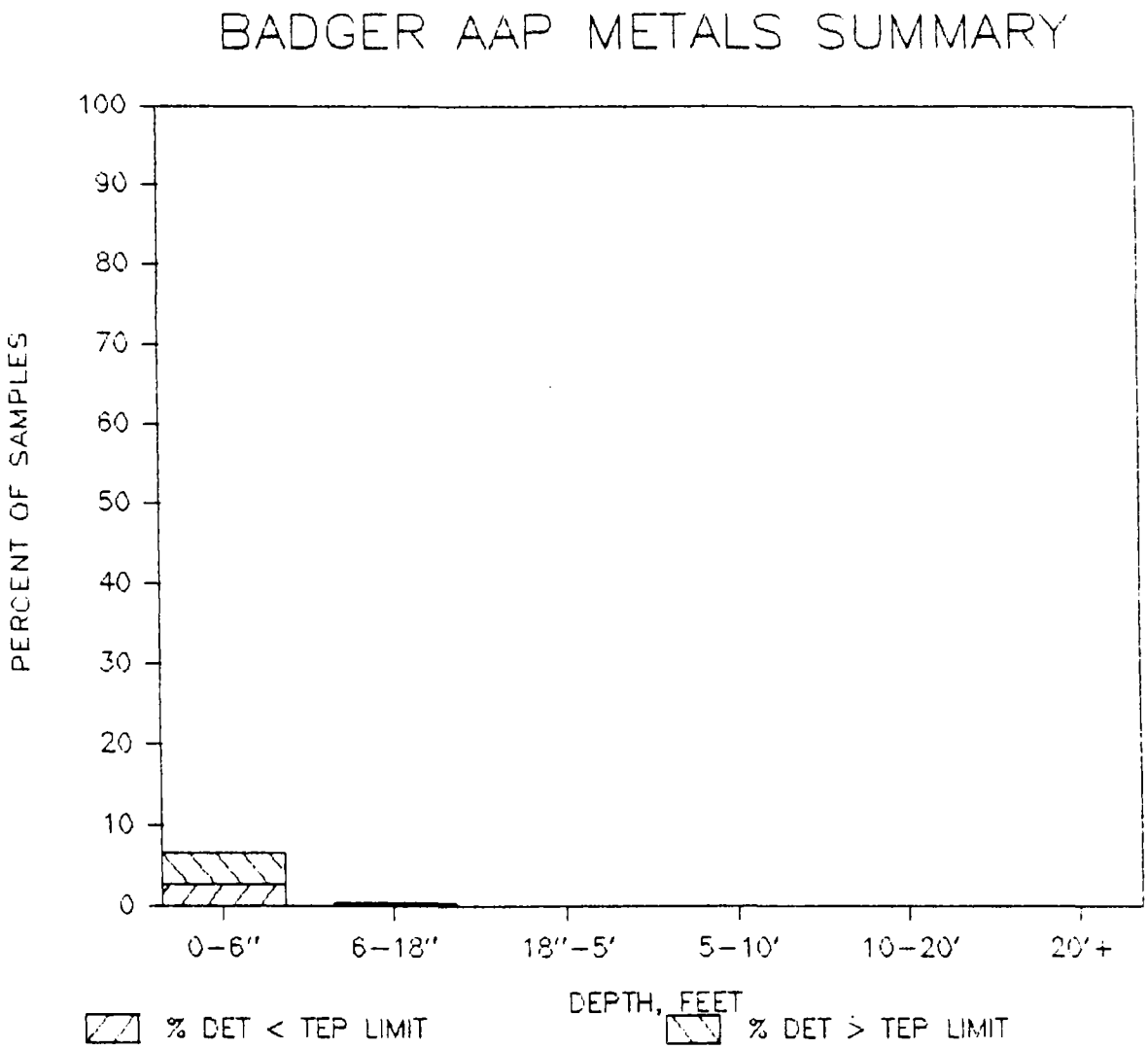

BADGER AAP EXPLOSIVES SUMMARY
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
20'+
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure D-3.


BADGER AAP METALS SUMMARY
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
20'+
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

APPENDIX E

SUMMARY OF OB SOIL INVESTIGATIONS AT HOLSTON ARMY AMMUNITION PLANT KINGSPORT, TENNESSEE

1. ENVIRONMENTAL SETTING.

a. General Physiography and Stratigraphy.

(1) Regional. Holston AAP lies totally within the Tennessee section of the Valley and Ridge Physiographic Province. The topography is controlled by major structural trends which is evident by the northwest to southeast strike of the valleys and ridges. The installation is primarily located on the Holston River flood plain. Area A lies in the flat flood-plain of the South Fork of the Holston River. This river flows diagonally across Area B, with the production plant occupying a point bar on the north side of the Holston River meander.

(2) Local. The OB area is located in Area B directly adjacent to the Holston River. Soils found in this location are alluvial in nature, and range in texture from fine sandy loams to silt loams with scattered lenses of clay loam.

b. Ground Water. Ground-water flow beneath Area B is south-southeast with its discharge point into the Holston River. Ground water is unconfined and found specific to the fluvial sands and gravels at a depth of 8- to 15-feet below the surface.

c. Precipitation and Evaporation. The mean annual precipitation in the Holston AAP area is approximately 44 inches. The mean annual lake evaporation in this area is approximately 32 inches.

2. OVERVIEW OF THE OPEN BURNING AREA. Open-burning of bulk waste munitions and other waste believed to be contaminated by explosive compounds at Holston AAP occurred on a 10-acre facility located at the south side of Area B, directly adjacent to the Holston River. Located in the 100-year flood plain, this site consists of two burn cages, two contaminated waste burning pads, and three bulk explosive burning pans.

3. BURNING GROUND SITE EVALUATIONS.

a. Phase 2 Sampling Methodologies and Locations. See Appendix A, reference 17, for a detailed discussion of this investigation. Phase 2 sampling was conducted on 16 and 17 June 1983. A total of 20 soil samples were collected from 13 locations at three active sites identified as Fields 2, 3, and 4. Samples were composited for depths of from 0- to 6-inches, and 6- to 18-inches.

b. Phase 4 Sampling Methodologies and Locations. See Appendix A, reference 18, for a detailed discussion of this investigation. Phase 4 sampling was conducted during the period 5-16 November 1984. Seventy-five

soil samples were collected from 25 boreholes drilled within the OB area. The borings were made using 4-inch-outside-diameter, hollow-stem auger to depths which ranged from 6 to 12 feet. Samples were collected at the surface and at 5-foot intervals using a split spoon sampling device.

c. Analytical Results of Sampling Investigations. Analytical results are summarized in Tables E-1 through E-9, and Figures E-1 and E-2.

(1) Metals. No TEP metals were detected in any samples.

(2) Explosives. The only explosives found in concentrations greater than the 1,000 µg/g reactivity guideline were RDX and HMX. A total of 29 percent of RDX 0- to 6-inch samples exceeded the guideline, while 21 percent of HMX samples from this interval exceeded this concentration. Additionally, one 18-inch to 5-foot sample contained concentrations of both of these explosives above the guideline. Buried open-burning residue was found in this latter sample, suggesting that the contamination found here was representative of surface samples rather than samples collected of undisturbed subsoils. RDX and HMX were also the explosives which were most often detected below the guideline, with TNT and 2,6 DNT detected at lower frequencies. Overall, the frequency of detection for the sum of explosives decreased from 42 percent in the 0- to 6-inch samples, to 16 percent in the 6- to 18-inch samples, to 0 percent in samples collected from 10 to 20 feet below the surface. Detailed analyses of individual borings indicated that some migration of the explosives was occurring in a vertical direction until the contaminants reach a saturated zone. Horizontal migration at the water table at one location was observed. This scenario suggests that migration of explosives in ground water to the Holston River is possible.

d. Site Operations. It has been suggested that at least a portion of the contamination at the OB area could be due to spillage in connection with the handling of the waste bulk explosive compounds and runoff of the unburnt compounds from the burn areas.

4. CONCLUSIONS.

a. As shown in Table E-9, 36 percent of samples collected from the top 6 inches of soil exceeded the applicable guideline, as did one sample from the 6- to 18-inch horizon. All samples from this level contained detectable concentrations of contaminants. As discussed above, the only sample collected at a lower depth which contained contaminants in excess of guidelines or TEP limits would more appropriately be considered as a surface soil. The frequency of detection of contaminants at levels less than their criteria reached zero as sampling depth increased.

b. Results obtained from some locations suggest trace levels of explosives were migrating vertically down to saturated zones, from which point horizontal migration with the ground water is predicted.

c. The primary contaminants were RDX and HMX.

TABLE E-1 INSTALLATION: HOLSTON AAP

CONTAMINANT: EACH METAL

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	14	100	0	0	100	0	0	14	100
6-18"	31	100	0	0	100	0	0	31	100
18"-5'	26	100	0	0	100	0	0	26	100
5-10'	22	100	0	0	100	0	0	22	100
10-20'	2	100	0	0	100	0	0	2	100

TABLE E-2 INSTALLATION: HOLSTON AAP

CONTAMINANT: TETRYL, 2,4-DNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	14	100	0	0	100	0	0	14	100
6-18"	31	100	0	0	100	0	0	31	100
18"-5'	26	100	0	0	100	0	0	26	100
5-10'	22	100	0	0	100	0	0	22	100
10-20'	2	100	0	0	100	0	0	2	100

TABLE E-3 INSTALLATION: HOLSTON AAP

CONTAMINANT: HMX

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	0	0	11	79	79	3	21	14	100
6-18"	17	55	14	45	100	0	0	31	100
18"-5'	22	85	3	12	96	1	4	26	100
5-10'	21	95	1	5	100	0	0	22	100
10-20'	2	100	0	0	100	0	0	2	100

TABLE E-4 INSTALLATION: HOLSTON AAP

CONTAMINANT: RDX

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	0	0	10	71	71	4	29	14	100
6-18"	19	61	12	39	100	0	0	31	100
18"-5'	21	81	4	15	96	1	4	26	100
5-10'	20	91	2	9	100	0	0	22	100
10-20'	2	100	0	0	100	0	0	2	100

TABLE E-5 INSTALLATION: HOLSTON AAP

CONTAMINANT: TNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	11	79	3	21	100	0	0	14	100
6-18"	27	87	4	13	100	0	0	31	100
18"-5'	24	92	2	8	100	0	0	26	100
5-10'	20	91	2	9	100	0	0	22	100
10-20'	2	100	0	0	100	0	0	2	100

TABLE E-6 INSTALLATION: HOLSTON AAP

CONTAMINANT: 2,6-DNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	10	71	4	29	100	0	0	14	100
6-18"	31	100	0	0	100	0	0	31	100
18"-5'	26	100	0	0	100	0	0	26	100
5-10'	21	95	1	5	100	0	0	22	100
10-20'	2	100	0	0	100	0	0	2	100

TABLE E-7 INSTALLATION: HOLSTON AAP

CONTAMINANT: SUM OF EXPLOSIVES DATA

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	49	58	28	33	92	7	8	84	100
6-18"	156	84	30	16	100	0	0	186	100
18"-5'	145	93	9	6	99	2	1	156	100
5-10'	126	95	6	5	100	0	0	132	100
10-20'	12	100	0	0	100	0	0	12	100

TABLE E-8 INSTALLATION: HOLSTON AAP

CONTAMINANT: SUM OF METALS DATA

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	112	100	0	0	100	0	0	112	100
6-18"	248	100	0	0	100	0	0	248	100
18"-5'	208	100	0	0	100	0	0	208	100
5-10'	176	100	0	0	100	0	0	176	100
10-20'	16	100	0	0	100	0	0	16	100

TABLE E-9 INSTALLATION: HOLSTON AAP

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	0	0	9	64	64	5	36	14	100
6-18"	16	52	14	45	97	1	3	31	100
18"-5'	19	73	6	23	96	1	4	26	100
5-10'	18	82	4	18	100	0	0	22	100
10-20'	2	100	0	0	100	0	0	2	100

Figure E-1.

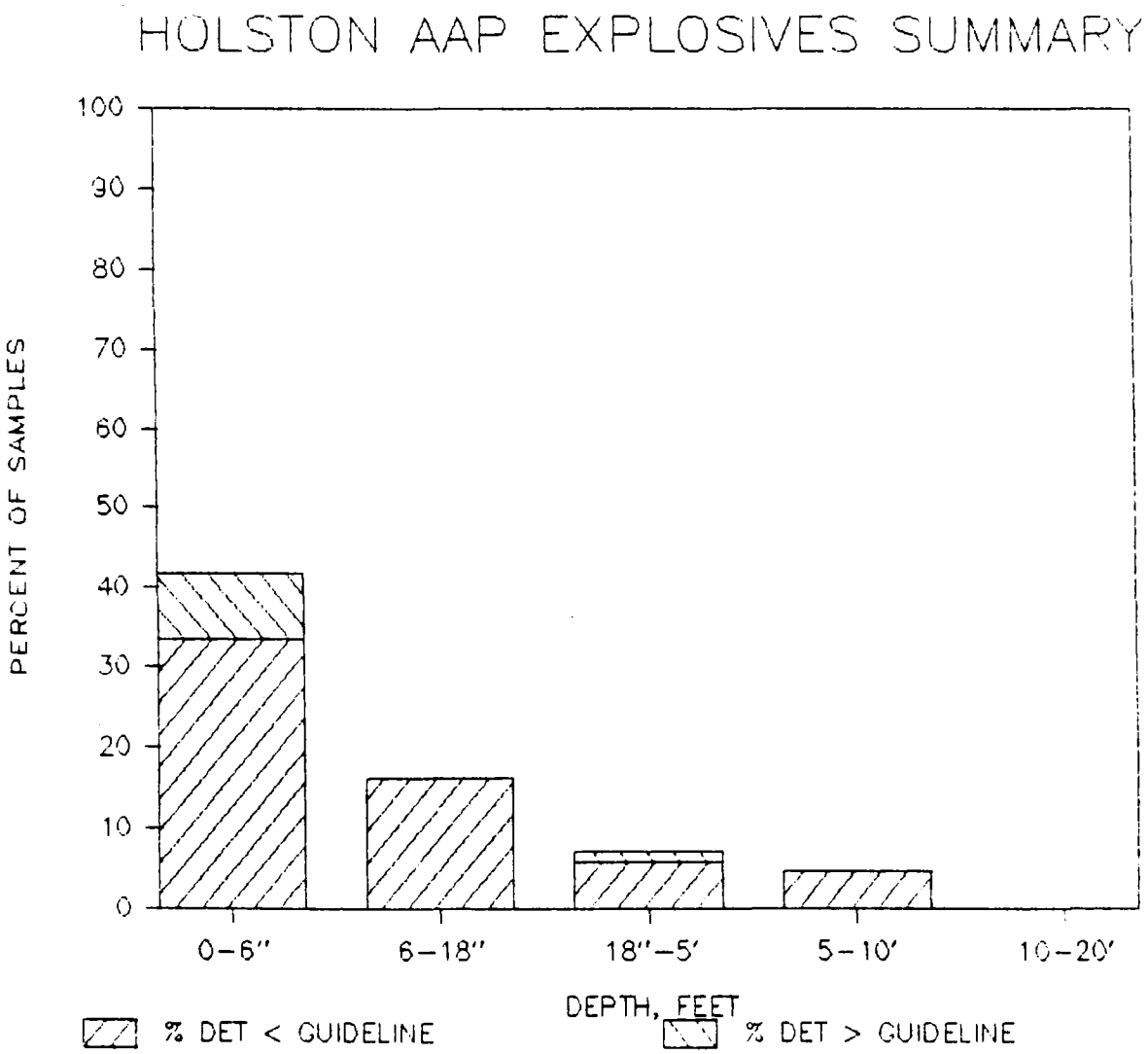
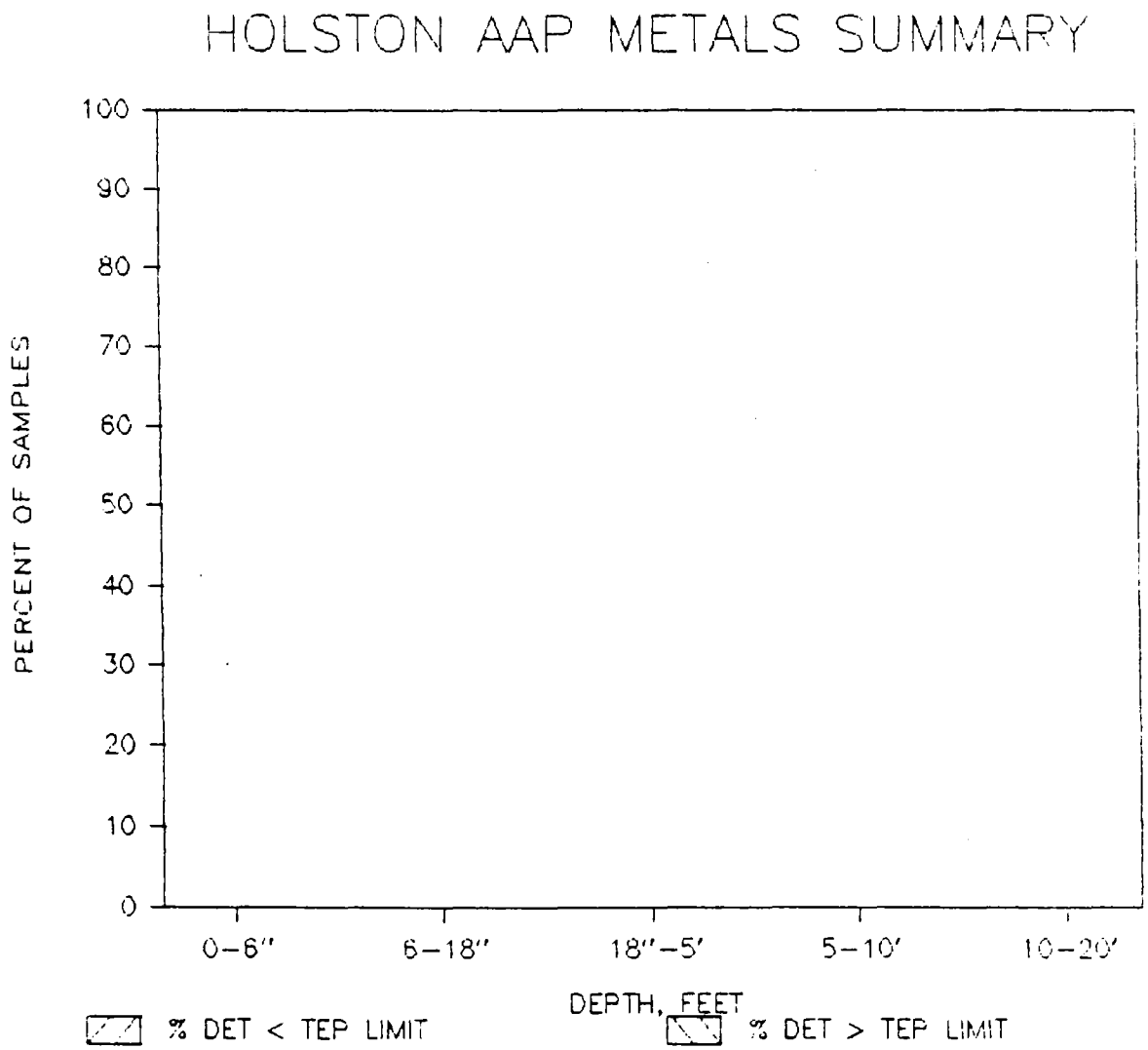

HOLSTON AAP EXPLOSIVES SUMMARY
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure E-2.


HOLSTON AAP METALS SUMMARY
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0–6"
6–18"
18"–5'
5–10'
10–20'
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

APPENDIX F

SUMMARY OF OB SOIL INVESTIGATIONS AT INDIANA ARMY AMMUNITION PLANT CHARLESTOWN, INDIANA

1. ENVIRONMENTAL SETTING.

a. General Physiography and Stratigraphy.

(1) Regional. Indiana AAP is located along the Ohio River in the Muscatuck Regional Slope unit of the Interior Lowlands physiographic province. The installation lies on the west flank of the Cincinnati Arch with the Illinois Basin to the southwest. Limestones and shales of the Paleozoic Era underlie the installation. Sinkholes, springs, and solution channels are commonly encountered. These stones are in turn covered by a thin layer of Illinoian glacial till. A narrow floodplain terrace exists along the Ohio River where deposits of unconsolidated material from the glacial and recent periods overlie the carbonate rock.

(2) Local. The OB grounds are situated on a limestone bluff about 200-feet above the Ohio River. The topography of the bluff is relatively level to slightly rolling, with surface waters generally flowing southward. Soils at the site are primarily silty clays, with silty sands and "fat" clays also present in minor amounts. The soil mantle averages 5 feet in thickness beneath the powder burn area. Soils exhibited a low permeability, resulting in runoff being more significant than infiltration during precipitation events.

b. Ground Water. Ground water is not usually found in the soil mantle above the bedrock, unless the soil contacts a saturated rock fracture. Ground water is found in the bedrock at about 100-200 feet in depth.

c. Precipitation and Evaporation. The mean annual precipitation in the vicinity of Indiana AAP is approximately 43 inches. The mean annual lake evaporation in this area is approximately 35 inches.

2. OVERVIEW OF THE OPEN BURNING AREA. There are two active OB areas at Indiana AAP located along the east-central border of the installation. The powder burn area burns bulk powder and igniter mix. As shown in Figure F-1, this site contains two active burn areas. The flashing area is used to burn out large explosives-contaminated pipes and metal containers to an explosive-free condition for salvage. Since samples from the flashing area were not collected during both site investigations, only analytical results from the powder burn area are discussed below.

3. BURNING GROUND SITE EVALUATIONS.

a. Phase 2 Sampling Methodologies and Locations. See Appendix A, reference 19, for a detailed discussion of this investigation. Phase 2 sampling was conducted in February 1982. A total of 23 sample were

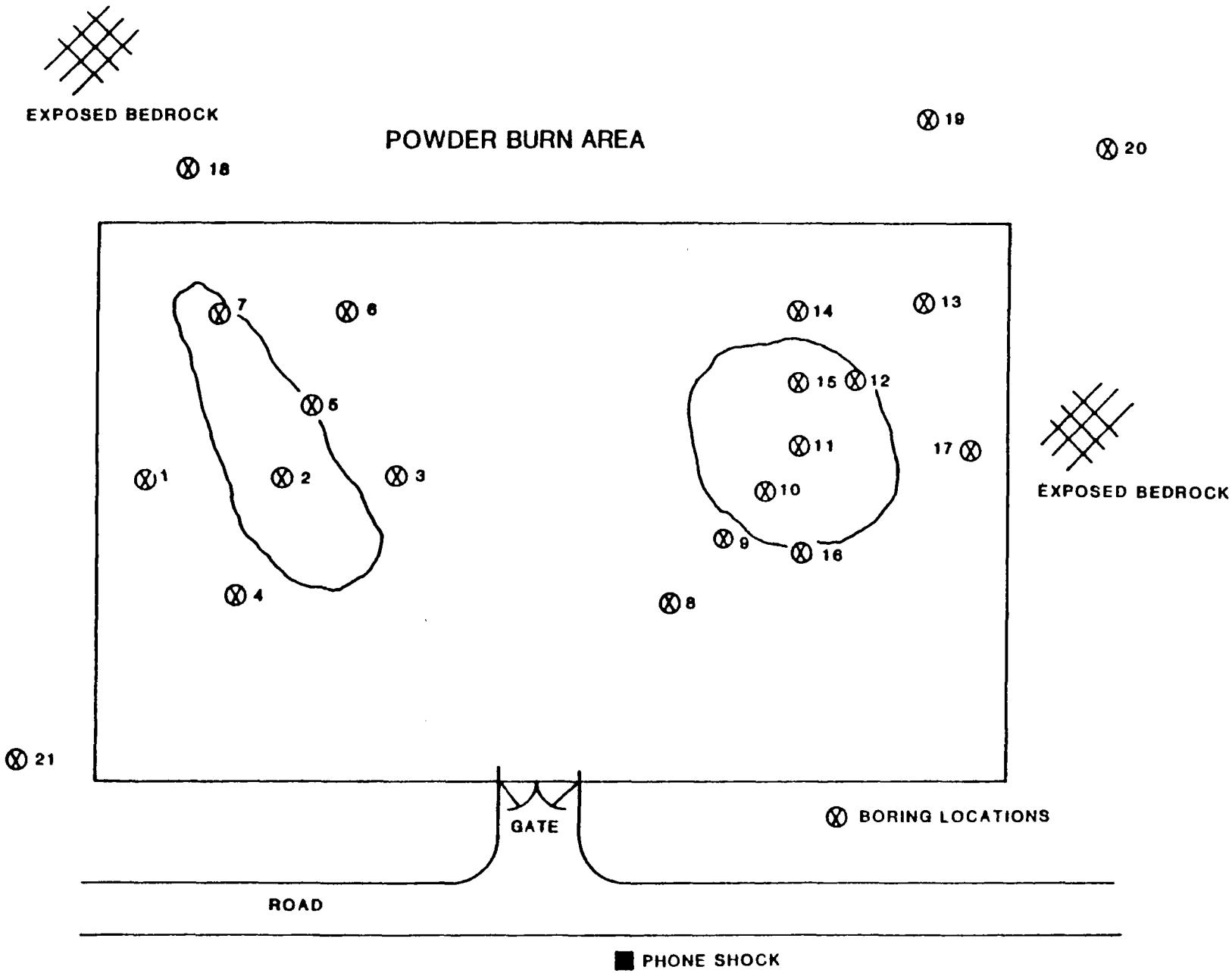


FIGURE F-1 INDIANA AAP OPEN BURNING GROUND POWDER BURN AREA

collected from 13 locations at the powder burn area. Samples were composited for depths of from 0 to 6 inches, and 6 to 18 inches.

b. Phase 4 Sampling Methodologies and Locations. See Appendix A, reference 20, for a detailed discussion of this investigation. Phase 4 sampling was conducted during the period 27 September to 3 October 1983. Subsurface borings were performed at 21 locations in the vicinity of the powder burn area. Nine of these borings were within or very near the active burn areas. A total of 25 samples were collected from these borings. The remaining 12 borings (21 samples) were situated away from the burn areas. The majority of these samples were collected at depths of less than 5 feet.

c. Analytical Results of Sampling Investigations. Analytical results are summarized in Tables F-1 through F-20, and Figures F-2 through F-5.

(1) Metals. Lead was the only metal detected in any sample. In samples collected within the site, all samples from the 0- to 6-inch horizon exceeded the TEP limit for lead, 59 percent of samples from the 6- to 18-inch level exceeded this limit, as did 9 percent (one sample) from the 18-inch to 5-feet level. Lead was not detected in 82 percent of the samples collected from this latter level; lead was not detected in any samples collected at greater depths. In samples collected away from the present burning site, none exceeded the TEP limit. However it should be noted 18 percent of samples from the 6- to 18-inch horizon contained detectable quantities of lead; lead was not detected in any samples collected at greater depths. Since this pattern roughly parallels that found in samples within the present OB site, it is possible that this contamination is due to previous burning activities at these locations rather than being due to migration of contaminants. The high lead levels were attributable to the past practice of burning polyester powder bags containing thin lead liners.

(2) Explosives. No explosives were found in concentrations exceeding the 1,000 µg/g reactivity guideline. Explosives most often detected were 2,4-DNT and 2,6-DNT. Although these compounds were found in most of the samples collected at depths less than 18 inches within or near the OB site, concentrations detected in the vast majority of these samples did not exceed 10 µg/g. A small percentage of samples collected within the OB area from the 0- to 6-inch horizon also contained detectable quantities of TNT and RDX. The percent of samples in which explosives were not detected increased to 100 with depth. It should be noted that of samples collected away from the OB site, 2,4-DNT was detected in 55 percent of the samples from the 6- to 18-inch level. As discussed in the previous paragraph, this contamination is probably due to past boring activities at these sites rather than migration of contaminants.

d. Site Operations. The high lead levels found near the surface were attributable to burning lead-lined powder bags. However, this practice has ceased.

4. CONCLUSIONS.

a. For samples collected within or near the OB site (see Table F-19), 100 percent of samples collected from the top 6 inches contained contaminants which exceeded applicable limits or guidelines, as did 59 percent of samples from the 6- to 18-inch horizon. Only one sample from the 18-inch to 5-feet level exceeded these limits or guidelines. Lead, the only parameter exceeding a limit/guideline, was attributable to a practice which has since been eliminated.

b. No samples collected away from the OB site contained contaminants which exceeded applicable limits or guidelines. The contaminants detecting less than the limits/guidelines were most probably attributable to past OB activities rather than horizontal migration of contaminants.

c. Contamination is basically confined to the upper 2 feet of soil, with little, if any, horizontal migration.

d. The primary contaminant was lead.

TABLE F-1 INSTALLATION: INDIANA AAP

CONTAMINANT: EACH METAL EXCEPT PB SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	10	100	0	0	100	0	0	10	100
6-18"	22	100	0	0	100	0	0	22	100
18"-5'	11	100	0	0	100	0	0	11	100
5-10'	3	100	0	0	100	0	0	3	100
10-20'	2	100	0	0	100	0	0	2	100

TABLE F-2 INSTALLATION: INDIANA AAP

CONTAMINANT: EACH METAL EXCEPT PB SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	11	100	0	0	100	0	0	11	100
18"-5'	8	100	0	0	100	0	0	8	100
5-10'	2	100	0	0	100	0	0	2	100
10-20'	--	--	--	--	--	--	--	0	--

TABLE F-3 INSTALLATION: INDIANA AAP

CONTAMINANT: PB SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	0	0	0	0	0	10	100	10	100
6-18"	2	9	7	32	41	13	59	22	100
18"-5'	9	82	1	9	91	1	9	11	100
5-10'	3	100	0	0	100	0	0	3	100
10-20'	2	100	0	0	100	0	0	2	100

TABLE F-4 INSTALLATION: INDIANA AAP

CONTAMINANT: PB SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	9	82	2	18	100	0	0	11	100
18"-5'	8	100	0	0	100	0	0	8	100
5-10'	2	100	0	0	100	0	0	2	100
10-20'	--	--	--	--	--	--	--	0	--

TABLE F-5 INSTALLATION: INDIANA AAP

CONTAMINANT: RDX SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	9	90	1	10	100	0	0	10	100
6-18"	22	100	0	0	100	0	0	22	100
18"-5'	11	100	0	0	100	0	0	11	100
5-10'	3	100	0	0	100	0	0	3	100
10-20'	2	100	0	0	100	0	0	2	100

TABLE F-6 INSTALLATION: INDIANA AAP

CONTAMINANT: RDX SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	11	100	0	0	100	0	0	11	100
18"-5'	8	100	0	0	100	0	0	8	100
5-10'	2	100	0	0	100	0	0	2	100
10-20'	--	--	--	--	--	--	--	0	--

TABLE F-7 INSTALLATION: INDIANA AAP

CONTAMINANT: TNT SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	8	80	2	20	100	0	0	10	100
6-18"	22	100	0	0	100	0	0	22	100
18"-5'	11	100	0	0	100	0	0	11	100
5-10'	3	100	0	0	100	0	0	3	100
10-20'	2	100	0	0	100	0	0	2	100

TABLE F-8 INSTALLATION: INDIANA AAP

CONTAMINANT: TNT SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	11	100	0	0	100	0	0	11	100
18"-5'	8	100	0	0	100	0	0	8	100
5-10'	2	100	0	0	100	0	0	2	100
10-20'	--	--	--	--	--	--	--	0	--

TABLE F-9 INSTALLATION: INDIANA AAP

CONTAMINANT: 2,6-DNT SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	8	80	2	20	100	0	0	10	100
6-18"	13	59	9	41	100	0	0	22	100
18"-5'	8	73	3	27	100	0	0	11	100
5-10'	3	100	0	0	100	0	0	3	100
10-20'	2	100	0	0	100	0	0	2	100

TABLE F-10 INSTALLATION: INDIANA AAP

CONTAMINANT: 2,6-DNT SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	11	100	0	0	100	0	0	11	100
18"-5'	8	100	0	0	100	0	0	8	100
5-10'	2	100	0	0	100	0	0	2	100
10-20'	--	--	--	--	--	--	--	0	--

TABLE F-11 INSTALLATION: INDIANA AAP

CONTAMINANT: 2,4-DNT SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	2	20	8	80	100	0	0	10	100
6-18"	4	18	18	82	100	0	0	22	100
18"-5'	7	64	4	36	100	0	0	11	100
5-10'	3	100	0	0	100	0	0	3	100
10-20'	2	100	0	0	100	0	0	2	100

TABLE F-12 INSTALLATION: INDIANA AAP

CONTAMINANT: 2,4-DNT SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	5	45	6	55	100	0	0	11	100
18"-5'	8	100	0	0	100	0	0	8	100
5-10'	1	50	1	50	100	0	0	2	100
10-20'	--	--	--	--	--	--	--	0	--

TABLE F-13 INSTALLATION: INDIANA AAP

CONTAMINANT: TETRYL AND HMX SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	10	100	0	0	100	0	0	10	100
6-18"	22	100	0	0	100	0	0	22	100
18"-5'	11	100	0	0	100	0	0	11	100
5-10'	3	100	0	0	100	0	0	3	100
10-20'	2	100	0	0	100	0	0	2	100

TABLE F-14 INSTALLATION: INDIANA AAP

CONTAMINANT: TETRYL AND HMX SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	11	100	0	0	100	0	0	11	100
18"-5'	8	100	0	0	100	0	0	8	100
5-10'	2	100	0	0	100	0	0	2	100
10-20'	--	--	--	--	--	--	--	0	--

TABLE F-15 INSTALLATION: INDIANA AAP

CONTAMINANT: SUM OF EXPLOSIVES DATA SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	47	78	13	22	100	0	0	60	100
6-18"	105	80	27	20	100	0	0	132	100
18"-5'	59	89	7	11	100	0	0	66	100
5-10'	18	100	0	0	100	0	0	18	100
10-20'	12	100	0	0	100	0	0	12	100

TABLE F-16 INSTALLATION: INDIANA AAP

CONTAMINANT: SUM OF EXPLOSIVES DATA SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	60	91	6	9	100	0	0	66	100
18"-5'	48	100	0	0	100	0	0	48	100
5-10'	11	92	1	8	100	0	0	12	100
10-20'	--	--	--	--	--	--	--	0	--

TABLE F-17 INSTALLATION: INDIANA AAP

CONTAMINANT: SUM OF METALS DATA SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	70	88	0	0	88	10	13	80	100
6-18"	156	89	7	4	93	13	7	176	100
18"-5'	86	98	1	1	99	1	1	88	100
5-10'	24	100	0	0	100	0	0	24	100
10-20'	16	100	0	0	100	0	0	16	100

TABLE F-18 INSTALLATION: INDIANA AAP

CONTAMINANT: SUM OF METALS DATA SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	86	98	2	2	100	0	0	88	100
18"-5'	64	100	0	0	100	0	0	64	100
5-10'	16	100	0	0	100	0	0	16	100
10-20'	--	--	--	--	--	--	--	0	--

TABLE F-19 INSTALLATION: INDIANA AAP

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	> TEP LIMIT OR GUIDELINE #	> TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	0	0	0	0	0	10	100	10	100
6-18"	0	0	9	41	41	13	59	22	100
18"-5'	7	64	3	27	91	1	9	11	100
5-10'	3	100	0	0	100	0	0	3	100
10-20'	2	100	0	0	100	0	0	2	100

TABLE F-20 INSTALLATION: INDIANA AAP

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	> TEP LIMIT OR GUIDELINE #	> TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	5	45	6	55	100	0	0	11	100
18"-5'	7	88	1	13	100	0	0	8	100
5-10'	2	100	0	0	100	0	0	2	100
10-20'	--	--	--	--	--	--	--	0	--

Figure F-2.

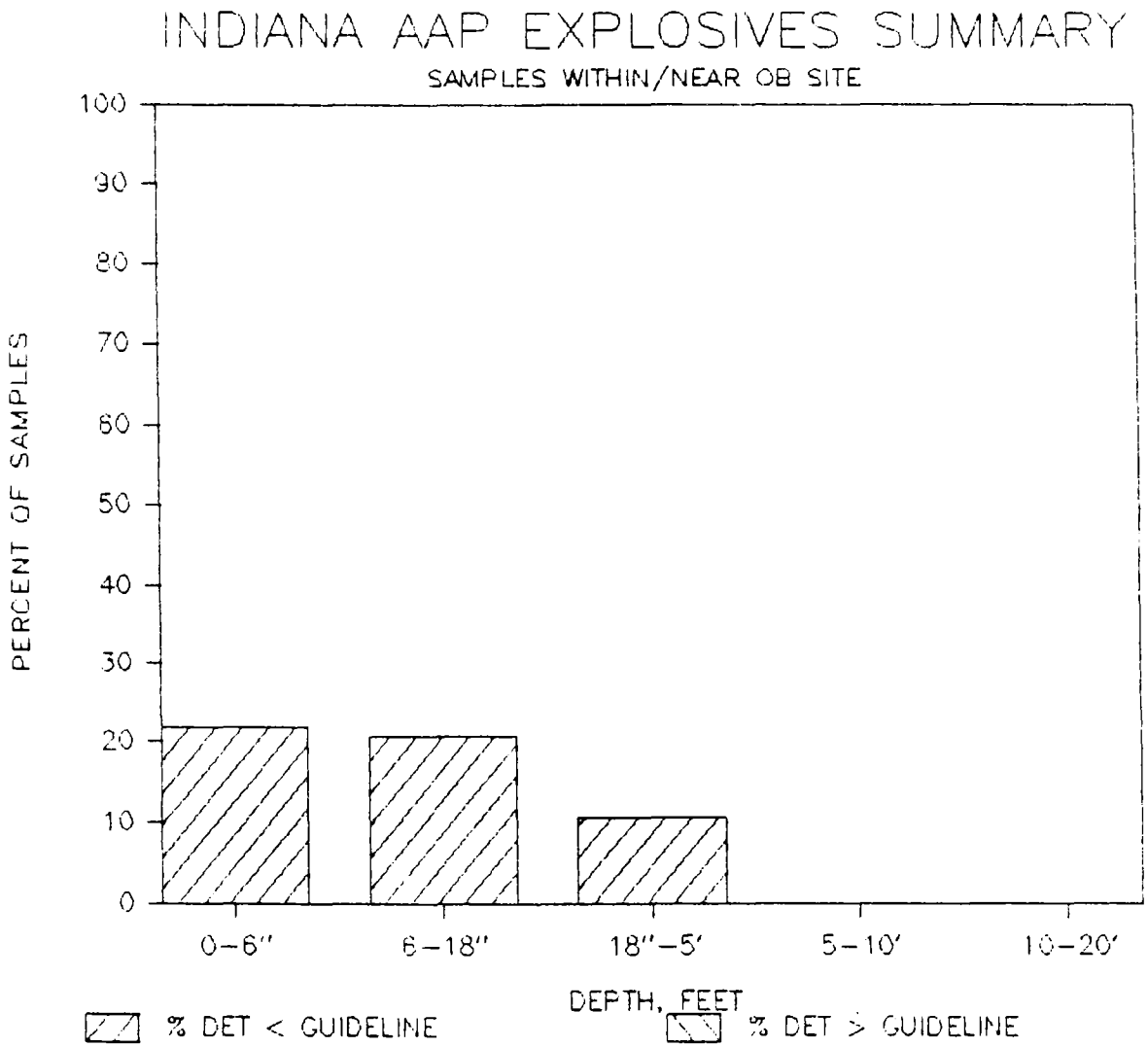

INDIANA AAP EXPLOSIVES SUMMARY
SAMPLES WITHIN/NEAR OB SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0–6"
6–18"
18"–5'
5–10'
10–20'
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure F-3.

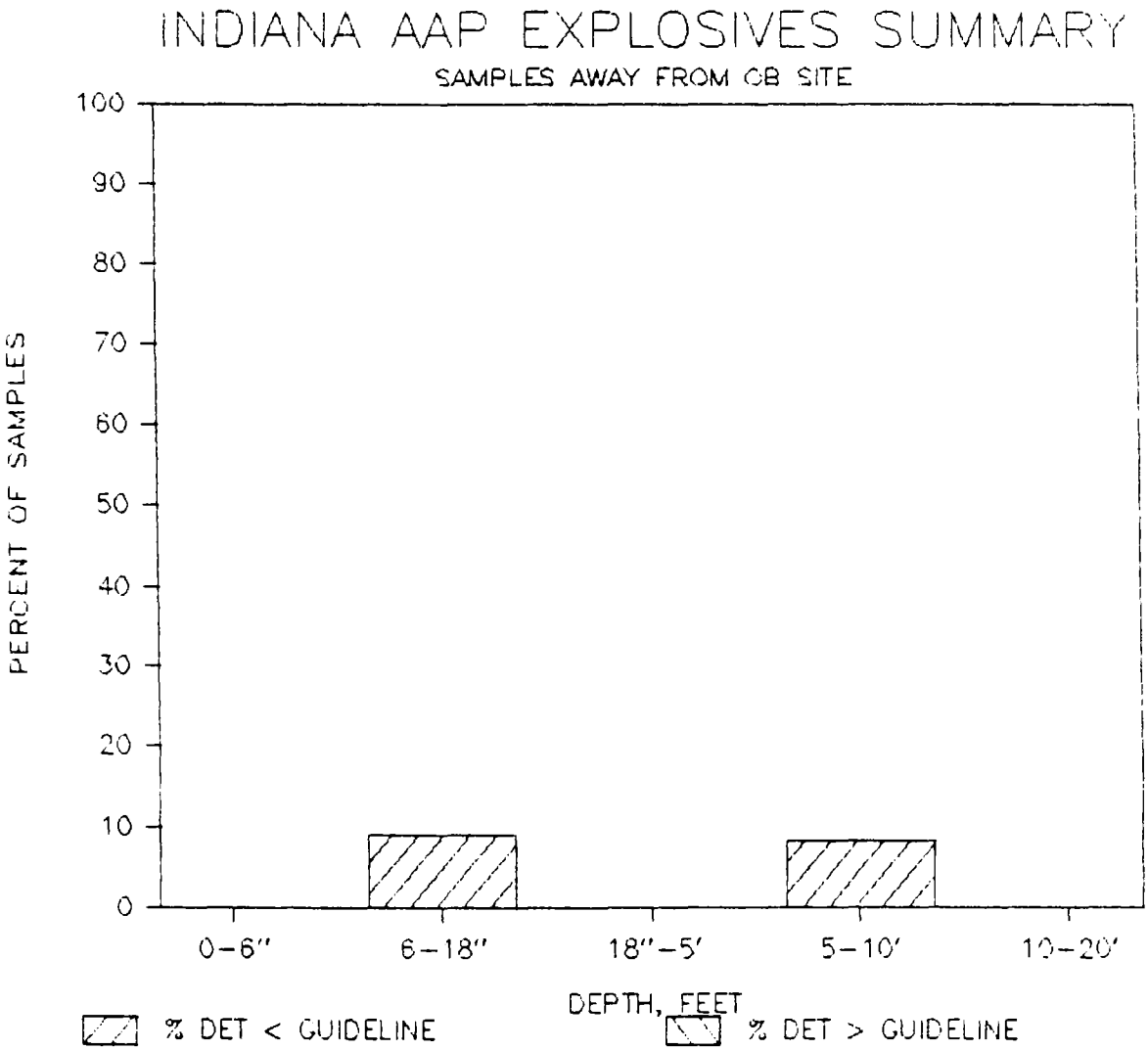

INDIANA AAP EXPLOSIVES SUMMARY
SAMPLES AWAY FROM OB SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure F-4.

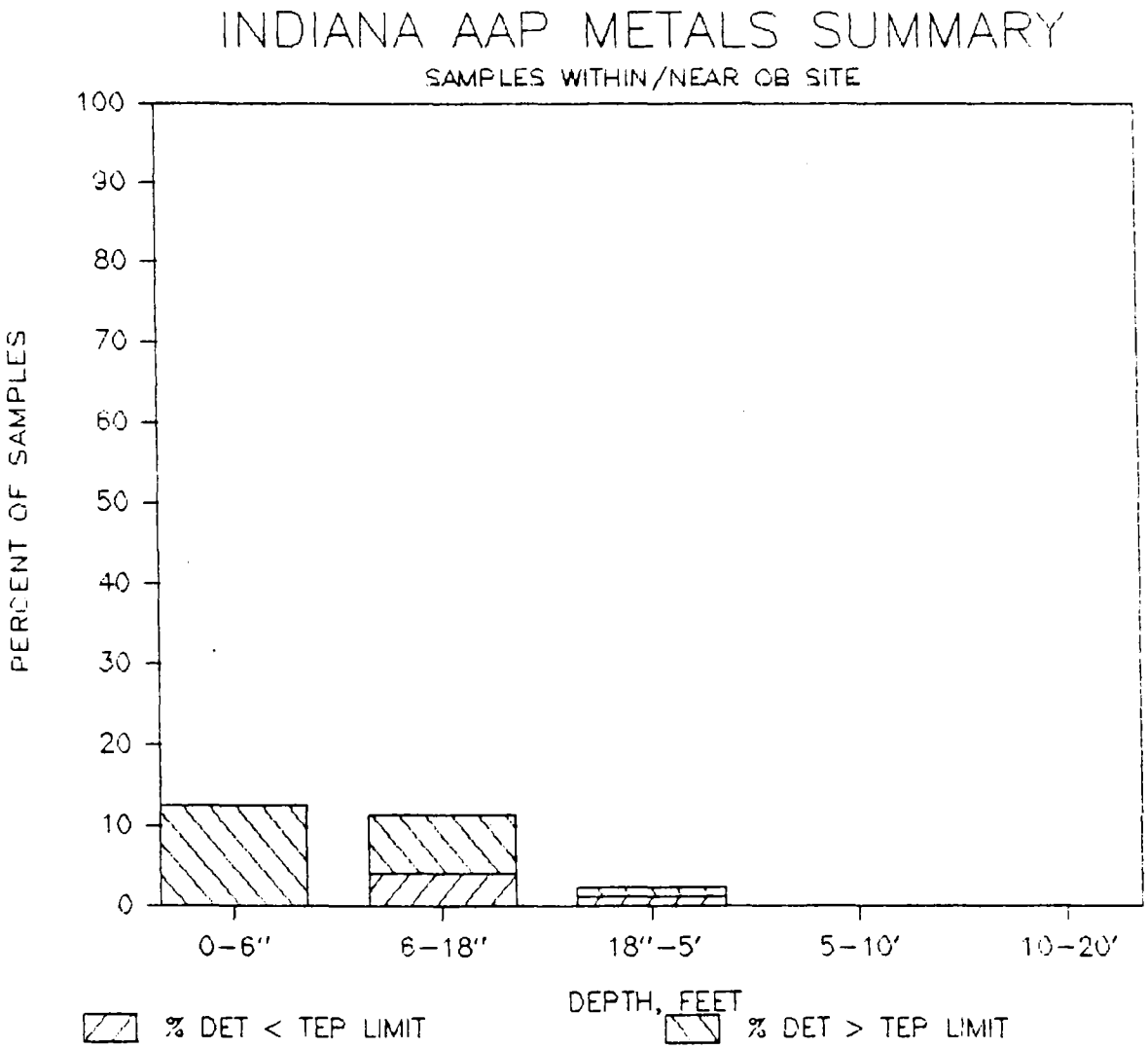
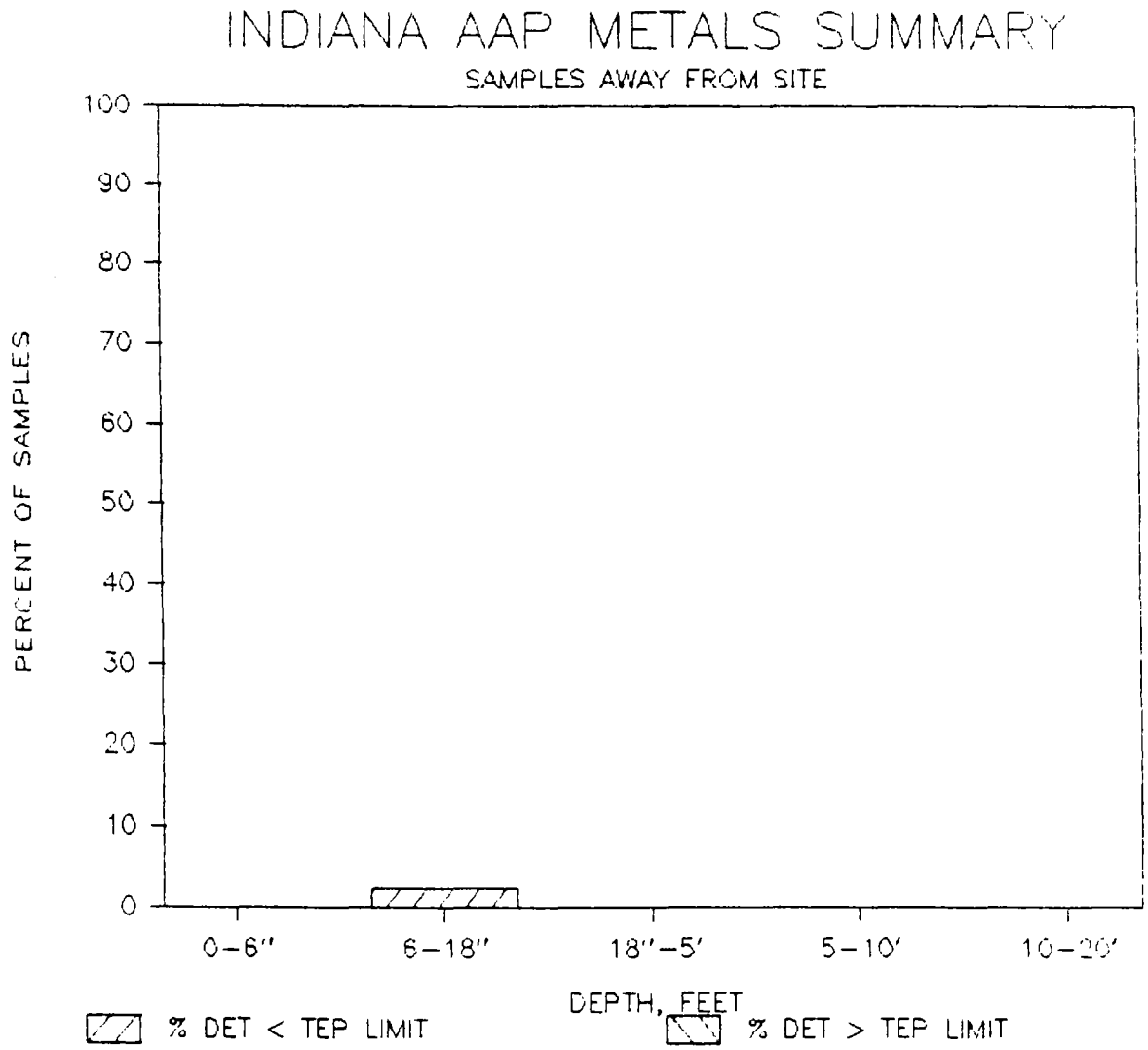

INDIANA AAP METALS SUMMARY
SAMPLES WITHIN/NEAR OB SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

Figure F-5.


INDIANA AAP METALS SUMMARY
SAMPLES AWAY FROM SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

APPENDIX G

SUMMARY OF OB SOIL INVESTIGATIONS AT IOWA ARMY AMMUNITION PLANT MIDDLETOWN, IOWA

1. ENVIRONMENTAL SETTING.

a. Soils. The soils at the Iowa AAP burning grounds were generally characterized as inorganic silty clays with low to moderate plasticity. These soils are classified as "CL" under the Unified Soil Classification System. Standard tests performed by this Agency's soils laboratory provided permeability data for these soils ranging from 1.4×10^{-7} cm/sec to 8.5×10^{-8} cm/sec. The mean value of permeability for those soils tested was 5.07×10^{-8} cm/sec, which is considered to be a practically impermeable soil.

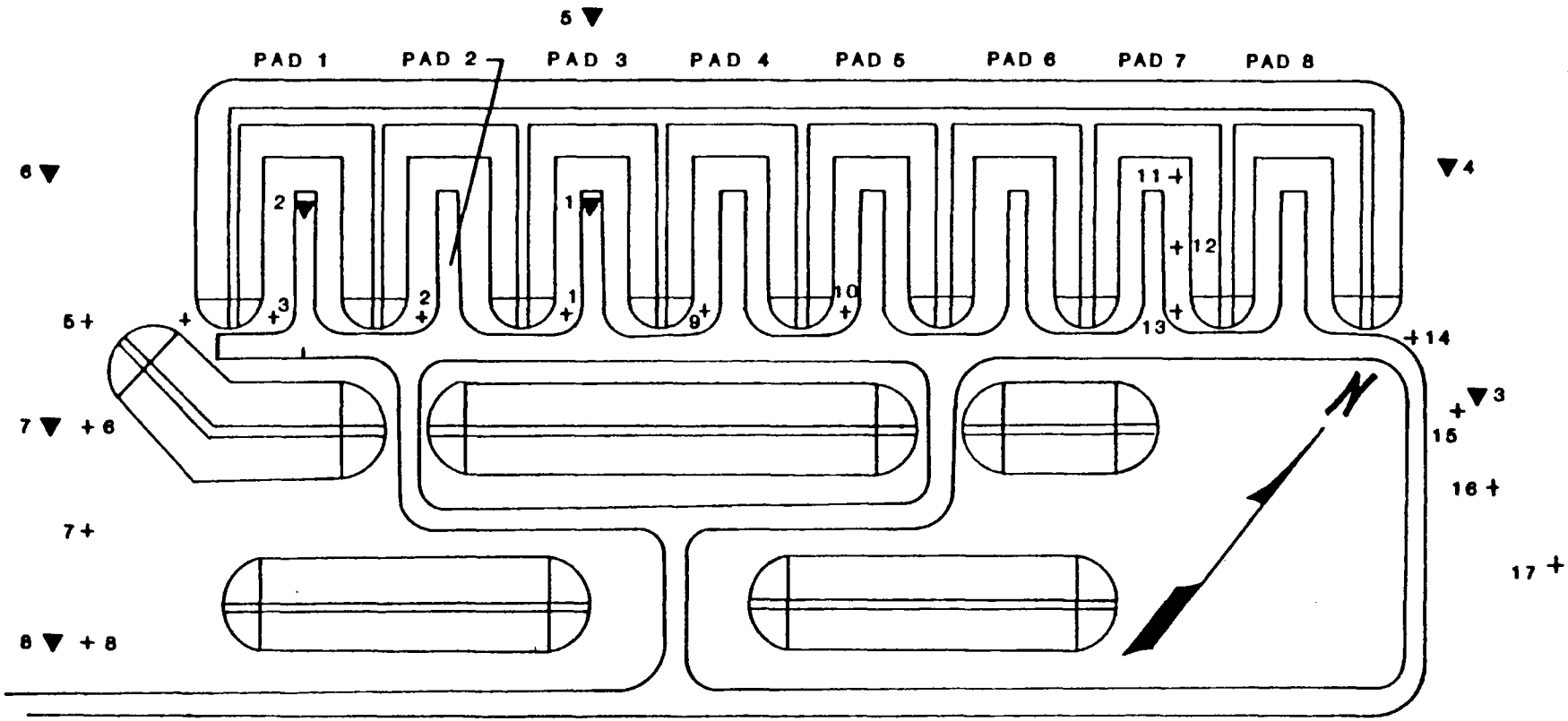
b. Ground Water. Five of eight borings at the OB site intercepted the ground-water table. The depth to ground water varied from 4 to 17 feet at these locations. Regional ground-water flow is to the southeast.

c. Precipitation and Evaporation. The mean annual precipitation for the Iowa AAP area is approximately 35 inches. The mean annual lake evaporation is approximately 35 inches.

2. OVERVIEW OF THE OPEN-BURNING AREA.

a. Background. Open-burning operations at Iowa AAP were conducted in an area of approximately 12 acres located in the northeastern sector of the installation. Burning of waste ammunition began around 1953 at the same time initial activities of the AEC commenced at Iowa AAP. The earthen berms surrounding the burn pads were constructed in 1955. The AEC disposed of waste TNT at the burning ground until July 1973 when that organization began to curtail operations at Iowa AAP. The installation continued to use the burning ground regularly until 31 December 1981. After that date, open burning was allowed by the State of Iowa only on a case-by-case basis. Since 31 December 1981, open-burning events have occurred twice and have involved oversized contaminated metal items that were too large for the Iowa AAP contaminated waste processor to handle. Burning of waste explosive material was accomplished by spreading 15-pound felt (tar paper) over the burning pads and spreading explosive on the felt. The explosive was ignited by remote control and monitored by personnel stationed in a bunker approximately 150 yards to the west of the burning grounds.

b. Physical Description. As shown in Figure G-1, the OB ground presently consists of 8 raised burning pads, approximately 150 feet by 10 feet each, bermed on three sides. A collection ditch drains runoff in a southwesterly direction.



KEY:

+ SEDIMENT SAMPLE SITES

▼ BORE HOLE SITES (BH-1 THROUGH BH-8)

FIGURE G-1 IOWA AAP OPEN BURNING GROUND

SCALE: 1" = 100'

NOTE: S-18 AND S-19 LOCATED BENEATH S-11 AT 4' AND 7' RESPECTIVELY.

3. BURNING GROUND SITE EVALUATIONS.

a. Phase 2 Sampling Methodologies and Locations. See Appendix A, reference 21, for a detailed discussion of this investigation. Phase 2 sampling was conducted on 20-22 April 1982. A total of 24 samples were collected at 12 locations within or very near the OB site. Samples were composited for depths of from 0 to 6 inches, and 6 to 18 inches.

b. Phase 4 Sampling Methodologies and Locations. See Appendix A, reference 22, for a detailed discussion of this investigation. Phase 4 sampling was conducted during the period 30 April to 4 May 1984. Eight boreholes were drilled in the vicinity of the OB grounds. Two boreholes (7 samples) were located within the OB site. The remaining six boreholes (22 samples) were located nearby. The borehole depths varied from 15 to 25 feet. In each borehole the first sample was taken at a depth of 4 to 6 feet. Subsequent samples were taken at intervals of 5 feet until either the water table or refusal was encountered. Additionally, 19 sediment samples were collected from drainage ditches leading away from the OB site.

c. Analytical Results of Sampling Investigations. Analytical results are summarized in Tables G-1 through G-22, and Figures G-2 through G-5.

(1) Metals. No metals exceeded applicable TEP limits. Barium was the only metal detected at concentrations less than the TEP limits. Of the samples collected within the OB site, 25 percent of samples collected from the 6- to 18-inch level contained detectable barium. A total of 33 percent of drainage samples also contained barium.

(2) Explosives.

(a) Samples Within/Near the OB Site. Twenty-five percent of the samples from the 0- to 6-inch and 6- to 18-inch levels contained TNT which exceeded the 1,000 µg/g reactivity guideline. No other explosives exceeded this guideline in any sample. RDX, HMX, TNT, and 2,4-DNT were detected at concentrations less than the guideline in virtually all samples collected from the top 18 inches of soil. Many of the RDX, HMX, and TNT concentrations were significant, whereas only trace levels of 2,4-DNT were found. Explosives were detected in only a small number of samples collected below 18 inches in depth.

(b) Samples Away from the OB Site. No explosives were detected in samples collected below the surface. TNT exceeded the 1,000 µg/g guideline in 38 percent of drainage samples, while HMX exceeded this guideline in 10 percent of these samples. The vast majority of these samples contained detectable quantities of RDX, HMX, and TNT. Many of these concentrations were great enough that the sum of the concentrations of all the explosives in a given sample exceeded the 1,000 µg/g guideline in 12 of 21 samples.

d. Site Operations. No observations of incorrect or abnormal site operations were made. As discussed in paragraph 2a of this Appendix, the OB area is inactive, with the facility being used on a case-by-case basis with the approval of the State of Iowa.

4. CONCLUSIONS.

a. As shown in Table G-21, of samples collected within the OB area, 38 percent of samples from the 0- to 6-inch level and 25 percent from the 6- to 18-inch level contained contaminants which exceeded any applicable limit or guideline. Explosives were detected in all samples collected above a depth of 18 inches but were detected in only 29 percent of samples from lower depths.

b. As shown in Table G-22, a total of 57 percent of drainage samples (away from the OB site) exceeded the reactivity guideline; explosives were detected in all of these samples. No other samples away from the OB site contained detectable levels of contaminants.

c. Significant soils contamination was detected at the site but was limited to the top 18 inches of soil.

d. The minute concentrations of contaminants found in borehole samples collected below 18 inches in depth, coupled with the practically impermeable soils beneath the OB site indicate that there is virtually no vertical migration of contaminants.

e. Significant horizontal migration of contaminants (particularly explosives) was observed. This migration, limited to surface soils, was found to be in conjunction with runoff from precipitation events.

f. The primary contaminants were TNT, RDX, HMX, and barium.

TABLE G-1 INSTALLATION: IOWA AAP

CONTAMINANT: BA SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	12	100	0	0	100	0	0	12	100
6-18"	9	75	3	25	100	0	0	12	100
18"-5'	2	100	0	0	100	0	0	2	100
5-10'	1	100	0	0	100	0	0	1	100
10-20'	4	100	0	0	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--
DRAING.	--	--	--	--	--	--	--	0	--

TABLE G-2 INSTALLATION: IOWA AAP

CONTAMINANT: BA SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	--	--	--	--	--	--	--	0	--
18"-5'	6	100	0	0	100	0	0	6	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	8	100	0	0	100	0	0	8	100
20'+	2	100	0	0	100	0	0	2	100
DRAING.	14	67	7	33	100	0	0	21	100

TABLE G-3 INSTALLATION: IOWA AAP

CONTAMINANT: EACH METAL EXCEPT BA SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	12	100	0	0	100	0	0	12	100
6-18"	12	100	0	0	100	0	0	12	100
18"-5'	2	100	0	0	100	0	0	2	100
5-10'	1	100	0	0	100	0	0	1	100
10-20'	4	100	0	0	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--
DRAING.	--	--	--	--	--	--	--	0	--

TABLE G-4 INSTALLATION: IOWA AAP

CONTAMINANT: EACH METAL EXCEPT BA SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	--	--	--	--	--	--	--	0	--
18"-5'	6	100	0	0	100	0	0	6	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	8	100	0	0	100	0	0	8	100
20'+	2	100	0	0	100	0	0	2	100
DRAING.	21	100	0	0	100	0	0	21	100

TABLE G-5 INSTALLATION: IOWA AAP

CONTAMINANT: RDX SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	0	0	12	100	100	0	0	12	100
6-18"	0	0	12	100	100	0	0	12	100
18"-5'	2	100	0	0	100	0	0	2	100
5-10'	1	100	0	0	100	0	0	1	100
10-20'	3	75	1	25	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--
DRAING.	--	--	--	--	--	--	--	0	--

TABLE G-6 INSTALLATION: IOWA AAP

CONTAMINANT: RDX SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	--	--	--	--	--	--	--	0	--
18"-5'	6	100	0	0	100	0	0	6	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	8	100	0	0	100	0	0	8	100
20'+	2	100	0	0	100	0	0	2	100
DRAING.	3	14	18	86	100	0	0	21	100

TABLE G-7 INSTALLATION: IOWA AAP

CONTAMINANT: HMX SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	0	0	12	100	100	0	0	12	100
6-18"	0	0	12	100	100	0	0	12	100
18"-5'	2	100	0	0	100	0	0	2	100
5-10'	1	100	0	0	100	0	0	1	100
10-20'	4	100	0	0	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--
DRAING.	--	--	--	--	--	--	--	0	--

TABLE G-8 INSTALLATION: IOWA AAP

CONTAMINANT: HMX SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	--	--	--	--	--	--	--	0	--
18"-5'	6	100	0	0	100	0	0	6	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	8	100	0	0	100	0	0	8	100
20'+	2	100	0	0	100	0	0	2	100
DRAING.	0	0	19	90	90	2	10	21	100

TABLE G-9 INSTALLATION: IOWA AAP

CONTAMINANT: TNT SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	0	0	9	75	75	3	25	12	100
6-18"	0	0	9	75	75	3	25	12	100
18"-5'	2	100	0	0	100	0	0	2	100
5-10'	0	0	1	100	100	0	0	1	100
10-20'	3	75	1	25	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--
DRAING.	--	--	--	--	--	--	--	0	--

TABLE G-10 INSTALLATION: IOWA AAP

CONTAMINANT: TNT SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	--	--	--	--	--	--	--	0	--
18"-5'	6	100	0	0	100	0	0	6	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	8	100	0	0	100	0	0	8	100
20'+	2	100	0	0	100	0	0	2	100
DRAING.	0	0	13	62	62	8	38	21	100

TABLE G-11 INSTALLATION: IOWA AAP

CONTAMINANT: TETRYL SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	11	92	1	8	100	0	0	12	100
6-18"	12	100	0	0	100	0	0	12	100
18"-5'	2	100	0	0	100	0	0	2	100
5-10'	1	100	0	0	100	0	0	1	100
10-20'	4	100	0	0	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--
DRAING.	--	--	--	--	--	--	--	0	--

TABLE G-12 INSTALLATION: IOWA AAP

CONTAMINANT: TETRYL SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	--	--	--	--	--	--	--	0	--
18"-5'	6	100	0	0	100	0	0	6	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	8	100	0	0	100	0	0	8	100
20'+	2	100	0	0	100	0	0	2	100
DRAING.	21	100	0	0	100	0	0	21	100

TABLE G-13 INSTALLATION: IOWA AAP

CONTAMINANT: 2,6-DNT SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	12	100	0	0	100	0	0	12	100
6-18"	12	100	0	0	100	0	0	12	100
18"-5'	2	100	0	0	100	0	0	2	100
5-10'	1	100	0	0	100	0	0	1	100
10-20'	4	100	0	0	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--
DRAING.	--	--	--	--	--	--	--	0	--

TABLE G-14 INSTALLATION: IOWA AAP

CONTAMINANT: 2,6-DNT SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	--	--	--	--	--	--	--	0	--
18"-5'	6	100	0	0	100	0	0	6	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	8	100	0	0	100	0	0	8	100
20'+	2	100	0	0	100	0	0	2	100
DRAING.	21	100	0	0	100	0	0	21	100

TABLE G-15 INSTALLATION: IOWA AAP

CONTAMINANT: 2,4-DNT SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	3	25	9	75	100	0	0	12	100
6-18"	1	8	11	92	100	0	0	12	100
18"-5'	2	100	0	0	100	0	0	2	100
5-10'	1	100	0	0	100	0	0	1	100
10-20'	4	100	0	0	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--
DRAING.	--	--	--	--	--	--	--	0	--

TABLE G-16 INSTALLATION: IOWA AAP

CONTAMINANT: 2,4-DNT SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	--	--	--	--	--	--	--	0	--
18"-5'	6	100	0	0	100	0	0	6	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	8	100	0	0	100	0	0	8	100
20'+	2	100	0	0	100	0	0	2	100
DRAING.	20	95	1	5	100	0	0	21	100

TABLE G-17 INSTALLATION: IOWA AAP

CONTAMINANT: SUM OF EXPLOSIVES DATA SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	26	36	43	60	96	3	4	72	100
6-18"	25	35	44	61	96	3	4	72	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	5	83	1	17	100	0	0	6	100
10-20'	22	92	2	8	100	0	0	24	100
20'+	--	--	--	--	--	--	--	0	--
DRAING.	--	--	--	--	--	--	--	0	--

TABLE G-18 INSTALLATION: IOWA AAP

CONTAMINANT: SUM OF EXPLOSIVES DATA SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	--	--	--	--	--	--	--	0	--
18"-5'	36	100	0	0	100	0	0	36	100
5-10'	36	100	0	0	100	0	0	36	100
10-20'	48	100	0	0	100	0	0	48	100
20'+	12	100	0	0	100	0	0	12	100
DRAING.	62	74	14	17	90	8	10	84	100

TABLE G-19 INSTALLATION: IOWA AAP

CONTAMINANT: SUM OF METALS DATA SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	96	100	0	0	100	0	0	96	100
6-18"	93	97	3	3	100	0	0	96	100
18"-5'	16	100	0	0	100	0	0	16	100
5-10'	8	100	0	0	100	0	0	8	100
10-20'	32	100	0	0	100	0	0	32	100
20'+	--	--	--	--	--	--	--	0	--
DRAING.	--	--	--	--	--	--	--	0	--

TABLE G-20 INSTALLATION: IOWA AAP

CONTAMINANT: SUM OF METALS DATA SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	--	--	--	--	--	--	--	0	--
18"-5'	48	100	0	0	100	0	0	48	100
5-10'	48	100	0	0	100	0	0	48	100
10-20'	64	100	0	0	100	0	0	64	100
20'+	16	100	0	0	100	0	0	16	100
DRAING.	161	96	7	4	100	0	0	168	100

TABLE G-21 INSTALLATION: IOWA AAP

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	> TEP LIMIT OR GUIDELINE #	> TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	0	0	8	67	67	4	33	12	100
6-18"	0	0	9	75	75	3	25	12	100
18"-5'	1	50	1	50	100	0	0	2	100
5-10'	1	100	0	0	100	0	0	1	100
10-20'	3	75	1	25	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--
DRAING.	--	--	--	--	--	--	--	0	--

TABLE G-22 INSTALLATION: IOWA AAP

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	> TEP LIMIT OR GUIDELINE #	> TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	--	--	--	--	--	--	--	0	--
18"-5'	6	100	0	0	100	0	0	6	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	8	100	0	0	100	0	0	8	100
20'+	2	100	0	0	100	0	0	2	100
DRAING.	0	0	9	43	43	12	57	21	100

Figure G-2.

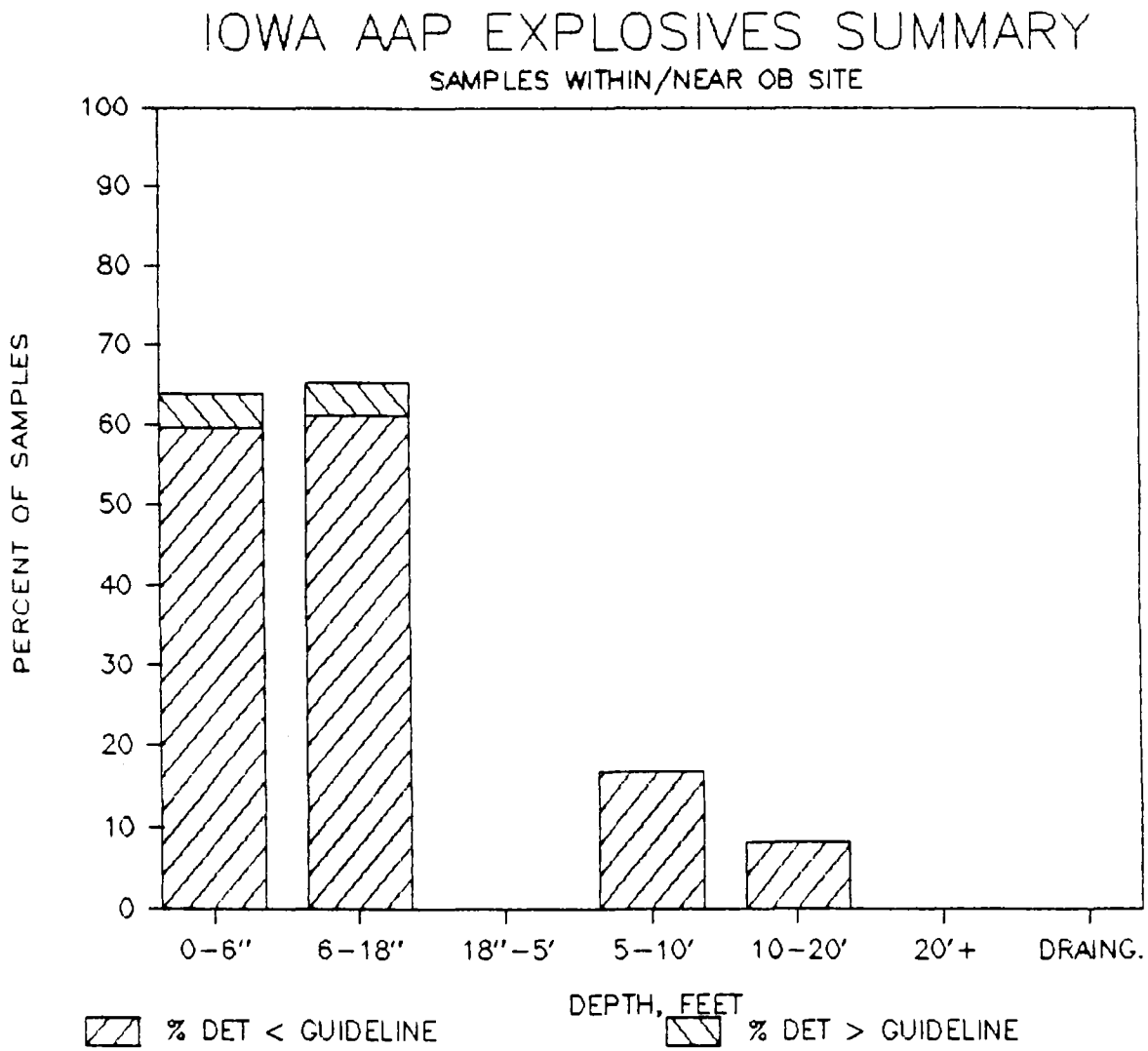

IOWA AAP EXPLOSIVES SUMMARY
SAMPLES WITHIN/NEAR OB SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
20'+
DRAING.
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure G-3.

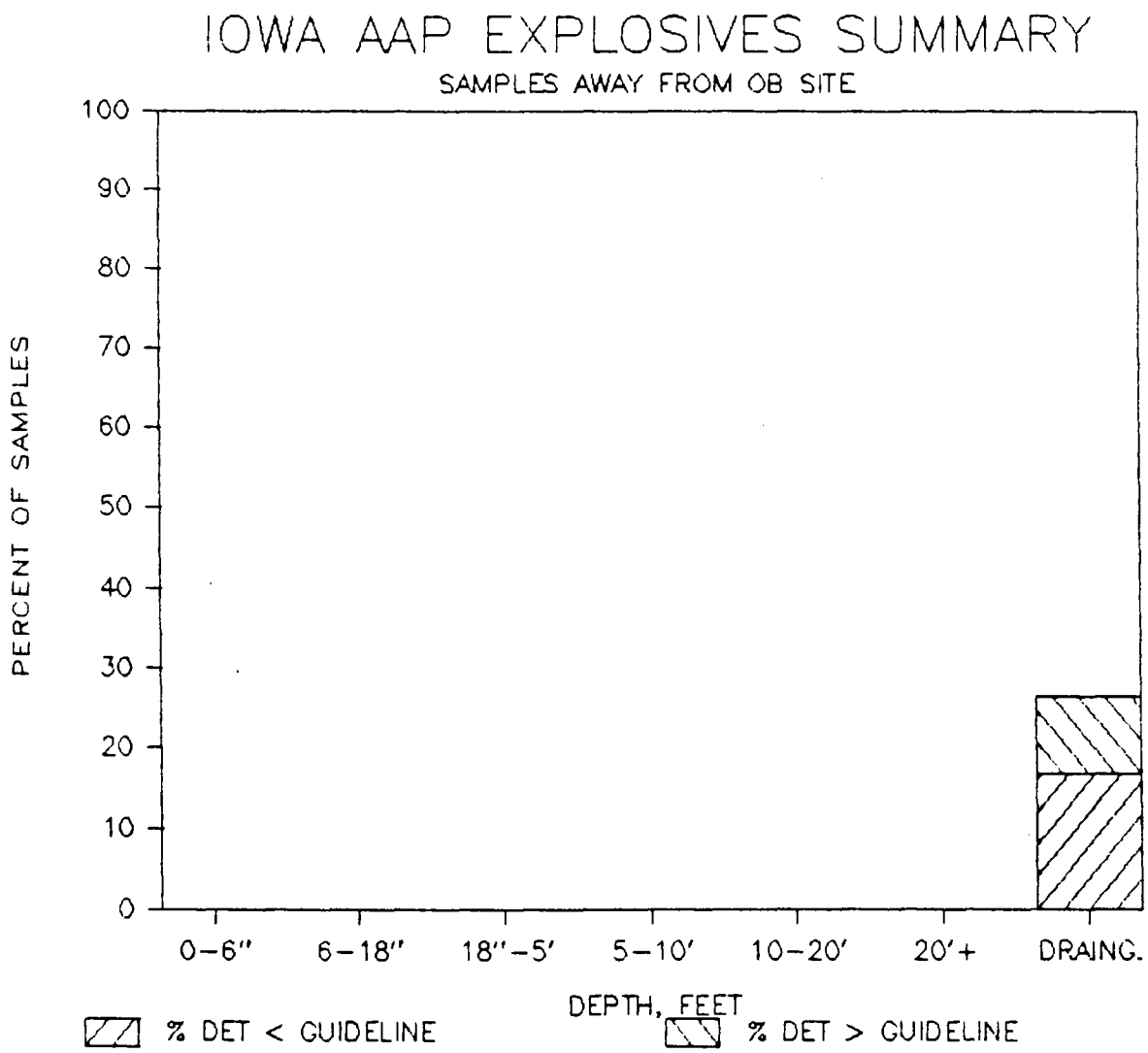

IOWA AAP EXPLOSIVES SUMMARY
SAMPLES AWAY FROM OB SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
20'+
DRAING.
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure G-4.

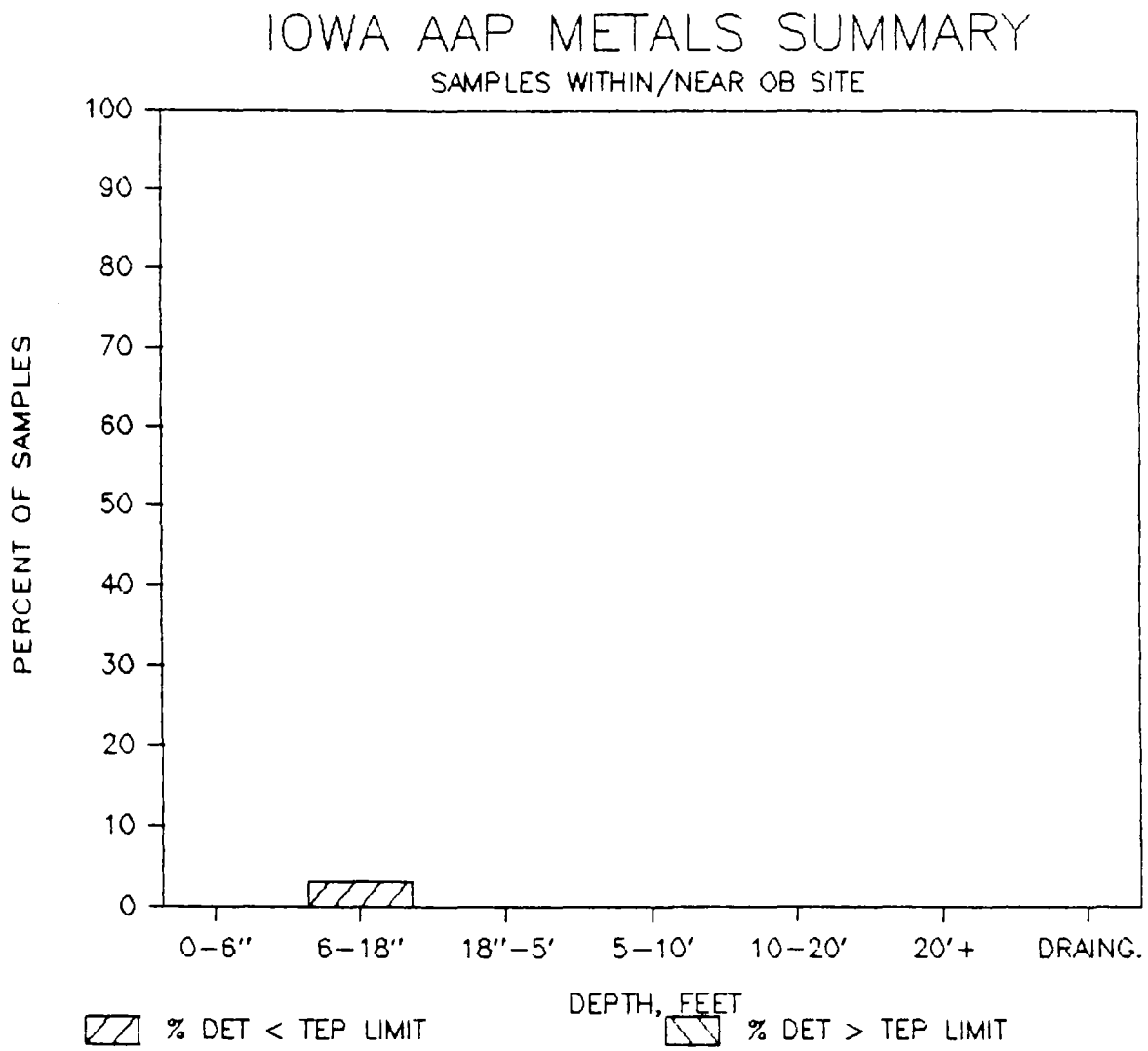
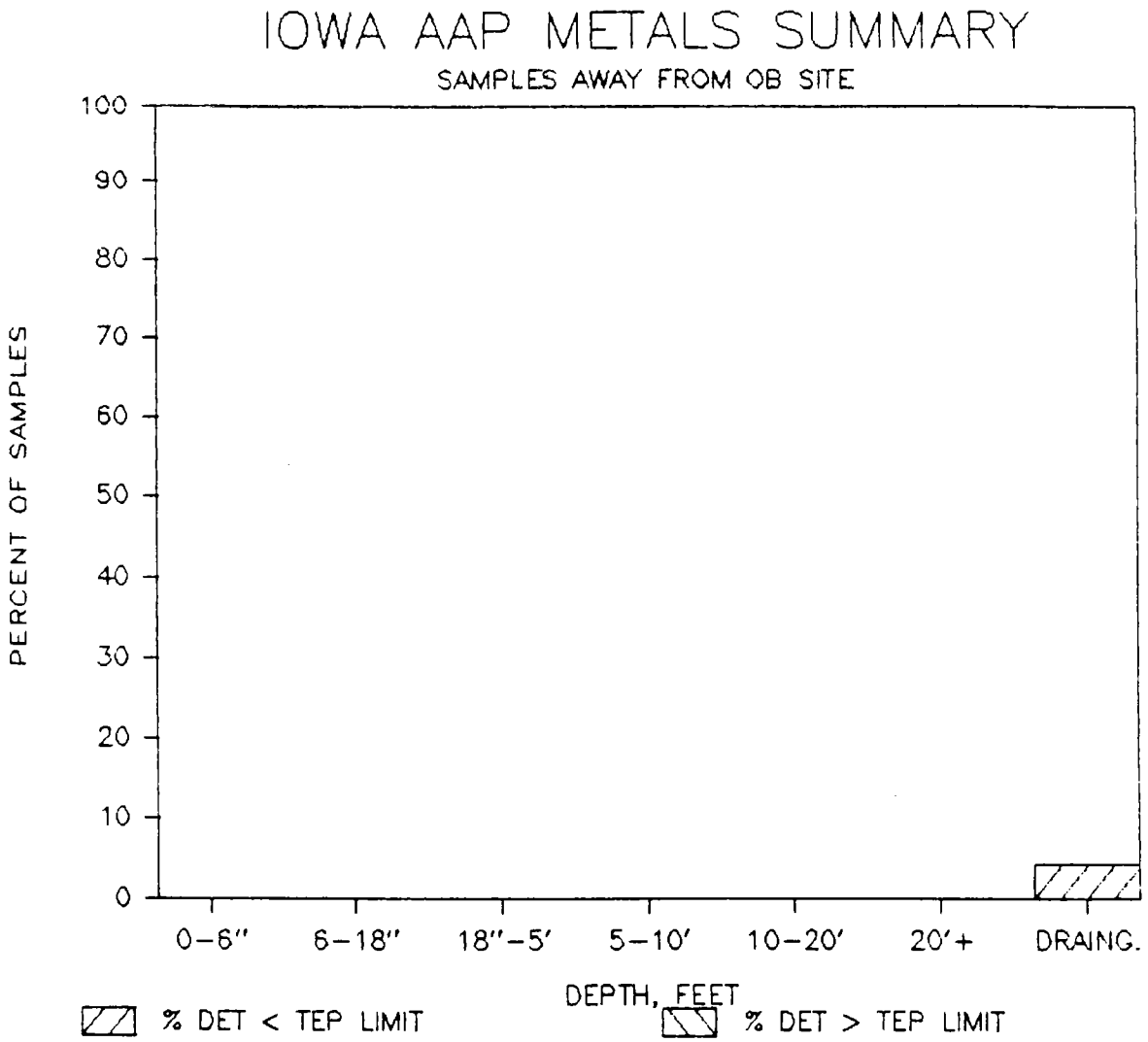

IOWA AAP METALS SUMMARY
SAMPLES WITHIN/NEAR OB SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
20'+
DRAING.
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

Figure G-5.


IOWA AAP METALS SUMMARY
SAMPLES AWAY FROM OB SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
20'+
DRAING.
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

APPENDIX H

SUMMARY OF OB SOIL INVESTIGATIONS AT LAKE CITY ARMY AMMUNITION PLANT INDEPENDENCE, MISSOURI

1. ENVIRONMENTAL SETTING.

a. General Physiography and Stratigraphy.

(1) Regional. Lake City AAP is located 7 miles east of Independence and 4 miles north of Blue Springs. The installation has two topographic subdivisions. The south and east area contains steeply sloping, narrow-crested ridges with elevations 150 to 160 feet above the valley floor. The north and west area is an abandoned river valley filled with approximately 90 feet of alluvial sediments. The major geologic units at Lake City AAP are Quaternary alluvium and the Pennsylvania Age Kansas City and Pleasanton Formations. The Pleasanton Formation underlies a large area of Lake City AAP and consists of shale, with minor beds of limestone and sandstone with a average thickness of 163 feet. The Kansas City Formation is found in the higher elevations and consists of alternating limestone and shale members. Alluvium underlies the north-western area of Lake City AAP, with a maximum thickness of 90 feet of clay, sand, and gravel. During the Pleistocene Epoch, stream patterns in the Lake City area were changed by advancing glaciers. The resulting abandoned stream valley was filled with alluvial material.

(2) Local. The burning ground lies on the north slope of a hill on a small, relatively flat area. An intermittent stream drains the west side of the burning ground area. Silty clay is the predominant subsurface material from ground surface to the top of bedrock. Bedrock was encountered at an approximate depth of 22 feet. In-situ permeabilities of the soils in the vicinity of the OB site range from 8.5×10^{-6} to 8.3×10^{-9} cm/sec. This indicates that the soils are nearly to practically impermeable.

b. Ground Water. Four monitoring wells were drilled at the burning ground in December 1981 - January 1982. These wells were constructed with 4-inch inside diameter well casing and screen. The aquifer is unconfined and the water table ranges from 6.1- to 18.6-feet below ground surface. The direction of ground-water flow is to the north-northeast; the ground-water flow rate had not been determined.

c. Precipitation and Evaporation. The mean annual precipitation in the Lake City AAP area is approximately 40 inches. The mean annual lake evaporation in this vicinity is approximately 40 inches.

2. OVERVIEW OF OPEN BURNING AREA. The OB area at Lake City AAP, located in the northeastern section of the installation, consists of two inactive burning pads and one active pad. The lower burning pad was used from 1970 through 1976 to burn cartridges. It was reactivated in 1978 and used until

1980 to burn tracer mix and tracer scrap. The upper burning pad was located adjacent to the east side of the present active burn pad. Miscellaneous metal parts, cartridges, and powder were burned or flashed on this pad. Samples from the active pad were only collected from surface soils. Therefore, analytical results from the active area are not included in the discussion below.

3. BURNING GROUND SITE EVALUATIONS.

a. Phase 2 Sampling Methodologies and Locations. All soil sampling was conducted during the Phase 4 site evaluation.

b. Phase 4 Sampling Methodologies and Locations. See Appendix A, reference 23, for a detailed discussion of this investigation. Phase 4 sampling was conducted during the period 24-29 August 1983. A total of 49 samples were collected in and around the two inactive OB pads. Eight samples from four locations were collected within or near the lower pad; 14 samples from seven locations were collected within the upper pad. The majority of these samples were composited for depths of from 0 to 6 inches, and 6 to 18 inches. Of the samples collected away from the OB sites, 21 were collected from 9 sites in the vicinity of the lower pad and six samples were collected from two sites in the vicinity of the upper pad.

c. Analytical Results of Sampling Investigations. Analytical results are summarized in Tables H-1 through H-14, and Figures H-1 through H-4.

(1) Metals.

(a) Samples Within/Near the OB Site. No samples contained metals in concentrations which exceeded applicable TEP limits. Lead was the only metal detected below the TEP limit. Low levels of this metal were found in one sample from the 0- to 6-inch horizon, and two samples from the 6- to 18-inch level.

(b) Samples Away From the OB Site. No samples contained metals in concentrations which exceeded applicable TEP limits. Lead was detected in one surface sample in a concentration below the TEP limit.

(2) Explosives. Samples Within/Near the OB Site. No samples contained explosives in concentrations which exceeded the 1,000 µg/g reactivity guideline. A small number of samples collected from the 0- to 6- and 6- to 18-inch levels contained RDX and HMX in trace concentrations.

d. Discussion of Site Location. The burning pads are situated at the base of low, rolling hills. This location, in conjunction with the presence of subsurface soils having extremely low permeabilities, has resulted in the creation of erosion problems.

4. CONCLUSIONS.

a. As shown in Table H-13, no samples collected within or near the OB pad contained contaminants which exceeded any applicable limit or guideline. Forty percent of samples from the 0- to 6-inch level contained detectable concentrations of contaminants. This percentage reduced to 30 percent in the 6- to 18-inch horizon. All detected contaminants were found at insignificant levels. The limited number of samples collected from lower depths did not contain detectable quantities of contaminants.

b. As shown in Table H-14, no samples collected away from the OB pad contained contaminants which exceeded any applicable limit or guideline. Only one sample (from the 0- to 6-inch horizon) contained a detectable quantity of a contaminant.

c. Contamination of the OB site was minimal. Insignificant horizontal or vertical contamination was detected.

d. Erosion of contaminated surface soils is a potential problem at the active OB site.

TABLE H-1 INSTALLATION: LAKE CITY AAP

CONTAMINANT: PB SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	9	90	1	10	100	0	0	10	100
6-18"	8	80	2	20	100	0	0	10	100
18"-5'	1	100	0	0	100	0	0	1	100
5-10'	--	--	--	--	--	--	--	0	--
10-20'	1	100	0	0	100	0	0	1	100

TABLE H-2 INSTALLATION: LAKE CITY AAP

CONTAMINANT: PB SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	5	83	1	17	100	0	0	6	100
6-18"	11	100	0	0	100	0	0	11	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	7	100	0	0	100	0	0	7	100
10-20'	3	100	0	0	100	0	0	3	100

TABLE H-3 INSTALLATION: LAKE CITY APP

CONTAMINANT: EACH METAL EXCEPT PB SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	10	100	0	0	100	0	0	10	100
6-18"	10	100	0	0	100	0	0	10	100
18"-5'	1	100	0	0	100	0	0	1	100
5-10'	0	--	--	--	--	--	--	0	--
10-20'	1	100	0	0	100	0	0	1	100

TABLE H-4 INSTALLATION: LAKE CITY AAP

CONTAMINANT: EACH METAL EXCEPT PB SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	6	100	0	0	100	0	0	6	100
6-18"	11	100	0	0	100	0	0	11	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	7	100	0	0	100	0	0	7	100
10-20'	3	100	0	0	100	0	0	3	100

TABLE H-5 INSTALLATION: LAKE CITY AAP

CONTAMINANT: RDX SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	7	70	3	30	100	0	0	10	100
6-18"	9	90	1	10	100	0	0	10	100
18"-5'	1	100	0	0	100	0	0	1	100
5-10'	--	--	--	--	--	--	--	0	--
10-20'	1	100	0	0	100	0	0	1	100

TABLE H-6 INSTALLATION: LAKE CITY AAP

CONTAMINANT: HMX SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	8	80	2	20	100	0	0	10	100
6-18"	10	100	0	0	100	0	0	10	100
18"-5'	1	100	0	0	100	0	0	1	100
5-10'	--	--	--	--	--	--	--	0	--
10-20'	1	100	0	0	100	0	0	1	100

TABLE H-7 INSTALLATION: LAKE CITY AAP

CONTAMINANT: EACH EXPLOSIVE EXCEPT RDX AND HMX SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	10	100	0	0	100	0	0	10	100
6-18"	10	100	0	0	100	0	0	10	100
18"-5'	1	100	0	0	100	0	0	1	100
5-10'	--	--	--	--	--	--	--	0	--
10-20'	1	100	0	0	100	0	0	1	100

TABLE H-8 INSTALLATION: LAKE CITY AAP

CONTAMINANT: EACH EXPLOSIVE SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	6	100	0	0	100	0	0	6	100
6-18"	11	100	0	0	100	0	0	11	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	7	100	0	0	100	0	0	7	100
10-20'	--	--	--	--	--	--	--	0	--

TABLE H-9 INSTALLATION: LAKE CITY AAP

CONTAMINANT: SUM OF EXPLOSIVES DATA SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	55	92	5	8	100	0	0	60	100
6-18"	59	98	1	2	100	0	0	60	100
18"-5'	6	100	0	0	100	0	0	6	100
5-10'	--	--	--	--	--	--	--	0	--
10-20'	6	100	0	0	100	0	0	6	100

TABLE H-10 INSTALLATION: LAKE CITY AAP

CONTAMINANT: SUM OF EXPLOSIVES DATA SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	36	100	0	0	100	0	0	36	100
6-18"	66	100	0	0	100	0	0	66	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	42	100	0	0	100	0	0	42	100
10-20'	--	--	--	--	--	--	--	0	--

TABLE H-11 INSTALLATION: LAKE CITY AAP

CONTAMINANT: SUM OF METALS DATA SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	79	99	1	1	100	0	0	80	100
6-18"	78	98	2	3	100	0	0	80	100
18"-5'	8	100	0	0	100	0	0	8	100
5-10'	--	--	--	--	--	--	--	--	--
10-20'	8	100	0	0	100	0	0	8	100

TABLE H-12 INSTALLATION: LAKE CITY AAP

CONTAMINANT: SUM OF METALS DATA SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	47	98	1	2	100	0	0	48	100
6-18"	88	100	0	0	100	0	0	88	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	56	100	0	0	100	0	0	56	100
10-20'	24	100	0	0	100	0	0	24	100

TABLE H-13 INSTALLATION: LAKE CITY AAP

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	> TEP LIMIT OR GUIDELINE #	> TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	6	60	4	40	100	0	0	10	100
6-18"	7	70	3	30	100	0	0	10	100
18"-5'	1	100	0	0	100	0	0	1	100
5-10'	--	--	--	--	--	--	--	--	--
10-20'	1	100	0	0	100	0	0	1	100

TABLE H-14 INSTALLATION: LAKE CITY AAP

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	> TEP LIMIT OR GUIDELINE #	> TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	5	83	1	17	100	0	0	6	100
6-18"	11	100	0	0	100	0	0	11	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	7	100	0	0	100	0	0	7	100
10-20'	3	100	0	0	100	0	0	3	100

Figure H-1.

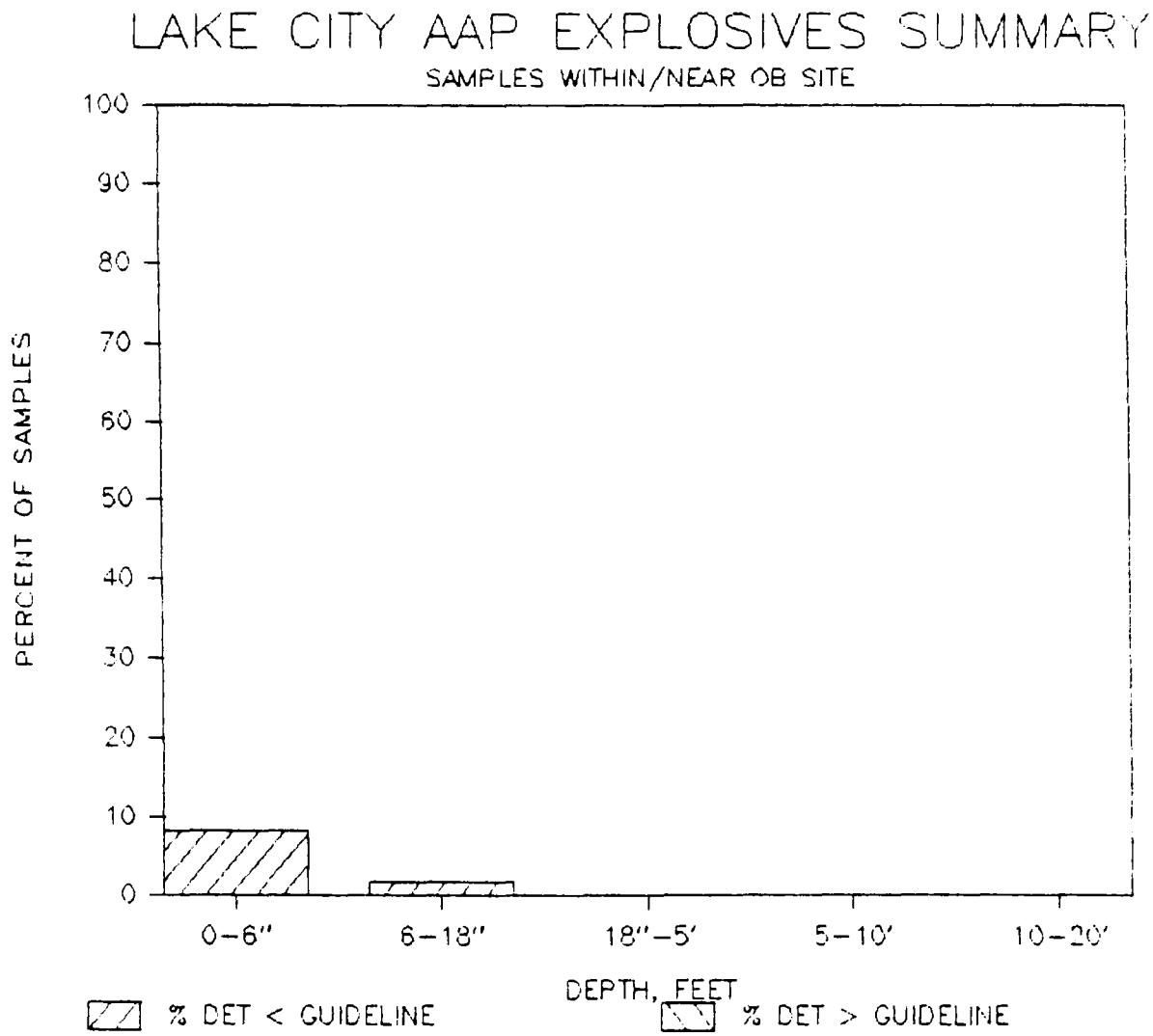

LAKE CITY AAP EXPLOSIVES SUMMARY
SAMPLES WITHIN/NEAR OB SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure H-2.

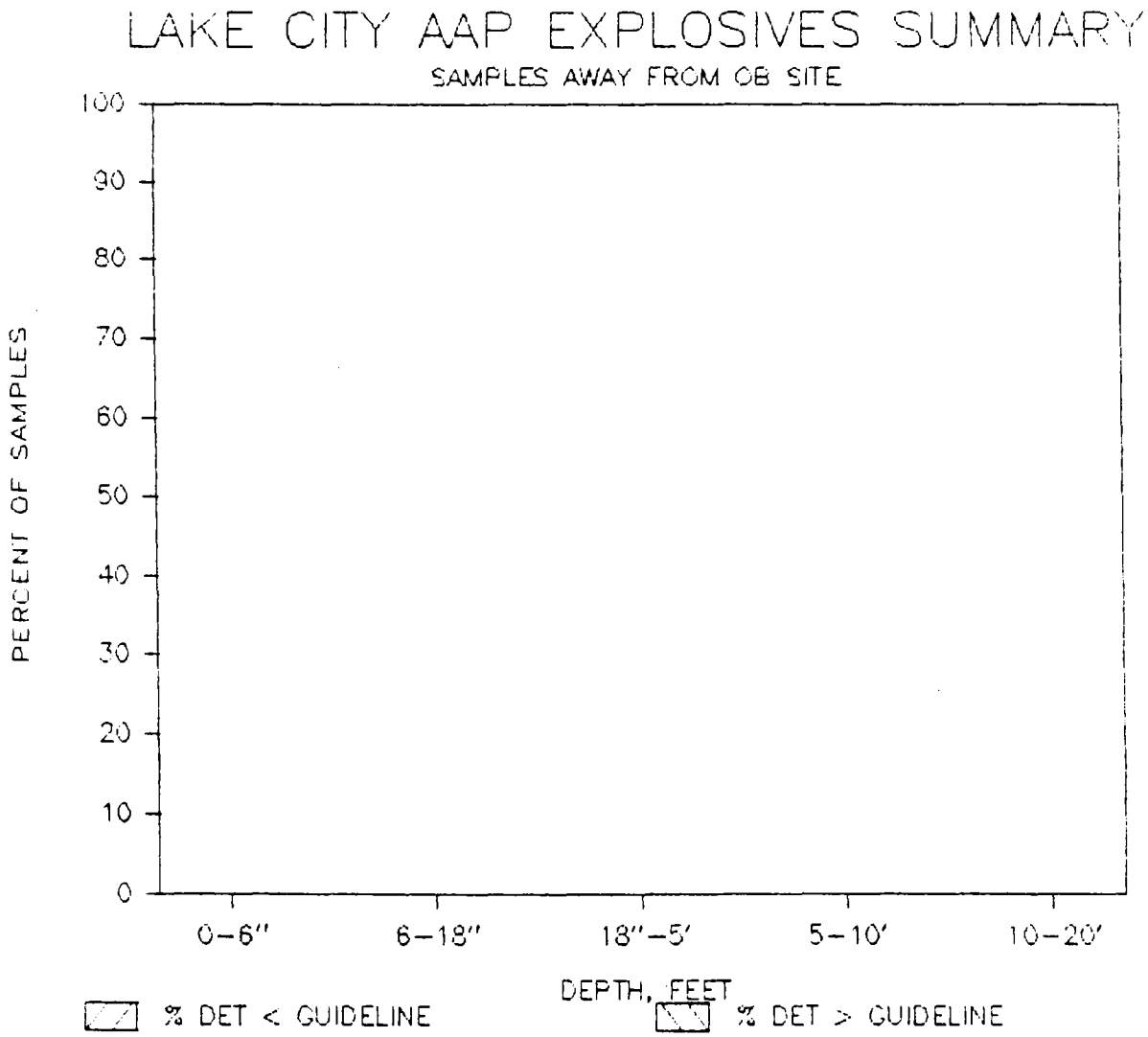

LAKE CITY AAP EXPLOSIVES SUMMARY
SAMPLES AWAY FROM OB SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure H-3.

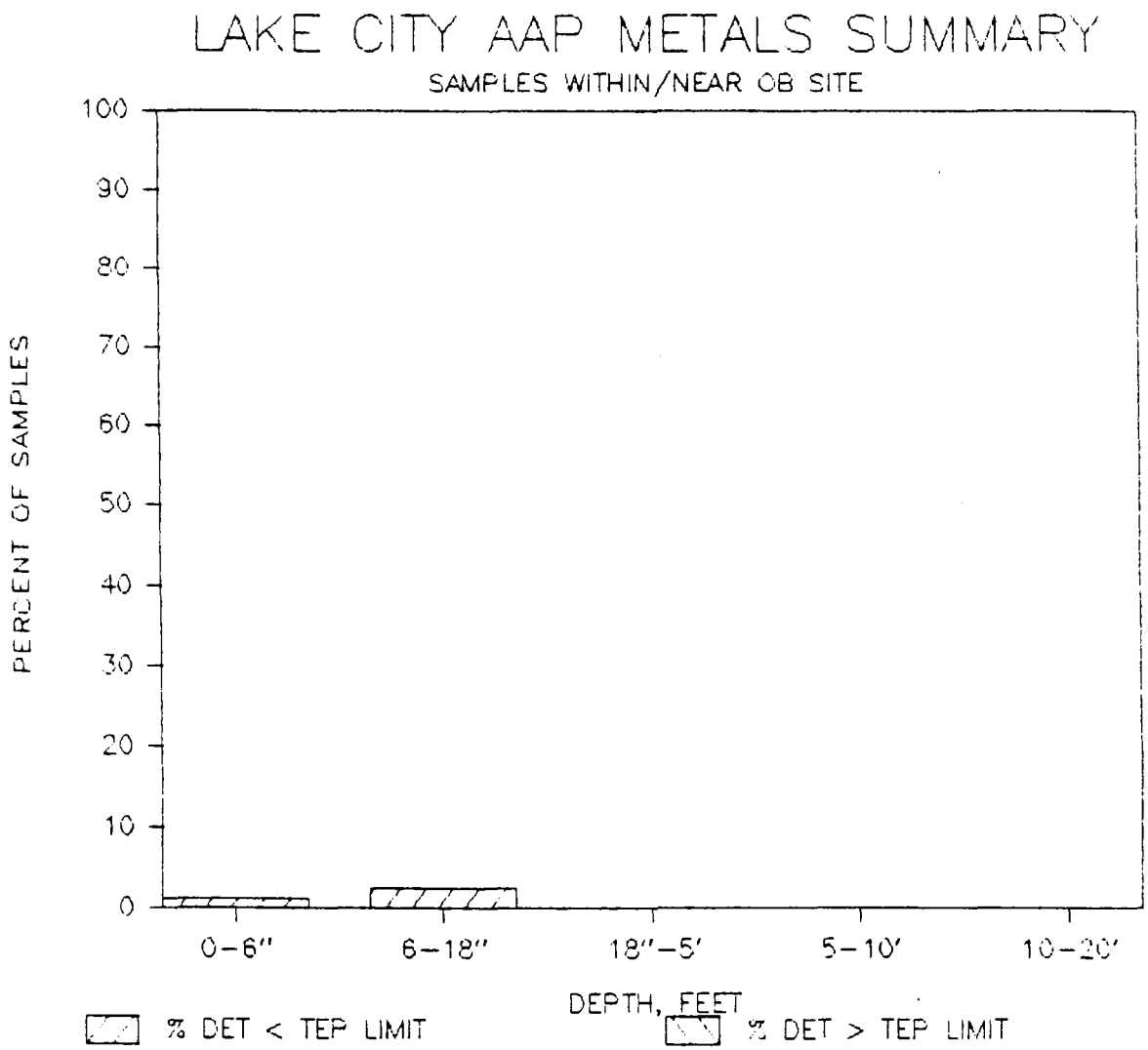
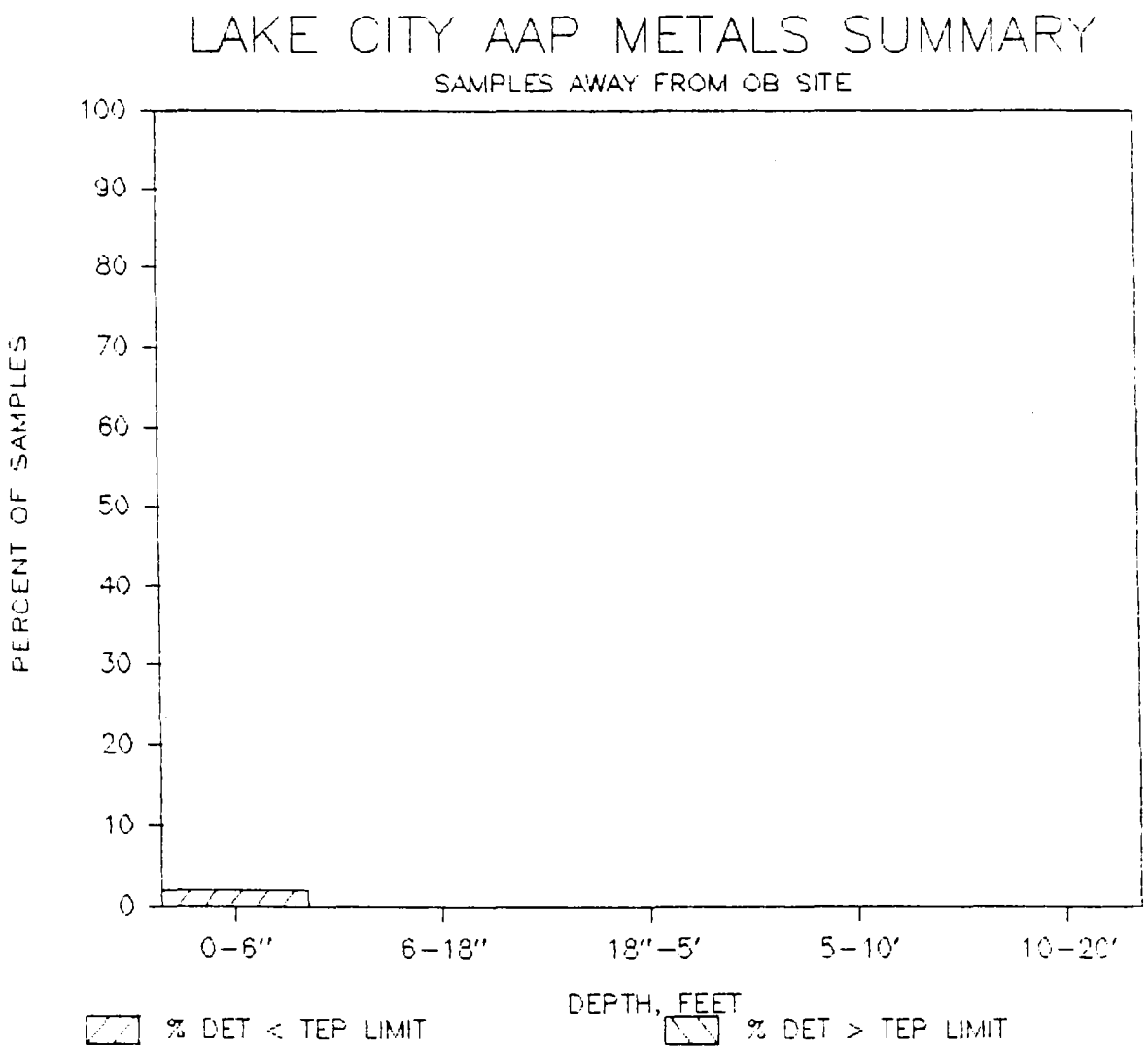

LAKE CITY AAP METALS SUMMARY
SAMPLES WITHIN/NEAR OB SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

Figure H-4.


LAKE CITY AAP METALS SUMMARY
SAMPLES AWAY FROM OB SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

APPENDIX I

SUMMARY OF OB SOIL INVESTIGATIONS AT LOUISIANA ARMY AMMUNITION PLANT SHREVEPORT, LOUISIANA

1. ENVIRONMENTAL SETTING.

a. Regional Physiography and Stratigraphy. Louisiana AAP is located in Webster and Bossier Parishes of northwestern Louisiana. The installation is situated within the West Gulf Coastal Plain section of the Coastal Plain physiographic province. Geologically, the installation is located on the Pleistocene Age Montgomery terrace formation. A terrace is one of the series of level surfaces in a stream valley, flanking and parallel to the stream channel originally occurring at or below but now above the level of the stream. It represents the dissected remnants of an abandoned flood plain, streambed, or valley floor produced during a former stage or erosion or deposition. The Montgomery terrace ranges in thickness from 70 to 90 feet within the installation. The terrace deposits consist of basal sands and gravels which grade upward into sandy silts, silts, silty clays, and clays.

b. Local Soils. The soils beneath the burning ground were generally categorized as nonorganic sandy silts and sand-silt mixtures. These soils would be classified as "SM" and "ML" type soils under the Unified Soil Classification System. The values of permeability of these soils ranged from 1.28×10^{-4} cm/sec to 2.4×10^{-8} cm/sec, with a mean value of 1.03×10^{-5} cm/sec. These soils, therefore, have a low degree of permeability.

c. Ground Water. Ground water occurs 2- to 24-feet below the land surface throughout the burning ground area and flows towards Boone Creek in a southeasterly direction. Water levels measured in March 1984 indicate that the flow direction is towards the southeast; however, the water levels measured in September 1984 indicate the flow direction is towards the south. It appears that when the water table is deeper (depth from ground surface), as it was in September, the major component of ground-water flow is towards the south. The water table gradient was calculated to be 0.00619 foot per foot, and the horizontal ground-water flow velocity was calculated to be between 20 and 47 feet per year.

d. Precipitation and Evaporation. The mean annual precipitation in the Louisiana AAP area is approximately 48 inches. The mean annual lake evaporation in this vicinity is 47 inches.

2. OVERVIEW OF BURNING GROUND.

a. Open-burning of waste explosives had been conducted in the eastern portion of the installation since 1947. Waste explosives were placed on top of a layer of straw. A black powder line extended from the straw to a squib. The squib was ignited and the burn was observed by remote control television cameras. Twenty-four hours after the burn, the residue was

tested for explosive content with a solution of potassium hydroxide with methanol. Residue that tested positive for explosive content was reburned using uncontaminated combustibles, and tested again 24-hours later. Residue that tested negative for explosive content was removed to the landfill for disposal after metal scraps were removed for salvage. The potassium hydroxide and methanol solution tests for the presence of nitrated organics, such as those found in military explosives.

b. The burning ground consisted of three raised earthen berms sloping down toward a concrete catchment basin. The catchment basin had approximate dimensions of 60-feet by 88-feet by 3-feet deep and was built between 1962 and 1965. By design, precipitation fell on the burn pads, flowed to the shallow dikes between burn pads, and then flowed to the concrete catchment basin. A plan view of the OB area is provided in Figure I-1.

3. BURNING GROUND SITE EVALUATIONS.

a. Phase 2 Sampling Methodologies and Locations. See Appendix A, reference 24, for a detailed discussion of this investigation. Phase 2 sampling was conducted on 11-12 August 1981. A total of 29 samples were collected as follows: 6 samples from 3 locations at both pads 1 and 2, 13 samples from 7 locations at pad 3, 3 samples from the perimeter of the OB area, and 1 sample at the edge of the sump. These samples were composited for the following depths: 0- to 6-inches, and 6- to 18-inches.

b. Phase 4 Sampling Methodologies and Locations. See Appendix A, reference 25, for a detailed discussion of this investigation. Phase 4 sampling was conducted during the periods 10-16 November 1983, and 25-27 April 1984. Samples were collected from 21 boreholes at depths as great as 35 feet. The locations of these borings are shown in Figure I-1. Ten borings (26 samples) were situated within or immediately downgradient of the OB pads. It should be noted that contamination in these down gradient samples would indicate horizontal migration of contaminants. The remaining 11 borings (38 samples) were located farther away from the pads. The first sample in each borehole was taken at a depth ranging from 1 to 5 feet with a Shelby tube. Subsequent samples were generally collected at intervals of 5 feet using either Shelby tubes or a split-spoon sampler with a retaining screen.

c. Analytical Results of Sampling Investigations. Analytical results are summarized in Tables I-1 through I-26, and Figures I-2 through I-5.

(1) Metals.

(a) Samples Within/Near the OB Site. Mercury exceeded its TEP limit in one sample collected from the 6- to 18-inch depth. This was the only sample containing a metal which exceeded the applicable TEP limit. Cadmium, mercury, and lead were each detected once at levels less than the appropriate TEP limits in other samples.

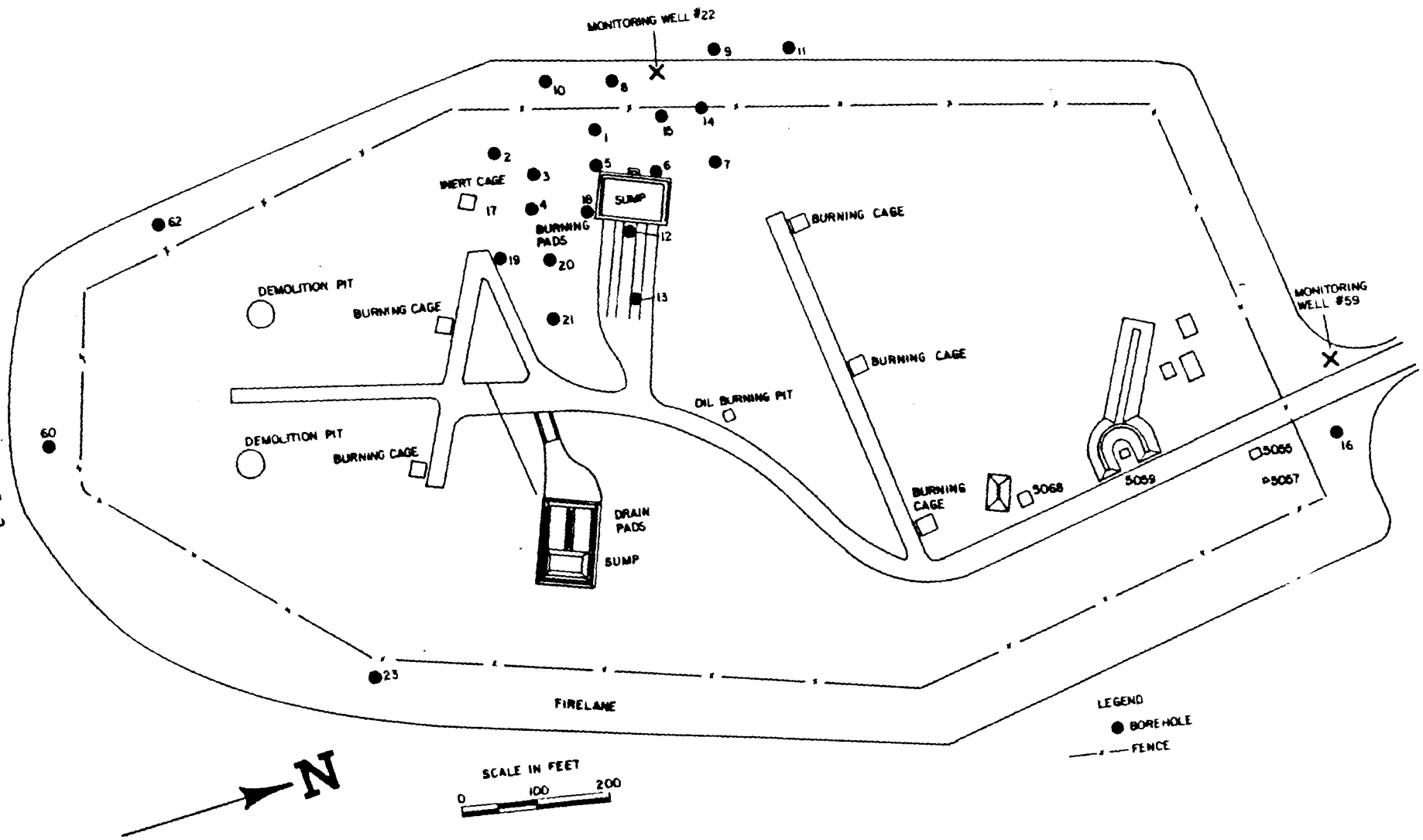


Figure I-1. Louisiana AAP Burning Grounds

(b) Samples Away from the OB Site. No TEP metals were detected.

(2) Explosives.

(a) Samples Within/Near the OB Site. Of the samples collected from the top two horizons (0- to 6-inches and 6- to 18-inches), 59 percent contained TNT in excess of the 1,000 µg/g reactivity guideline, 45 percent contained RDX in excess of this guideline, and 17 percent exceeded the HMX guideline. Additionally, these three explosives were detected in virtually all samples from these shallow depths. The remaining explosives were detected at concentrations less than the guideline in a major portion of these samples as well. This discussion includes samples collected directly at the OB site as well as those collected immediately downgradient. The high explosives levels in all of these samples indicate that horizontal migration of contaminants is occurring in surface soils. In comparison, no explosives exceeded the guideline in samples collected from depths greater than 18 inches. Although explosives were detected in some samples collected from greater depths, only trace concentrations were found.

(b) Samples Away from the OB Site. One sample contained an explosive (RDX) in a concentration exceeding the 1,000 µg/g guideline. No logical explanation can be given for this anomoly since samples collected above and below that sample contained little if any contamination, and adjacent boreholes contained no contamination. Three other samples contained trace levels of explosives. The lack of significant levels of explosives farther away from the OB site indicates that migration of contaminants has, thus far, been limited to the area adjacent to the burning pads.

d. Site Operations. The following incorrect operational practices were noted: OB of nonexplosive materials, burning of waste-containing liquids, and leaving OB residue on the surface for an extended period of time. Additionally, it was noted that at the time of soil sampling, the concrete catchment basin was reported to have had significant cracks causing the impoundment to leak. A project to seal these cracks has since been initiated. The leaking basin is probably the source of contaminants which migrated from the OB site. It is unlikely that OB activities have caused this contamination since samples collected directly beneath the pads contained only low levels of contaminants.

4. CONCLUSIONS.

a. As shown in Table I-25, 66 percent of soil samples collected within or near the OB site from the top 18 inches of soil contained contaminants which exceeded applicable limits or guidelines. No samples collected from depths greater than 18 inches exceeded limits/guidelines. Only trace levels of contaminants were detected in any samples from these lower levels.

b. As shown in Table I-26, one soil sample collected away from the OB site exceeded limits/guidelines. However, this contamination could not be explained and may be due to sampling or analytical errors. A small number of samples contained trace levels of contaminants.

c. Significant contamination exists at the OB site but was limited to the top 18 inches of soil.

d. Significant contamination exists immediately down gradient in the top 18 inches of soil. This contamination is most likely due to contaminated runoff leaking from the OB site catchment basin.

e. The primary contaminants were TNT, RDX, and HMX.

TABLE I-1 INSTALLATION: LOUISIANA AAP

CONTAMINANT: CD SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	17	100	0	0	100	0	0	17	100
6-18"	12	100	0	0	100	0	0	12	100
18"-5'	10	100	0	0	100	0	0	10	100
5-10'	10	91	1	9	100	0	0	11	100
10-20'	4	100	0	0	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--

TABLE I-2 INSTALLATION: LOUISIANA AAP

CONTAMINANT: CD SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	1	100	0	0	100	0	0	1	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	11	100	0	0	100	0	0	11	100
10-20'	9	100	0	0	100	0	0	9	100
20'+	3	100	0	0	100	0	0	3	100

TABLE I-3 INSTALLATION: LOUISIANA AAP

CONTAMINANT: HG SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	17	100	0	0	100	0	0	17	100
6-18"	11	92	0	0	92	1	8	12	100
18"-5'	9	90	1	10	100	0	0	10	100
5-10'	11	100	0	0	100	0	0	11	100
10-20'	4	100	0	0	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--

TABLE I-4 INSTALLATION: LOUISIANA AAP

CONTAMINANT: HG SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	1	100	0	0	100	0	0	1	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	11	100	0	0	100	0	0	11	100
10-20'	9	100	0	0	100	0	0	9	100
20'+	3	100	0	0	100	0	0	3	100

TABLE I-5 INSTALLATION: LOUISIANA AAP

CONTAMINANT: PB SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	16	94.117	1	5.8823	100	0	0	17	100
6-18"	12	100	0	0	100	0	0	12	100
18"-5'	10	100	0	0	100	0	0	10	100
5-10'	11	100	0	0	100	0	0	11	100
10-20'	4	100	0	0	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--

TABLE I-6 INSTALLATION: LOUISIANA AAP

CONTAMINANT: PB SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	1	100	0	0	100	0	0	1	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	11	100	0	0	100	0	0	11	100
10-20'	9	100	0	0	100	0	0	9	100
20'+	3	100	0	0	100	0	0	3	100

TABLE I-7 INSTALLATION: LOUISIANA AAP

CONTAMINANT: AG, AS, BA, CR, SE SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	17	100	0	0	100	0	0	17	100
6-18"	12	100	0	0	100	0	0	12	100
18"-5'	10	100	0	0	100	0	0	10	100
5-10'	11	100	0	0	100	0	0	11	100
10-20'	4	100	0	0	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--

TABLE I-8 INSTALLATION: LOUISIANA AAP

CONTAMINANT: AG, AS, BA, CR, SE SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	1	100	0	0	100	0	0	1	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	11	100	0	0	100	0	0	11	100
10-20'	9	100	0	0	100	0	0	9	100
20'+	3	100	0	0	100	0	0	3	100

TABLE I-9 INSTALLATION: LOUISIANA AAP

CONTAMINANT: RDX SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	0	0	9	53	53	8	47	17	100
6-18"	0	0	7	58	58	5	42	12	100
18"-5'	5	50	5	50	100	0	0	10	100
5-10'	5	45	6	55	100	0	0	11	100
10-20'	1	25	3	75	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--

TABLE I-10 INSTALLATION: LOUISIANA AAP

CONTAMINANT: RDX SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	1	100	0	0	100	0	0	1	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	11	85	1	8	92	1	8	13	100
10-20'	8	89	1	11	100	0	0	9	100
20'+	3	100	0	0	100	0	0	3	100

TABLE I-11 INSTALLATION: LOUISIANA AAP

CONTAMINANT: HMX SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	0	0	14	82	82	3	18	17	100
6-18"	1	8	9	75	83	2	17	12	100
18"-5'	7	70	3	30	100	0	0	10	100
5-10'	9	82	2	18	100	0	0	11	100
10-20'	4	100	0	0	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--

TABLE I-12 INSTALLATION: LOUISIANA AAP

CONTAMINANT: HMX SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	1	100	0	0	100	0	0	1	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	12	92	1	8	100	0	0	13	100
10-20'	9	100	0	0	100	0	0	9	100
20'+	3	100	0	0	100	0	0	3	100

TABLE I-13 INSTALLATION: LOUISIANA AAP

CONTAMINANT: TNT SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	0	0	8	47	47	9	53	17	100
6-18"	0	0	4	33	33	8	67	12	100
18"-5'	10	100	0	0	100	0	0	10	100
5-10'	11	100	0	0	100	0	0	11	100
10-20'	4	100	0	0	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--

TABLE I-14 INSTALLATION: LOUISIANA AAP

CONTAMINANT: TNT SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	1	100	0	0	100	0	0	1	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	13	100	0	0	100	0	0	13	100
10-20'	9	100	0	0	100	0	0	9	100
20'+	3	100	0	0	100	0	0	3	100

TABLE I-15 INSTALLATION: LOUISIANA AAP

CONTAMINANT: TETRYL SAMPLES WITHIN OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	15	88	2	12	100	0	0	17	100
6-18"	10	83	2	17	100	0	0	12	100
18"-5'	10	100	0	0	100	0	0	10	100
5-10'	11	100	0	0	100	0	0	11	100
10-20'	4	100	0	0	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--

TABLE I-16 INSTALLATION: LOUISIANA AAP

CONTAMINANT: TETRYL SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	1	100	0	0	100	0	0	1	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	13	100	0	0	100	0	0	13	100
10-20'	9	100	0	0	100	0	0	9	100
20'+	3	100	0	0	100	0	0	3	100

TABLE I-17 INSTALLATION: LOUISIANA AAP

CONTAMINANT: 2,6-DNT SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	12	71	5	29	100	0	0	17	100
6-18"	4	33	8	67	100	0	0	12	100
18"-5'	10	100	0	0	100	0	0	10	100
5-10'	11	100	0	0	100	0	0	11	100
10-20'	4	100	0	0	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--

TABLE I-18 INSTALLATION: LOUSIANA AAP

CONTAMINANT: 2,6-DNT SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	1	100	0	0	100	0	0	1	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	13	100	0	0	100	0	0	13	100
10-20'	9	100	0	0	100	0	0	9	100
20'+	3	100	0	0	100	0	0	3	100

TABLE I-19 INSTALLATION: LOUISIANA AAP

CONTAMINANT: 2,4-DNT SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	11	65	6	35	100	0	0	17	100
6-18"	6	50	6	50	100	0	0	12	100
18"-5'	10	100	0	0	100	0	0	10	100
5-10'	11	100	0	0	100	0	0	11	100
10-20'	4	100	0	0	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--

TABLE I-20 INSTALLATION: LOUISIANA AAP

CONTAMINANT: 2,4-DNT SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	1	100	0	0	100	0	0	1	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	13	100	0	0	100	0	0	13	100
10-20'	9	100	0	0	100	0	0	9	100
20'+	3	100	0	0	100	0	0	3	100

TABLE I-21 INSTALLATION: LOUISIANA AAP

CONTAMINANT: SUM OF EXPLOSIVES DATA SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	38	37	44	43	80	20	20	102	100
6-18"	21	29	36	50	79	15	21	72	100
18"-5'	52	87	8	13	100	0	0	60	100
5-10'	58	88	8	12	100	0	0	66	100
10-20'	21	88	3	13	100	0	0	24	100
20'+	--	--	--	--	--	--	--	0	--

TABLE I-22 INSTALLATION: LOUISIANA AAP

CONTAMINANT: SUM OF EXPLOSIVES DATA SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	6	100	0	0	100	0	0	6	100
18"-5'	72	100	0	0	100	0	0	72	100
5-10'	75	96	2	3	99	1	1	78	100
10-20'	53	98	1	2	100	0	0	54	100
20'+	18	100	0	0	100	0	0	18	100

TABLE I-23 INSTALLATION: LOUISIANA AAP

CONTAMINANT: SUM OF METALS DATA SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	135	99	1	1	100	0	0	136	100
6-18"	95	99	0	0	99	1	1	96	100
18"-5'	79	99	1	1	100	0	0	80	100
5-10'	87	99	1	1	100	0	0	88	100
10-20'	32	100	0	0	100	0	0	32	100
20'+	--	--	--	--	--	--	--	0	--

TABLE I-24 INSTALLATION: LOUISIANA AAP

CONTAMINANT: SUM OF METALS DATA SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	8	100	0	0	100	0	0	8	100
18"-5'	96	100	0	0	100	0	0	96	100
5-10'	88	100	0	0	100	0	0	88	100
10-20'	72	100	0	0	100	0	0	72	100
20'+	24	100	0	0	100	0	0	24	100

TABLE I-25 INSTALLATION: LOUISIANA AAP

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS SAMPLES WITHIN/NEAR OB SITE

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	> TEP LIMIT OR GUIDELINE #	> TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	0	0	7	41	41	10	59	17	100
6-18"	0	0	3	25	25	9	75	12	100
18"-5'	3	30	7	70	100	0	0	10	100
5-10'	5	45	6	55	100	0	0	11	100
10-20'	2	50	2	50	100	0	0	4	100
20'+	--	--	--	--	--	--	--	0	--

TABLE I-26 INSTALLATION: LOUISIANA AAP

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS SAMPLES AWAY FROM OB SITE

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	> TEP LIMIT OR GUIDELINE #	> TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	--	--	--	--	--	--	--	0	--
6-18"	1	100	0	0	100	0	0	1	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	11	85	1	8	92	1	8	13	100
10-20'	8	89	1	11	100	0	0	9	100
20'+	3	100	0	0	100	0	0	3	100

Figure I-2.

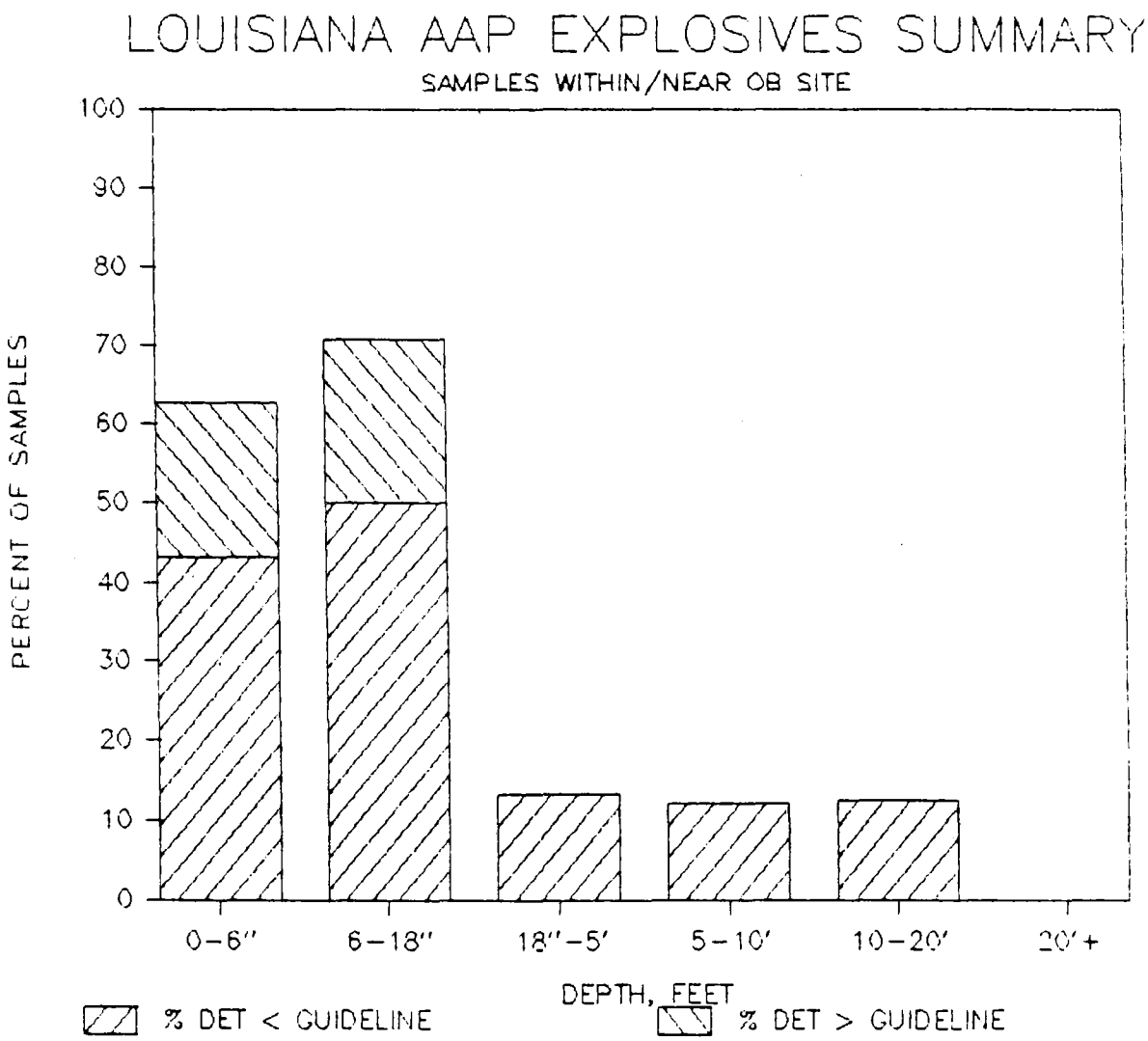

LOUISIANA AAP EXPLOSIVES SUMMARY
SAMPLES WITHIN/NEAR OB SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
20'+
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure I-3.

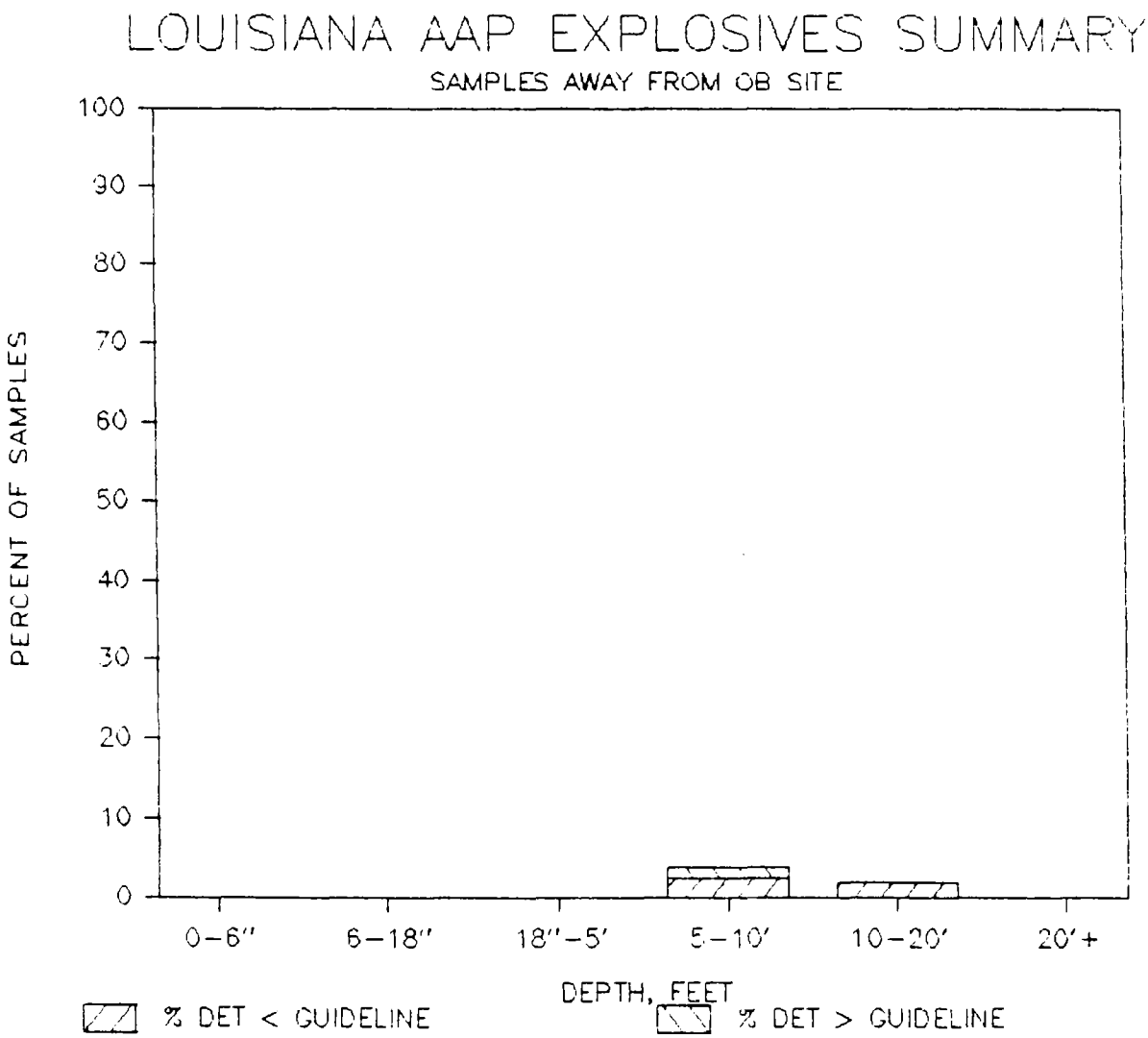

LOUISIANA AAP EXPLOSIVES SUMMARY
SAMPLES AWAY FROM OB SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
20'+
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure I-4.

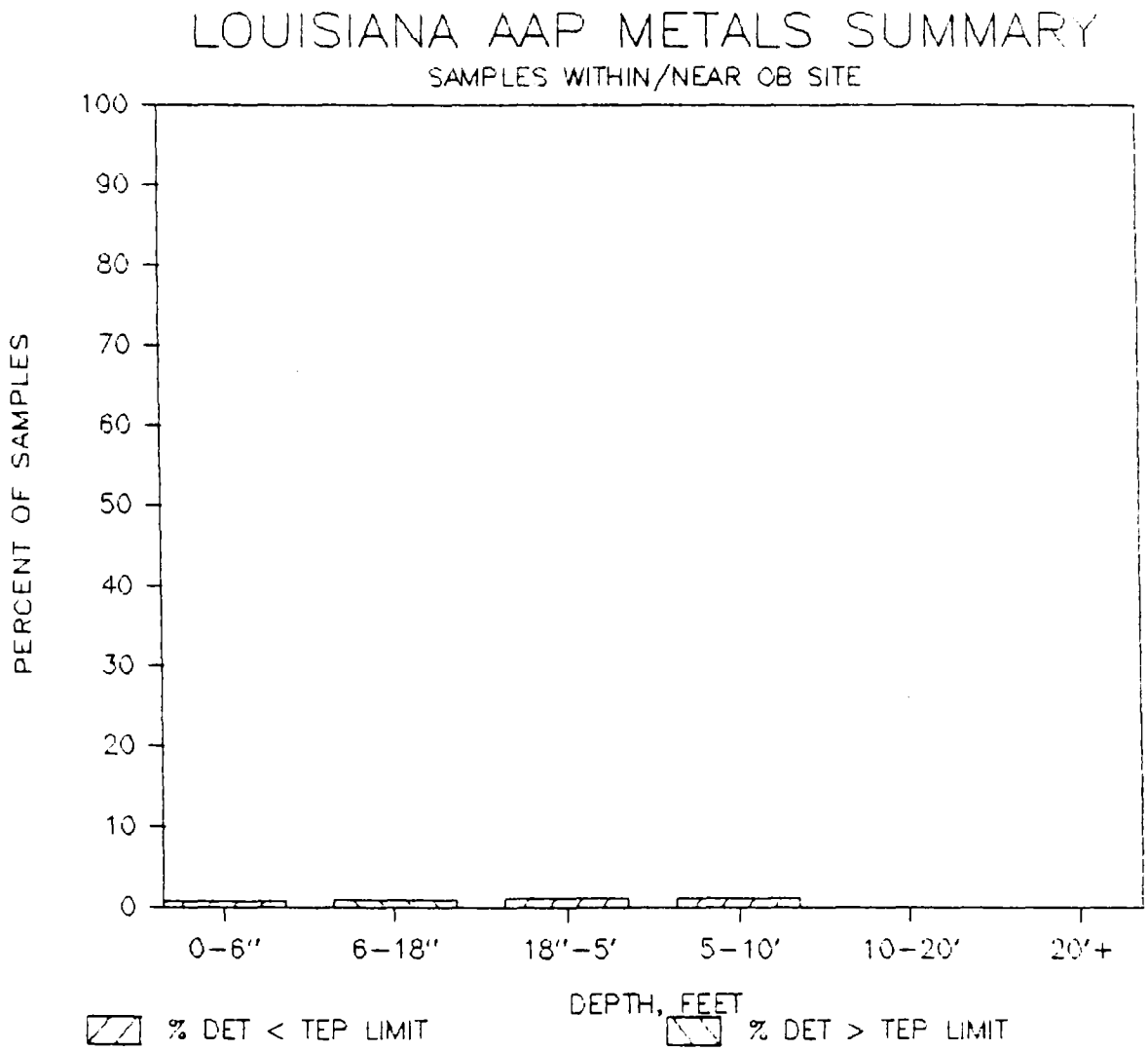
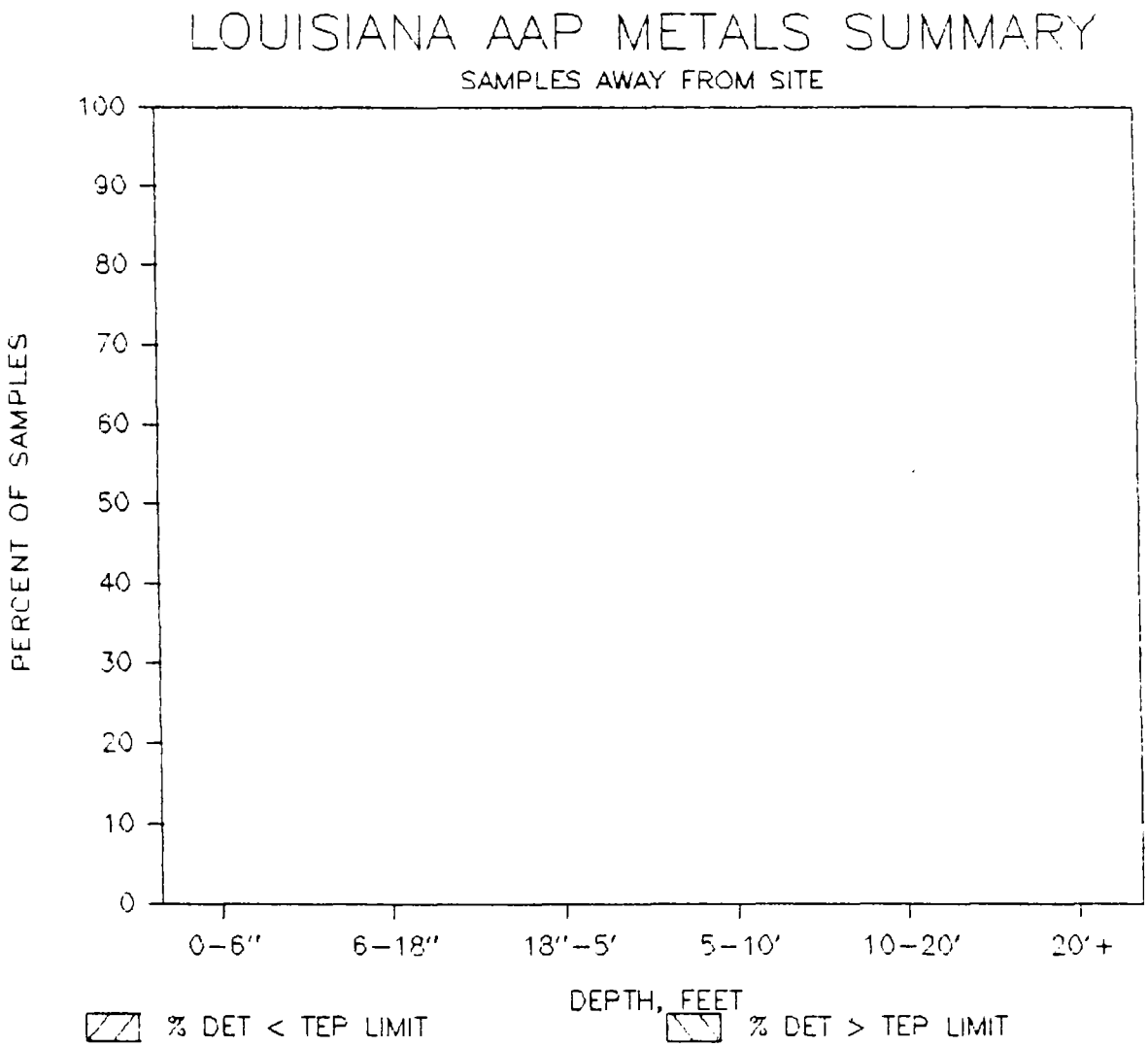

LOUISIANA AAP METALS SUMMARY
SAMPLES WITHIN/NEAR OB SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
20'+
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

Figure I-5.


LOUISIANA AAP METALS SUMMARY
SAMPLES AWAY FROM SITE
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
20'+
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

APPENDIX J

SUMMARY OF OB SOIL INVESTIGATION AT NEWPORT ARMY AMMUNITION PLANT NEWPORT, INDIANA

1. ENVIRONMENTAL SETTING.

a. General Physiography and Stratigraphy. Newport AAP is located within the Central Lowlands physiographic province. It is situated on a glacial till plain, modified by stream dissection. Most of the installation's land is characterized by slightly depressional to nearly level upland. A surface water drainage divide separates the southern watershed (Little Raccoon Creek), which displays rather shallow and broad stream valleys, from the northern watershed (Little Vermillion River), which has somewhat steeper channel slopes. Surface elevations of Newport AAP range from about 650-feet above mean sea level near the main entrance to about 530 feet in the northern drainage system. During the Pleistocene Epoch, the Newport area had been covered by at least two ice sheets, namely the Kansan and Wisconsin Stages. Most of the installation is underlain by about 70 to 80 feet of unconsolidated glacial till which is primarily a stratified ground moraine capped by thin loess (wind-deposited silt and fine sand) and grades into end moraine deposits along the escarpment formed by the Wabash River to the east. The till is composed of unsorted clay, silt, sand, and minor gravel and displays both vertical and lateral variability. The uppermost consolidated bedrock unit below the glacial deposits is the Carbondale Group composed of shale and sandstone of Pennsylvania Age, ranging in thickness from about 10 to 100 feet. The bedrock units form part of the western limb of a large anticline striking north-south and gently dipping to the southwest. There is no evidence of any significant local faulting.

b. Soils. The explosives burning ground is immediately underlain by about 2 to 4 feet of black, gray, tan, to brown silty clay which, in turn, is underlain by 4 to 12 feet of gray sandy clay with sand and gravel stringers. There is much vertical variability. The depth to bedrock below the glacial deposits is estimated to be about 80-feet below the surface at the burning ground according to a generalized cross section.

c. Ground Water. During the drilling of the four ground-water monitoring wells at the explosives burning ground area, the initial water level in wells No. 1, 2, and 3 was about 10-feet below the surface according to the drilling logs. The water rose to a depth of about 4 to 5 feet below the surface in all four wells after 24 hours. The 24-hour ground-water depth in the borings drilled during Phase 4 varied from 5- to 15-feet below the surface. Apparently, the ground water in the glacial till in this particular area flows toward the south-southeast.

d. Precipitation and Evaporation. The mean annual precipitation in the Newport AAP area is approximately 37 inches. The mean annual lake evaporation in this vicinity is approximately 32 inches.

2. OVERVIEW OF THE OPEN BURNING AREA. The NAAP conducts all of its OB activities in one burn area located in the southwest portion of the installation. As shown in the drawing in Figure J-1, this area consists of two large burn pads, each approximately 150-feet square, and a burn cage in the northwest corner of the site. Additionally, operators at the site reported the existence of an explosives burial trench near the southwest corner of the OB area. This trench was used to dispose of various explosive sludges generated during the closing of the TNT production facility around 1974.

3. BURNING GROUND SITE EVALUATIONS.

a. Phase 2 Site Sampling Methodologies and Locations. See Appendix A, reference 26, for a detailed discussion of this investigation. Phase 2 sampling was conducted in February 1982. A total of 19 soil samples were collected from 10 locations at the two OB pads. The majority of these locations were immediately adjacent to the OB pads. Samples were composited for depths of from 0 to 6 inches, and 6 to 18 inches.

b. Phase 4 Site Sampling Methodologies and Locations. See Appendix A, reference 27, for a detailed discussion of this investigation. Phase 4 sampling was conducted during the period 5-11 October 1983. A total of 65 samples were collected from 18 boreholes around the OB area as shown in Figure J-1. Note that six of the boreholes were located at the periphery of the OB pads, one was at the edge of the burn cage, and the 11 others were sited farther away beyond the fence line surrounding the OB site. Additional sampling was also performed near the suspected site of the burial trench. All sampling was conducted with a hollow-stem augering system, which greatly reduces down-hole contamination between samples. The depths of these boreholes ranged from 9 to 20 feet.

c. Analytical Results of Sampling Investigations. Analytical results are summarized in Tables J-1 through J-8, and Figures J-2 and J-3.

(1) Metals. No TEP metals were detected in any samples.

(2) Explosives. No explosives were detected above the 1,000 µg/g reactivity guideline in any samples away from the burial trench. Explosives detected in concentrations less than this guideline, in decreasing frequency of detection, were 2,4-DNT, 2,6-DNT, and TNT. These compounds were only found in samples collected greater than 18 inches below the surface. As shown in Figure J-4, most of the soils contamination is located in the vicinity of the burial trench. This plume of contamination was migrating within the shallow, perched ground-water. In comparison, limited contamination was found in the vicinity of the OB pads and burn cage. This implies that subsurface soil contamination, due to OB operations, is quite limited.

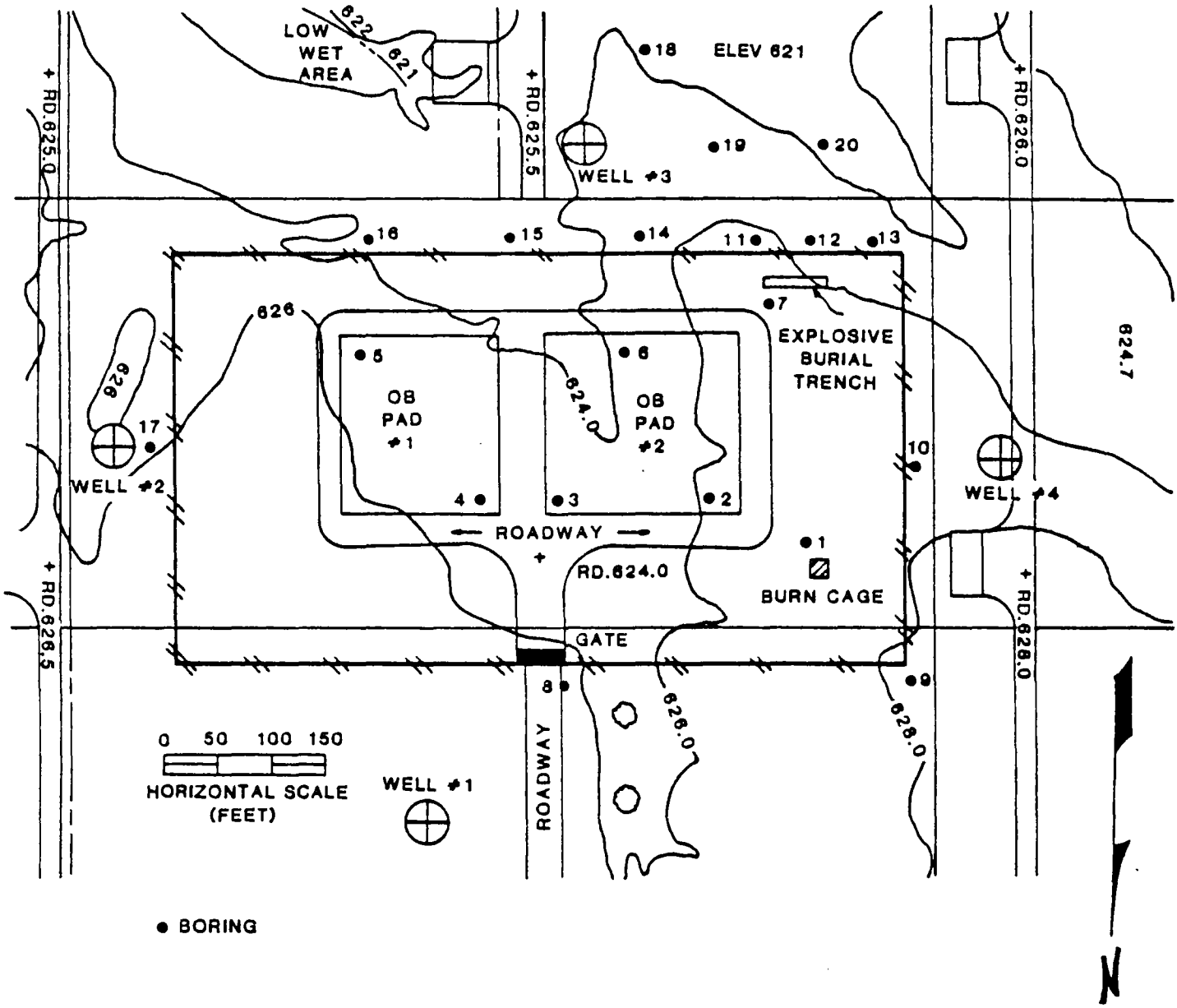


FIGURE J-1 NEWPORT AAP OPEN BURNING GROUND

d. Site Operations. No observations of incorrect or abnormal OB site operations were made.

4. CONCLUSIONS. As shown in Table J-8, no soil samples exceeded applicable limits or guidelines. Samples in which explosives were detected below the applicable guideline comprised 29 percent of the total number of samples collected at depths greater than 18 inches. However, the majority of this contamination was due to migration of explosives from an old burial trench. Contamination attributable to OB operations was minimal.

TABLE J-1 INSTALLATION: NEWPORT AAP

CONTAMINANT: EACH METAL

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	9	100	0	0	100	0	0	9	100
6-18"	11	100	0	0	100	0	0	11	100
18"-5'	18	100	0	0	100	0	0	18	100
5-10'	26	100	0	0	100	0	0	26	100
10-20'	21	100	0	0	100	0	0	21	100

TABLE J-2 INSTALLATION: NEWPORT AAP

CONTAMINANT: TNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	9	100	0	0	100	0	0	9	100
6-18"	11	100	0	0	100	0	0	11	100
18"-5'	16	89	2	11	100	0	0	18	100
5-10'	22	88	3	12	100	0	0	25	100
10-20'	20	95	1	5	100	0	0	21	100

TABLE J-3 INSTALLATION: NEWPORT AAP

CONTAMINANT: 2,6-DNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	9	100	0	0	100	0	0	9	100
6-18"	11	100	0	0	100	0	0	11	100
18"-5'	16	89	2	11	100	0	0	18	100
5-10'	21	84	4	16	100	0	0	25	100
10-20'	19	90	2	10	100	0	0	21	100

TABLE J-4 INSTALLATION: NEWPORT AAP

CONTAMINANT: 2,4-DNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	9	100	0	0	100	0	0	9	100
6-18"	11	100	0	0	100	0	0	11	100
18"-5'	13	72	5	28	100	0	0	18	100
5-10'	15	60	10	40	100	0	0	25	100
10-20'	17	81	4	19	100	0	0	21	100

TABLE J-5 INSTALLATION: NEWPORT AAP

CONTAMINANT: RDX, HMX, TETRYL

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	9	100	0	0	100	0	0	9	100
6-18"	11	100	0	0	100	0	0	11	100
18"-5'	18	100	0	0	100	0	0	18	100
5-10'	25	100	0	0	100	0	0	25	100
10-20'	21	100	0	0	100	0	0	21	100

TABLE J-6 INSTALLATION: NEWPORT AAP

CONTAMINANT: SUM OF METALS DATA

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	72	100	0	0	100	0	0	72	100
6-18"	88	100	0	0	100	0	0	88	100
18"-5'	144	100	0	0	100	0	0	144	100
5-10'	208	100	0	0	100	0	0	208	100
10-20'	168	100	0	0	100	0	0	168	100

TABLE J-7 INSTALLATION: NEWPORT AAP

CONTAMINANT: SUM OF EXPLOSIVES DATA

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	54	100	0	0	100	0	0	54	100
6-18"	66	100	0	0	100	0	0	66	100
18"-5'	99	92	9	8	100	0	0	108	100
5-10'	133	89	17	11	100	0	0	150	100
10-20'	119	94	7	6	100	0	0	126	100

TABLE J-8 INSTALLATION: NEWPORT AAP

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	> TEP LIMIT OR GUIDELINE #	> TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	9	100	0	0	100	0	0	9	100
6-18"	11	100	0	0	100	0	0	11	100
18"-5'	13	72	5	28	100	0	0	18	100
5-10'	16	62	10	38	100	0	0	26	100
10-20'	17	81	4	19	100	0	0	21	100

Figure J-2.

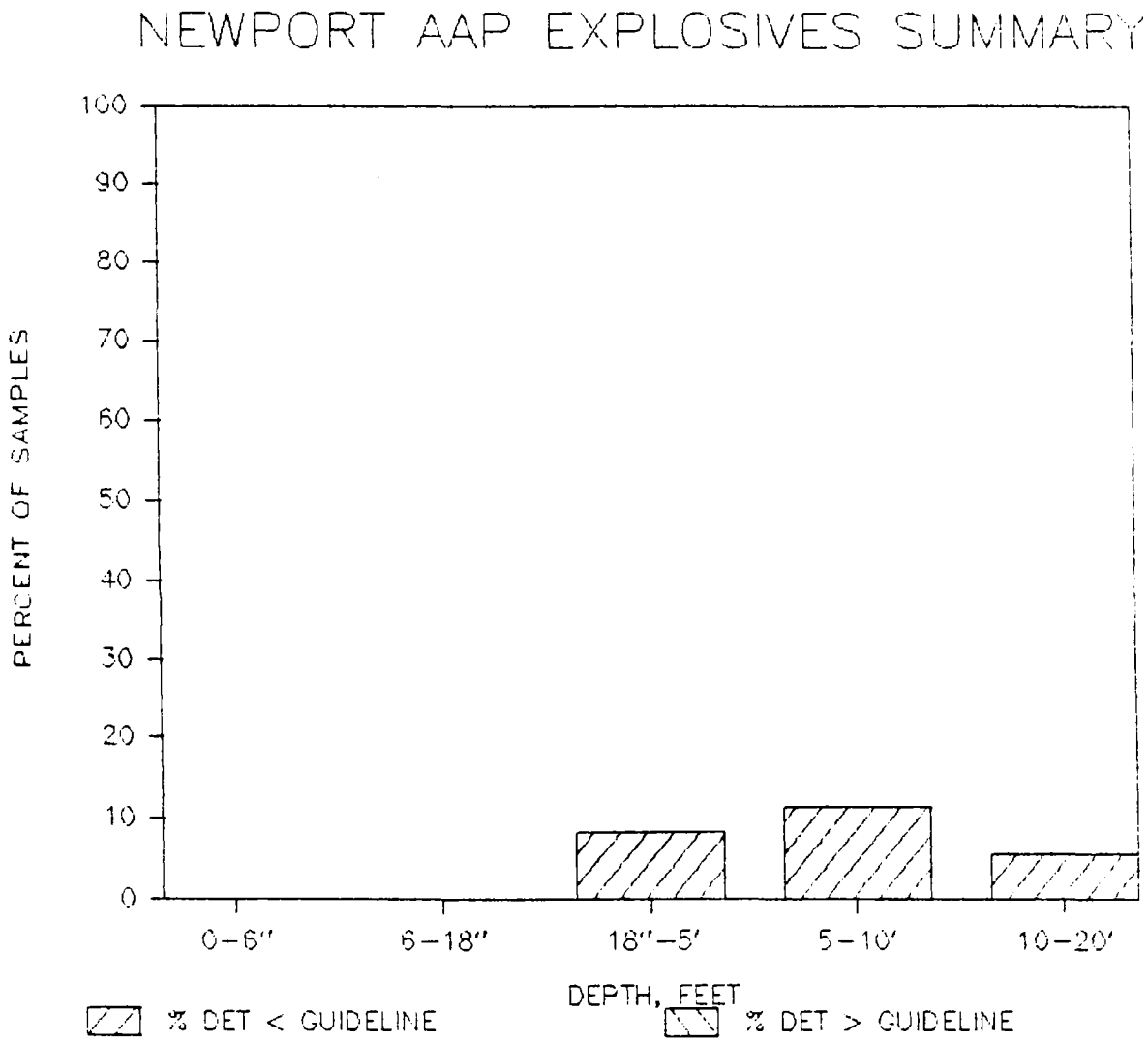
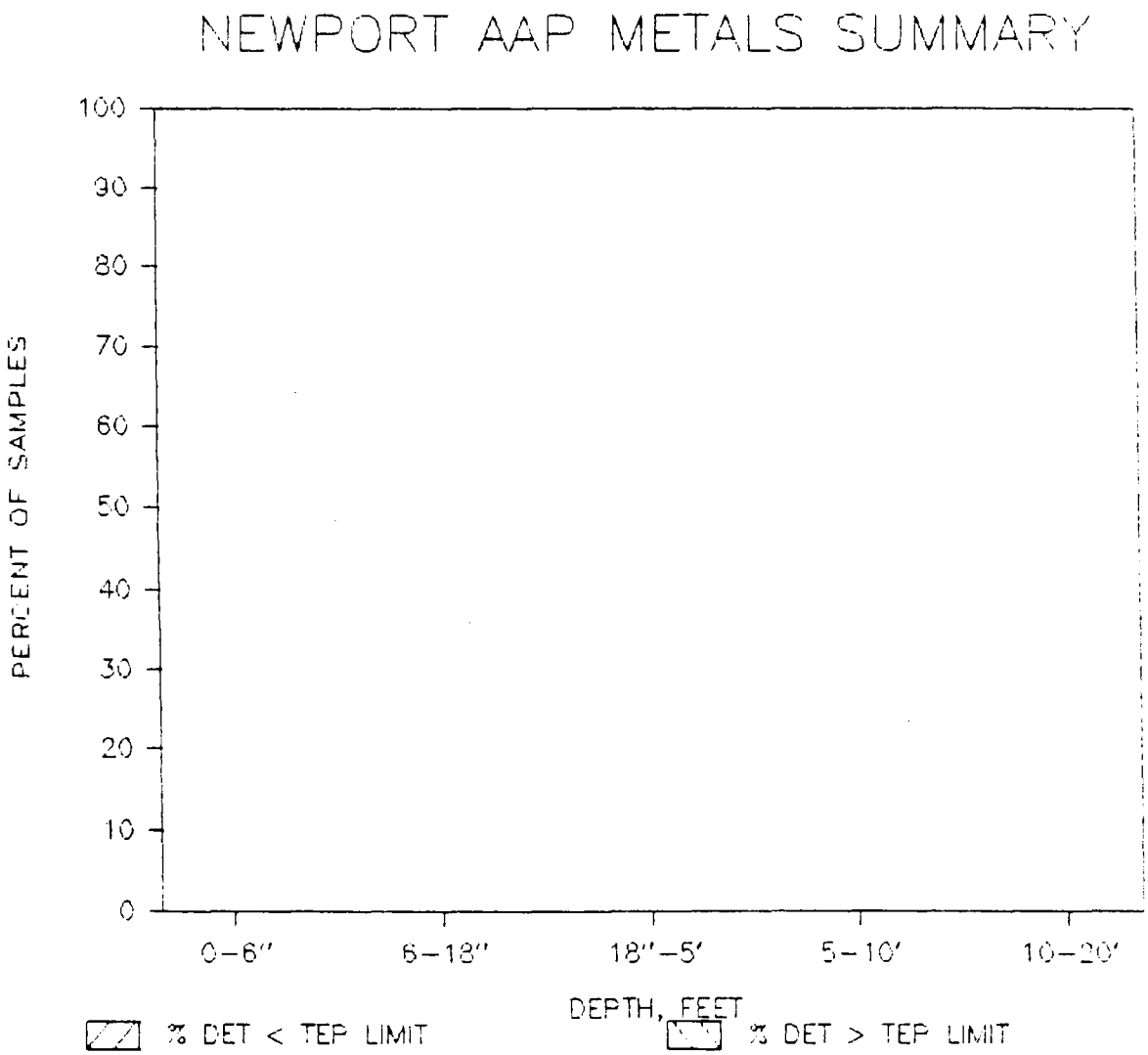

NEWPORT AAP EXPLOSIVES SUMMARY
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure J-3.


NEWPORT AAP METALS SUMMARY
100
90
80
70
60
50
40
30
20
10
0
PERCENT OF SAMPLES
0-6"
6-18"
18"-5'
5-10'
10-20'
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

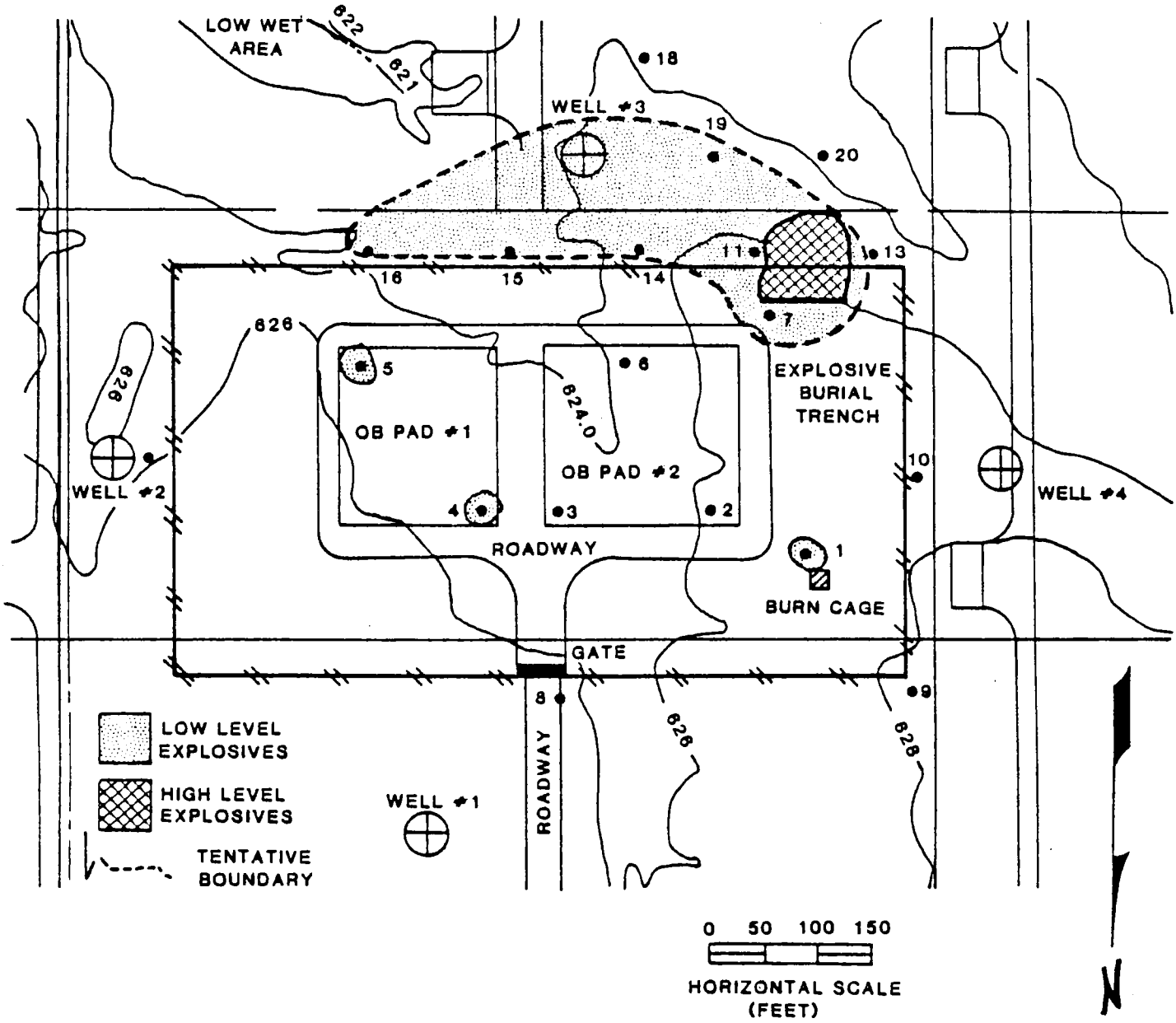


FIGURE J-4 NEWPORT AAP EXPLOSIVES CONTAMINATION

APPENDIX K

SUMMARY OF OB SOIL INVESTIGATIONS AT RADFORD ARMY AMMUNITION PLANT RADFORD, VIRGINIA

1. ENVIRONMENTAL SETTING.

a. General Physiography and Stratigraphy.

(1) Regional. Radford AAP is located in Pulaski and Montgomery Counties, in southwest Virginia, approximately 7 miles northwest of the city of Radford. Radford AAP lies totally within the Southern Virginia section of the Valley and Ridge physiographic province, which is part of the Appalachian Highland Region of North America. The topography is characterized by elongated, narrow, flat-topped ridges of resistant sandstone and dolomites that strike southwest to northeast. Conversely, the valleys are composed of less resistant limestones and shales. The New River bisects Radford AAP from west to east forming a prominent horseshoe bend. Radford AAP occupies the rolling, terraced, karst floodplain and the horseshoe-shaped, entrenched, meander loop of the New River. The entrenched meander has limestone escarpments which approach 250 feet in height at places along the south bank of the horseshoe and along the north and east cutbank of the New River. A small ridge which opens to the southeast circumvents the plant, the highest portion of which is found on the southeastern corner. From this point, the terrain slopes gradually north beneath the main plant to the New River. Elevations range from 1,700 feet MSL along the New River to 2,225 feet MSL in the extreme southeast section of Radford AAP. The horseshoe meander exhibits a rolling karst terrain with three prominent terraces and escarpments. The terraced plains and escarpments are remnants of the ancient New River floodplains.

(2) Local. The OB ground is situated in the floodplain area between the base of the exposed Elbrook escarpment and the New River. The site lies within the 100 year floodplain of this river.

b. Soils. The overburden soil at the OB ground consists of unconsolidated, alluvial plain, bank deposits from the New River. The alluvium is composed of a rather homogeneous matrix of reddish-brown fine sandy silts and inorganic clays which extend uniformly from the surface to bedrock. The overburden soil averages about 13.5 feet in depth above bedrock. Soil samples taken at various depths from around the OB pads revealed a relatively narrow range of moderate permeabilities between 2.39×10^{-3} cm/sec to 9.6×10^{-4} cm/sec. These permeability values would indicate that precipitation, carrying solubilized contaminants, could slowly infiltrate the soil column down to bedrock. Infiltrated water at bedrock elevation is then probably diverted directly to the New River through ground-surfacing seeps, since the dip of the bedrock is to the southeast and the elevation of the bedrock in the borings is about 1 to 3 feet above the elevation of the partially exposed bedrock in h New River.

c. Ground Water. Ground-water flow at Radford AAP is site specific and follows local structural trends. Earlier test borings in the floodplain have indicated that the elevation of the water table in the floodplain alluvium adjacent to the New River is approximately the same as the surface elevation of the river. It is also suggested that the New River recharges and reverses the gradient of the ground-water table in the floodplain during flood stage. During the drilling of the borings, and after 24 hours and 48 hours, there was no evidence of ground water in the borings at the OB ground. Except for borings 3 and 5, which were terminated due to Radford AAP-required OB operations, all borings encountered bedrock at between 13.5 feet (1,681.78 feet MSL) and 14 feet (1,684.39 feet MSL). These bedrock elevations, which dip to the southeast, are approximately 1 to 3 feet above the elevation of the New River at 1,680 feet MSL and tend to collaborate the lack of ground water observed during drilling, at this time of year.

d. Precipitation and Evaporation. The mean annual precipitation for the Radford AAP area is approximately 40 inches. The mean annual lake evaporation is approximately 34 inches.

2. OVERVIEW OF THE OPEN BURNING AREA. The OB area, located along the New River in the southeastern portion of the Horseshoe Area, is approximately 100 feet by 1,500 feet in size. The actual burning of explosive waste is performed on raised pads about 25 feet square. There are eight sites in the area, each consisting of two raised pads for a total of 16 pads (see Figure K-1). The lowest elevation of the OB ground nearest the New River is girded by a high, crushed-rock berm. The rear portion of each burn pad, at a distance of 10 feet from the rock berm, is raised to provide a flat burning surface on the sloping topography (see Figure K-2). The elevated pads prevent surface water run-on, but cannot prevent surface water runoff from the pad. The OB area is used daily for the burning of floor sweepings, faulty batches of explosives, and other explosive waste which cannot be processed in the waste incinerator located on-post.

3. BURNING GROUND SITE EVALUATIONS.

a. Phase 2 Sampling Methodologies and Locations. See Appendix A, reference 28, for a detailed discussion of this investigation. Phase 2 sampling was conducted on 14-15 June 1983. A total of 17 samples were collected from 12 locations at the OB pads. Samples were composited for depths of from 0 to 6 inches, and 6 to 18 inches.

b. Phase 4 Sampling Methodologies and Locations. See Appendix A, reference 29, for a detailed discussion of this investigation. Phase 4 sampling was conducted during the period 22-26 October 1984. A total of 35 samples were collected from 7 boreholes located, as shown in Figure K-1. Borehole depths ranged from 9 to 14 feet.

c. Analytical Results of Sampling Investigations. Analytical results are summarized in Tables K-1 through K-12 and Figures K-3 and K-4.

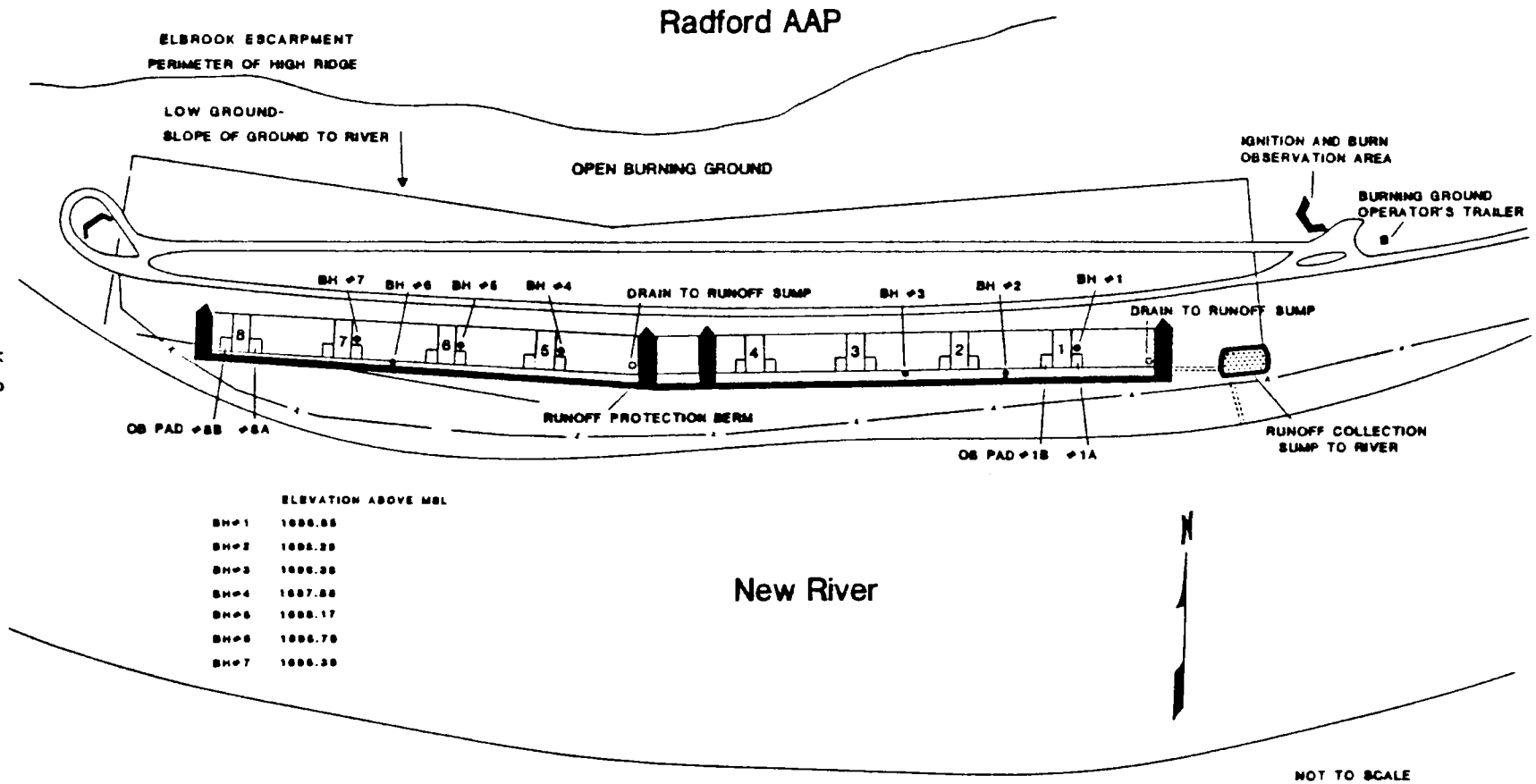


FIGURE K-1. RADFORD AAP OPEN BURNING GROUND

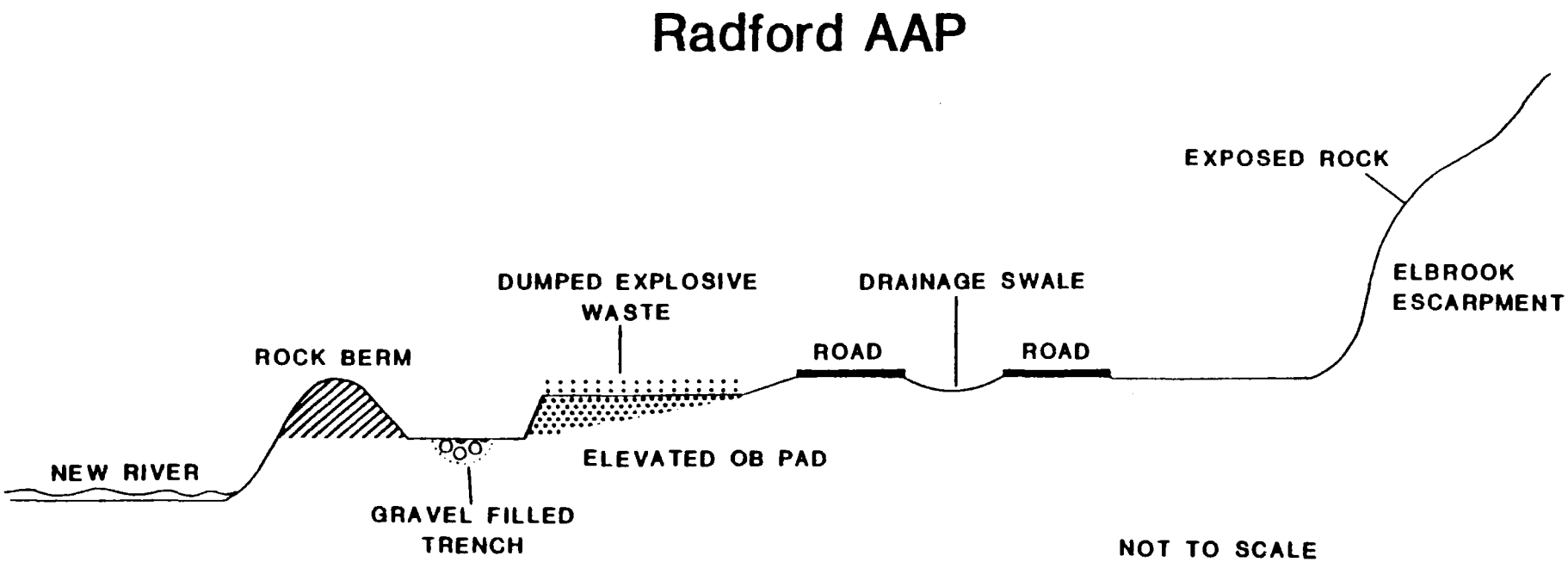


FIGURE K-2. IDEALIZED CROSS-SECTION OF RADFORD AAP OPEN BURNING AREA

(1) Metals. Two 0- to 6-inch samples contained lead which exceeded its TEP limit. Lead was also detected in concentrations less than the TEP limit in three other 0- to 6-inch samples. Cadmium was detected at a trace level in one surface sample. No samples collected at greater depths contained detectable quantities of TEP metals.

(2) Explosives. TNT and 2,4-DNT were each found in two 0- to 6-inch samples at concentrations exceeding the 1,000 µg/g reactivity guideline. These two explosives were detected at levels less than this guideline in approximately half of the samples collected from the top 18 inches of soil. Three other explosives were detected in a small number of 0- to 6-inch or 6- to 18-inch samples. Trinitrotoluene and 2,4-DNT were detected in insignificant trace levels in a small number of samples collected at greater depths.

d. Site Operations and Design. The French drain located below the OB pads rapidly conveys surface water runoff away from the OB area. The potential exists for this runoff to be contaminated by OB residues. No observations of incorrect or abnormal OB site operations were made.

4. CONCLUSIONS.

a. As shown in Table K-12, 26 percent of samples collected in the 0- to 6-inch interval contained contaminants which exceeded the applicable limits or guidelines. No other samples exceeded these limits/guidelines. The percentage of samples in which no contaminants were detected increased from 16 percent to 60 percent as sample depth increased from 0- to 6-inches to 10-20 feet. Only trace levels of contaminants were detected in samples collected from depths exceeding 18 inches.

b. Surface soils down to a depth of 18 inches are contaminated with substantial concentrations of explosives, and to a lesser extent, metals.

c. The potential exists for contaminated surface soils to be transported from the OB site via surface runoff.

d. The primary contaminants were TNT, 2,4-DNT, and lead.

TABLE K-1 INSTALLATION: RADFORD AAP

CONTAMINANT: CD

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	18	95	1	5	100	0	0	19	100
6-18"	8	100	0	0	100	0	0	8	100
18"-5'	7	100	0	0	100	0	0	7	100
5-10'	13	100	0	0	100	0	0	13	100
10-20'	5	100	0	0	100	0	0	5	100

TABLE K-2 INSTALLATION: RADFORD AAP

CONTAMINANT: PB

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	14	74	3	16	89	2	11	19	100
6-18"	8	100	0	0	100	0	0	8	100
18"-5'	7	100	0	0	100	0	0	7	100
5-10'	13	100	0	0	100	0	0	13	100
10-20'	5	100	0	0	100	0	0	5	100

TABLE K-3 INSTALLATION: RADFORD AAP

CONTAMINANT: EACH METAL EXCEPT CD & PB

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	19	100	0	0	100	0	0	19	100
6-18"	8	100	0	0	100	0	0	8	100
18"-5'	7	100	0	0	100	0	0	7	100
5-10'	13	100	0	0	100	0	0	13	100
10-20'	5	100	0	0	100	0	0	5	100

TABLE K-4 INSTALLATION: RADFORD AAP

CONTAMINANT: RDX

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	18	95	1	5	100	0	0	19	100
6-18"	8	100	0	0	100	0	0	8	100
18"-5'	7	100	0	0	100	0	0	7	100
5-10'	13	100	0	0	100	0	0	13	100
10-20'	5	100	0	0	100	0	0	5	100

TABLE K-5 INSTALLATION: RADFORD AAP

CONTAMINANT: HMX

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	19	100	0	0	100	0	0	19	100
6-18"	7	88	1	13	100	0	0	8	100
18"-5'	7	100	0	0	100	0	0	7	100
5-10'	13	100	0	0	100	0	0	13	100
10-20'	5	100	0	0	100	0	0	5	100

TABLE K-6 INSTALLATION: RADFORD AAP

CONTAMINANT: TNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	10	53	7	37	89	2	11	19	100
6-18"	4	50	4	50	100	0	0	8	100
18"-5'	5	71	2	29	100	0	0	7	100
5-10'	10	77	3	23	100	0	0	13	100
10-20'	4	80	1	20	100	0	0	5	100

TABLE K-10 INSTALLATION: RADFORD AAP

CONTAMINANT: SUM OF EXPLOSIVES DATA

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	89	78	21	18	96	4	4	114	100
6-18"	40	83	8	17	100	0	0	48	100
18"-5'	38	90	4	10	100	0	0	42	100
5-10'	75	96	3	4	100	0	0	78	100
10-20'	28	93	2	7	100	0	0	30	100

TABLE K-11 INSTALLATION: RADFORD AAP

CONTAMINANT: SUM OF METALS DATA

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	146	96	4	3	99	2	1	152	100
6-18"	64	100	0	0	100	0	0	64	100
18"-5'	56	100	0	0	100	0	0	56	100
5-10'	104	100	0	0	100	0	0	104	100
10-20'	40	100	0	0	100	0	0	40	100

TABLE K-12 INSTALLATION: RADFORD AAP

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	> TEP LIMIT OR GUIDELINE #	> TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	3	16	11	58	74	5	26	19	100
6-18"	3	38	5	63	100	0	0	8	100
18"-5'	4	57	3	43	100	0	0	7	100
5-10'	9	69	4	31	100	0	0	13	100
10-20'	3	60	2	40	100	0	0	5	100

Figure K-3.

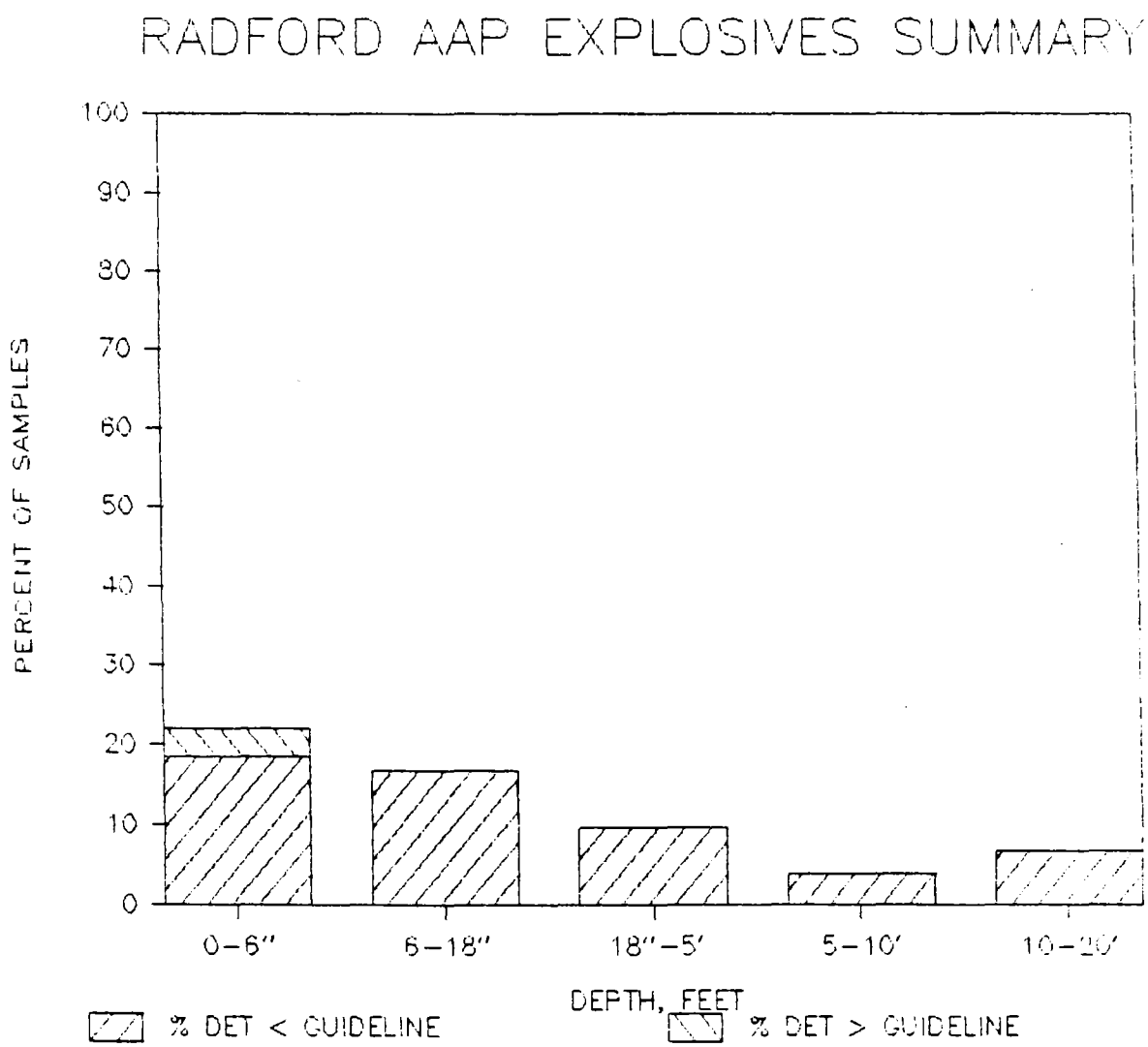
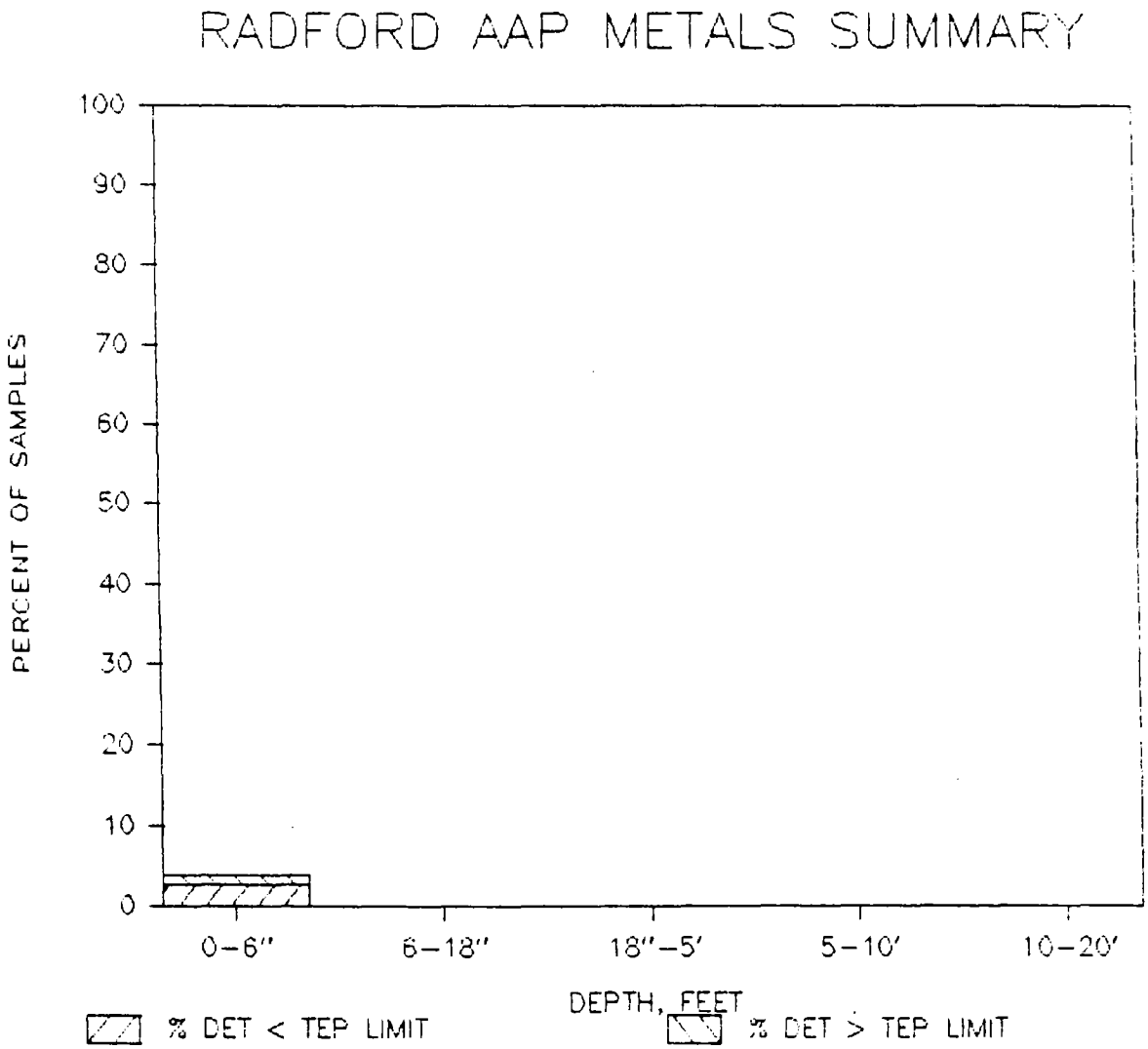

RADFORD AAP EXPLOSIVES SUMMARY
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure K-4.


RADFORD AAP METALS SUMMARY
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

APPENDIX L

SUMMARY OF OB SOIL INVESTIGATIONS AT SENECA ARMY DEPOT ROMULUS, NEW YORK

1. ENVIRONMENTAL SETTING.

a. General Physiography and Stratigraphy. The depot is on the western side of a series of north-south trending rock terraces which separate Seneca Lake and Cayuga Lake. The rock terraces range in elevation from 490 to 1600 feet above MSL. Elevations on Seneca AD range from 450 feet above MSL on the western boundary to 760 feet above MSL in the southeast corner. The surface of Seneca AD generally consists of a west- and north-sloping surface. In the vicinity of Seneca AD, consolidated Pleistocene glacial till deposits overlie Devonian age bedrock consisting primarily of shales. Thickness of the glacial deposits on Seneca AD ranges from 1 to 10 feet. The bedrock unit underlying Seneca Ad is the Moscow shale, a black, fissile, highly jointed unit with thin interbedded calcareous shale and limestone layers. The Moscow shale dips to the south at 30 to 35 feet per mile beneath Seneca AD.

b. Soils. Surface soils are relatively poorly drained and consist of silty clays and clays derived from the underlying glacial till and shale bedrock. The depth to bedrock in this vicinity varies from 6 to 12 feet. The permeabilities of soils from the OB site area were measured by recompacting soil samples in a mold to standard proctor density. The resulting permeabilities were found to cover a narrow range from 5.9 $X10^{-7}$ to 1.4 $X10^{-7}$ cm/sec. These soils could be considered to be nearly impermeable.

c. Ground Water. Seven ground-water monitoring wells are located around the OB site. The depth to ground water is quite low in this area, ranging from as little as 3 feet up to 6 feet. Ground water flows toward the northeast and east toward Reeder Creek.

d. Precipitation and Evaporation. The mean annual precipitation in the Seneca AD area is approximately 30 inches. The mean annual lake evaporation in this area is approximately 27 inches.

2. OVERVIEW OF THE OPEN BURNING AREA. Active OB/OD operations have been conducted since 1941 in a 90-acre area in the northwestern section of Seneca AD. The OB/OD grounds consist of a detonation hill and nine burning pads (labeled A through J) where items such as lead-containing fuses; projectiles with TNT, composition B, and amatol; and explosives contaminated trash are disposed of. Usage in the past 5 years has ranged from once per day to once per week. A plan view of the OB grounds is shown in Figure L-1. All pads were constructed by placing crushed shale fill over the natural ground surface and then dozing up the berms around the pad.

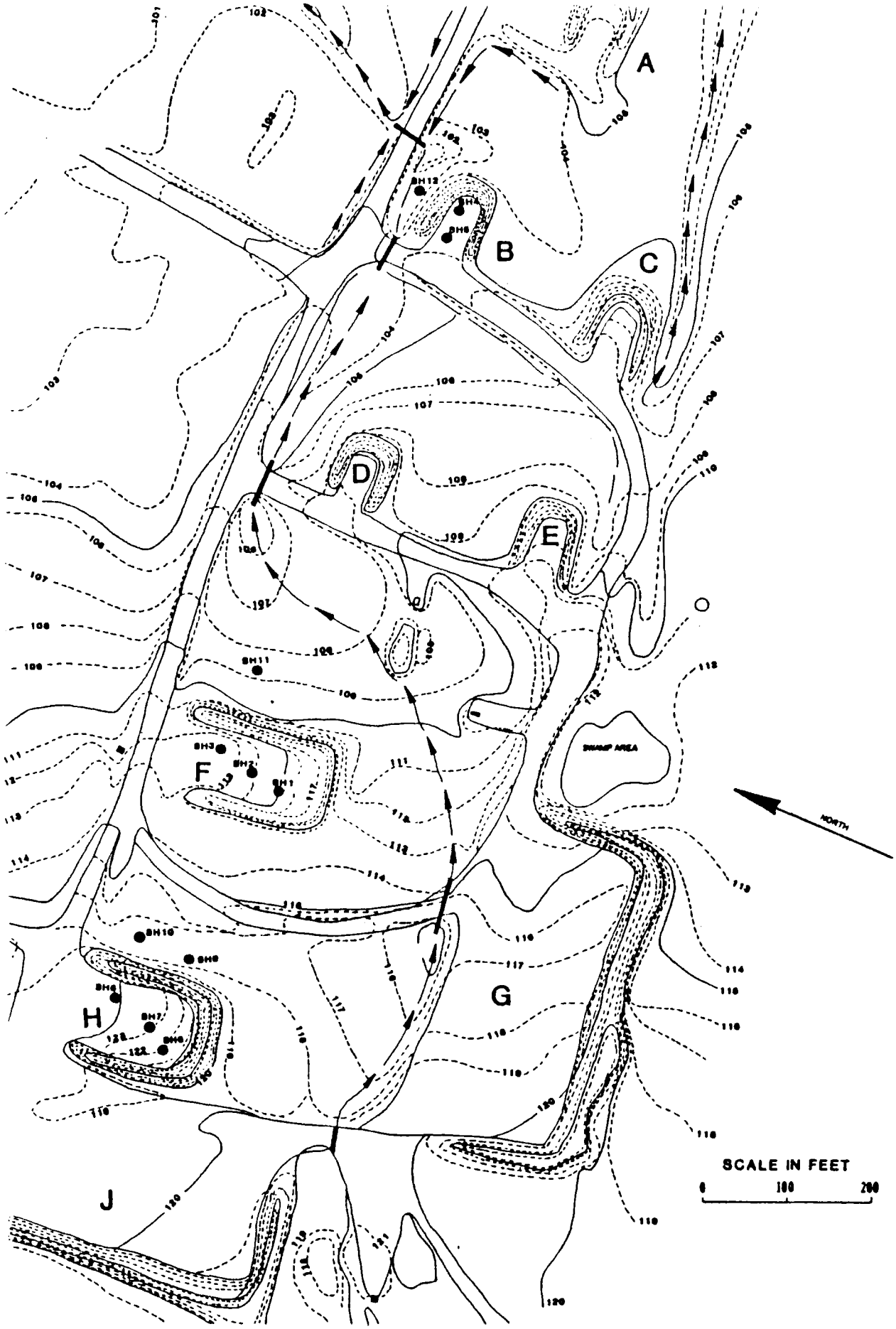


FIGURE L-1. SENECA AD OPEN BURNING AREA

3. BURNING GROUND SITE EVALUATIONS.

a. Phase 2 Sampling Methodologies and Locations. See Appendix A, reference 30, for a detailed discussion of this investigation. Phase 2 sampling was conducted in May 1982. Samples were collected from the 0 to 6 inch horizon from seven burning pads labeled B through H. With Phase 4 sampling being limited to Pads B, F, and H (see paragraph 3b below), only Phase 2 samples from these three pads are included in the analytical summary. Three samples were collected from each of these pads during the Phase 2 investigation.

b. Phase 4 Sampling Methodologies and Locations. See Appendix A, reference 31, for a detailed discussion of this investigation. Phase 4 sampling was conducted during the period 13-19 August 1984. Samples were collected in the following manner: 10 samples were collected from three boreholes at pad B, 13 samples were collected from five boreholes at pad F, and 11 samples were collected from two boreholes at pad H. Borehole depths ranged from 3 to 8 feet. A 4-inch-outside-diameter hollow-stem auger was used with the drill assembly. Additionally, three samples were collected of sediments from drainage ditches adjacent to the pads.

c. Analytical Results of Sampling Investigations. Analytical results are summarized in Tables L-1 through L-13 and Figures L-2 and L-3.

(1) Metals. Four samples from various depths contained lead in concentrations which exceeded the applicable TEP limit. Barium exceeded its TEP limit in three samples. Six samples from various depths contained lead concentrations less than the TEP limit. A trace of cadmium and a low level of barium were also detected in two other samples. Although the sampling horizon with the highest number of contaminated samples was the 0- to 6-inch level, contamination was rather evenly divided among the sampling groups. More than half of the contaminated samples were collected at pad B. This is, in part, due to the fact that a prior OB ground surface was encountered at a depth of 4 feet, very near the ground-water table. Numerous chunks of charred wood, bullets, and nails were found at this level. Prior OB pads may be present beneath the other existing OB sites as well. The only metal detected in drainage sediment samples was a trace of lead in the sediment from pad B.

(2) Explosives. Only one sample contained an explosive (TNT) at a concentration which exceeded the 1,000 µg/g reactivity guideline. Trace or otherwise insignificant levels of five different explosives were detected in 75 percent of the samples collected from the 0- to 6-inch horizon and 62 percent from the 6- to 18-inch level. The explosives detected in decreasing order of frequency of detection were RDX, 2,4-DNT, TNT, 2,6-DNT, and HMX. No explosives were detected at greater depths. No explosives were detected in any drainage sediment samples.

d. Site Operations. No observations of incorrect or abnormal site observations were made.

4. CONCLUSIONS.

a. As shown in Table L-13, 25 percent of soils from the 0- to 6-inch level contained contaminants at concentrations which exceeded the applicable TEP limits or explosives guidelines. Only one sample from each of the remaining horizons exceeded the limits/guidelines. A total of 80 percent of surface samples contained detectable concentrations of contaminants, although most concentrations were at trace or insignificant levels.

b. Soils contamination was significant at pad B down to the ground-water table, partially due to the existence of a buried OB site located 4 feet beneath the existing OB pad. Although a small number of samples at the other pads exceeded limits/guidelines, contamination at these other pads is not considered to be significant.

c. Subsurface lateral migration of contaminants using ground water as a transport medium is possible at pad B.

d. Horizontal migration of contaminants due to surface runoff is not significant.

e. The primary contaminants were lead and barium.

TABLE L-1 INSTALLATION: SENECA AD

CONTAMINANT: BA

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	18	90	0	0	90	2	10	20	100
6-18"	8	100	0	0	100	0	0	8	100
18"-5'	10	83	1	8	92	1	8	12	100
5-10'	3	100	0	0	100	0	0	3	100

TABLE L-2 INSTALLATION: SENECA AD

CONTAMINANT: CD

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	19	95	1	5	100	0	0	20	100
6-18"	8	100	0	0	100	0	0	8	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	3	100	0	0	100	0	0	3	100

TABLE L-3 INSTALLATION: SENECA AD

CONTAMINANT: PB

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	17	85	1	5	90	2	10	20	100
6-18"	5	63	2	25	88	1	13	8	100
18"-5'	11	92	1	8	100	0	0	12	100
5-10'	0	0	2	67	67	1	33	3	100

TABLE L-4 INSTALLATION: SENECA AD

CONTAMINANT: EACH METAL EXCEPT BA, CD & PB

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	20	100	0	0	100	0	0	20	100
6-18"	8	100	0	0	100	0	0	8	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	3	100	0	0	100	0	0	3	100

TABLE L-5 INSTALLATION: SENECA AD

CONTAMINANT: RDX

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	11	55	9	45	100	0	0	20	100
6-18"	7	88	1	13	100	0	0	8	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	3	100	0	0	100	0	0	3	100

TABLE L-6 INSTALLATION: SENECA AD

CONTAMINANT: HMX

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	19	95	1	5	100	0	0	20	100
6-18"	7	88	1	13	100	0	0	8	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	3	100	0	0	100	0	0	3	100

TABLE L-7 INSTALLATION: SENECA AD

CONTAMINANT: TNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	14	70	5	25	95	1	5	20	100
6-18"	6	75	2	25	100	0	0	8	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	3	100	0	0	100	0	0	3	100

TABLE L-8 INSTALLATION: SENECA AD

CONTAMINANT: TETRYL

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	20	100	0	0	100	0	0	20	100
6-18"	8	100	0	0	100	0	0	8	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	3	100	0	0	100	0	0	3	100

TABLE L-9 INSTALLATION: SENECA AD

CONTAMINANT: 2,6-DNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	14	70	6	30	100	0	0	20	100
6-18"	8	100	0	0	100	0	0	8	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	3	100	0	0	100	0	0	3	100

TABLE L-10 INSTALLATION: SENECA AD

CONTAMINANT: 2,4-DNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	12	60	8	40	100	0	0	20	100
6-18"	7	88	1	13	100	0	0	8	100
18"-5'	12	100	0	0	100	0	0	12	100
5-10'	3	100	0	0	100	0	0	3	100

TABLE L-11 INSTALLATION: SENECA AD

CONTAMINANT: SUM OF EXPLOSIVES DATA

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	90	75	29	24	99	1	1	120	100
6-18"	43	90	5	10	100	0	0	48	100
18"-5'	72	100	0	0	100	0	0	72	100
5-10'	18	100	0	0	100	0	0	18	100

TABLE L-12 INSTALLATION: SENECA AD

CONTAMINANT: SUM OF METALS DATA

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	154	96	2	1	98	4	3	160	100
6-18"	61	95	2	3	98	1	2	64	100
18"-5'	93	97	2	2	99	1	1	96	100
5-10'	21	88	2	8	96	1	4	24	100

TABLE L-13 INSTALLATION: SENECA AD

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	> TEP LIMIT OR GUIDELINE #	> TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	4	20	11	55	75	5	25	20	100
6-18"	2	25	5	63	88	1	13	8	100
18"-5'	9	75	2	17	92	1	8	12	100
5-10'	0	0	2	67	67	1	33	3	100

Figure L-2.

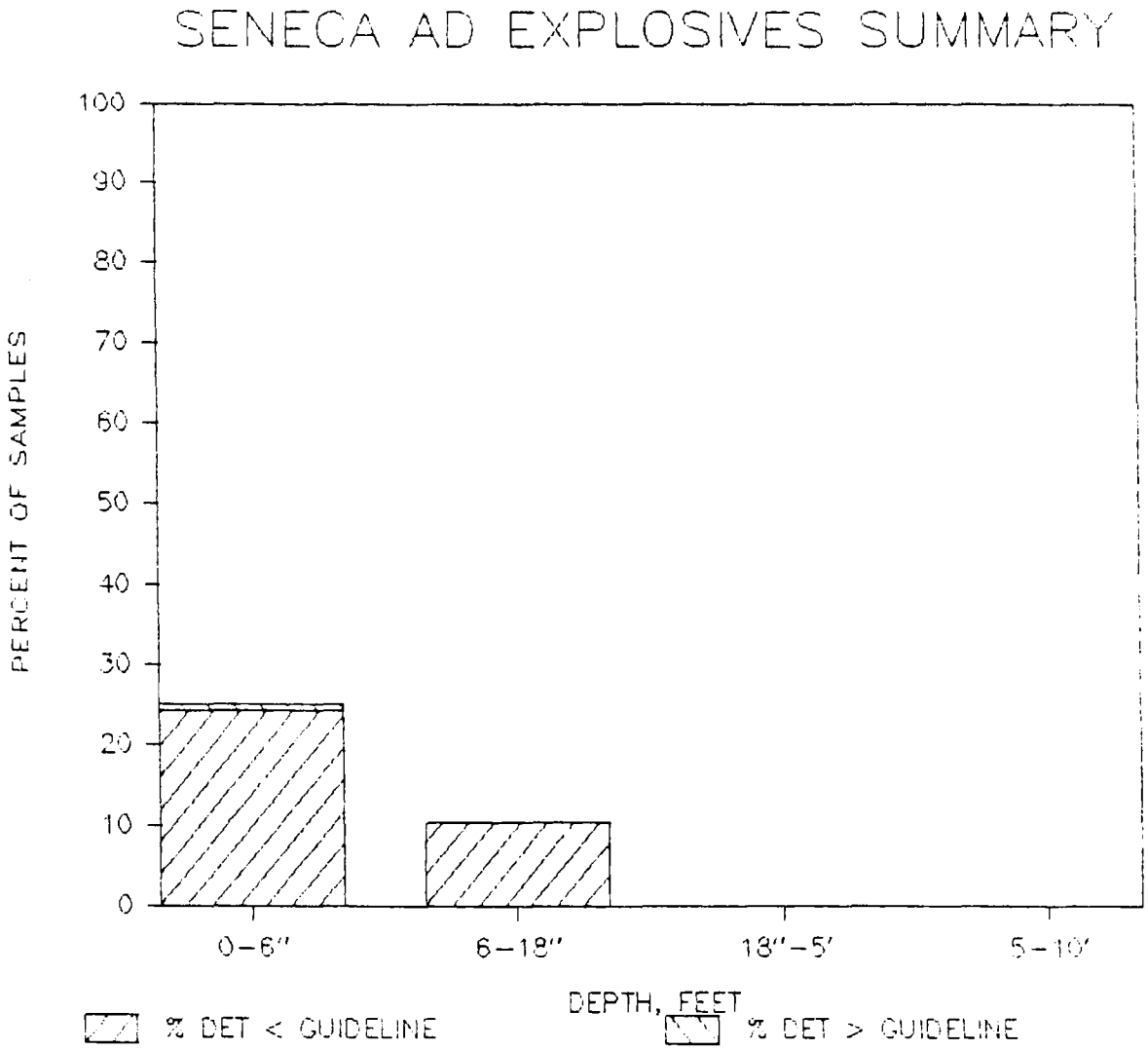
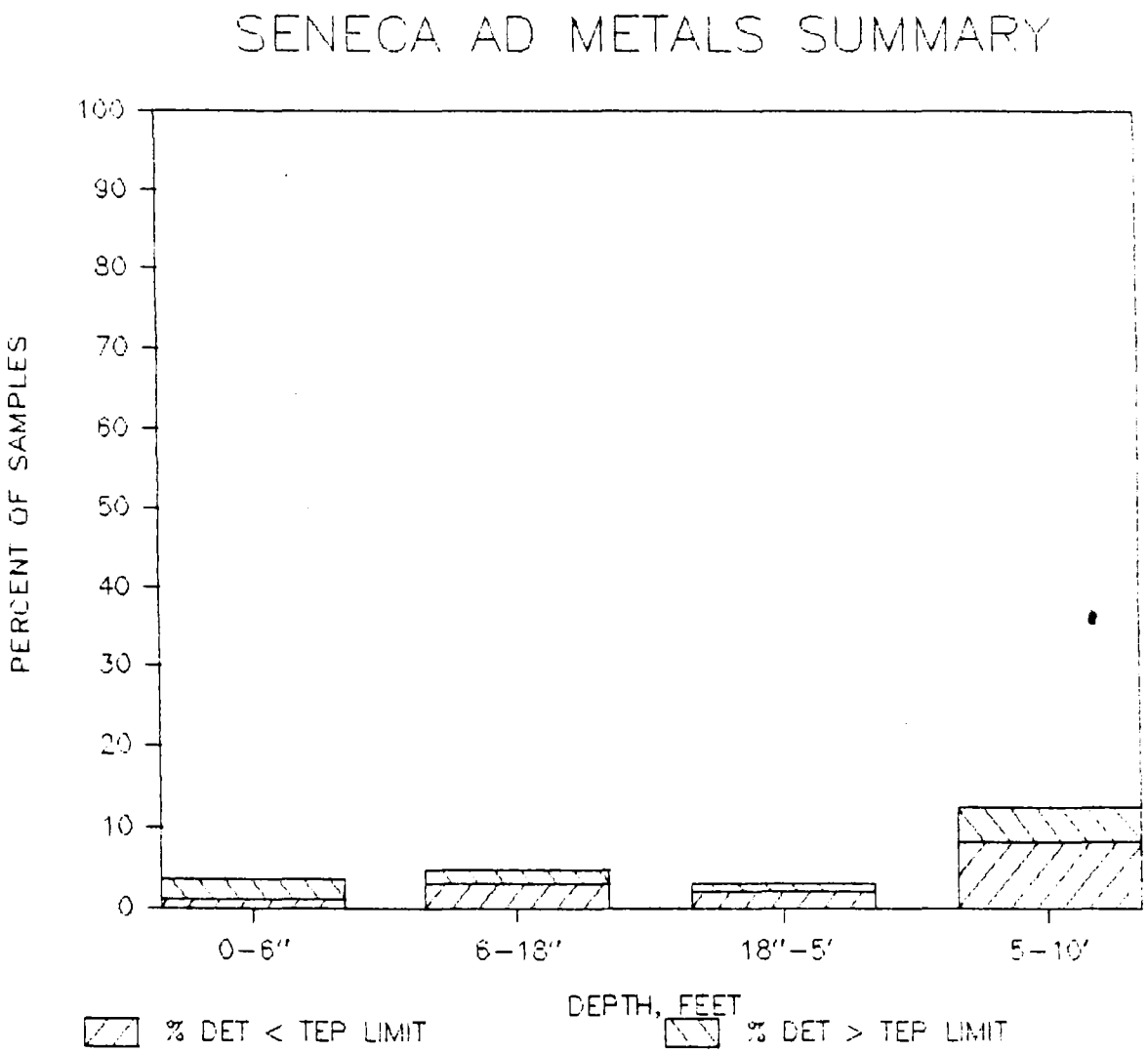

SENECA AD EXPLOSIVES SUMMARY
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure L-3.


SENECA AD METALS SUMMARY
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

APPENDIX M

SUMMARY OF OB SOIL INVESTIGATIONS AT SIERRA ARMY DEPOT HERLONG, CALIFORNIA

1. ENVIRONMENTAL SETTING.

a. General Physiography and Stratigraphy. Sierra AD is located in Lassen County, California, approximately 80 kilometers north of Reno, Nevada. The installation is located in the Honey Lake Valley in the Basin and Range physiographic province. The valley is bounded on the southeast side by the Fort Sage Mountains, on the northeast by the Skedaddle and Amadee Mountains, and on the north by the Shaffer Mountains. Surface elevations at the main depot area run from 1,215 m above MSL along the shore line of Honey Lake to 1,260 m at Herlong. The upper burning demolition area is in rugged terrain and ranges in elevation from 1,231 to 1,670 m above MSL.

b. Soils. Soils in the vicinity of the two OB pads can generally be described as having very slow infiltration rates, i.e., clay soils, soils with a claypan or clay layer at or near the surface, shallow soils over nearly impervious materials, or soils with a permanent high water table. These soils have a very slow rate of water transmission. Permeabilities range from about 5.6×10^{-4} to 5.6×10^{-6} cm/sec. Soil series contained in this group include the Diaz-Karlo complex, Herlong loam, Madeline very stony loam, Ninemile extremely cobbly loam, playas, rock land, and Standish loam.

c. Ground Water.

(1) Lower OB Ground. Ground water at this site was encountered between 18 and 20 feet. The borings were drilled during a time that the ground-water table is normally lower than average. Even at this time the water table was only 8- to 10-feet below the bottom of the 10-foot-deep trench. The direction of ground-water flow was assumed to be west, towards Honey Lake. Further study, however, would be required to determine the actual direction of ground-water flow.

(2) Upper OB Ground. Ground water at the upper OB/OD ground was located below an impermeable bedrock surface, which prevented migration of contaminants to this aquifer. Surface water which flowed down from the upper areas to these trenches followed two pathways, depending on the intensity of flow. During normal rainfall the water entered the trenches and infiltrated to the bedrock surface, which followed the topography down to the southeastern boundary of the area. During high-intensity rainfall the runoff could fill the trenches and carry contaminants along the surface to the lower areas.

d. Precipitation and Evaporation. The mean annual precipitation in the Sierra AD area is approximately 10 inches. The mean annual lake evaporation in this vicinity is approximately 43 inches.

2. OVERVIEW OF BURNING GROUND SITES. All active OB/OD operations at Sierra AD are located on approximately 4,000 acres of land on a separate area northeast of the main installation. The OB sites included in this study were the lower burning ground and the upper burning ground. The OB activities are conducted within trenches at both sites. The lower burning ground consists of one trench while the upper site consists of five trenches and one pit.

3. BURNING GROUND SITE EVALUATIONS.

a. Phase 2 Sampling Methodologies and Locations. See Appendix A, reference 32, for a detailed discussion of this investigation. Phase 2 sampling was conducted on 13-15 October 1981. A total of 11 lower burning ground samples were collected from 6 locations. Seven samples were collected from five sites at the upper burning ground.

b. Phase 4 Sampling Methodologies and Locations. See Appendix A, reference 33, for a detailed discussion of this investigation. Phase 4 sampling was conducted during the period 24-30 October 1984. A total of 42 samples were collected from the two OB grounds. Five borings (20 samples) were drilled near the lower OB ground trench. Four borings (16 samples) were drilled near the upper OB ground. The depths of these boreholes ranged from 12 to 22 feet. Samples were generally collected every 5 feet until either ground water or bedrock was encountered. Additionally, one surface sample was collected from each of the five upper burning ground trenches and the burning pit.

c. Analytical Results of Sampling Investigations. Analytical results are summarized in Tables M-1 through M-14, and Figures M-1 and M-2.

(1) Metals.

(a) TEP Metals. No metals were detected in concentrations which exceeded the applicable TEP limits. All samples containing detectable levels of the TEP metals were collected from the top 6 inches of soil. The metals which were detected, in decreasing order of frequency of detection, were barium, lead, cadmium, and chromium. Although, as mentioned above, none of these detected levels exceeded the TEP limits, many of the concentrations approached these limits.

(b) Total Metals. In addition to TEP limits the State of California also places limits on the total concentrations of the metals on the TEP list. Called the TTCL's, these standards are 10 times the Federal TEP limits. Therefore, to determine if California solid wastes are hazardous, due to metals content, analyses must be performed on the TEP metals both on total and TEP bases.

Total metals analyses were only performed on samples collected in the Phase 4 investigation. All six samples collected from the 0- to 6-inch horizon exceeded at least one TTCL. Lead exceeded its limit in all surface samples. Barium exceeded its limit in five of six samples. Only one sample collected at greater depths contained a metal which exceeded its TTCL.

(2) Explosives. No explosives were detected in concentrations which exceeded the 1,000 µg/g reactivity guideline. Although a small number of samples contained detectable concentrations of explosives, only trace levels were detected.

c. Site Operations. Past OB methods had allowed residues to remain in the trenches a considerable amount of time after OB operations had ceased. This practice increased the possibility for contaminants to leach from the residues. Additionally, topography of the OB sites could result in surface runoff collecting in the OB trenches. This ponded water would provide the driving force for contaminants to migrate from the site.

4. CONCLUSIONS.

a. No samples contained contaminants in concentrations which exceeded the TEP limits or the explosive guideline. However, all surface samples for which total metals were analyzed exceeded at least one TTCL. Only trace levels of TEP metals or explosives were detected in samples collected from depths greater than 6 inches.

b. Significant soils contamination is limited to the top 6 inches at the base of the trenches.

c. Past OB practices, in conjunction with runoff problems, increased the possibility for contaminants to leach from burning residues.

d. The primary contaminants were lead and barium.

TABLE M-1 INSTALLATION: SIERRA AD

CONTAMINANT: BA

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	9	69	4	31	100	0	0	13	100
6-18"	15	100	0	0	100	0	0	15	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	9	100	0	0	100	0	0	9	100
10-20'	18	100	0	0	100	0	0	18	100
20'+	5	100	0	0	100	0	0	5	100

TABLE M-2 INSTALLATION: SIERRA AD

CONTAMINANT: CD

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	11	85	2	15	100	0	0	13	100
6-18"	15	100	0	0	100	0	0	15	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	9	100	0	0	100	0	0	9	100
10-20'	18	100	0	0	100	0	0	18	100
20'+	5	100	0	0	100	0	0	5	100

TABLE M-3 INSTALLATION: SIERRA AD

CONTAMINANT: CR

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	12	92	1	8	100	0	0	13	100
6-18"	15	100	0	0	100	0	0	15	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	9	100	0	0	100	0	0	9	100
10-20'	18	100	0	0	100	0	0	18	100
20'+	5	100	0	0	100	0	0	5	100

TABLE M-4 INSTALLATION: SIERRA AD

CONTAMINANT: PB

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	11	85	2	15	100	0	0	13	100
6-18"	15	100	0	0	100	0	0	15	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	9	100	0	0	100	0	0	9	100
10-20'	18	100	0	0	100	0	0	18	100
20'+	5	100	0	0	100	0	0	5	100

TABLE M-5 INSTALLATION: SIERRA AD

CONTAMINANT: AG, AS, HG, SE

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	13	100	0	0	100	0	0	13	100
6-18"	15	100	0	0	100	0	0	15	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	9	100	0	0	100	0	0	9	100
10-20'	18	100	0	0	100	0	0	18	100
20'+	5	100	0	0	100	0	0	5	100

TABLE M-6 INSTALLATION: SIERRA AD

CONTAMINANT: RDX

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	9	69	4	31	100	0	0	13	100
6-18"	15	100	0	0	100	0	0	15	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	8	89	1	11	100	0	0	9	100
10-20'	16	89	2	11	100	0	0	18	100
20'+	5	100	0	0	100	0	0	5	100

TABLE M-7 INSTALLATION: SIERRA AD

CONTAMINANT: HMX

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	9	69	4	31	100	0	0	13	100
6-18"	14	93	1	7	100	0	0	15	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	9	100	0	0	100	0	0	9	100
10-20'	18	100	0	0	100	0	0	18	100
20'+	5	100	0	0	100	0	0	5	100

TABLE M-8 INSTALLATION: SIERRA AD

CONTAMINANT: TNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	12	92	1	8	100	0	0	13	100
6-18"	15	100	0	0	100	0	0	15	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	8	89	1	11	100	0	0	9	100
10-20'	18	100	0	0	100	0	0	18	100
20'+	5	100	0	0	100	0	0	5	100

TABLE M-9 INSTALLATION: SIERRA AD

CONTAMINANT: TETRYL

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	11	85	2	15	100	0	0	13	100
6-18"	13	87	2	13	100	0	0	15	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	9	100	0	0	100	0	0	9	100
10-20'	18	100	0	0	100	0	0	18	100
20'+	5	100	0	0	100	0	0	5	100

TABLE M-10 INSTALLATION: SIERRA AD

CONTAMINANT: 2,6-DNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	13	100	0	0	100	0	0	13	100
6-18"	15	100	0	0	100	0	0	15	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	9	100	0	0	100	0	0	9	100
10-20'	18	100	0	0	100	0	0	18	100
20'+	5	100	0	0	100	0	0	5	100

TABLE M-11 INSTALLATION: SIERRA AD

CONTAMINANT: 2,4-DNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	9	69	4	31	100	0	0	13	100
6-18"	15	100	0	0	100	0	0	15	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	9	100	0	0	100	0	0	9	100
10-20'	18	100	0	0	100	0	0	18	100
20'+	5	100	0	0	100	0	0	5	100

TABLE M-12 INSTALLATION: SIERRA AD

CONTAMINANT: SUM OF EXPLOSIVES DATA

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	63	81	15	19	100	0	0	78	100
6-18"	87	97	3	3	100	0	0	90	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	52	96	2	4	100	0	0	54	100
10-20'	106	98	2	2	100	0	0	108	100
20'+	30	100	0	0	100	0	0	30	100

TABLE M-13 INSTALLATION: SIERRA AD

CONTAMINANT: SUM OF METALS DATA

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	95	91	9	9	100	0	0	104	100
6-18"	120	100	0	0	100	0	0	120	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	72	100	0	0	100	0	0	72	100
10-20'	144	100	0	0	100	0	0	144	100
20'+	40	100	0	0	100	0	0	40	100

TABLE M-14 INSTALLATION: SIERRA AD

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	> TEP LIMIT OR GUIDELINE #	> TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	2	15	11	85	100	0	0	13	100
6-18"	12	80	3	20	100	0	0	15	100
18"-5'	--	--	--	--	--	--	--	0	--
5-10'	8	89	1	11	100	0	0	9	100
10-20'	16	89	2	11	100	0	0	18	100
20'+	5	100	0	0	100	0	0	5	100

Figure M-1.

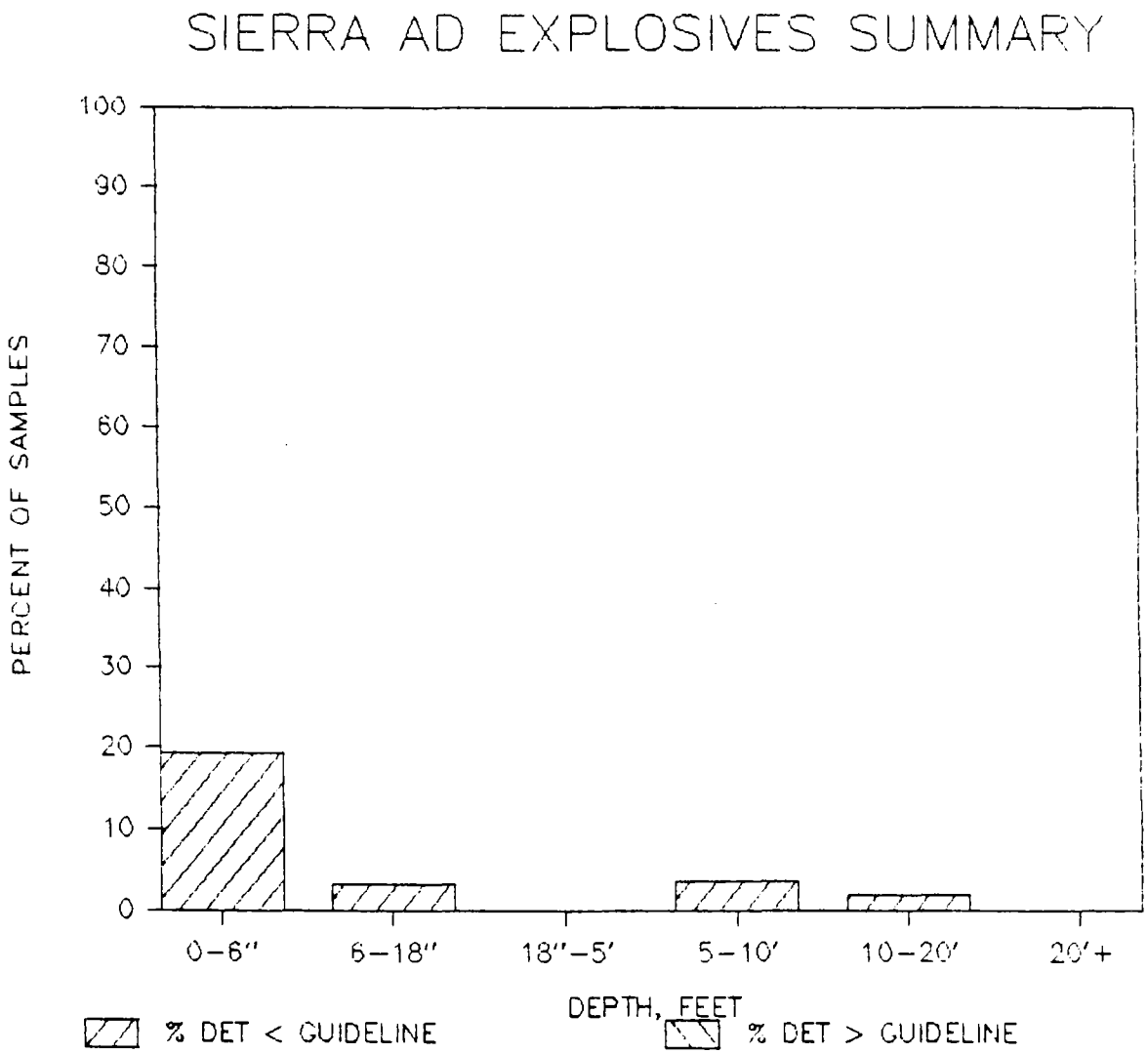
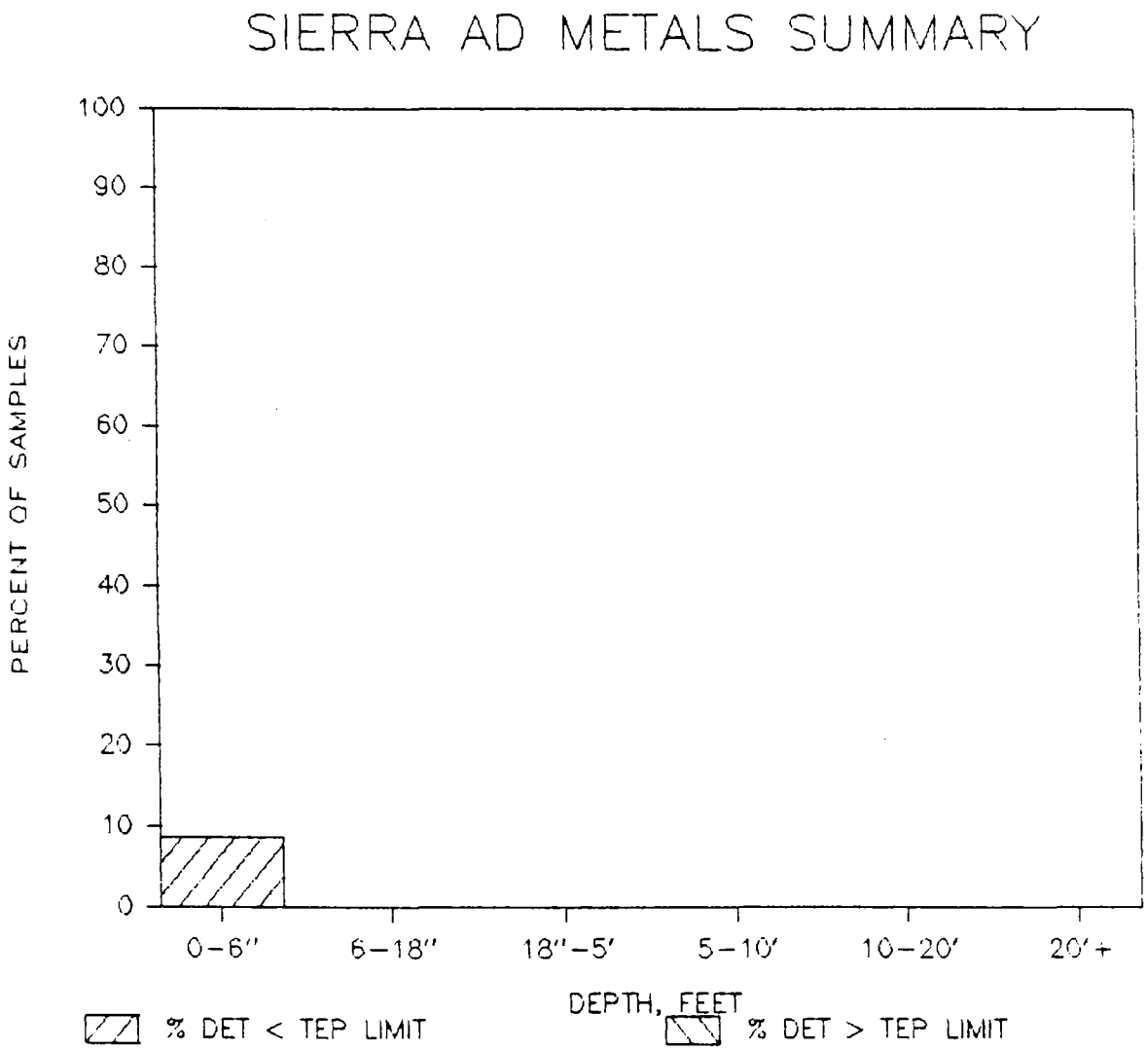

SIERRA AD EXPLOSIVES SUMMARY
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
20'+
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure M-2.


SIERRA AD METALS SUMMARY
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
20'+
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

APPENDIX N

SUMMARY OF OB SOIL INVESTIGATIONS AT TOOELE ARMY DEPOT TOOELE, UTAH

1. ENVIRONMENTAL SETTING.

a. General Physiography and Stratigraphy. Tooele AD is located approximately 2 miles south of Tooele, Utah, and 25 miles southwest of Salt Lake City. The OB area at Tooele AD was situated at the base of the Stansbury and South Mountains in the block-faulted, structural trough which forms the Tooele Valley. Sedimentology of the OB area consisted of constructional lake shore features underlain by Lake Bonneville and pre-Lake Bonneville deposits. The actual burning pads were located in an erosional dissection of a hanging delta near the foot of the Stansbury Mountains. The contaminated waste area was located at the mouth of this erosional opening.

b. Soils. Borings taken in the OB area show that the soil is composed of varved silts, sands and clays, which are sloped towards the east, characteristic of deposition during formation of a delta.

c. Ground Water. Ground water at the Tooele Valley was located in discontinuous granular strata of the valley fill. Recharge was reported as being primarily through gravel benches at the base of mountains surrounding the installation. One of the most significant recharge areas is the installation's southwest corner, which encompasses the OB area. The depth to ground water at the OB site is unknown. One boring drilled in this location, with a total depth of 709 feet, was a dry hole.

d. Precipitation and Evaporation. The mean annual precipitation in the Tooele AD area is approximately 15 inches. The mean annual lake evaporation in this vicinity is approximately 42 inches.

2. OVERVIEW OF THE BURNING GROUND. Open burning activities at Tooele AD have been performed at a remote location near the southwestern corner of the north area of the installation. The OB sites consist of a burn pad and several burn pits. The burn pad, approximately 100 by 300 feet in size, has been used for the burning of propellant and for the flashing of projectiles. The burn pits have been used for the OB of explosive-contaminated waste such as dunnage, metal banding, ammunition boxes, and other similar wastes from munitions handling operations. A drawing of the OB area is provided in Figure N-1.

3. BURNING GROUND SITE EVALUATIONS.

a. Phase 2 Sampling Methodologies and Locations. See Appendix A, reference 34, for a detailed discussion of this investigation. Phase 2 sampling was conducted on 25-26 September 1981. A total of 14 samples were collected from 7 sites at the burning pad. Samples were composited for depths of 0-6 inches, and 6-18 inches.

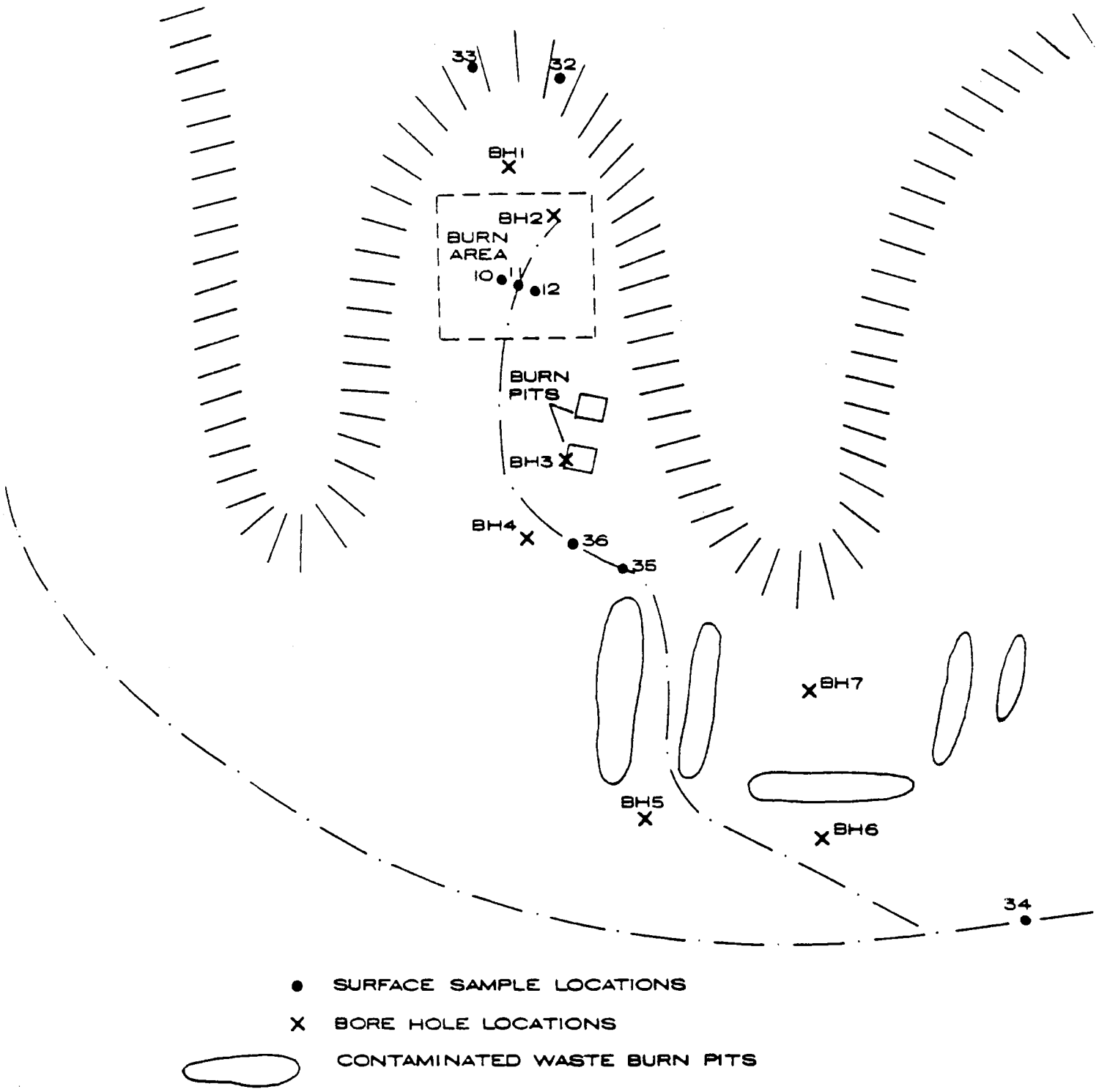


FIGURE N-1. TOOELE AD OPEN BURNING GROUND

b. Phase 4 Sampling Methodologies and Locations. See Appendix A, reference 35, for a detailed discussion of this investigation. Phase 4 sampling was conducted during the period 27 July to 10 August 1984. Seven boreholes were drilled, from which 26 samples were collected. The depths of the boreholes ranged from 5 to 20 feet. At each site, samples were collected from the surface and at 5-foot intervals to the bottom of the boreholes. As shown in Figure N-1, the boreholes were located in and around the burn pad as well as the burn pits.

c. Analytical Results of Sampling Investigations. Analytical results are summarized in Tables N-1 through N-10 and Figures N-2 and N-3.

(1) Metals. No TEP metals were detected.

(2) Explosives. No explosives were detected in concentrations which exceeded the 1,000 µg/g reactivity guideline. Explosives were detected in trace concentrations in 38 percent of the samples collected from the top 18 inches of soils. No explosives were detected in samples collected at greater depths.

d. Site Operations. In the past, wastes unrelated to explosives have been burned in the OB pits.

4. CONCLUSIONS.

a. As shown in Table N-10, no samples contained contaminants in concentrations which exceeded the applicable TEP limits or guidelines. Trace levels of explosives were detected in 38 percent of the samples collected from depths less than 18 inches.

b. Soils contamination at the OB site is insignificant.

TABLE N-1 INSTALLATION: TOOELE AD

CONTAMINANT: EACH METAL

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	14	100	0	0	100	0	0	14	100
6-18"	7	100	0	0	100	0	0	7	100
18"-5'	9	100	0	0	100	0	0	9	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	4	100	0	0	100	0	0	4	100

TABLE N-2 INSTALLATION: TOOELE AD

CONTAMINANT: RDX

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	11	79	3	21	100	0	0	14	100
6-18"	5	71	2	29	100	0	0	7	100
18"-5'	9	100	0	0	100	0	0	9	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	4	100	0	0	100	0	0	4	100

TABLE N-3 INSTALLATION: TOOELE AD

CONTAMINANT: HMX

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	11	79	3	21	100	0	0	14	100
6-18"	6	86	1	14	100	0	0	7	100
18"-5'	9	100	0	0	100	0	0	9	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	4	100	0	0	100	0	0	4	100

TABLE N-4 INSTALLATION: TOOELE AD

CONTAMINANT: TNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	12	86	2	14	100	0	0	14	100
6-18"	6	86	1	14	100	0	0	7	100
18"-5'	9	100	0	0	100	0	0	9	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	4	100	0	0	100	0	0	4	100

TABLE N-5 INSTALLATION: TOOELE AD

CONTAMINANT: TETRYL

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	14	100	0	0	100	0	0	14	100
6-18"	7	100	0	0	100	0	0	7	100
18"-5'	9	100	0	0	100	0	0	9	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	4	100	0	0	100	0	0	4	100

TABLE N-6 INSTALLATION: TOOELE AD

CONTAMINANT: 2,6-DNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	13	93	1	7	100	0	0	14	100
6-18"	7	100	0	0	100	0	0	7	100
18"-5'	9	100	0	0	100	0	0	9	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	4	100	0	0	100	0	0	4	100

TABLE N-7 INSTALLATION: TOOELE AD

CONTAMINANT: 2,4-DNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	14	100	0	0	100	0	0	14	100
6-18"	6	86	1	14	100	0	0	7	100
18"-5'	9	100	0	0	100	0	0	9	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	4	100	0	0	100	0	0	4	100

TABLE N-8 INSTALLATION: TOOELE AD

CONTAMINANT: SUM OF EXPLOSIVES DATA

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	75	89	9	11	100	0	0	84	100
6-18"	37	88	5	12	100	0	0	42	100
18"-5'	54	100	0	0	100	0	0	54	100
5-10'	36	100	0	0	100	0	0	36	100
10-20'	24	100	0	0	100	0	0	24	100

TABLE N-9 INSTALLATION: TOOELE AD

CONTAMINANT: SUM OF METALS DATA

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	112	100	0	0	100	0	0	112	100
6-18"	56	100	0	0	100	0	0	56	100
18"-5'	72	100	0	0	100	0	0	72	100
5-10'	48	100	0	0	100	0	0	48	100
10-20'	32	100	0	0	100	0	0	32	100

TABLE N-10 INSTALLATION: TOOELE AD

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	> TEP LIMIT OR GUIDELINE #	> TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	10	71	4	29	100	0	0	14	100
6-18"	3	43	4	57	100	0	0	7	100
18"-5'	9	100	0	0	100	0	0	9	100
5-10'	6	100	0	0	100	0	0	6	100
10-20'	4	100	0	0	100	0	0	4	100

Figure N-2.

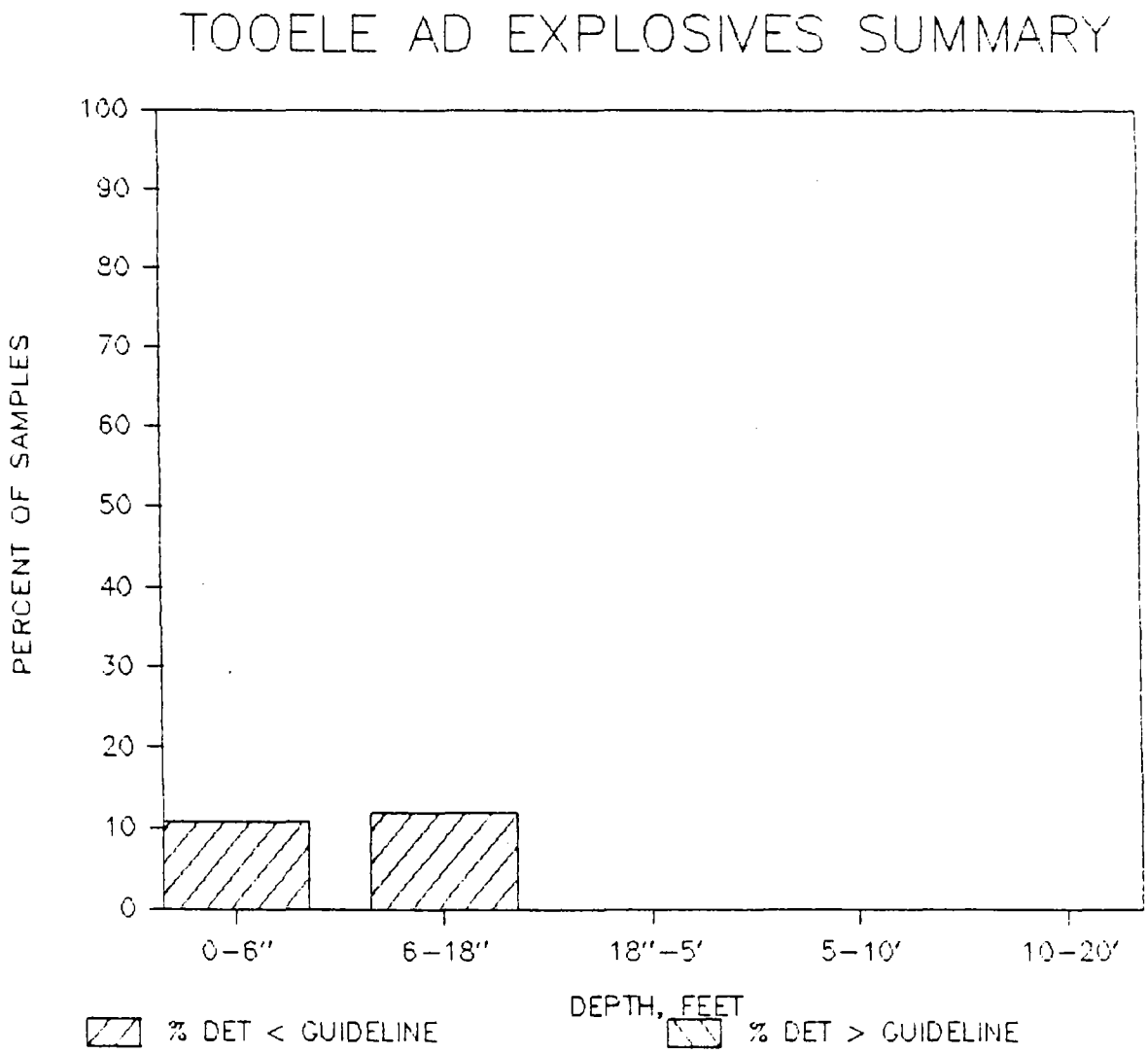
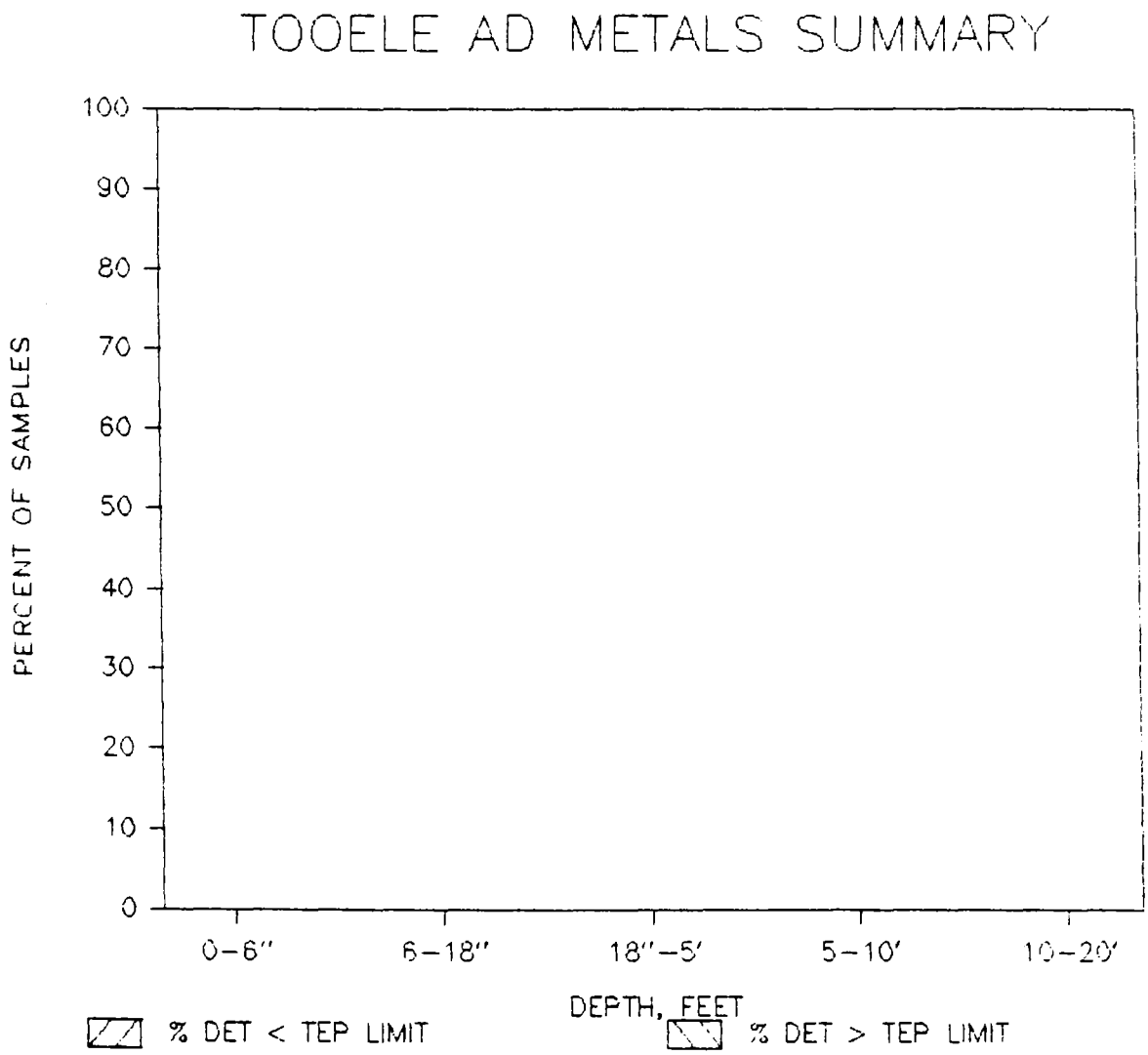

TOOELE AD EXPLOSIVES SUMMARY
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure N-3.


TOOELE AD METALS SUMMARY
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0-6"
6-18"
18"-5'
5-10'
10-20'
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

APPENDIX O

SUMMARY OF OB SOIL INVESTIGATIONS AT VOLUNTEER ARMY AMMUNITION PLANT CHATTANOOGA, TENNESSEE

1. ENVIRONMENTAL SETTING.

a. General Physiography and Stratigraphy.

(1) Regional. Volunteer AAP is located within the Appalachian Valley Physiographic Province. This province is flanked on the east by the Blue Ridge Mountains and on the west by the Appalachian Plateaus Province. Elevations range from 680 feet above MSL at the southwestern corner to 1,100 feet above MSL in the southern part of the magazine area. Most of the installation is underlain by the Knox group, an undifferentiated sequence of gray, cherty, silicious dolomites, characterized by solution cavities and channels.

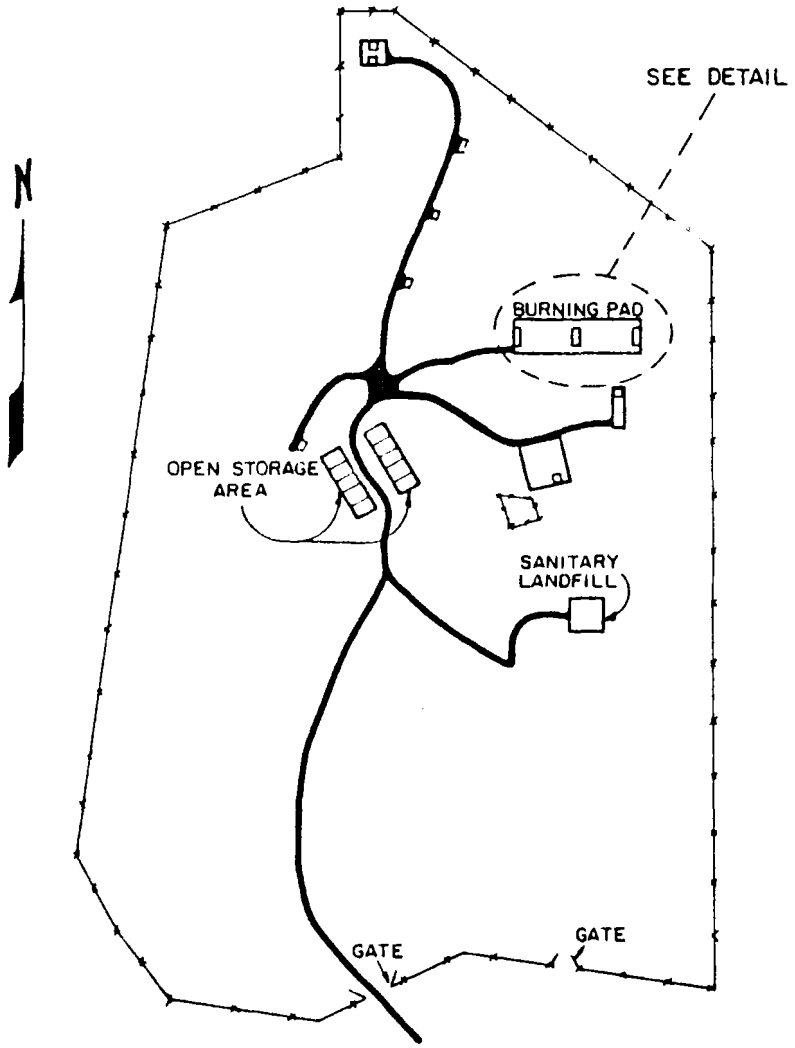
(2) Local. The burning ground is located in the northeast area of the installation on an outcrop of the Copper Ridge Dolomite, a lower portion of the Knox group. The formation is covered by weathered residuum and soil, consisting mostly of a silty, loam topsoil with a silty clay in the subsoil. The depth to bedrock ranges widely over small, horizontal distances from 50 to 150 feet in depth, due primarily to differential weathering and solution-filled cavities along the bedrock surface.

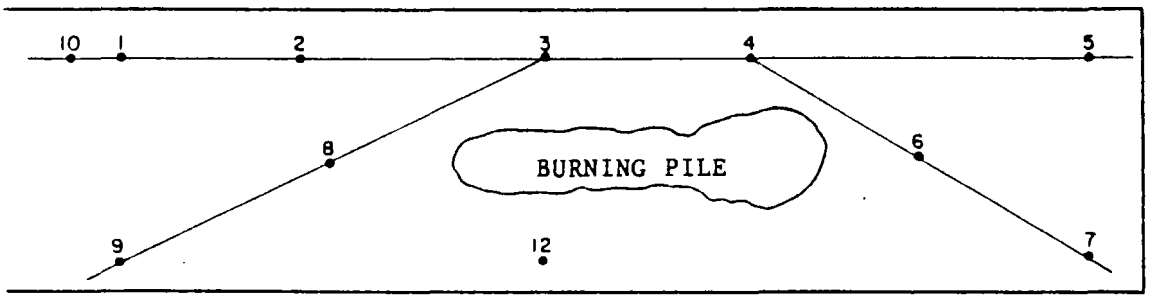
b. Soils. Soil samples collected from the OB site consisted of silty clays with slight to medium plasticity. Permeabilities of these samples ranged from 7×10^{-5} to 4.2×10^{-8} cm/sec. These values correspond to low permeability to practically impermeable soils.

c. Ground Water. Ground water under Volunteer AAP flows in a north to northwest direction in an unconfined aquifer, at an average depth of 120 feet. The thick overlying residuum contains small pockets of perched water which are of essentially no economic value. The burning area contains six shallow wells, all of which were completed in perched zones at surface depths of 7 to 132 feet. Only one of these wells (Well No. 19), located along the east fence, provides enough water for chemical analysis. The location of Well No. 19 is depicted on the map in Figure O-1. The other wells are considered dry holes.

d. Precipitation and Evaporation. The mean annual precipitation in the Volunteer AAP area is approximately 53 inches. The mean annual lake evaporation in this vicinity is approximately 36 inches.

2. OVERVIEW OF THE BURNING GROUND. The active OB operations at Volunteer AAP are confined to one burning ground located in the northeastern quadrant of the installation. Established in 1969, the lone burning pad at this site is a cut out and leveled area of approximately 75 feet x 350 feet on the northeast side of the burning ground. See Figure O-1 for a map of the





DETAIL

FIGURE O-1. VOLUNTEER AAP OPEN BURNING AREA

burning pad. It was cut out from the north face of a hill and the remaining three sides dropped off steeply. The only access to the burning pad was a road which entered the pad on the southwest corner and a set of stairs which ran down the center of the south wall. Most of the drainage off the pad was concentrated down the center of the north side, as evidenced by a large erosion ditch; however, small erosion patterns were seen off the north, east, and west sides.

3. BURNING GROUND SITE EVALUATIONS.

a. Phase 2 Sampling Methodologies and Locations. See Appendix A, reference 36, for a detailed discussion of this investigation. Phase 2 sampling was conducted in February 1982. A total of eight samples were collected from five sites at the OB pad. Samples were composited for depths of 0-6 inches, and 6-12 inches.

b. Phase 4 Sampling Methodologies and Locations. See Appendix A, reference 37, for a detailed discussion of this investigation. Phase 4 sampling was conducted during the period 4-9 November 1983. A total of 58 samples were collected from 11 boreholes located in the immediate vicinity of the OB pad. The sampling schedule used on the burning pad was to take an initial sample at a depth of 1-1/2 to 2 feet and every 5 feet or change of strata, thereafter, down to 35 feet. Initial sampling started at 1-1/2 feet because results from the surface to 1 ft had previously been recorded during the Phase 2 study. Eight of the eleven bore holes encountered refusal at depths from 4 to 31 feet, due to chert and other geologic formations underlying the pad. As a result, borehole depths ranged from 4 to 37 feet. Samples were collected using either Shelby tubes or manual composites of auger cuttings.

c. Analytical Results of Sampling Investigations. Analytical results are summarized in Tables O-1 through O-8, and Figures O-2 and O-3.

(1) Metals. No TEP metals were detected.

(2) Explosives. Three samples contained TNT, 2,6-DNT, and 2,4-DNT in concentrations which exceeded the 1,000 µg/g reactivity guideline. These three samples were collected from the top 18 inches of soil at two locations. Samples from the top 18 inches at one other location contained significant levels of explosives. Surface samples from two other locations contained only trace concentrations of these compounds. Trace concentrations were detected in 25 percent of samples collected from the 18-inch to 5-foot interval. No explosives were detected in samples collected from greater depths.

d. Site Operations and Design. As discussed above, design of the OB pad does not prevent the occurrence of run-on and runoff at the site. Erosion ditches were located on all sides of the OB pad.

4. CONCLUSIONS.

a. As shown in Table O-8, samples containing contaminants in excess of the applicable TEP limits or reactivity guidelines were limited to 37 percent of those collected from the top 18 inches of soil. Contaminants were detected in trace concentrations in 25 percent of the samples from the 18-inch to 5-feet horizon. No contaminants were detected in samples collected from greater depths.

b. Significant soils contamination probably exists at the OB site. This statement cannot be made conclusively because only a limited number of samples were collected from the soils near the surface, and these samples contained a wide range of explosives concentrations. What contamination is present is limited to the top18 inches soil

c. Horizontal surface migration of contaminants can be expected in conjunction with runoff events. This is due to the impermeable nature of the surface soils and the existence of runoff ditches at the OB site.

d. The primary contaminants were TNT, 2,6-DNT, and 2,4-DNT.

TABLE O-1 INSTALLATION: VOLUNTEER AAP

CONTAMINANT: EACH METAL

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	5	100	0	0	100	0	0	5	100
6-18"	3	100	0	0	100	0	0	3	100
18"-5'	20	100	0	0	100	0	0	20	100
5-10'	10	100	0	0	100	0	0	10	100
10-20'	12	100	0	0	100	0	0	12	100
20'+	16	100	0	0	100	0	0	16	100

TABLE O-2 INSTALLATION: VOLUNTEER AAP

CONTAMINANT: TNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	2	40	2	40	80	1	20	5	100
6-18"	0	0	1	33	33	2	67	3	100
18"-5'	17	85	3	15	100	0	0	20	100
5-10'	10	100	0	0	100	0	0	10	100
10-20'	12	100	0	0	100	0	0	12	100
20'+	16	100	0	0	100	0	0	16	100

TABLE O-3 INSTALLATION: VOLUNTEER AAP

CONTAMINANT: 2,6-DNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	0	0	4	80	80	1	20	5	100
6-18"	0	0	1	33	33	2	67	3	100
18"-5'	17	85	3	15	100	0	0	20	100
5-10'	10	100	0	0	100	0	0	10	100
10-20'	12	100	0	0	100	0	0	12	100
20'+	16	100	0	0	100	0	0	16	100

TABLE O-4 INSTALLATION: VOLUNTEER AAP

CONTAMINANT: 2,4-DNT

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	0	0	4	80	80	1	20	5	100
6-18"	0	0	1	33	33	2	67	3	100
18"-5'	17	85	3	15	100	0	0	20	100
5-10'	10	100	0	0	100	0	0	10	100
10-20'	12	100	0	0	100	0	0	12	100
20'+	16	100	0	0	100	0	0	16	100

TABLE O-5 INSTALLATION: VOLUNTEER AAP

CONTAMINANT: RDX, HMX, OR TETRYL

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	5	100	0	0	100	0	0	5	100
6-18"	3	100	0	0	100	0	0	3	100
18"-5'	20	100	0	0	100	0	0	20	100
5-10'	10	100	0	0	100	0	0	10	100
10-20'	12	100	0	0	100	0	0	12	100
20'+	16	100	0	0	100	0	0	16	100

TABLE O-6 INSTALLATION: VOLUNTEER AAP

CONTAMINANT: SUM OF EXPLOSIVES DATA

DEPTH	ND #	ND %	< GUIDELINE #	< GUIDELINE %	TOTAL % ND OR < GUIDLN	> GUIDELINE #	> GUIDELINE %	TOTAL #	TOTAL %
0-6"	17	57	10	33	90	3	10	30	100
6-18"	9	50	3	17	67	6	33	18	100
18"-5'	111	93	9	8	100	0	0	120	100
5-10'	60	100	0	0	100	0	0	60	100
10-20'	72	100	0	0	100	0	0	72	100
20'+	96	100	0	0	100	0	0	96	100

TABLE O-7 INSTALLATION: VOLUNTEER AAP

CONTAMINANT: SUM OF METALS DATA

DEPTH	ND #	ND %	< TEP LIMIT #	< TEP LIMIT %	TOTAL % ND OR < TEP LMT	> TEP LIMIT #	> TEP LIMIT %	TOTAL #	TOTAL %
0-6"	40	100	0	0	100	0	0	40	100
6-18"	24	100	0	0	100	0	0	24	100
18"-5'	160	100	0	0	100	0	0	160	100
5-10'	80	100	0	0	100	0	0	80	100
10-20'	96	100	0	0	100	0	0	96	100
20'+	128	100	0	0	100	0	0	128	100

TABLE O-8 INSTALLATION: VOLUNTEER AAP

CONTAMINANT: SUMMARY FOR ALL CONTAMINANTS

DEPTH	ND #	ND %	< TEP LIMIT OR GUIDELINE #	< TEP LIMIT OR GUIDELINE %	TOTAL % ND OR < LMT/GDL	> TEP LIMIT OR GUIDELINE #	> TEP LIMIT OR GUIDELINE %	TOTAL #	TOTAL %
0-6"	0	0	4	80	80	1	20	5	100
6-18"	0	0	1	33	33	2	67	3	100
18"-5'	15	75	5	25	100	0	0	20	100
5-10'	10	100	0	0	100	0	0	10	100
10-20'	12	100	0	0	100	0	0	12	100
20'+	16	100	0	0	100	0	0	16	100

Figure 0-2.

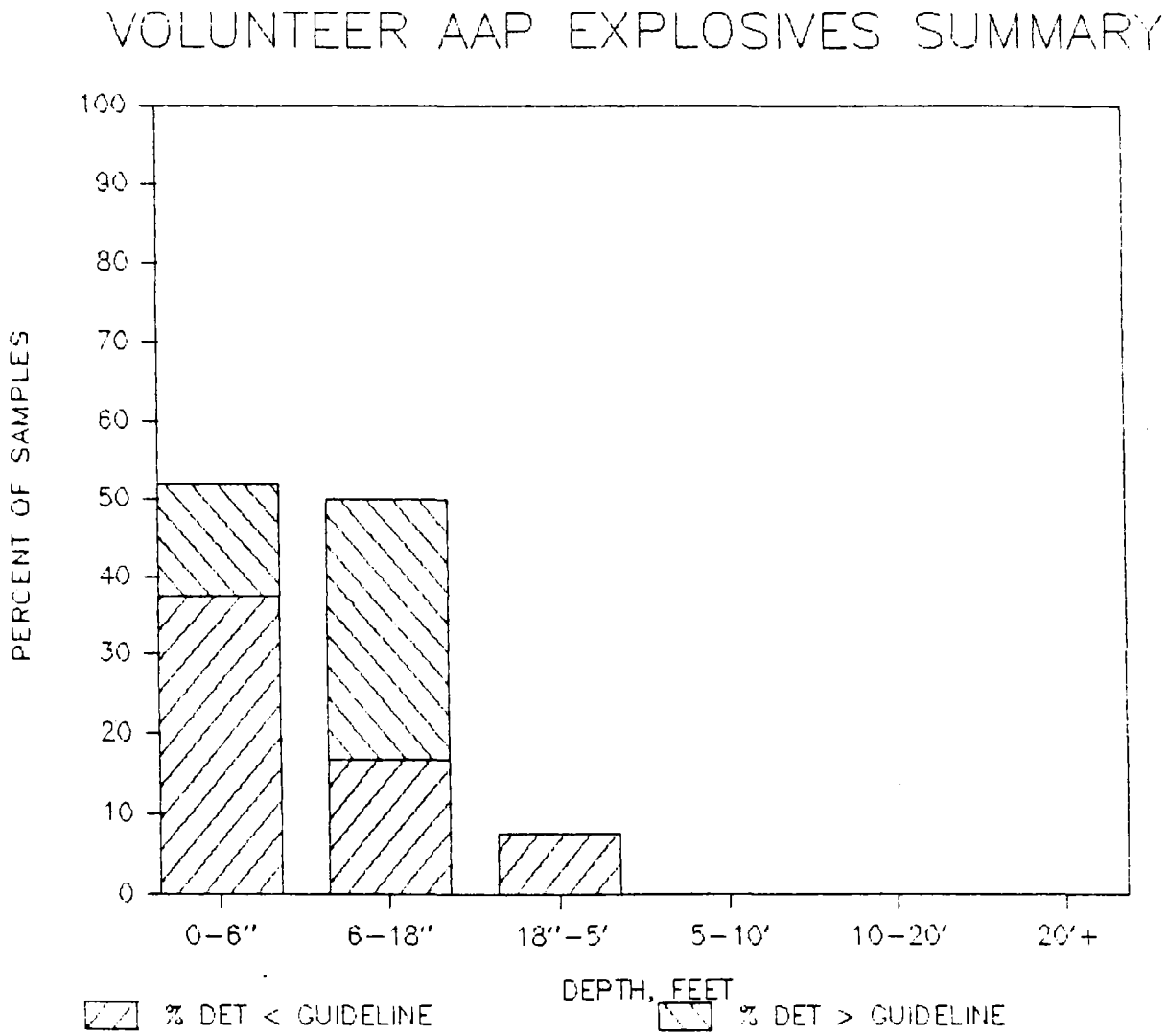
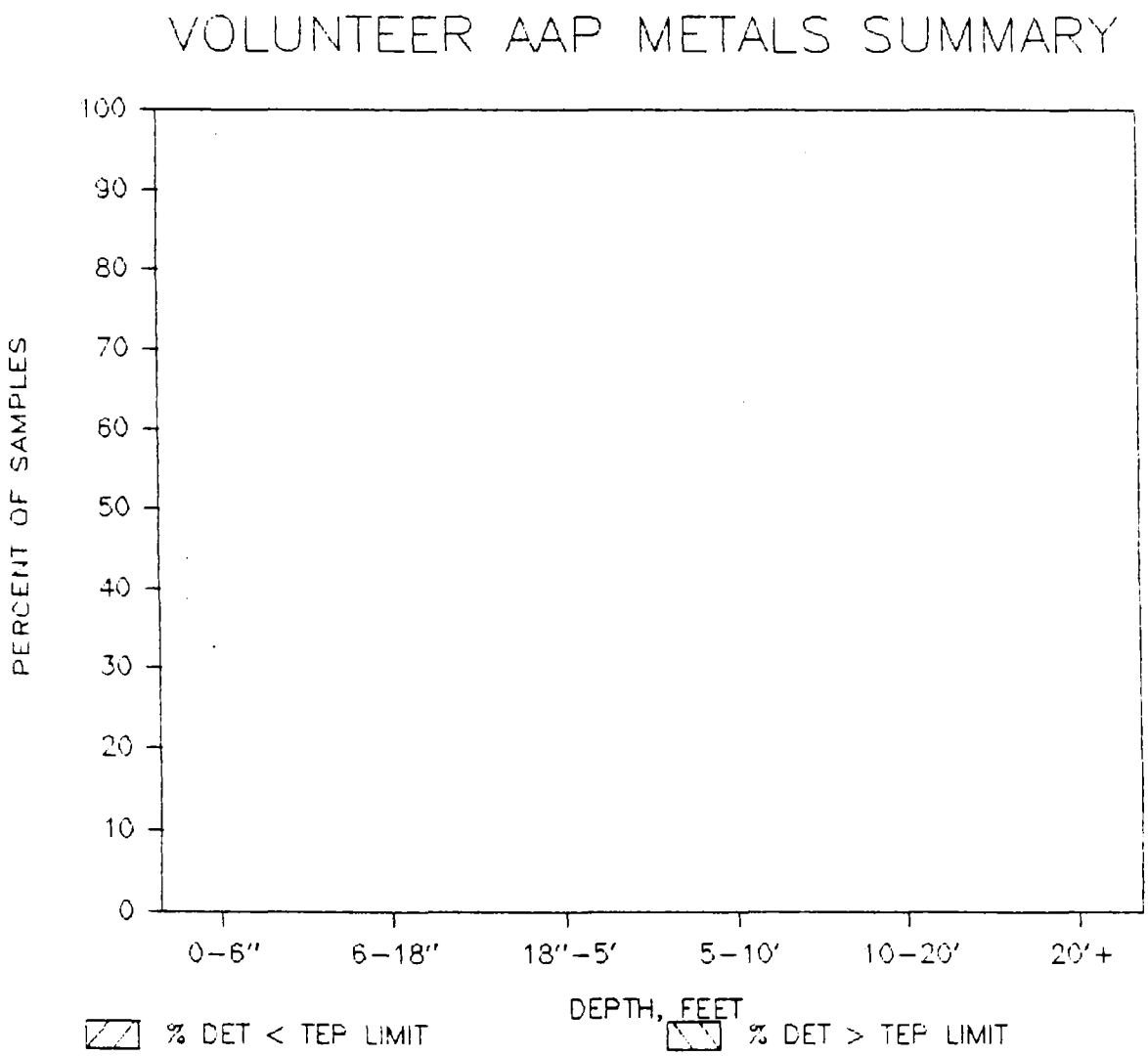

VOLUNTEER AAP EXPLOSIVES SUMMARY
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0–6"
6–18"
18"–5'
5–10'
10–20'
20'+
DEPTH, FEET
% DET < GUIDELINE
% DET > GUIDELINE

Figure 0-3.


VOLUNTEER AAP METALS SUMMARY
PERCENT OF SAMPLES
100
90
80
70
60
50
40
30
20
10
0
0–6"
6–18"
18"–5'
5–10'
10–20'
20'+
DEPTH, FEET
% DET < TEP LIMIT
% DET > TEP LIMIT

APPENDIX P

CONCLUSIONS AND RECOMMENDATIONS FROM PHASE 3 OB/OD REPORT

1. CONCLUSIONS.

a. Ninety-nine percent of the residues and soils tested contained no RCRA TEP metals.

b. Ninety-eight percent of the residues and soils tested contained levels of explosives less than 1,000 µg/g.

c. While the residues and soils are potentially reactive, in reality it is unlikely that the concentrations of explosives found in this study would present a reactive danger according to the newly accepted Bureau of Mines reactivity tests.

d. Almost all AMC installations can confidently continue to conduct current OB/OD operations, provided greater emphasis is given to facility and residue management.

e. Due to a favorable ambient environment, large-scale OB/OD operations can best be conducted at the six western-area DESCOM installations, AMCCOM's Hawthorne AAP, and the three TECOM installations studied.

f. Several OB/OD facilities in flood hazard areas will have to be upgraded, relocated, or closed.

g. Use of the OB/OD site selection guidelines seems to be a rational way to select relocated or new OB/OD sites to reduce potential impacts to human health or to the environment.

h. The lists of "good and poor" practices outlined for OB/OD facilities and operations are an excellent guide to help preclude deleterious health or environmental impacts.

i. The TEP metals of concern from the study are lead, cadmium, and, to a limited extent, barium.

j. The explosives most frequently encountered in the analyses were 2,4,6-TNT, RDX, and HMX.

k. The chemical content of certain explosives in residues may present a real toxicity danger to human health and to the environment which must be researched.

l. Any data on TEP metals, reactivity, or chemical toxicity must be tempered with a full geohydrological site evaluation to interpret a site's total impact to human health and aquatic biotas.

m. The results of this study, coupled with the proposed OB/OD site selection guidelines, should be formulated into a policy statement regarding the siting of new or relocated OB/OD facilities.

n. Observations cited in the section on "good and poor" operational practices should be formulated into an OB/OO operational policy.

2. RECOMMENDATIONS. The following recommendations are based on good environmental engineering practices.

a. Continue to operate currently active OB/OD facilities, providing greater emphasis on facility and residue management.

b. Conduct the large-scale OB/OD workloads in principally the six western-area DESCOM installations, AMCCOM's Hawthorne AAP, and the three western TECOM installations.

c. Upgrade, relocate, or close those OB/OD facilities located in regulatory flood hazard areas.

d. Determine the reactivity of OB/OD residues using the newly EPA-approved Bureau of Mines reactivity test procedures.

e. Develop a policy statement for OB/OD facility manager and operators incorporating the "good and poor" operational practices at OB/OD facilities.

f. Develop a policy statement concerning the use of the proposed OB/OD site selection guidelines for establishing or relocating OB/OD facilities.

g. Institute a program with the appropriate research and development agency within the Department of the Army to determine and evaluate the chemical toxicity of munitions-related metals and explosives.

APPENDIX Q

SPECIFIC INFORMATION ON THE PROCEDURES USED TO ANALYZE FOR REACTIVITY USING THE BUREAU OF MINES TESTS

1. GENERAL. The Bureau of Mines has developed two procedures to be used to analyze a sample for reactivity. These two test are detailed in paragraphs 2 and 3 below. These tests were developed to determine if solid wastes exhibit the following reactive hazardous characteristics cited in 40 CFR 261.23(a)(6) and (7):

a. Capable of detonation or explosive reaction if subjected to a strong initiation source or if heated under confinement.

b. Readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.

2. US INTERNAL IGNITION TEST.

a. The experimental arrangement for this Bureau of Mines test is shown in Figure Q-1. The sample of material to be tested is contained in an 18-inch (45.7 cm) length of "3 in schedule 80" carbon steel pipe with inside diameter 2.9 inch (7.37 cm), wall thickness 0.30 inch (0.76 cm), capped at both ends with "3000 lb" forged steel pipe caps.

b. The sample is subjected to the thermal and pressure stimulus generated by an ignitor consisting of 0.7 oz (20 g) of grade FFF_g black powder located at the center of the sample vessel. The ignitor assembly consists of a cylindrical container 0.81 inch (2.06 cm) in diameter and 2.5-inch (6.4 cm) long, which is made of 0.01-inch (0.0254 cm) thick cellulose acetate which is held together by two layers of nylon filament reinforced cellulose acetate tape. The ignitor capsule contains a small loop formed from a 1-inch (2.54 cm) length of nickel-chromium alloy resistance wire 0.012 inch (0.030 cm) in diameter, having a resistance of 0.343 ohms. This loop is attached to two insulated copper-tinned lead wires 0.026 inch (0.066 cm) in diameter. The overall wire diameter including insulation is 0.05 inch (0.127 cm). These lead wires are fed through small holes in a brass disc approximately 0.4 inch (1 cm) in diameter and 0.03-inch (0.08 cm) thick, which is soldered to the end of a 9-inch (23 cm) length of 1/8 inch steel pipe having a diameter of 0.405 inch (1.03 cm), which is threaded at the other end and screwed into a threaded hole on the inside of one of the pipe caps. This pipe supports the ignitor capsule and serves as a channel for the ignitor wires. The ignitor is fired by a current of 15 amperes obtained from a 20-volt transformer.

c. The criterion currently used in the interpretation of this test is that for a positive result, either the pipe or at least one of the end caps be fragmented into at least two distinct pieces, i.e., results in which the pipe is merely split or laid open or in which the pipe or caps are distorted to the point at which the caps are blown off are considered to be negative results. Although it may be argued that a small number of

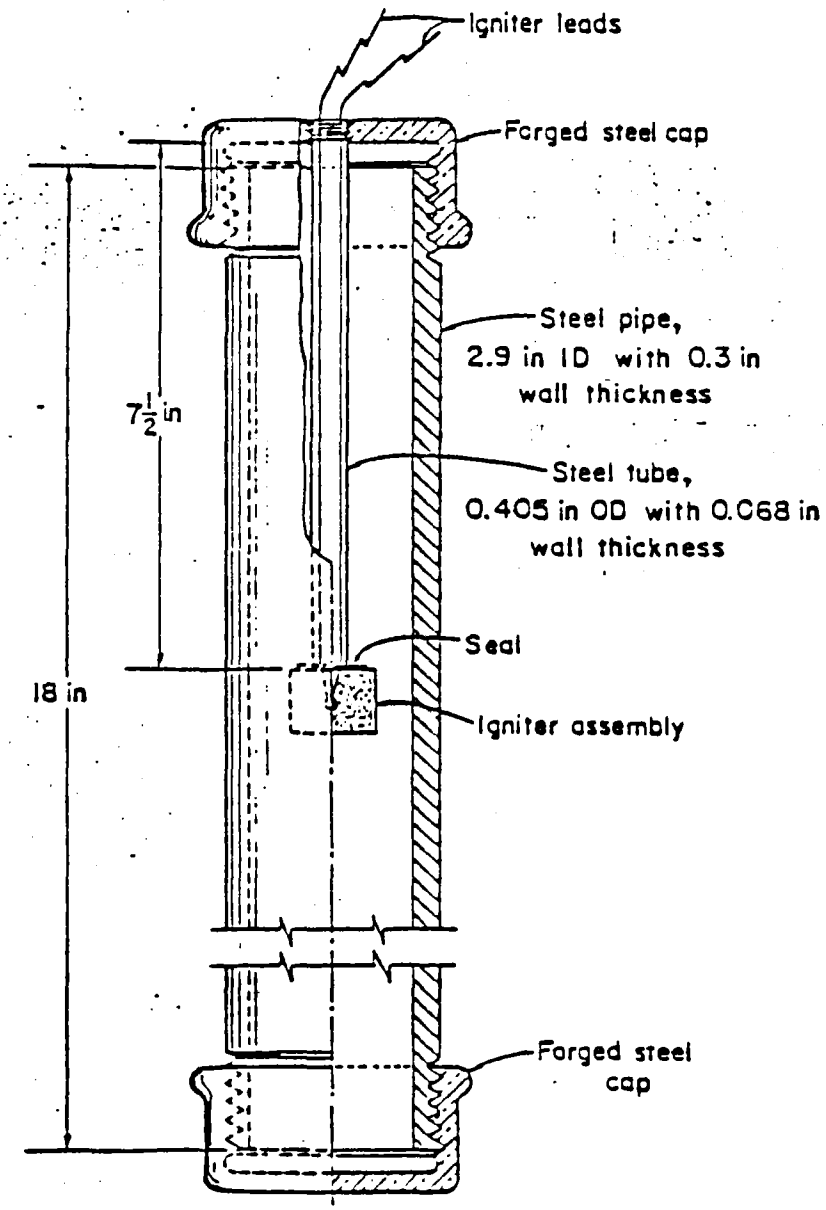


Figure Q-1. Pipe Bomb Used in the Internal Ignition Test

fragments does not indicate the development of a detonation, it at least indicates a very rapidly rising pressure which in a larger sample could lead to development of detonation.

3. US GAP TEST.

a. The apparatus for the US Gap Test, the second Bureau of Mines reactivity test, is shown in Figure Q-2. The test sample is contained in a cylinder consisting of a 16-inch (40.6-cm) length of 1 1/2-inch schedule 80 black seamless steel pipe. A mild steel witness plate 6-inches (15.24 cm) square and 0.125-inch (0.32 cm) thick is mounted at the upper end of the sample tubing and separated from it by spacers 0.062-inch (0.16 cm) thick. The bottom of the cylinder is closed with two layers of 0.003-inch (0.008 cm) thick polyethylene sheet held in place with gum rubber bands and polyvinyl chloride electrical insulating tape. There is no other gap between the pentolite booster and the test sample as used in this test. A continuous velocity of detonation probe made of thin aluminum tube with an axial resistance wire having a resistance of 7.62 ohms/inches (3.0 ohms/cm) is mounted on the wall of the sample tubing. The outer tubing of the probe is crimped against the inner wire at the lower end forming a resistor. When this assembly is inserted in a medium which transmits a shock wave, the outer wall crushes against the inner wire, as the wave moves up the tubing shortening the effective length and changing the resistance. If a constant current (usually 0.06 amperes) is made to flow between the outer and inner conductors, the voltage between them is proportional to the effective length and can be recorded as a function of the time using an oscilloscope. The slope of the oscilloscope trace is thus proportional to the velocity of the shock wave.

b. The apparatus for the gap test for liquids is the same as that for solids except that a method of injecting bubbles into the liquid sample is provided. The experimental set-up is given in Figure Q-3. The bubbles are injected by means of a 0.925-inch (2.35 cm) diameter loop of vinyl plastic tubing of the type used for medical catheterization with an outside diameter of 0.07 inch (0.18 cm) and a wall thickness of 0.016 inch (0.04 cm) located at the bottom of the sample. This loop is perforated with two rows of holes diametrically opposite to each other with the holes in each row spaced 0.125 inch (0.32 cm) apart. The holes are made by inserting a 0.05-inch (0.13 cm) diameter needle through the wall of the tubing. Due to the elastic nature of the tubing, the holes contract almost completely when the needle is withdrawn, so the actual hole diameter is much smaller than 0.04 inch (0.1 cm). The tubing is sealed at one end of the loop with epoxy cement and a length of the tubing from the other end of the loop is led outside to the air supply through a hole in the steel tubing, which is sealed with epoxy cement. Air is supplied at a pressure of 0.3 to 1.0 atm (30 to 100 kPa) to obtain a flow rate of 2.5 ft^3 /hr (0.12 L/min). Where it is suspected that the sample may react with the steel tube, the inside of the tube is sprayed with a fluorocarbon resin coating.

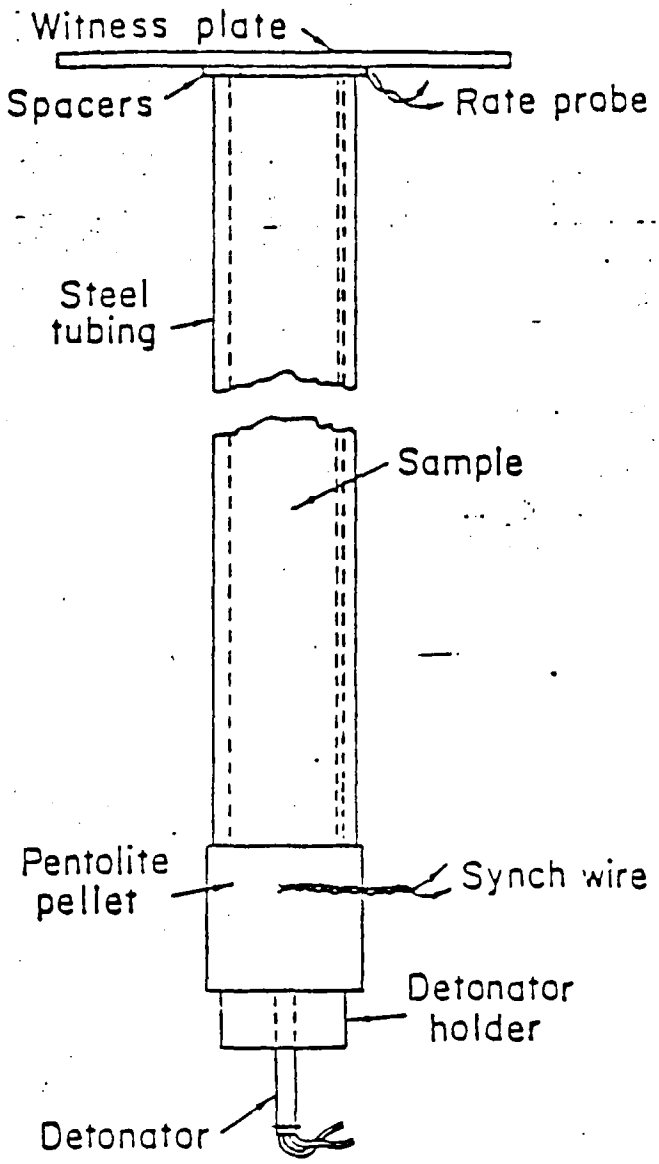


Figure Q-2. US Gap Test for Solids

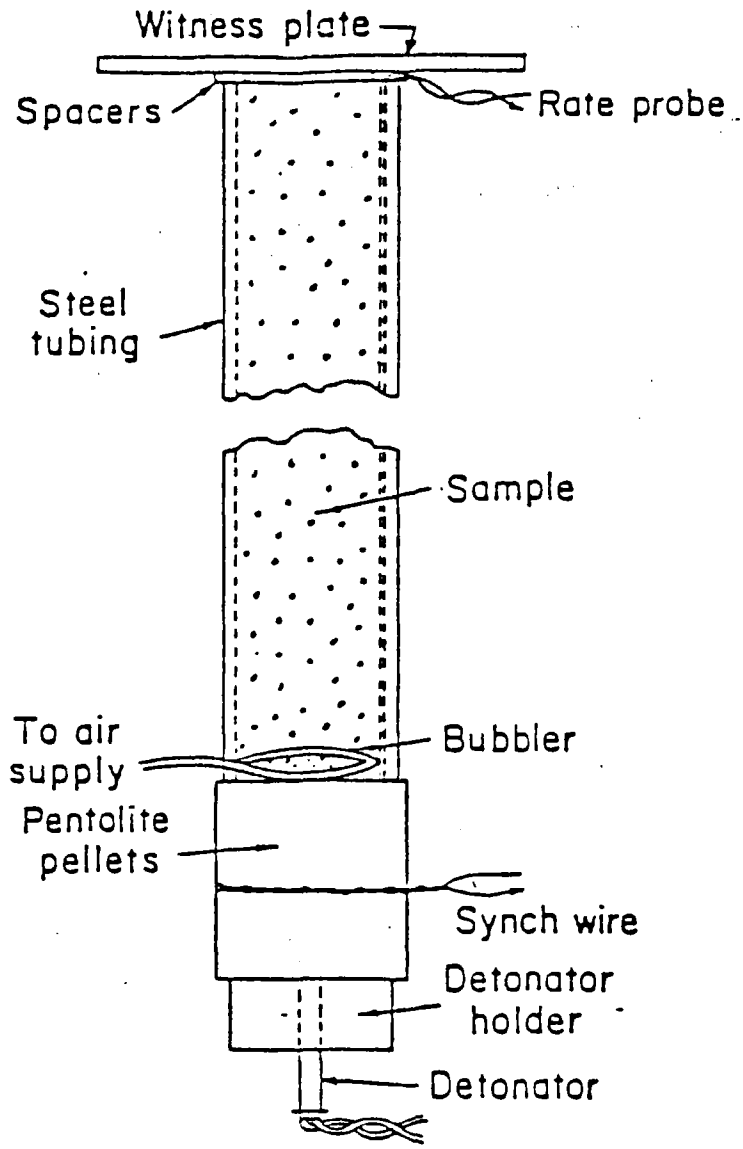


Figure Q-3. US Gap Test for Liquids

c. The sample is loaded to the top of the steel tube. For liquid samples, adequate ullage should be allowed. Solid samples are loaded to the density attained by tapping the cylinder until further settling becomes imperceptible. The sample at 20 °C ± 3 °C is subjected to the shock wave generated by the detonation of a pentolite (50/50 PETN/TNT) pellet, 2 inches (5.08 cm) in diameter and 2-inches (5.08 cm) thick having a density of 1.6 ± 0.05 g/cc. The pentolite pellet is butted against the bottom of the test sample and initiated with a No. 8 strength detonator. The detonator is held in place by a cork detonator holder.

d. The criteria for propagation are:

(1) A stable propagation velocity greater than 4,900 ft/sec (1.5 km/sec) is observed.

(2) A hole is punched through the witness plate.

(3) The sample tube is fragmented along its entire length.

The overall test results are considered positive if any two of the three criteria are met.

4. POSITIVE REACTIVITY TEST. Three trials of both the Internal Ignition Test and the Gap Test are performed on each sample. If any one or more of these trials provides results, the sample is determined to be reactive based on the Bureau of Mines procedures.

APPENDIX R

PHASE 2 OB/OD FIELD SAMPLING METHODOLOGIES AND PATTERNS

1. Because existing OB/OD operations encompass areas ranging from a few to hundreds of acres, a full-scale sampling program would involve hundreds of samples from each OB/OD facility. The sheer magnitude of samples multiplied by 14 chemical parameters would be well beyond existing, although considerable, Agency analytical capabilities. An alternative sampling program was developed to provide a cross-sectional representation of each OB/OD facility, with a practical and manageable number of samples.

2. Using statistician support, three basic sampling methodologies were developed. Application of any one or more of the methods was left to the discretion of the project officer based on his onsite evaluation of facilities and operations. The three basic methods are illustrated in Figures R-1 through R-5.

3. A very simple and common burning ground operation was to burn the material in a trench in a long row. In such cases there is little lateral spreading of the waste since the trench confines it. For trenches, samples were taken from points 5-feet apart along the lengthwise axis of the trench, with a minimum of 3 and a maximum of 10 sampling points (see Figure R-1.

4. Many burning ground areas were located on relatively flat, broad expanses of terrain. However. the actual burning facility may be considerably smaller, ranging from 10-foot-diameter circles to 150- to 200-foot squares. For burning facilities such as these, a circular sampling pattern was used (see Figures R-2 and R-3). A burn facility 5-20 feet in diameter generally required five sample points. Facilities 20-60 feet in diameter usually required five to nine sample points. Facilities greater than 60 feet required proportionally more sample points (see Figure R-4). Many burning facilities did not fit rectangular or circular sampling modes. Some facilities were "X" or "T" shaped or combinations of all modes (see Figure R-5). Choice of sampling mode, by intent, was at the project officer's discretion.

5. At OB facilities, there was a possibility of taking four samples at each sampling point. The initial sample was from the small piles of ash residues, if any. The second sample was a composited surface residue/soil sample taken within a 3-foot diameter of the sample point. After the ash and surface soils were taken, the 3-foot-diameter circle was further cleared of loose surface debris. An augered soil sample, or third sample, was then taken from 0 to 6 inches in depth. The hole was then cleared and a second subsurface soil sample, or fourth sample, was taken from 6 to 18 inches in depth.

6. At OD facilities, only surface soil samples were taken. Surface soils were recovered at each sampling point from no deeper than 3 inches. Almost universally, a circular mode of sampling was used.

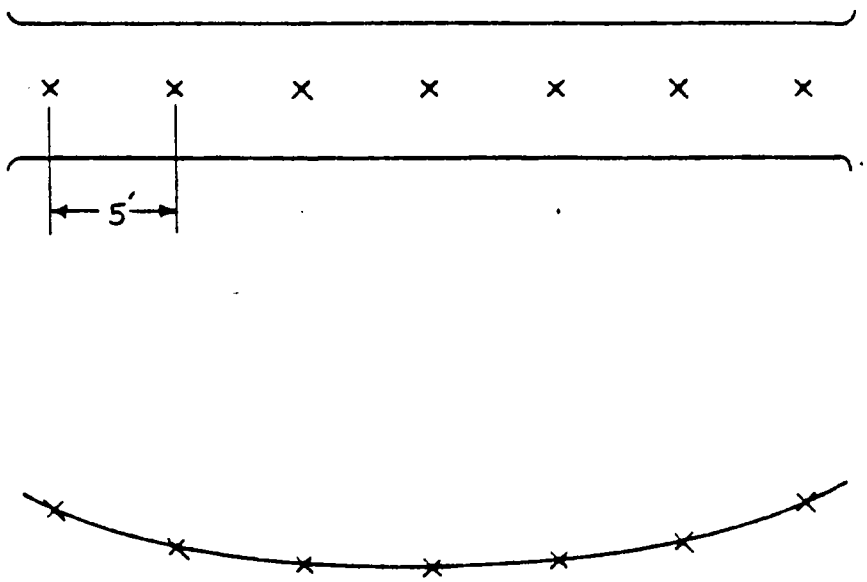


Figure R-1. Trench and Strip Sampling Pattern

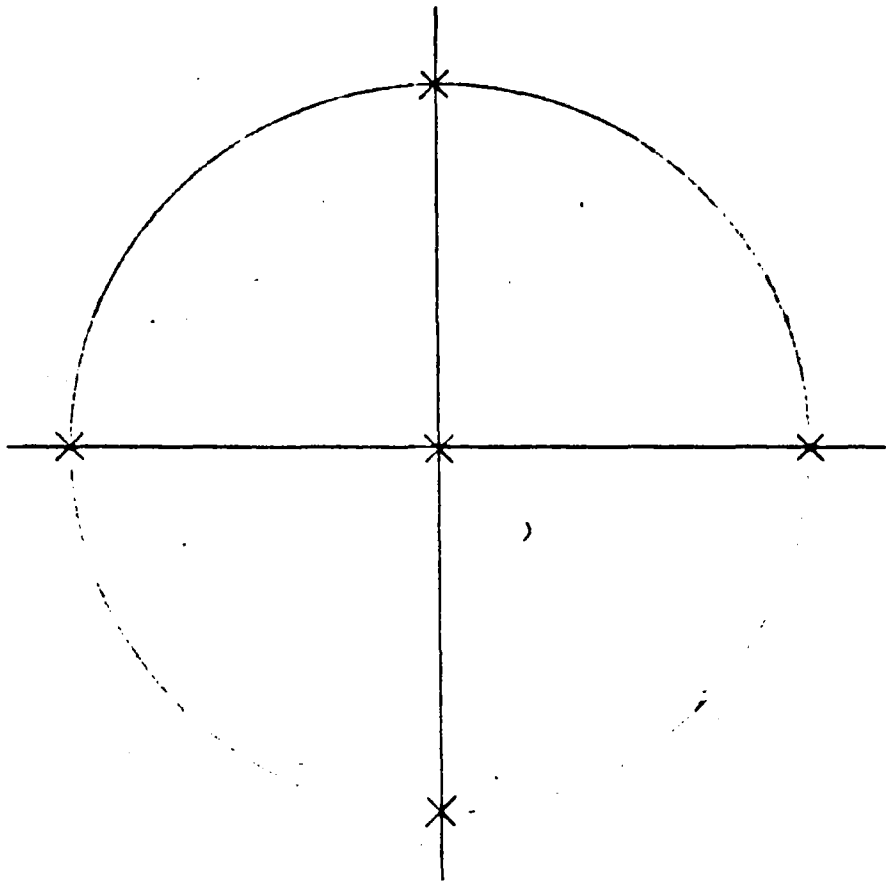


Figure R-2. Five Point Sampling Pattern

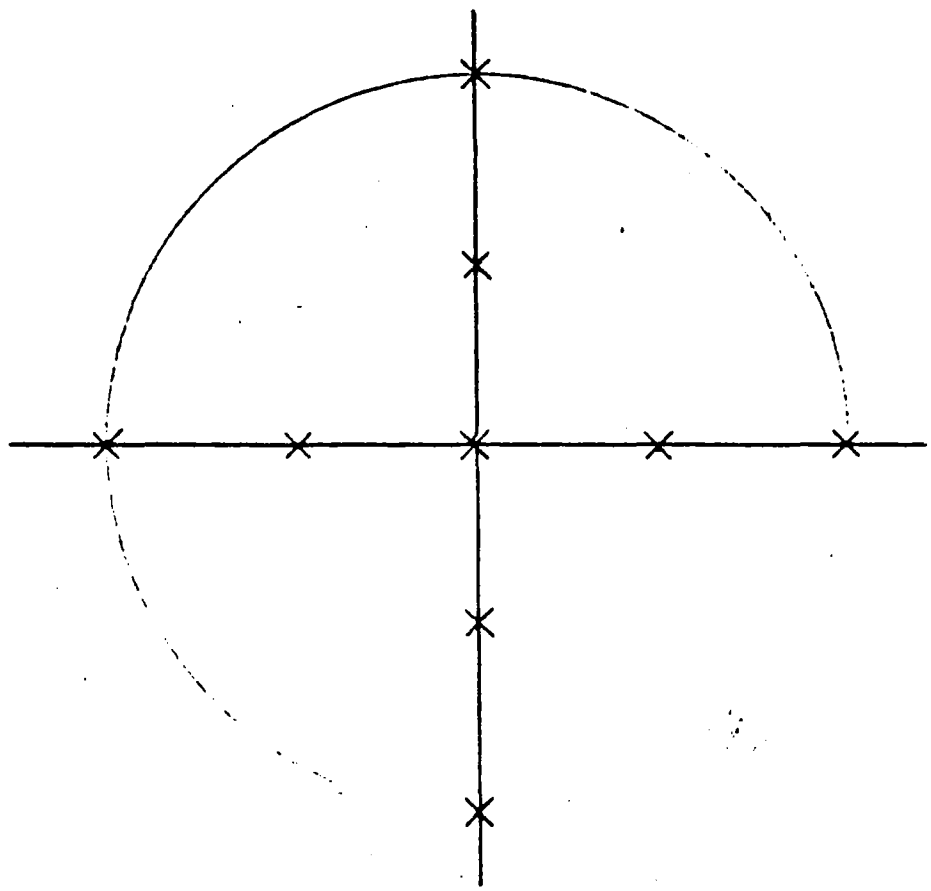


Figure R-3. Nine Point Sampling Pattern

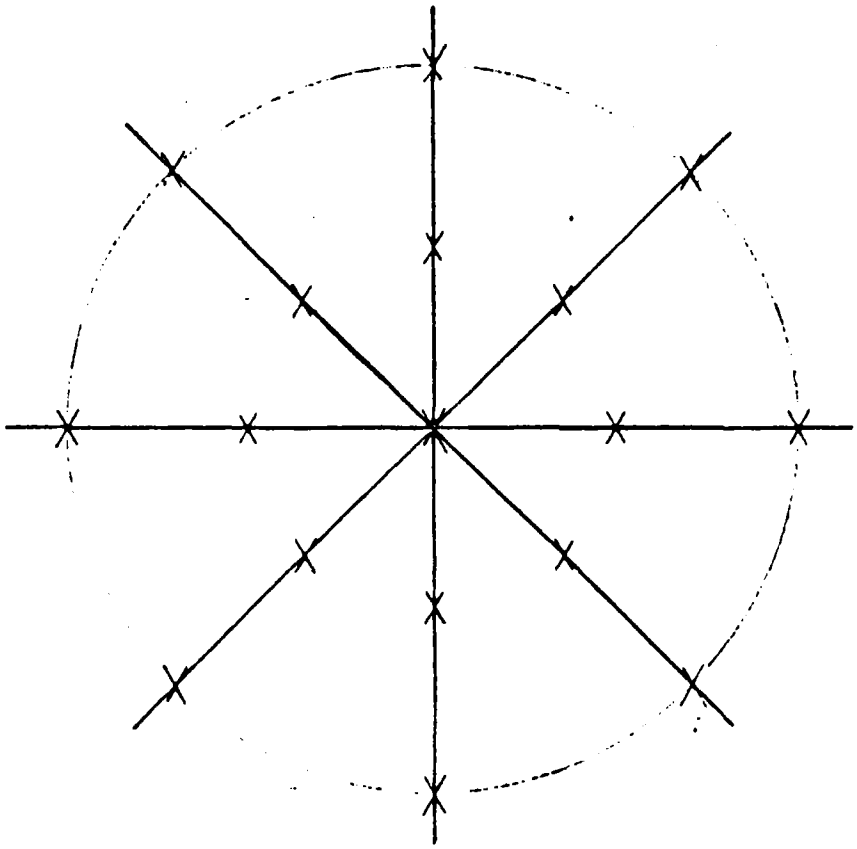


Figure R-4. Greater Than Nine Point Sampling Pattern

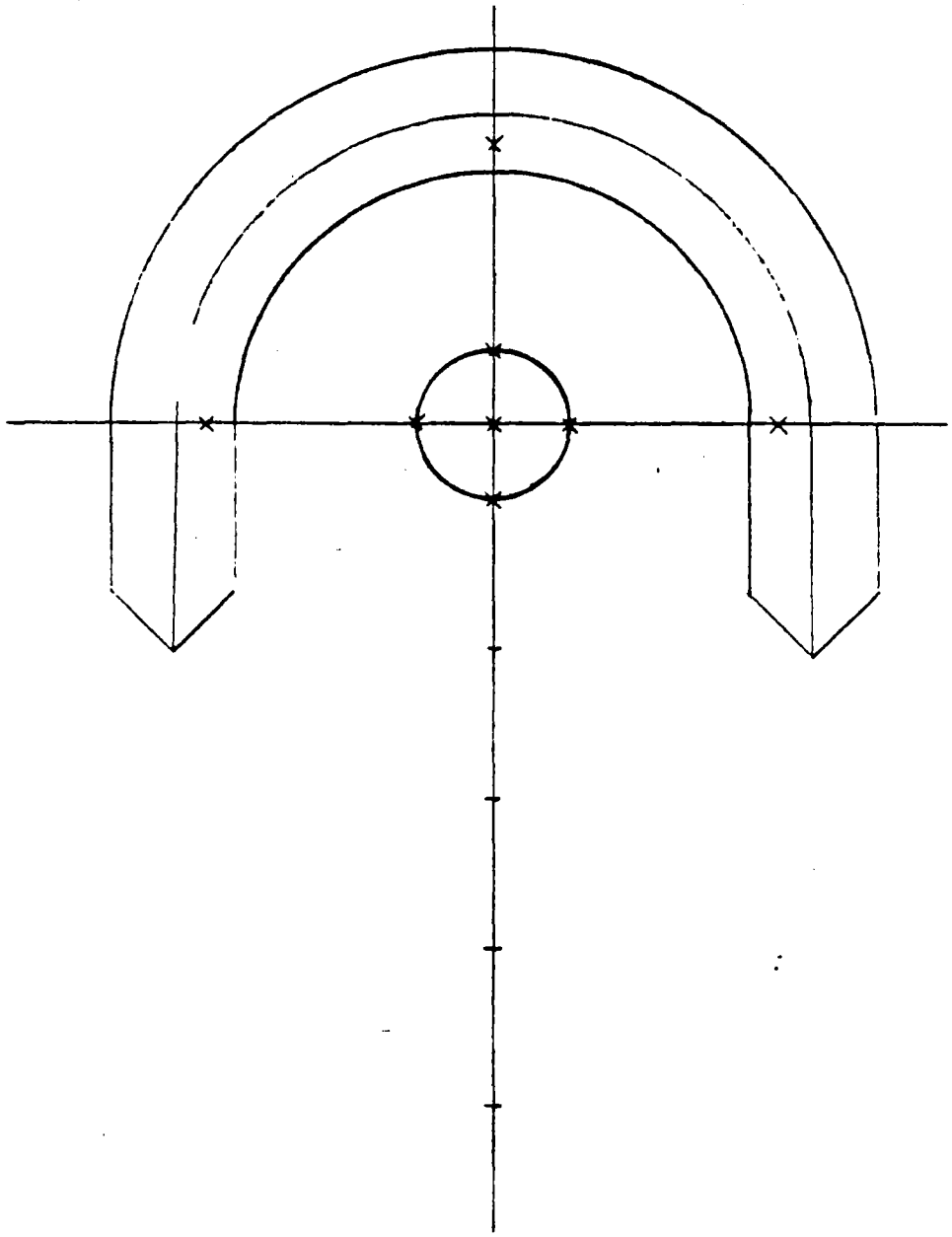


Figure R-5. Extended Sampling Pattern

7. Upon completion of the sampling scenario at each facility, several samples (a minimum of two at very small facilities) were taken upgradient and downgradient to provide a clean control background. These samples were taken several hundred feet from the known fringes of past operations. All surface samples were collected with a disposable plastic scoop. Subsurface soil samples were taken with a stainless steel basket auger. This auger was driven by a remote-control, trailer-mounted drill rig. The drill rig is capable of being operated by electric remote control at distances up to 150 feet. After setup and from a distance of 150 feet, the drill was rotated 6 inches into the soil and left to set for 2 minutes. The sample was then removed and the procedure repeated for the 6- to 18-inch sample. the samples were placed into 1-quart, straight-sided, glass containers with Teflon® lid liner. the following information was written on each container: sample type, date, location, depth of sample, and installation name as outlined in the chain of custody. A log was kept for each site, including a map of the facility with sample locations marked.

® Teflon is a registered trademark of the E. I. Dupont de Nemours and Company, Inc., Wilmington, Delaware. Use of trademarked names does not imply endorsement by the US Army but is intended only to assist in identification of a specific product.

APPENDIX S

RECOMMENDED OB/OD OPERATIONAL PRACTICES

1. GOOD PRACTICES.

a. Minimizing waste slated for OB/OD by source segregation at the points of generation.

b. Visually inspecting incoming PEP and ordnance loads to see if they contain items not intended to be, or not normally burned or detonated.

c. Conducting OB/OD operations in good weather conditions, particularly observing the specific provisions of the air quality control portions of yearly permits or waivers.

d. Controlling run-on/runoff by appropriately engineered diversion and drainage systems.

e. Using steel pans to open-burn bulk PEP wastes.

f. Collecting and testing residues after each OB operation for EP Toxicity metals and reactivity.

g. Storing residues, pending test results, in a facility meeting RCRA storage requirements under 40 CFR 264.170 through 264.177.

h. Disposing of hazardous residues at a permitted hazardous waste disposal facility.

i. Disposing of nonhazardous residues in a permitted sanitary landfill.

j. Confining OB/OD operations to as small an area as possible to preclude potentially contaminating large areas.

k. Locating new OB/OD facilities according to the factors listed in Appendix T.

l. Monitoring local ground and surface waters, for metals and explosives, if necessary based on hydrogeological interpretations and data contained in this study. Monitoring for other identifiable parameters from unique operations having potential environmental impact may also be necessary.

2. POOR PRACTICES.

a. Accumulating large quantities of PEP and ordnance waste onsite prior to conducting OB/OD operations.

b. Burning liquid PEP, sludges, solvents, and oils by dumping waste on the ground prior to ignition.

c. Accepting miscellaneous organics for burning merely as a convenient method of disposal.

d. Accepting, for disposal, certain wastes such as PEP, PCB, DDT, or other specialized organic formulations which can only be disposed of under controlled incineration methods.

e. Burying any untested residues.

f. Using residues as a fill material in low areas, in ravines, or in drainageways.

g. Covering over an OB facility with "clean fill" or "gravel" to improve appearance. (This constitutes disposal as a landfill).

h. Burning incompatible wastes.

APPENDIX T

FACTORS INVOLVED IN OB/OD SITE SELECTION

1. If performance standards, vis a vis the RCRA regulations, are to be achievable, then it logically follows that an OB/OD facility should be located in a geographical area where "natural" conditions help preclude multimedia environmental damage or impacts to human health. In some instances, such as in the western DESCOM installations, OB/OD grounds were fortuitously selected on the basis of remoteness to human populations for safety reasons - not necessarily for environmental concern. Fortunately, the natural geohydrology, soils, and climatological phenomena at many of these depots have obviated a number of adverse environmental concern. Fortunately, the natural geohydrology, soils, and climatological phenomena at many of these depots have obviated a number of adverse environmental impacts. Unfortunately, these unique phenomena are not the universal conditions at OB/OD grounds located in the midwest and eastern environs, particularly at AMCCOM installations, where complex ambient conditions are not necessarily optimal for open-air-type thermal treatment/disposal systems.

2. During Phase 1, this Agency compiled a set of guidelines or "factors" which it used to categorize installations having a high, medium, or low potential for contaminant migration to surface or subsurface waters. These guidelines or factors of consideration, while founded in the technical disciplines, are intended for professional/subjective interpretation. (No attempts have been made to develop a complex alpha/numerical matrix-ranking system for OB/OD site selection using these factors). The guidelines are not all-inclusive but are put forth merely as one method of evaluating the impact of the natural or in-situ conditions at an OB/OD facility. The major factors and supportive statements are as follows:

a. General Site Selection Indicators.

(1) Human Populations. More of a problem in midwestern and eastern installations where communities surround installation borders and are more immediately impacted by noise (facilities must be consistent with the Installation Compatibility Use Plan), air pollutants, or contaminated water resources.

(2) Quantity/distance Relationship. Can be a severe restriction in eastern installations especially if the OB/OD site is relocated [e.g., Holston AAP has only one other area for possible OB site relocation even though existing igloo contents would have to be reallocated (quantity/distance), and visual problems (smoke from the burning of the PEP) would impact on downriver communities].

(3) Topography. Important for site access, isolation against sound, and site drainage. Usually slopes >3 percent will require surface-water diversion techniques to control run-on/runoff problems.

(4) Surface-water Bodies. Important from pollution potential in terms of surface drainage. May also indicate high ground-water table and potential for ground-water contamination. Bedrock units may be an important factor.

(5) Floor Hazard Areas. Unless the OB/OD site cannot be relocated due to quantity/distance or other space allocation requirements, it may require special designs to avoid washout of waste during peak floods or changes in operational schedules.

(6) Critical Habitat of Endangered Species. The OB/OD operations may impact on certain species with limited mobility, feeding range, or unique flora.

b. Geologic Units.

(1) Stratigraphy. From surface to bedrock units, identify type and thickness of each subsurface geologic unit.

(2) Regional Geologic Structures. Type of bedrock units, dip/strike of bedrock formations, anticline/syncline features, highly folded/faulted or fractured rock units, karst formations, etc. Uniqueness of bedrock units helps determine the influences on the regional ground-water movements.

c. Soils. The following soil characteristics are important for an understanding of potential contaminant migration from a pollution source:

(1) Depth of soil overburden above bedrock units.

(2) Uniformity or stratification of soil types.

(3) Soil classifications in stratographic profiles.

(4) Soil physical data from borings or other sources - compaction, compaction permeability, in-situ permeability, grain size distribution, Atterberg limits, moisture content, cation exchange capacity, shrink-swell potential, etc.

(5) Soil chemical data in terms of acid versus alkaline soils, particularly with reference to metals leaching or retention and inorganic/organic constituents.

(a) Acid Soils. Metals in form of leachable nitrates, sulfates, chlorides, phosphates.

(b) Alkaline Soils. Metals complexed in form of oxides, hydroxides, carbonates.

(6) Drill Logs. Ease of sampling with respect to type of sampler used, standard penetration test data, etc.

(7) Geophysical Data. Seismic and resistivity profiles, gama and electric logging of bore holes if available.

d. Ground Water. Uses of local ground waters that may be influenced by OB/OD operations: potable, recreational, irrigational, and industrial.

(1) Aquifer systems in proximity to OB/OD sites may include unconfined or confined aquifers, single or interconnected aquifer systems. Aquifers may also be shallow of deep, with or without a perched table.

(2) Direction of flow and velocity of ground waters help predict contaminant movement.

(3) Data on the chemical quality of ground and surface waters upgradient and downgradient from OB/OD sites are also helpful in determining the level of contaminant impact, if any, to local water resources.

e. Climatology. Several factors may influence the potential for contaminant generation and migration to ground water in addition to causing air pollution problems:

(1) Annual Excess Precipitation. This factor can be approximated by precipitation minus lake evaporation. Examples of geographic areas in the United States are provided below.

(a) Bishop, California: -33 inches/year (similar to Herlong, California - Sierra AD).

(b) Independence, Missouri: 0 inches/year (Lake City AAP).

(c) Chattanooga, Tennessee: +17 inches/year (Volunteer AAP).

Precipitation is also a key factor in determining potential problems with run-on/runoff and subsurfae infiltration and contaminant movement in permeable soils and bedrock units.

(2) Smokes from OB/OD operations may exacerbate local air pollution problems especially in areas noted for stagnant air masses or in valley situations where inversions are frequent. Drifting smokes may greatly affect localized communities due to prevailing wind patterns.

based standards and criteria table are found in the generic closure plan. At OB sites, soils will be tested at six inches, one foot and two feet. If no residual explosives or metals are found at these depths and are not greater than what EPA finds acceptable, then clean closure has been achieved. No GW monitoring will be needed at this point.

Reference and use the UDAEHA Phase 5 report as much as possible to help support no contamination below 18 inches at OB sites, no GW contamination, or lateral contamination. At OD sites, testing will consist only of surface soil sampling. No drilling will be performed at OD sites due to the possibility of running into explosives in the subsurface from previous detonation operations. The Phase 5 report has good justification as to why the Army believes it is dangerous to drill at OD sites. Where appropriate, try to justify no wells. Use page 42 and 43 of the permit writers guide to aid in the closure of OD sites. Recognize however that EPA will not agree with no GW monitoring and that the Army has built in a N.O.D. on this issue.

Phase II is a Contingent Closure Plan (CCP). The CCP will be initiated if clean closure can not be achieved at either the OB or OD site. Refer to the generic CP for an explanation of the CCP.

Phase III is the Post Closure Care Plan which will be submitted to EPA if GW monitoring during the CCP phase shows data higher than EPA finds acceptable.

28. Ammunition becomes hazardous waste upon arrival at the OB/OD site when the transfer forms are signed. This is true for all facilities. The forms used are DA 4508 and/or DD 1348-1. Some facilities use both, others use just one or the other.

29. The Army has requested not ot mention their past practices in the facility description section, but want us to address it in the "Land Use" and in the "exposure potential" sections. Soil data can be inserted in the soil exposure section.

30. Replace pyrotechnics, explosives, and propellants with PEP.

31. In all applications, delete any references to flashing procedures. It was decided that flashing is not related to RCRA.

32. A statement needs to be made in the Contingency Plan that any uncontrolled fires (excluding normal treatment operations) at the OB/OD site will not be fought, but just contained to the area. This means that the fire department would only control brush fires, etc. to contain the fire. An example of an uncontrolled fire would be a tractor trailer of PEP catching fire.

33. Address in more detail the Environmental Performance Standards, 40 CFR 264.601.

34. Remove all references to US Army Armament Munitions Chemical Command, June 1987.

35. Tailor your minimum protective distance section after the attached example. IF the quantity of waste explosive burned or detonated at your facility does not exceed 1,000 pounds, only list the first two lines. Do not give EPA more information on this issue than they need. This is just an example. Tailor this attachment to your facility.

36. Delete any reference to economical benefit of open burning or detonation as a treatment method.

37. Insert a land use map for the area surrounding the OB/OD unit. One may be found in the ICUZ (NOISE) study.

38. FORCECOM facilities were found in some instances to not have inspection schedules, contingency plans, etc. If this is so, write them for the facility to meet the minimum regulatory requirements.

39. Include an environmental setting discussion for all facilities in Section E.

BLP/jad

7. Thermal treatment operations shall not be conducted during electrical storms.

F-6 Minimum Protective Distances for Organic Explosives and Propellants: 265.382

Organic explosives and propellants are burned or detonated in the Ammunition Disposal Area (ADA) in accordance with minimum safety distances detailed in 40 CFR 265.382. These safety distances refer to the distance from the open burning or open detonation unit to the property of others and are specified in the following table:

MINIMUM SAFETY DISTANCES FOR OPEN BURNING AND OPEN DETONATION OPERATIONS

Quantity of Waste Explosives	Minimum Distance from Open Burning or Detonation to Property of Others
0 to 100 pounds	670 feet
101 to 1,000 pounds	1,250 feet
1,001 to 10,000 pounds	1,730 feet
10,001 to 30,000 pounds	2,260 feet

Open burning and open detonation at UMDA take place at distances greater than those required by 40 CFR 265.382. Open burning is limited to 10,000 pounds of waste explosives per burn. Open burning takes place in Open Burn Area 1 and Open Burn Area 2. These areas are located approximately 2,325 feet and 2,400 feet, respectively, from the western facility boundary, which is the boundary closest to the ADA.

Open detonation is limited to 100 pounds of waste explosives per detonation pit. Open detonation takes place in the Open Detonation Area which is located approximately 3,325 feet from the western facility boundary.

Additional security procedures and mechanisms regarding open burning and open detonation are detailed in SOP No. UM-0000-G-007 and SOP No. UM-0000-H-017 (located in Appendices D and E). These Standard Operating Procedures identify mechanisms and procedures to insure that unauthorized personnel cannot enter the OB/OD areas and that OB/OD operations are conducted in a manner that does not threaten human health or the environment.

RCRA PART B
HAZARDOUS WASTE FACILITY
PERMIT APPLICATION
VOLUME IV, APPENDICES L8 - L9

for

ATLANTIC FLEET WEAPONS TRAINING FACILITY
VIEQUES ISLAND, PUERTO RICO

Prepared for

ATLANTIC DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORFOLK, VIRGINIA

Prepared by

ENVIRONMENTAL AND SAFETY DESIGNS, INC.
5724 SUMMER TREES DRIVE
MEMPHIS, TENNESSEE 38134
(901) 372-7962

JUNE 28, 1993

APPENDIX L-9

WORKPLAN AND STATISTICAL EVALUATION
OB AND OD VERSUS PIA
AFWTF VIEQUES

STATISTICAL EVALUATION
OB AND OD UNITS VS. PIA
BOMBING RANGE; VIEQUES, PR

prepared for
ATLANTIC DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
Norfolk, VA

prepared by
ENVIRONMENTAL AND SAFETY DESIGNS, INC. (EnSafe)
Memphis, TN

October 1991

STATISTICAL EVALUATION OF SOILS CONCENTRATIONS

PRIMARY IMPACT AREA
VS.
HAZARDOUS WASTE MANAGEMENT UNITS
(OPEN BURNING AND OPEN DETONATION)

INTRODUCTION

As part of a Part B permit application for a hazardous waste treatment facility, the Navy agreed to conduct an investigation to determine whether previous operation of the units has had a significant determental effect to human health and the environment. Surface soil samples were collected from the Primary Impact Area (PIA); the Open Burning (OB) unit and the Open Detonation (OD) unit within the Bombing Range at the Atlantic Weapons Training Facility Vieques, PR, following the sampling protocol Presented In Methodology, Statistical Comparison; Primary Impact Area Vs. Hazardous Waste Management Units (Open Burning And Open Detonation).

ANALYTICAL RESULTS

The soil samples were analyzed according to the Toxicity Characteristic Leachate Procedure (TCLP). The original laboratory results of each TCLP analysis of each soil sample are presented in Appendicies A, B and C (OB unit, OD unit and PIA, respectively). The substantial majority of the TCLP constituents were not detected (i.e. were below analytical quantitation limits) in the soil extracts from the PIA, OB unit or OD unit. Table 1 identifies those constituents.

STATISTICAL EVALUATION

The objective of the statistical evaluation is to assess any statistically significant differences in TCLP constituent concentrations in soils in the PIA and that in the OB or OD units.

To accommodate the statistical evaluation in those instances in which the constituent was not detected, the quantitation limit concentration was included in the statistical evaluation.

For each constituent, these statistics were computed, using sample results from the PIA:

* the 95 percent upper confidence level (UCL_{95M}) of the mean concentration, and
* the 95 percent upper confidence level (UCL_{95S}) concentration of the statistical sample.

Those "reference" concentrations were compared sequentially to results from the OB and OD units, following these steps:

* the mean concentration of each constituent at the OB was compared to the UCL_{95M} of the mean concentration at the PIA; if the mean OB concentration was equal to or less than the UCL_{95M} of the mean PIA concentration, the OB was judged to be not significantly different from the PIA.

Table 1 Constituents Not Detected in Any Soil Extract			
Constituent	HW No.	Constituent	HW No.
Endrin	D012	1,1-Dichloroethylene	D029
Lindane	D013	2,4-Dinitrotoluene	D030
Methoxychlor	D014	Heptachlor (& epoxide)	D031
Toxaphene	D015	Hexachlorobenzene	D032
2,4-D	D016	Hexachlorobutadiene	D033
Silvex	D017	Hexachloroethane	D034
Carbon Tetrachloride	D019	Methyl Ethyl Ketone	D035
Chlordane	D020	Nitrobenzene	D036
Chlorobenzene	D021	Pentachlorophenol	D037
o-Cresol	D023	Pyridine	D038
m-Cresol	D024	Tetrachloroethene	D039
p-Cresol	D025	Trichloroethene	D040
Total Cresol	D026	2,4,5-Trichlorophenol	D041
1,4-Dichlorobenzene	D027	2,4,6-Trichlorophenol	D042
1,2-Dichloroethane	D028	Vinyl Chloride	D043

* if the mean OB concentration exceeded the mean PIA concentration for any constituent, each discrete analytical result was compared to the UCL_{95M} of the PIA statistical sample.

Appendix D presents the results of those comparisons for both the OB and OD units to the PIA.

DATA EVALUATION

Of the ten (10) constituents detected in any soil extract, three (3) exhibited mean concentrations at the OB or OD exceeding the UCL_{95M} from the PIA. Table 2 details those results.

Table 2 Mean Concentrations Exceeding UCL_{95M}						
Constituent (HW No.)	PIA UCL_{95M} (ug/L)	PIA UCL_{95M} (ug/L)	OB Unit		OD Unit	
			Mean Conc	Fail Ratio	Mean Conc	Fail Ratio
Benzene (D018)	4.8	7.0	11.0	1/11	12.7	3/10
Chloroform (D022)	5.0	5.0	5.7	1/11		
Selenium (D010)	0.49	0.49	0.68	8/13	0.52	3/12

At the OB unit, two (2) organic constituents [in one (1) extract] exhibited concentrations exceeding UCL_{95S}. By contrast, selenium exceeded UCL_{95S} in more than 60 percent of the extracts.

At the OD unit, benzene concentrations exceeded the UCL_{95S} in 30 percent of the extracts. Selenium concentrations exceeded the UCL_{95S} in 25 percent of the extracts; however, absence of quantifiable selenium concentrations at the PIA resulted in a computed UCL_{95S} equal to the quantitation limit of 0.49, and the OD concentrations were 0.57, 0.62 and 0.64.

RECOMMENDATIONS

The presence of mean concentrations of benzene and selenium at the OB and OD units, and chloroform an the OB unit, exceeding the UCL_{95M} of the PIA suggests that the OB and OD operations contribute higher mass of those constituents to the soil than does bombing in the surrounding PIA. Inasmuch as the PIA constitutes "background," the soils at the OB and OD units must be characterized as containing residual contamination of those constituents. Any Hazardous Waste Facility Closure Plan for the OB or OD unit must consider the following factors:

* since benzene and chloroform are volatile, in-situ alternatives to reduction of their concentrations should be considered;
* since selenium is occurs naturally in soil, "total" concentrations of the metal should be evaluated for residual contamination; and
* the concentrations of the constituents in the extracts are sufficiently low (ug/L range) that assessments of the risk of those residual concentrations to human health and the environment may be appropriate, prior to committing to elaborate removal, in-situ treatment or containment alternatives.

Apendix

A

APPENDIX A

LABORATORY RESULTS
TCLP ANALYSIS OF SOILS
IN THE OPEN BURNING UNIT
OF THE INNER RANGE; VIEQUES, PR

GP Work Order # 91-03-025

SAMPLE ANALYSIS REPORT

Prepared For:

COMMANDER ATLANTIC DIVISION
NAVAL FAC.ENG.COM./CODE 181A
NORFOLK, VA 23511-6287

PUERTO RICO EXTRACTS

Prepared By:

GP Environmental Services
202 Perry Parkway
Gaithersburg, Maryland 20877

April 5, 1991

Paul Ioannides, Laboratory Director

GP ENVIRONMENTAL SERVICES
ANALYTICAL RESULTS

Work order: 9103025
Work ID: PUERTO RICO EXTRACTS
Date Received: 03/01/91

COMMANDER ATLANTIC DIVISION
NAVAL FAC.ENG.COM./CODE 181A
NORFOLK, VA 23511-6287
Atten: WAYNE MILLER

GP ENVIRONMENTAL SERVICES
202 Perry Parkway
Gaithersburg, MD 20877

Atten: Client Services
Phone: (800) 926-6802

Certified by:

SAMPLE IDENTIFICATION

GP ID	Client ID
9103025-01A	OB-2-1
9103025-01B	
9103025-01C	
9103025-01D	
9103025-01E	
9103025-02A	OB-2-1 SPIKE
9103025-03A	OB-5-1
9103025-03B	
9103025-03C	
9103025-03D	
9103025-03E	
9103025-04A	OB-30-1
9103025-04B	
9103025-04C	
9103025-04D	
9103025-04E	
9103025-05A	TCLPV BLANK
9103025-05B	TCLPO BLANK
9103025-05C	
9103025-05D	
9103025-05E	TCLPM BLANK
9103025-06A	OB-37-1
9103025-07A	OB-38-1
9103025-07B	
9103025-07C	
9103025-07D	
9103025-07E	
9103025-08A	OB-38-1 (SPIKED)

GP ENVIRONMENTAL SERVICES
ANALYTICAL RESULTS

SAMPLE IDENTIFICATION

GP ID	Client ID
9103025-09A	OB-59-1
9103025-09B	
9103025-09C	
9103025-09D	
9103025-09E	
9103025-09F	
9103025-10A	OB-69-1
9103025-10B	
9103025-10C	
9103025-10D	
9103025-10E	
9103025-11A	OB-77-1
9103025-11B	
9103025-11C	
9103025-11D	
9103025-11E	
9103025-11F	
9103025-12A	OD-3-1
9103025-12B	
9103025-12C	
9103025-12D	
9103025-12E	
9103025-13A	OD-17-1
9103025-13B	
9103025-13C	
9103025-13D	
9103025-13E	
9103025-14A	OD-17-1 (SPIKED)

NOTES:

Additional sample results on GP Work Orders 91-03-042 and 91-03-051.

Date collected is the date the TCLP extraction was performed.

The following sample bottles were broken during shipment: OB-37-1, OD-25-1, PIA-11-1, PIA-119-1. The volatile vials for these samples were intact. The lab analyzed these samples for volatile organics only.

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-01A
Client ID: 08-2-1
Collected: 03/05/91

Matrix: EXTRACTS
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/11/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	5.0	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-01B
Client ID: OB-2-1
Collected: 03/05/91

Matrix: EXTRACTS
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/27/91
Extracted: 03/06/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-01C
Client ID: OB-2-1
Collected: 03/05/91

Matrix: EXTRACTS
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/13/91
Extracted: 03/06/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-01D
Client ID: OB-2-1
Collected: 03/05/91

Matrix: EXTRACTS
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/15/91
Extracted: 03/07/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-03A
Client ID: OB-5-1
Collected: 03/05/91

Matrix: EXTRACTS
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/11/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	5.0	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-03B
Client ID: 08-5-1
Collected: 03/05/91

Matrix: EXTRACTS
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/27/91
Extracted: 03/06/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-03C
Client ID: OB-5-1
Collected: 03/05/91

Matrix: EXTRACTS
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/13/91
Extracted: 03/06/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-03D
Client ID: OB-5-1
Collected: 03/05/91

Matrix: EXTRACTS
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/15/91
Extracted: 03/07/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-04A
Client ID: 08-30-1
Collected: 03/05/91

Matrix: EXTRACTS
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/11/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	5.0	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	2	5.0	J
Vinyl Chloride	BQL	10	

Notes and definitions for this report:

BQL = Below Quantitation Limit

J = Indicates an estimated value, below method detection limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-04B
Client ID: OB-30-1
Collected: 03/05/91

Matrix: EXTRACTS
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/27/91
Extracted: 03/06/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-04C
Client ID: OB-30-1
Collected: 03/05/91

Matrix: EXTRACTS
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/13/91
Extracted: 03/06/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-04D
Client ID: OB-30-1
Collected: 03/05/91

Matrix: EXTRACTS
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/15/91
Extracted: 03/07/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-05A
Client ID: TCLPV BLANK
Collected: 03/05/91

Matrix: EXTRACTS
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/11/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	5.0	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-05B
Client ID: TCLPO BLANK
Collected: 03/05/91

Matrix: EXTRACTS
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/27/91
Extracted: 03/06/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-05C
Client ID: TCLPO BLANK
Collected: 03/05/91

Matrix: EXTRACTS
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/14/91
Extracted: 03/06/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-05D
Client ID: TCLPO BLANK
Collected: 03/05/91

Matrix: EXTRACTS
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/15/91
Extracted: 03/07/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-06A
Client ID: 08-37-1
Collected: 03/06/91

Matrix: EXTRACTS
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/11/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	5.0	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-07A
Client ID: 08-38-1
Collected: 03/06/91

Matrix: EXTRACTS
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/11/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	5.0	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	2	5.0	J
Vinyl Chloride	BQL	10	

Notes and definitions for this report:

BQL = Below Quantitation Limit

J = Indicates an estimated value, below method detection limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-07B
Client ID: OB-38-1
Collected: 03/06/91

Matrix: EXTRACTS
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/26/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-07C
Client ID: 08-38-1
Collected: 03/06/91

Matrix: EXTRACTS
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/15/91
Extracted: 03/06/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-07D
Client ID: OB-38-1
Collected: 03/06/91

Matrix: EXTRACTS
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/15/91
Extracted: 03/07/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-09A
Client ID: 08-59-1
Collected: 03/06/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/11/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	5.0	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	6	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-09C
Client ID: 08-59-1
Collected: 03/06/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/26/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-09D
Client ID: OB-59-1
Collected: 03/06/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/15/91
Extracted: 03/06/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-09E
Client ID: OB-59-1
Collected: 03/06/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/15/91
Extracted: 03/07/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-10A
Client ID: 08-69-1
Collected: 03/06/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/11/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	5.0	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-10B
Client ID: OB-69-1
Collected: 03/06/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/26/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-10C
Client ID: OB-69-1
Collected: 03/06/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/15/91
Extracted: 03/06/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-100
Client ID: OB-69-1
Collected: 03/06/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/15/91
Extracted: 03/07/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-11A
Client ID: 08-77-1
Collected: 03/06/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/11/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	5.0	
2-Butanone	BQL	10	
Benzene	71	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	13	5.0	
Tetrachloroethene	1	5.0	J
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-11C
Client ID: 08-77-1
Collected: 03/06/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/26/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-11D
Client ID: OB-77-1
Collected: 03/06/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/15/91
Extracted: 03/06/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-11E
Client ID: OB-77-1
Collected: 03/06/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/15/91
Extracted: 03/07/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-12A
Client ID: OD-3-1
Collected: 03/06/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/11/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	5.0	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-12B
Client ID: OD-3-1
Collected: 03/06/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/26/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-12C
Client ID: OO-3-1
Collected: 03/06/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/15/91
Extracted: 03/06/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-12D
Client ID: OO-3-1
Collected: 03/06/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/15/91
Extracted: 03/07/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-13A
Client ID: CD-17-1
Collected: 03/06/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/11/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	5.0	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-13B
Client ID: OD-17-1
Collected: 03/06/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/26/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-13C
Client ID: OO-17-1
Collected: 03/06/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/15/91
Extracted: 03/06/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103025-13D
Client ID: OD-17-1
Collected: 03/06/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/15/91
Extracted: 03/07/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
METALS ANALYSIS RESULTS

GP ID: 9103025-01E
Client ID: OB-2-1

Matrix: EXTRACTS
Collected: 03/05/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/28/91
Barium	MCAWW 200.7	0.3220	0.0490	mg/L	03/15/91	DB	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/28/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/28/91
Mercury	SW846 7470	0.0510	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/15/91	DB	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103025-02A
Client ID: OB-2-1 SPIKE

Matrix: EXTRACTS
Collected: 03/05/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	3.8800	0.5900	mg/L	03/15/91	DB	03/28/91
Barium	MCAWW 200.7	7.7200	0.0490	mg/L	03/15/91	DB	03/28/91
Cadmium	MCAWW 200.7	0.9050	0.0550	mg/L	03/15/91	DB	03/28/91
Chromium	MCAWW 200.7	4.2000	0.0890	mg/L	03/15/91	DB	03/28/91
Lead	MCAWW 200.7	3.9600	0.5500	mg/L	03/15/91	DB	03/28/91
Mercury	SW846 7470	0.0830	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	1.0100	0.4930	mg/L	03/15/91	DB	03/28/91
Silver	MCAWW 200.7	2.4200	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103025-03E
Client ID: OB-5-1

Matrix: EXTRACTS
Collected: 03/05/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/28/91
Barium	MCAWW 200.7	0.4590	0.0490	mg/L	03/15/91	DB	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/28/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/28/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/15/91	DB	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
METALS ANALYSIS RESULTS

GP ID: 9103025-04E
Client ID: 08-30-1

Matrix: EXTRACTS
Collected: 03/05/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/28/91
Barium	MCAWW 200.7	0.2770	0.0490	mg/L	03/15/91	DB	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/28/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/28/91
Mercury	SW846 7470	0.0340	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/15/91	DB	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103025-05E
Client ID: TCLPM BLANK

Matrix: EXTRACTS
Collected: 03/05/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/28/91
Barium	MCAWW 200.7	BQL	0.0490	mg/L	03/15/91	DB	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/28/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/28/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	0.8150	0.4930	mg/L	03/15/91	DB	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103025-07E
Client ID: 08-38-1

Matrix: EXTRACTS
Collected: 03/06/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	1.1600	0.5900	mg/L	03/15/91	DB	03/28/91
Barium	MCAWW 200.7	0.2970	0.0490	mg/L	03/15/91	DB	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/28/91
Lead	MCAWW 200.7	1.1100	0.5500	mg/L	03/15/91	DB	03/28/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	0.6820	0.4930	mg/L	03/15/91	DB	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
METALS ANALYSIS RESULTS

GP ID: 9103025-08A
Client ID: 08-38-1 (SPIKED)

Matrix: EXTRACT
Collected: 03/06/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	4.3800	0.5900	mg/L	03/15/91	DB	03/28/91
Barium	MCAWW 200.7	8.4900	0.0490	mg/L	03/15/91	DB	03/28/91
Cadmium	MCAWW 200.7	0.8400	0.0550	mg/L	03/15/91	DB	03/28/91
Chromium	MCAWW 200.7	4.2400	0.0890	mg/L	03/15/91	DB	03/28/91
Lead	MCAWW 200.7	4.2900	0.5500	mg/L	03/15/91	DB	03/28/91
Mercury	SW846 7470	0.1570	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	0.9600	0.4930	mg/L	03/15/91	DB	03/28/91
Silver	MCAWW 200.7	2.8400	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103025-09F
Client ID: 08-59-1

Matrix: EXTRACT
Collected: 03/06/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/28/91
Barium	MCAWW 200.7	0.4860	0.0490	mg/L	03/15/91	DB	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/28/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/28/91
Mercury	SW846 7470	0.0350	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	0.5240	0.4930	mg/L	03/15/91	DB	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103025-10E
Client ID: 08-69-1

Matrix: EXTRACT
Collected: 03/06/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/28/91
Barium	MCAWW 200.7	0.3340	0.0490	mg/L	03/15/91	DB	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/28/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/28/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	0.6340	0.4930	mg/L	03/15/91	DB	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
METALS ANALYSIS RESULTS

GP ID: 9103025-11F
Client ID: 08-77-1

Matrix: EXTRACT
Collected: 03/06/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/28/91
Barium	MCAWW 200.7	0.1820	0.0490	mg/L	03/15/91	DB	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/28/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/28/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/15/91	DB	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103025-12E
Client ID: 00-3-1

Matrix: EXTRACT
Collected: 03/06/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/28/91
Barium	MCAWW 200.7	BQL	0.0490	mg/L	03/15/91	DB	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/28/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/28/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	0.6560	0.4930	mg/L	03/15/91	DB	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103025-13E
Client ID: 00-17-1

Matrix: EXTRACT
Collected: 03/06/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/28/91
Barium	MCAWW 200.7	0.5570	0.0490	mg/L	03/15/91	DB	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/28/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/28/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/15/91	DB	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
METALS ANALYSIS RESULTS

GP ID: 9103025-14A
Client ID: OD-17-1 (SPIKED)

Matrix: EXTRACT
Collected: 03/06/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	4.3700	0.5900	mg/L	03/15/91	DB	03/28/91
Barium	MCAWW 200.7	9.5800	0.0490	mg/L	03/15/91	DB	03/28/91
Cadmium	MCAWW 200.7	0.8730	0.0550	mg/L	03/15/91	DB	03/28/91
Chromium	MCAWW 200.7	4.1500	0.0890	mg/L	03/15/91	DB	03/28/91
Lead	MCAWW 200.7	4.6000	0.5500	mg/L	03/15/91	DB	03/28/91
Mercury	SW846 7470	0.1710	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	1.1300	0.4930	mg/L	03/15/91	DB	03/28/91
Silver	MCAWW 200.7	2.1200	0.1950	mg/L	03/15/91	DH	03/29/91

Notes and definitions for this report:
BQL = Below Quantitation Limit

APPENDIX B

LABORATORY RESULTS
TCLP ANALYSIS OF SOILS
IN THE OPEN DETONATION UNIT
OF THE INNER RANGE; VIEQUES, PR

GP Work Order # 91-03-042

SAMPLE ANALYSIS REPORT

Prepared For:

COMMANDER ATLANTIC DIVISION
NAVAL FAC.ENG.COM./CODE 181A
NORFOLK, VA 23511-6287

PUERTO RICO - EXTRACTS

Prepared By:

GP Environmental Services
202 Perry Parkway
Gaithersburg, Maryland 20877

April 3, 1991

Paul Ioannides, Laboratory Director

GP ENVIRONMENTAL SERVICES
ANALYTICAL RESULTS

Work order: 9103042
Work ID: PUERTO RICO - EXTRACTS
Date Received: 03/01/91

COMMANDER ATLANTIC DIVISION
NAVAL FAC.ENG.COM./CODE 181A
NORFOLK, VA 23511-6287
Atten: WAYNE MILLER

GP ENVIRONMENTAL SERVICES
202 Perry Parkway
Gaithersburg, MD 20877

Atten: Client Services
Phone: (800) 926-6802

Certified by:

SAMPLE IDENTIFICATION

GP ID	Client ID
9103042-01A	TCLPO BLANK - EF1
9103042-01B	
9103042-01C	
9103042-01D	TCLPM BLANK - EF1
9103042-02A	TCLPO BLANK - EF2
9103042-02B	
9103042-02C	
9103042-02D	TCLPM BLANK - EF2
9103042-03A	ZHE BLANK
9103042-04A	OO-25-1
9103042-04B	
9103042-05A	OO-27-1
9103042-05B	
9103042-05C	
9103042-05D	
9103042-05E	
9103042-05F	
9103042-06A	OO-27-1 (SPIKED)
9103042-07A	OO-55-1
9103042-07B	
9103042-07C	
9103042-07D	
9103042-07E	
9103042-08A	OO-69-1
9103042-08B	
9103042-08C	
9103042-08D	

Note: Date collected is the date the TCLP extraction was performed.
Results for other samples are on GP Work Orders #91-03-025 and 91-03-051.

GP ENVIRONMENTAL SERVICES
ANALYTICAL RESULTS

SAMPLE IDENTIFICATION

GP ID	Client ID
9103042-08E	OD-69-1
9103042-09A	OD-70-1
9103042-09B	
9103042-09C	
9103042-09D	
9103042-09E	
9103042-10A	ZHE BLANK
9103042-11A	TCLPO BLANK - EF1
9103042-11B	
9103042-11C	
9103042-11D	TCLPM BLANK - EF1
9103042-12A	TCLPO BLANK - EF2
9103042-12B	
9103042-12C	
9103042-12D	TCLPM BLANK - EF2
9103042-13A	OD-74-1
9103042-13B	
9103042-13C	
9103042-13D	
9103042-13E	
9103042-14A	OD-74-1 SPIKE
9103042-15A	PIA-11-1
9103042-16A	PIA-12-1
9103042-16B	
9103042-16C	
9103042-16D	
9103042-16E	

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-01A
Client ID: TCLPO BLANK - EF1
Collected: 03/06/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/26/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-01B
Client ID: TCLPO BLANK - EF1
Collected: 03/06/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/15/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-01C
Client ID: TCLPO BLANK - EF1
Collected: 03/06/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/16/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-02A
Client ID: TCLPO BLANK - EF2
Collected: 03/06/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/26/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-028
Client ID: TCLPO BLANK - EF2
Collected: 03/06/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/15/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-02C
Client ID: TCLPO BLANK - EF2
Collected: 03/06/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/16/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-03A
Client ID: ZHE BLANK
Collected: 03/06/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: RT
Analyzed: 03/12/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-04A
Client ID: CO-25-1
Collected: 03/07/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: RT
Analyzed: 03/12/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-05A
Client ID: OO-27-1
Collected: 03/07/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: RT
Analyzed: 03/12/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	35	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	4	5.0	J
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:

BQL = Below Quantitation Limit

J = Indicates an estimated value, below method detection limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-05C
Client ID: OO-27-1
Collected: 03/07/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/26/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	21	
2,4,6-Trichlorophenol	BQL	21	
2,4-Dinitrotoluene	BQL	21	
Hexachlorobenzene	BQL	21	
Hexachlorobutadiene	BQL	21	
Hexachloroethane	BQL	21	
Nitrobenzene	BQL	21	
Pentachlorophenol	17	106	J
Pyridine	BQL	21	
Total Cresol	BQL	21	
m-Cresol	BQL	21	
o-Cresol	BQL	21	
p-Cresol	BQL	21	

Notes and definitions for this report:

BQL = Below Quantitation Limit

J = indicates an estimated value, below method detection limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-05D
Client ID: OD-27-1
Collected: 03/07/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/15/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-05E
Client ID: OD-27-1
Collected: 03/07/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/16/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-07A
Client ID: OO-55-1
Collected: 03/07/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: RT
Analyzed: 03/12/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-07B
Client ID: OD-55-1
Collected: 03/07/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/26/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-07C
Client ID: OD-55-1
Collected: 03/07/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/15/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-07D
Client ID: OD-55-1
Collected: 03/07/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/16/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-08A
Client ID: OO-69-1
Collected: 03/07/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: RT
Analyzed: 03/12/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	38	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	7	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-08B
Client ID: OO-69-1
Collected: 03/07/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/26/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-08C
Client ID: 00-69-1
Collected: 03/07/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/15/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-08D
Client ID: 00-69-1
Collected: 03/07/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/16/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-09A
Client ID: CO-70-1
Collected: 03/07/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: RT
Analyzed: 03/12/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	19	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	3	5.0	J
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:

BQL = Below Quantitation Limit

J = Indicates an estimated value, below method detection limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-09B
Client ID: OD-70-1
Collected: 03/07/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/26/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-09C
Client ID: CO-70-1
Collected: 03/07/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/15/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-090
Client ID: 00-70-1
Collected: 03/07/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/16/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-10A
Client ID: ZHE BLANK
Collected: 03/07/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: RT
Analyzed: 03/12/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-11A
Client ID: TCLPO BLANK - EF1
Collected: 03/07/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/26/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-11B
Client ID: TCLPO BLANK - EF1
Collected: 03/07/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/15/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-11C
Client ID: TCLPO BLANK - EF1
Collected: 03/07/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/16/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-12A
Client ID: TCLPO BLANK - EF2
Collected: 03/07/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/26/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-12B
Client ID: TCLPO BLANK - EF2
Collected: 03/07/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/15/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-12C
Client ID: TCLPO BLANK - EF2
Collected: 03/07/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/16/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-13A
Client ID: OD-74-1
Collected: 03/12/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/13/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-13B
Client ID: OD-74-1
Collected: 03/12/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/27/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-13C
Client ID: OO-74-1
Collected: 03/12/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: MN
Analyzed: 03/18/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-13D
Client ID: OO-74-1
Collected: 03/12/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/16/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-15A
Client ID: PIA-11-1
Collected: 03/12/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: RT
Analyzed: 03/14/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-16A
Client ID: PIA-12-1
Collected: 03/12/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/13/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-16B
Client ID: PIA-12-1
Collected: 03/12/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/27/91
Extracted: 03/12/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-16C
Client ID: PIA-12-1
Collected: 03/12/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: MN
Analyzed: 03/18/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103042-16D
Client ID: PIA-12-1
Collected: 03/12/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: MN
Analyzed: 03/16/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
METALS ANALYSIS RESULTS

GP ID: 9103042-01D
Client ID: TCLPM BLANK - EF1

Matrix: EXTRACT
Collected: 03/06/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/27/91
Barium	MCAWW 200.7	BQL	0.0490	mg/L	03/15/91	DB	03/27/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/27/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/27/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/27/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/15/91	DB	03/27/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103042-02D
Client ID: TCLPM BLANK - EF2

Matrix: EXTRACT
Collected: 03/06/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/27/91
Barium	MCAWW 200.7	BQL	0.0490	mg/L	03/15/91	DB	03/27/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/27/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/27/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/27/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/15/91	DB	03/27/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103042-05F
Client ID: OD-27-1

Matrix: EXTRACT
Collected: 03/07/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/27/91
Barium	MCAWW 200.7	0.7650	0.0490	mg/L	03/15/91	DB	03/27/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/27/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/27/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/27/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/15/91	DB	03/27/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
METALS ANALYSIS RESULTS

GP ID: 9103042-06A
Client ID: OO-27-1 (SPIKED)

Matrix: EXTRACT
Collected: 03/07/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	4.2800	0.5900	mg/L	03/15/91	DB	03/27/91
Barium	MCAWW 200.7	7.2400	0.0490	mg/L	03/15/91	DB	03/27/91
Cadmium	MCAWW 200.7	1.1600	0.0550	mg/L	03/15/91	DB	03/27/91
Chromium	MCAWW 200.7	4.2300	0.0890	mg/L	03/15/91	DB	03/27/91
Lead	MCAWW 200.7	5.6100	0.5500	mg/L	03/15/91	DB	03/27/91
Mercury	SW846 7470	0.1330	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/15/91	DB	03/27/91
Silver	MCAWW 200.7	2.4500	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103042-07E
Client ID: OO-55-1

Matrix: EXTRACT
Collected: 03/07/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/27/91
Barium	MCAWW 200.7	0.3760	0.0490	mg/L	03/15/91	DB	03/27/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/27/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/27/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/27/91
Mercury	SW846 7470	0.0496	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	0.6210	0.4930	mg/L	03/15/91	DB	03/27/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103042-08E
Client ID: OO-69-1

Matrix: EXTRACT
Collected: 03/07/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/27/91
Barium	MCAWW 200.7	0.3000	0.0490	mg/L	03/15/91	DB	03/27/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/27/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/27/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/27/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/15/91	DB	03/27/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
METALS ANALYSIS RESULTS

GP ID: 9103042-09E
Client ID: OD-70-1

Matrix: EXTRACT
Collected: 03/07/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/27/91
Barium	MCAWW 200.7	0.3310	0.0490	mg/L	03/15/91	DB	03/27/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/27/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/27/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/27/91
Mercury	SW846 7470	0.0403	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/15/91	DB	03/27/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103042-11D
Client ID: TCLPM BLANK - EF1

Matrix: EXTRACT
Collected: 03/07/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/27/91
Barium	MCAWW 200.7	BQL	0.0490	mg/L	03/15/91	DB	03/27/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/27/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/27/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/27/91
Mercury	SW846 7470	0.0229	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/15/91	DB	03/27/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103042-12D
Client ID: TCLPM BLANK - EF2

Matrix: EXTRACT
Collected: 03/07/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/27/91
Barium	MCAWW 200.7	BQL	0.0490	mg/L	03/15/91	DB	03/27/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/27/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/27/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/27/91
Mercury	SW846 7470	0.0229	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/15/91	DB	03/27/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
METALS ANALYSIS RESULTS

GP ID: 9103042-13E
Client ID: OO-74-1

Matrix: EXTRACT
Collected: 03/12/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/27/91
Barium	MCAWW 200.7	0.6440	0.0490	mg/L	03/15/91	DB	03/27/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/27/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/27/91
Lead	MCAWW 200.7	2.3900	0.5500	mg/L	03/15/91	DB	03/27/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/15/91	DB	03/27/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103042-14A
Client ID: OO-74-1 SPIKE

Matrix: EXTRACT
Collected: 03/12/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	3.8900	0.5900	mg/L	03/15/91	DB	03/27/91
Barium	MCAWW 200.7	9.2000	0.0490	mg/L	03/15/91	DB	03/27/91
Cadmium	MCAWW 200.7	0.7490	0.0550	mg/L	03/15/91	DB	03/27/91
Chromium	MCAWW 200.7	4.0900	0.0890	mg/L	03/15/91	DB	03/27/91
Lead	MCAWW 200.7	6.3300	0.5500	mg/L	03/15/91	DB	03/27/91
Mercury	SW846 7470	0.1290	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	0.6420	0.4930	mg/L	03/15/91	DB	03/27/91
Silver	MCAWW 200.7	2.5100	0.1950	mg/L	03/15/91	DH	03/29/91

GP ID: 9103042-16E
Client ID: PIA-12-1

Matrix: EXTRACT
Collected: 03/12/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/15/91	DB	03/27/91
Barium	MCAWW 200.7	0.3140	0.0490	mg/L	03/15/91	DB	03/27/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/15/91	DB	03/27/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/15/91	DB	03/27/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/15/91	DB	03/27/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/15/91	IM	03/15/91
Selenium	MCAWW 200.7	0.5670	0.4930	mg/L	03/15/91	DB	03/27/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/15/91	DH	03/29/91

Notes and definitions for this report:
BQL = Below Quantitation Limit

APPENDIX C

LABORATORY RESULTS
TCLP ANALYSIS OF SOILS
OF THE PRIMARY IMPACT AREA
OF THE INNER RANGE; VIEQUES, PR

GP Work Order # 91-03-051

SAMPLE ANALYSIS REPORT

Prepared For:

COMMANDER ATLANTIC DIVISION
NAVAL FAC.ENG.COM./CODE 181A
NORFOLK, VA 23511-6287

PUERTO RICO - EXTRACTS

Prepared By:

GP Environmental Services
202 Perry Parkway
Gaithersburg, Maryland 20877

April 8, 1991

Paul Ioannides, Laboratory Director

GP ENVIRONMENTAL SERVICES
ANALYTICAL RESULTS

Work order: 9103051
Work ID: PUERTO RICO - EXTRACTS
Date Received: 03/01/91

COMMANDER ATLANTIC DIVISION
NAVAL FAC.ENG.COM./CODE 181A
NORFOLK, VA 23511-6287
Atten: WAYNE MILLER

GP ENVIRONMENTAL SERVICES
202 Perry Parkway
Gaithersburg, MD 20877

Atten: Client Services
Phone: (800) 926-6802

Certified by:

SAMPLE IDENTIFICATION

GP ID	Client ID
9103051-01A	PIA-56-1
9103051-01B	
9103051-01C	
9103051-01D	
9103051-01E	
9103051-02A	PIA-60-1
9103051-02B	
9103051-02C	
9103051-02D	
9103051-02E	
9103051-03A	TCLPV BLANK
9103051-03B	TCLPO BLANK
9103051-03C	
9103051-03D	
9103051-03E	TCLPM BLANK
9103051-04A	PIA-72-1
9103051-04B	
9103051-04C	
9103051-04D	

GP ENVIRONMENTAL SERVICES
ANALYTICAL RESULTS

SAMPLE IDENTIFICATION

GP ID	Client ID
9103051-04E	PIA-72-1
9103051-05A	PIA-72-1 SPIKED
9103051-06A	PIA-85-1
9103051-06B	
9103051-06C	
9103051-06D	
9103051-06E	
9103051-07A	PIA-93-1
9103051-07B	
9103051-07C	
9103051-07D	
9103051-07E	
9103051-08A	PIA-119-1
9103051-09A	TCLPV BLANK
9103051-09B	TCLPO BLANK
9103051-09C	
9103051-09D	
9103051-09E	TCLPM BLANK

NOTES: Additional sample results on GP Work Orders 91-03-025 and 91-03-042.
Date collected is the date the TCLP extraction was performed.

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-01A
Client ID: PIA-56-1
Collected: 03/12/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/13/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-01B
Client ID: PIA-56-1
Collected: 03/12/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/27/91
Extracted: 03/13/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-01C
Client ID: PIA-56-1
Collected: 03/12/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: MN
Analyzed: 03/18/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.28	
Endrin	BQL	0.12	
Heptachlor	BQL	0.060	
Heptachlor Epoxide	BQL	1.7	
Methoxychlor	BQL	3.5	
Toxaphene	BQL	4.8	
gamma-BHC (Lindane)	BQL	0.080	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-01D
Client ID: PIA-56-1
Collected: 03/12/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: AD
Analyzed: 04/06/91
Extracted: 04/05/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:

BQL = Below Quantitation Limit

Herbicide extraction was not performed within holding time.

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-02A
Client ID: PIA-60-1
Collected: 03/12/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/13/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	2	5.0	J
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:

BQL = Below Quantitation Limit

J = Indicates an estimated value, below method detection limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-02B
Client ID: PIA-60-1
Collected: 03/12/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/27/91
Extracted: 03/13/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-02C
Client ID: PIA-60-1
Collected: 03/12/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: MN
Analyzed: 03/18/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-02D
Client ID: PIA-60-1
Collected: 03/12/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: AD
Analyzed: 04/06/91
Extracted: 04/05/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:

BQL = Below Quantitation Limit

Herbicide extraction was not performed within holding time.

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-03A
Client ID: TCLPV BLANK
Collected: 03/12/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: FLP
Analyzed: 03/13/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	1	5.0	J
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:

BQL = Below Quantitation Limit

J = Indicates an estimated value, below method detection limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-03B
Client ID: TCLPO BLANK
Collected: 03/12/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/27/91
Extracted: 03/13/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-03C
Client ID: TCLPO BLANK
Collected: 03/12/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: MN
Analyzed: 03/18/91
Extracted: 03/13/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-03D
Client ID: TCLPO BLANK
Collected: 03/12/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: AD
Analyzed: 03/25/91
Extracted: 03/18/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-04A
Client ID: PIA-72-1
Collected: 03/13/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: RT
Analyzed: 03/14/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-048
Client ID: P1A-72-1
Collected: 03/13/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/29/91
Extracted: 03/13/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	11	
2,4,6-Trichlorophenol	BQL	11	
2,4-Dinitrotoluene	BQL	11	
Hexachlorobenzene	BQL	11	
Hexachlorobutadiene	BQL	11	
Hexachloroethane	BQL	11	
Nitrobenzene	BQL	11	
Pentachlorophenol	BQL	55	
Pyridine	BQL	11	
Total Cresol	BQL	11	
m-Cresol	BQL	11	
o-Cresol	BQL	11	
p-Cresol	BQL	11	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-04C
Client ID: PIA-72-1
Collected: 03/13/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/20/91
Extracted: 03/18/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-04D
Client ID: PIA-72-1
Collected: 03/13/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: AD
Analyzed: 03/25/91
Extracted: 03/18/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-06A
Client ID: PIA-85-1
Collected: 03/13/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: RT
Analyzed: 03/14/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	1	5.0	J
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:

BQL = Below Quantitation Limit

J = Indicates an estimated value, below method detection limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-068
Client ID: PIA-85-1
Collected: 03/13/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/29/91
Extracted: 03/13/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-06C
Client ID: PIA-85-1
Collected: 03/13/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/21/91
Extracted: 03/18/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-06D
Client ID: PIA-85-1
Collected: 03/13/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: AD
Analyzed: 03/25/91
Extracted: 03/18/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	0.05	1.7	J

Notes and definitions for this report:

BQL = Below Quantitation Limit

J = Indicates an estimated value, below method detection limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-07A
Client ID: PIA-93-1
Collected: 03/13/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: RT
Analyzed: 03/14/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-07B
Client ID: PIA-93-1
Collected: 03/13/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/29/91
Extracted: 03/13/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	23	
2,4,6-Trichlorophenol	BQL	23	
2,4-Dinitrotoluene	BQL	23	
Hexachlorobenzene	BQL	23	
Hexachlorobutadiene	BQL	23	
Hexachloroethane	BQL	23	
Nitrobenzene	BQL	23	
Pentachlorophenol	BQL	110	
Pyridine	BQL	23	
Total Cresol	BQL	23	
m-Cresol	BQL	23	
o-Cresol	BQL	23	
p-Cresol	BQL	23	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-07C
Client ID: PIA-93-1
Collected: 03/13/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/21/91
Extracted: 03/18/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-07D
Client ID: PIA-93-1
Collected: 03/13/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: AD
Analyzed: 03/25/91
Extracted: 03/18/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-08A
Client ID: PIA-119-1
Collected: 03/13/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: RT
Analyzed: 03/14/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-09A
Client ID: TCLPV BLANK
Collected: 03/13/91

Matrix: EXTRACT
Method: 8240TC
Units: ug/L

Analyst: RT
Analyzed: 03/14/91

VOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
1,1-Dichloroethene	BQL	5.0	
1,2-Dichloroethane	BQL	5.0	
1,4-Dichlorobenzene	BQL	10	
2-Butanone	BQL	10	
Benzene	BQL	5.0	
Carbon Tetrachloride	BQL	5.0	
Chlorobenzene	BQL	5.0	
Chloroform	BQL	5.0	
Tetrachloroethene	BQL	5.0	
Trichloroethene	BQL	5.0	
Vinyl Chloride	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-098
Client ID: TCLPO BLANK
Collected: 03/13/91

Matrix: EXTRACT
Method: 8270(TC)
Units: ug/L

Analyst: YY
Analyzed: 03/29/91
Extracted: 03/13/91

SEMIVOLATILE TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4,5-Trichlorophenol	BQL	10	
2,4,6-Trichlorophenol	BQL	10	
2,4-Dinitrotoluene	BQL	10	
Hexachlorobenzene	BQL	10	
Hexachlorobutadiene	BQL	10	
Hexachloroethane	BQL	10	
Nitrobenzene	BQL	10	
Pentachlorophenol	BQL	50	
Pyridine	BQL	10	
Total Cresol	BQL	10	
m-Cresol	BQL	10	
o-Cresol	BQL	10	
p-Cresol	BQL	10	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-09C
Client ID: TCLPO BLANK
Collected: 03/13/91

Matrix: EXTRACT
Method: SW846 8080
Units: ug/L

Analyst: AD
Analyzed: 03/21/91
Extracted: 03/18/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
Chlordane	BQL	0.14	
Endrin	BQL	0.060	
Heptachlor	BQL	0.030	
Heptachlor Epoxide	BQL	0.83	
Methoxychlor	BQL	1.8	
Toxaphene	BQL	2.4	
gamma-BHC (Lindane)	BQL	0.040	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
ORGANIC ANALYSIS RESULTS

GP ID: 9103051-09D
Client ID: TCLPO BLANK
Collected: 03/13/91

Matrix: EXTRACT
Method: SW846 8150
Units: ug/L

Analyst: AD
Analyzed: 03/25/91
Extracted: 03/18/91

GC TARGET COMPOUNDS

Parameter	Result	Det.Lim.	Qualifier
2,4-D	BQL	12	
Silvex	BQL	1.7	

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
METALS ANALYSIS RESULTS

GP ID: 9103051-01E
Client ID: PIA-56-1

Matrix: EXTRACT
Collected: 03/12/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/19/91	DH	03/28/91
Barium	MCAWW 200.7	0.4360	0.0490	mg/L	03/19/91	DH	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/19/91	DH	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/19/91	DH	03/28/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/19/91	DH	03/28/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/18/91	IM	03/18/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/19/91	DH	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/19/91	DH	03/28/91

GP ID: 9103051-02E
Client ID: PIA-60-1

Matrix: EXTRACT
Collected: 03/12/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/l	03/19/91	DH	03/28/91
Barium	MCAWW 200.7	1.0000	0.0490	mg/L	03/19/91	DH	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/19/91	DH	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/19/91	DH	03/28/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/19/91	DH	03/28/91
Mercury	SW846 7470	0.0226	0.0200	mg/L	03/18/91	IM	03/18/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/19/91	DH	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/19/91	DH	03/28/91

GP ID: 9103051-03E
Client ID: TCLPM BLANK

Matrix: EXTRACT
Collected: 03/12/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	0.5920	0.5900	mg/l	03/19/91	DH	03/28/91
Barium	MCAWW 200.7	BQL	0.0490	mg/L	03/19/91	DH	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/19/91	DH	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/19/91	DH	03/28/91
Lead	MCAWW 200.7	0.5780	0.5500	mg/L	03/19/91	DH	03/28/91
Mercury	SW846 7470	0.0208	0.0200	mg/L	03/18/91	IM	03/18/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/19/91	DH	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/19/91	DH	03/28/91

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
METALS ANALYSIS RESULTS

GP ID: 9103051-04E
Client ID: PIA-72-1

Matrix: EXTRACT
Collected: 03/13/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/19/91	DH	03/28/91
Barium	MCAWW 200.7	0.2600	0.0490	mg/L	03/19/91	DH	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/19/91	DH	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/19/91	DH	03/28/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/19/91	DH	03/28/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/18/91	IM	03/18/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/19/91	DH	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/19/91	DH	03/28/91

GP ID: 9103051-05A
Client ID: PIA-72-1 SPIKED

Matrix: EXTRACT
Collected: 03/13/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	4.1900	0.5900	mg/L	03/19/91	DH	03/28/91
Barium	MCAWW 200.7	8.9700	0.0490	mg/L	03/19/91	DH	03/20/91
Cadmium	MCAWW 200.7	0.8480	0.0550	mg/L	03/19/91	DH	03/28/91
Chromium	MCAWW 200.7	3.5900	0.0890	mg/L	03/19/91	DH	03/28/91
Lead	MCAWW 200.7	4.0000	0.5500	mg/L	03/19/91	DH	03/28/91
Mercury	SW846 7470	0.1310	0.0200	mg/L	03/18/91	IM	03/18/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/19/91	DH	03/28/91
Silver	MCAWW 200.7	2.8900	0.1950	mg/L	03/19/91	DH	03/28/91

GP ID: 9103051-06E
Client ID: PIA-85-1

Matrix: EXTRACT
Collected: 03/13/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/19/91	DH	03/28/91
Barium	MCAWW 200.7	1.1100	0.0490	mg/L	03/19/91	DH	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/19/91	DH	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/19/91	DH	03/28/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/19/91	DH	03/28/91
Mercury	SW846 7470	0.0417	0.0200	mg/L	03/18/91	IM	03/18/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/19/91	DH	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/19/91	DH	03/28/91

Notes and definitions for this report:
BQL = Below Quantitation Limit

GP ENVIRONMENTAL SERVICES
METALS ANALYSIS RESULTS

GP ID: 9103051-07E
Client ID: PIA-93-1

Matrix: EXTRACT
Collected: 03/13/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/19/91	DH	03/28/91
Barium	MCAWW 200.7	0.4190	0.0490	mg/L	03/19/91	DH	03/28/91
Cadmium	MCAWW 200.7	0.0886	0.0550	mg/L	03/19/91	DH	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/19/91	DH	03/28/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/19/91	DH	03/28/91
Mercury	SW846 7470	0.0218	0.0200	mg/L	03/18/91	IM	03/18/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/19/91	DH	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/19/91	DH	03/28/91

GP ID: 9103051-09E
Client ID: TCLPM BLANK

Matrix: EXTRACT
Collected: 03/13/91

Element	Method	Result	Det.Lim.	Units	Digested	Analyzed by	
Arsenic	MCAWW 200.7	BQL	0.5900	mg/L	03/19/91	DH	03/28/91
Barium	MCAWW 200.7	BQL	0.0490	mg/L	03/19/91	DH	03/28/91
Cadmium	MCAWW 200.7	BQL	0.0550	mg/L	03/19/91	DH	03/28/91
Chromium	MCAWW 200.7	BQL	0.0890	mg/L	03/19/91	DH	03/28/91
Lead	MCAWW 200.7	BQL	0.5500	mg/L	03/19/91	DH	03/28/91
Mercury	SW846 7470	BQL	0.0200	mg/L	03/18/91	IM	03/18/91
Selenium	MCAWW 200.7	BQL	0.4930	mg/L	03/19/91	DH	03/28/91
Silver	MCAWW 200.7	BQL	0.1950	mg/L	03/19/91	DH	03/28/91

Notes and definitions for this report:
BQL = Below Quantitation Limit

APPENDIX D

STATISTICAL COMPUTATIONS
SOIL EXTRACT CONCENTRATIONS
OB AND OD UNITS VS. PIA

CONSTITUENT CONCENTRATIONS IN SOIL
BOMBING RANGE; VIEQUES, PR

SAMPLING RESULTS (ug/L)

	1,1 Dichloroethene					1,4-Dichlorobenzene					1,2-Dichloroethane				
	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	10.0	PASS	10.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	10.0	PASS	10.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	10.0	PASS	10.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	10.0	PASS	10.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	10.0	PASS	10.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	10.0	PASS	10.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	10.0	PASS	10.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	10.0	PASS	10.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS		5.0	PASS	10.0	PASS		5.0	PASS	5.0	PASS	
	5.0	PASS	5.0	PASS		5.0	PASS	10.0	PASS		5.0	PASS	5.0	PASS	
	5.0	PASS				5.0	PASS				5.0	PASS			
MEAN	5.0	PASS	5.0	PASS	5.0	5.0	PASS	10.0	PASS	10.0	5.0	PASS	5.0	PASS	5.0
STDV					0.00					0.00					0.00
STDMN					0.00					0.00					0.00
t FTR					1.895					1.895					1.895
UCL					5.0					10.0					5.0
UCLM					5.0					10.0					5.0

	Vinyl Chloride					2,4,5-Trichlorophenol					2,4,6-Trichlorophenol				
	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	21.0	FAIL	10.0	10.0	PASS	21.0	FAIL	10.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	11.0	10.0	PASS	10.0	PASS	11.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	23.0	10.0	PASS	10.0	PASS	23.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS	
	10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS	
	10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS	
	10.0	PASS													
MEAN	10.0	PASS	10.0	PASS	10.0	10.0	PASS	11.1	PASS	12.0	10.0	PASS	11.1	PASS	12.0
STDV					0.00					4.50					4.50
STDMN					0.00					1.70					1.70
t FTR					1.895					1.943					1.943
UCL					10.0					20.8					20.8
UCLM					10.0					15.3					15.3

CONSTITUENT CONCENTRATIONS IN SOIL
BOMBING RANGE; VIEQUES, PR

SAMPLING RESULTS (ug/L)

	Total Cresol					m-Cresol					o-Cresol				
	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0
	10.0	PASS	21.0	FAIL	10.0	10.0	PASS	21.0	FAIL	10.0	10.0	PASS	21.0	FAIL	10.0
	10.0	PASS	10.0	PASS	11.0	10.0	PASS	10.0	PASS	11.0	10.0	PASS	10.0	PASS	11.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0
	10.0	PASS	10.0	PASS	23.0	10.0	PASS	10.0	PASS	23.0	10.0	PASS	10.0	PASS	23.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0
	10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS	
	10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS	
	10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS	
MEAN	10.0	PASS	11.1	PASS	12.0	10.0	PASS	11.1	PASS	12.0	10.0	PASS	11.1	PASS	12.0
STDV					4.50					4.50					4.50
STDMN					1.70					1.70					1.70
t FTR					1.943					1.943					1.943
UCL					20.8					20.8					20.8
UCLM					15.3					15.3					15.3

	gamma-BHC (Lindane)					2,4-D					Silvex				
	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA
	0.04	PASS	0.04	PASS	0.08	12.0	PASS	12.0	PASS	12.0	1.7	PASS	1.7	PASS	1.7
	0.04	PASS	0.04	PASS	0.04	12.0	PASS	12.0	PASS	12.0	1.7	PASS	1.7	PASS	1.7
	0.04	PASS	0.04	PASS	0.04	12.0	PASS	12.0	PASS	12.0	1.7	PASS	1.7	PASS	1.7
	0.04	PASS	0.04	PASS	0.04	12.0	PASS	12.0	PASS	12.0	1.7	PASS	1.7	PASS	1.7
	0.04	PASS	0.04	PASS	0.04	12.0	PASS	12.0	PASS	12.0	1.7	PASS	1.7	PASS	0.05
	0.04	PASS	0.04	PASS	0.04	12.0	PASS	12.0	PASS	12.0	1.7	PASS	1.7	PASS	1.7
	0.04	PASS	0.04	PASS	0.04	12.0	PASS	12.0	PASS	12.0	1.7	PASS	1.7	PASS	1.7
	0.04	PASS	0.04	PASS		12.0	PASS	12.0	PASS		1.7	PASS	1.7	PASS	
	0.04	PASS	0.04	PASS		12.0	PASS	12.0	PASS		1.7	PASS	1.7	PASS	
	0.04	PASS	0.04	PASS		12.0	PASS	12.0	PASS		1.7	PASS	1.7	PASS	
MEAN	0.04	PASS	0.04	PASS	0.05	12.0	PASS	12.0	PASS	12.0	1.7	PASS	1.7	PASS	1.5
STDV					0.01					0.00					0.58
STDMN					0.01					0.00					0.22
t FTR					1.943					1.943					1.943
UCL					0.1					12.0					2.6
UCLM					0.1					12.0					1.9

CONSTITUENT CONCENTRATIONS IN SOIL
BOMBING RANGE; VIEQUES, PR

SAMPLING RESULTS (ug/L)

	2-Butanone					Benzene					Carbon Tetrachloride				
	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA
	10.0	PASS	10.0	PASS	10.0	5.0	PASS	5.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0
	10.0	PASS	10.0	PASS	10.0	5.0	PASS	5.0	PASS	2.0	5.0	PASS	5.0	PASS	5.0
	10.0	PASS	10.0	PASS	10.0	5.0	PASS	35.0	FAIL	1.0	5.0	PASS	5.0	PASS	5.0
	10.0	PASS	10.0	PASS	10.0	5.0	PASS	5.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0
	10.0	PASS	10.0	PASS	10.0	5.0	PASS	38.0	FAIL	1.0	5.0	PASS	5.0	PASS	5.0
	10.0	PASS	10.0	PASS	10.0	5.0	PASS	19.0	FAIL	5.0	5.0	PASS	5.0	PASS	5.0
	10.0	PASS	10.0	PASS	10.0	5.0	PASS	5.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0
	10.0	PASS	10.0	PASS	10.0	5.0	PASS	5.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0
	10.0	PASS	10.0	PASS		71.0	FAIL	5.0	PASS		5.0	PASS	5.0	PASS	
	10.0	PASS	10.0	PASS		5.0	PASS	5.0	PASS		5.0	PASS	5.0	PASS	
	10.0	PASS				5.0	PASS				5.0	PASS			
MEAN	10.0	PASS	10.0	PASS	10.0	11.0	FAIL	12.7	FAIL	3.6	5.0	PASS	5.0	PASS	5.0
STDV					0.00					1.80					0.00
STDMN					0.00					0.64					0.00
t FTR					1.895					1.895					1.895
UCL					10.0					7.0					5.0
UCLM					10.0					4.8					5.0

	2,4-Dinitrotoluene					Hexachlorobenzene					Hexachlorobutadiene				
	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0
	10.0	PASS	21.0	FAIL	10.0	10.0	PASS	21.0	FAIL	10.0	10.0	PASS	21.0	FAIL	10.0
	10.0	PASS	10.0	PASS	11.0	10.0	PASS	10.0	PASS	11.0	10.0	PASS	10.0	PASS	11.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0
	10.0	PASS	10.0	PASS	23.0	10.0	PASS	10.0	PASS	23.0	10.0	PASS	10.0	PASS	23.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0
	10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS	
	10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS	
	10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS	
MEAN	10.0	PASS	11.1	PASS	12.0	10.0	PASS	11.1	PASS	12.0	10.0	PASS	11.1	PASS	12.0
STDV					4.50					4.50					4.50
STDMN					1.70					1.70					1.70
t FTR					1.943					1.943					1.943
UCL					20.8					20.8					20.8
UCLM					15.3					15.3					15.3

CONSTITUENT CONCENTRATIONS IN SOIL
BOMBING RANGE; VIEQUES, PR

SAMPLING RESULTS (ug/L)

	p-Cresol					Chlordane					Endrin				
	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA
	10.0	PASS	10.0	PASS	10.0	0.14	PASS	0.14	PASS	0.28	0.06	PASS	0.06	PASS	0.12
	10.0	PASS	10.0	PASS	10.0	0.14	PASS	0.14	PASS	0.14	0.06	PASS	0.06	PASS	0.06
	10.0	PASS	21.0	FAIL	10.0	0.14	PASS	0.14	PASS	0.14	0.06	PASS	0.06	PASS	0.06
	10.0	PASS	10.0	PASS	11.0	0.14	PASS	0.14	PASS	0.14	0.06	PASS	0.06	PASS	0.06
	10.0	PASS	10.0	PASS	10.0	0.14	PASS	0.14	PASS	0.14	0.06	PASS	0.06	PASS	0.06
	10.0	PASS	10.0	PASS	23.0	0.14	PASS	0.14	PASS	0.14	0.06	PASS	0.06	PASS	0.06
	10.0	PASS	10.0	PASS	10.0	0.14	PASS	0.14	PASS	0.14	0.06	PASS	0.06	PASS	0.06
	10.0	PASS	10.0	PASS		0.14	PASS	0.14	PASS		0.06	PASS	0.06	PASS	
	10.0	PASS	10.0	PASS		0.14	PASS	0.14	PASS		0.06	PASS	0.06	PASS	
	10.0	PASS	10.0	PASS		0.14	PASS	0.14	PASS		0.06	PASS	0.06	PASS	
MEAN	10.0	PASS	11.1	PASS	12.0	0.1	PASS	0.1	PASS	0.2	0.1	PASS	0.1	PASS	0.1
STDV					4.50					0.05					0.02
STDMN					1.70					0.02					0.01
t FTR					1.943					1.943					1.943
UCL					20.8					0.3					0.1
UCLM					15.3					0.2					0.1

	Arsenic					Barium					Cadmium				
	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA
	0.6	PASS	0.6	PASS	0.6	0.3	PASS	0.0	PASS	0.4	0.1	PASS	0.1	PASS	0.1
	3.9	FAIL	0.6	PASS	0.6	7.7	FAIL	0.0	PASS	1.0	0.9	FAIL	0.1	PASS	0.1
	0.6	PASS	0.6	PASS	0.6	0.5	PASS	0.8	PASS	0.0	0.1	PASS	0.1	PASS	0.1
	0.6	PASS	4.3	FAIL	0.6	0.3	PASS	7.2	FAIL	0.3	0.1	PASS	1.2	FAIL	0.1
	0.6	PASS	0.6	PASS	4.2	0.0	PASS	0.4	PASS	9.0	0.1	PASS	0.1	PASS	0.8
	1.2	PASS	0.6	PASS	0.6	0.3	PASS	0.3	PASS	1.1	0.1	PASS	0.1	PASS	0.1
	4.4	FAIL	0.6	PASS	0.6	8.5	FAIL	0.3	PASS	0.4	0.8	FAIL	0.1	PASS	0.1
	0.6	PASS	0.6	PASS	0.6	0.5	PASS	0.0	PASS	0.0	0.1	PASS	0.1	PASS	0.1
	0.6	PASS	0.6	PASS		0.3	PASS	0.0	PASS		0.1	PASS	0.1	PASS	
	0.6	PASS	0.6	PASS		0.2	PASS	0.6	PASS		0.1	PASS	0.1	PASS	
	0.6	PASS	3.9	FAIL		0.0	PASS	9.2	FAIL		0.1	PASS	0.7	FAIL	
	0.6	PASS	0.6	PASS		0.6	PASS	0.3	PASS		0.1	PASS	0.1	PASS	
	4.4	FAIL				9.6	FAIL				0.9	FAIL			
MEAN	1.5	PASS	1.2	PASS	1.0	2.2	PASS	1.6	PASS	1.5	0.2	PASS	0.2	PASS	0.2
STDV					1.19					2.83					0.26
STDMN					0.45					1.07					0.10
t FTR					1.943					1.943					1.943
UCL					3.4					7.0					0.7
UCLM					1.9					3.6					0.3

CONSTITUENT CONCENTRATIONS IN SOIL
BOMBING RANGE; VIEQUES, PR

SAMPLING RESULTS (ug/L)

	Chlorobenzene					Chloroform					Tetrachloroethene				
	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	4.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	7.0	FAIL	5.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	3.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0	5.0	PASS	5.0	PASS	5.0
	5.0	PASS	5.0	PASS		13.0	FAIL	5.0	PASS		1.0	PASS	5.0	PASS	
	5.0	PASS	5.0	PASS		5.0	PASS	5.0	PASS		5.0	PASS	5.0	PASS	
	5.0	PASS				5.0	PASS				5.0	PASS			
MEAN	5.0	PASS	5.0	PASS	5.0	5.7	FAIL	4.9	PASS	5.0	4.6	PASS	5.0	PASS	5.0
STDV					0.00					0.00					0.00
STDMN					0.00					0.00					0.00
t FTR					1.895					1.895					1.895
UCL					5.0					5.0					5.0
UCLM					5.0					5.0					5.0

	Hexachloroethane					Nitrobenzene					Pentachlorophenol				
	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	50.0	PASS	50.0	PASS	50.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	50.0	PASS	50.0	PASS	50.0
	10.0	PASS	21.0	FAIL	10.0	10.0	PASS	21.0	FAIL	10.0	50.0	PASS	17.0	PASS	50.0
	10.0	PASS	10.0	PASS	11.0	10.0	PASS	10.0	PASS	11.0	50.0	PASS	50.0	PASS	55.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	50.0	PASS	50.0	PASS	50.0
	10.0	PASS	10.0	PASS	23.0	10.0	PASS	10.0	PASS	23.0	50.0	PASS	50.0	PASS	110.0
	10.0	PASS	10.0	PASS	10.0	10.0	PASS	10.0	PASS	10.0	50.0	PASS	50.0	PASS	50.0
	10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS		50.0	PASS	50.0	PASS	
	10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS		50.0	PASS	50.0	PASS	
	10.0	PASS	10.0	PASS		10.0	PASS	10.0	PASS		50.0	PASS	50.0	PASS	
MEAN	10.0	PASS	11.1	PASS	12.0	10.0	PASS	11.1	PASS	12.0	50.0	PASS	46.7	PASS	59.3
STDV					4.50					4.50					20.78
STDMN					1.70					1.70					7.85
t FTR					1.943					1.943					1.943
UCL					20.8					20.8					99.7
UCLM					15.3					15.3					74.5

CONSTITUENT CONCENTRATIONS IN SOIL
BOMBING RANGE; VIEQUES, PR

SAMPLING RESULTS (ug/L)

	Heptachlor					Heptachlor Epoxide					Methoxychlor				
	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA
	0.03	PASS	0.03	PASS	0.06	0.83	PASS	0.83	PASS	1.70	1.8	PASS	1.8	PASS	3.5
	0.03	PASS	0.03	PASS	0.03	0.83	PASS	0.83	PASS	0.83	1.8	PASS	1.8	PASS	1.8
	0.03	PASS	0.03	PASS	0.03	0.83	PASS	0.83	PASS	0.83	1.8	PASS	1.8	PASS	1.8
	0.03	PASS	0.03	PASS	0.03	0.83	PASS	0.83	PASS	0.83	1.8	PASS	1.8	PASS	1.8
	0.03	PASS	0.03	PASS	0.03	0.83	PASS	0.83	PASS	0.83	1.8	PASS	1.8	PASS	1.8
	0.03	PASS	0.03	PASS	0.03	0.83	PASS	0.83	PASS	0.83	1.8	PASS	1.8	PASS	1.8
	0.03	PASS	0.03	PASS	0.03	0.83	PASS	0.83	PASS	0.83	1.8	PASS	1.8	PASS	1.8
	0.03	PASS	0.03	PASS		0.83	PASS	0.83	PASS		1.8	PASS	1.8	PASS	
	0.03	PASS	0.03	PASS		0.83	PASS	0.83	PASS		1.8	PASS	1.8	PASS	
	0.03	PASS	0.03	PASS		0.83	PASS	0.83	PASS		1.8	PASS	1.8	PASS	
MEAN	0.0	PASS	0.0	PASS	0.0	0.8	PASS	0.8	PASS	1.0	1.8	PASS	1.8	PASS	2.0
STDV					0.01					0.30					0.59
STDMN					0.00					0.12					0.22
t FTR					1.943					1.943					1.943
UCL					0.1					1.5					3.2
UCLM					0.0					1.2					2.5

	Chromium					Lead					Mercury				
	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA
	0.1	PASS	0.1	PASS	0.1	0.6	PASS	0.6	PASS	0.6	0.05	PASS	0.02	PASS	0.02
	4.2	FAIL	0.1	PASS	0.1	4.0	FAIL	0.6	PASS	0.6	0.08	PASS	0.02	PASS	0.02
	0.1	PASS	0.1	PASS	0.1	0.6	PASS	0.6	PASS	0.6	0.02	PASS	0.02	PASS	0.02
	0.1	PASS	4.2	FAIL	0.1	0.6	PASS	5.6	FAIL	0.6	0.03	PASS	0.13	FAIL	0.02
	0.1	PASS	0.1	PASS	3.6	0.6	PASS	0.6	PASS	4.0	0.02	PASS	0.05	PASS	0.13
	0.1	PASS	0.1	PASS	0.1	1.1	PASS	0.6	PASS	0.6	0.02	PASS	0.02	PASS	0.04
	4.2	FAIL	0.1	PASS	0.1	4.3	FAIL	0.6	PASS	0.6	0.16	FAIL	0.04	PASS	0.02
	0.1	PASS	0.1	PASS	0.1	0.6	PASS	0.6	PASS	0.6	0.04	PASS	0.02	PASS	0.02
	0.1	PASS	0.1	PASS		0.6	PASS	0.6	PASS		0.02	PASS	0.02	PASS	
	0.1	PASS	0.1	PASS		0.6	PASS	2.4	PASS		0.02	PASS	0.02	PASS	
	0.1	PASS	4.1	FAIL		0.6	PASS	6.3	FAIL		0.02	PASS	0.13	FAIL	
	0.1	PASS	0.1	PASS		0.6	PASS	0.6	PASS		0.02	PASS	0.02	PASS	
	4.2	FAIL									0.17	FAIL			
MEAN	1.0	PASS	0.8	PASS	0.5	1.2	PASS	1.6	PASS	1.0	0.05	PASS	0.04	PASS	0.04
STDV					1.16					1.14					0.04
STDMN					0.44					0.43					0.01
t FTR					1.943					1.943					1.943
UCL					2.8					3.2					0.1
UCLM					1.4					1.8					0.1

CONSTITUENT CONCENTRATIONS IN SOIL
BOMBING RANGE; VIEQUES, PR

SAMPLING RESULTS (ug/L)

	Trichloroethene					Pyridine					Silver				
	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA
	5.0	PASS	5.0	PASS	5.0	10.0	PASS	10.0	PASS	10.0	0.20	PASS	0.20	PASS	0.20
	5.0	PASS	5.0	PASS	5.0	10.0	PASS	10.0	PASS	10.0	2.42	FAIL	0.20	PASS	0.20
	2.0	PASS	5.0	PASS	5.0	10.0	PASS	21.0	FAIL	10.0	0.20	PASS	0.20	PASS	0.20
	5.0	PASS	5.0	PASS	5.0	10.0	PASS	10.0	PASS	11.0	0.20	PASS	2.45	FAIL	0.20
	5.0	PASS	5.0	PASS	5.0	10.0	PASS	10.0	PASS	10.0	0.20	PASS	0.20	PASS	2.89
	2.0	PASS	5.0	PASS	5.0	10.0	PASS	10.0	PASS	23.0	0.20	PASS	0.20	PASS	0.20
	6.0	FAIL	5.0	PASS	5.0	10.0	PASS	10.0	PASS	10.0	2.84	FAIL	0.20	PASS	0.20
	5.0	PASS	5.0	PASS	5.0	10.0	PASS	10.0	PASS		0.20	PASS	0.20	PASS	0.20
	5.0	PASS	5.0	PASS		10.0	PASS	10.0	PASS		0.20	PASS	0.20	PASS	
	5.0	PASS	5.0	PASS		10.0	PASS	10.0	PASS		0.20	PASS	0.20	PASS	
	5.0	PASS									0.20	PASS	2.51	FAIL	
											0.20	PASS	0.20	PASS	
MEAN	4.5	PASS	5.0	PASS	5.0	10.0	PASS	11.1	PASS	12.0	0.60	PASS	0.58	PASS	0.53
STDV					0.00					4.50					0.89
STDMN					0.00					1.59					0.32
t FTR					1.895					1.895					1.895
UCL					5.0					20.5					2.2
UCLM					5.0					15.0					1.1

	Toxaphene					Selenium				
	OB	P/F	OD	P/F	PIA	OB	P/F	OD	P/F	PIA
	2.4	PASS	2.4	PASS	4.8	0.49	PASS	0.49	PASS	0.49
	2.4	PASS	2.4	PASS	2.4	1.01	FAIL	0.49	PASS	0.49
	2.4	PASS	2.4	PASS	2.4	0.49	PASS	0.49	PASS	0.49
	2.4	PASS	2.4	PASS	2.4	0.49	PASS	0.49	PASS	0.49
	2.4	PASS	2.4	PASS	2.4	0.82	FAIL	0.62	FAIL	0.49
	2.4	PASS	2.4	PASS	2.4	0.68	FAIL	0.49	PASS	0.49
	2.4	PASS	2.4	PASS	2.4	0.96	FAIL	0.49	PASS	0.49
	2.4	PASS	2.4	PASS	2.4	0.52	FAIL	0.49	PASS	0.49
	2.4	PASS	2.4	PASS		0.63	FAIL	0.49	PASS	
	2.4	PASS	2.4	PASS		0.49	PASS	0.49	PASS	
						0.66	FAIL	0.64	FAIL	
						0.49	PASS	0.57	FAIL	
						1.13	FAIL			
MEAN	2.4	PASS	2.4	PASS	2.7	0.68	FAIL	0.52	FAIL	0.49
STDV					0.79					0.00
STDMN					0.28					0.00
t FTR					1.895					1.895
UCL					4.2					0.49
UCLM					3.2					0.49

EnSafe Environmental and Safety Designs, Inc.
901/372-7962
5724 SUMMER TREES DR. • P.O. BOX 341315 • MEMPHIS, TN 38184-1315

November 1, 1991

Commanding Officer, Atlantic Division
Naval Facilities Engineering Command
ATTN: Code 1821; C. Menia
Norfolk, VA 23511

RE: Statistical Evaluation of TCLP Extracts; OB and OD Units vs. PIA; Vieques, PR; Contract N62470-85-B-7934

Dear Sir:

The Public Works Department, NAVSTA Roosevelt Roads, PR, has requested elaboration on the implications of the results of the statistical evaluation on current OB/OD operations at the Vieques Bombing Range.

The statistical evaluation identifies three constituents (benzene, chloroform and selenium) for which mean concentrations in OB or OD unit soils are higher (at the 95 percent confidence level) than those in the PIA. Those results have these implications relating to current operations:

* Part B Permit Application - 40 CFR 264.601 requires demonstration that the permitted operations of the hazardous waste units will not adversely affect human health and the environment. Current operations do not include open burning or open detonation of materials containing the hazardous constituents exceeding background, and cannot be projected to contribute additional contamination.
* Closure of OB and OD Units - Since the hazardous constituents have been detected at the units, they must be addressed at the end of the useful life of each unit, either as an element of Facility Closure or Corrective Actions of SWMUs.

The enclosed Statistical Evaluation Report contains corrections of typographical errors in the original submittal.

If you have questions or comments, please call.

Very truly yours,

James N. Speakman, Ph.D., P.E.
Vice President; Engineering

Enclosures

EnSafe Environmental and Safety Designs, Inc.
901/372-7962
5724 SUMMER TREES DR. • P.O. BOX 341315 • MEMPHIS, TN 38184-1315

October 28, 1991

Commanding Officer, Atlantic Division
Naval Facilities Engineering Command
ATTN: Code 1821; C. Menia
Norfolk, VA 23511

RE: Statistical Evaluation of TCLP Extracts; OB and OD Units vs. PIA; Vieques, PR; Contract N62470-85-B-7934

Dear Sir:

Environmental and Safety Designs, Inc. (EnSafe) is pleased to submit the enclosed evaluation of TCLP analysis of soil samples collected by U.S. Navy personnel form the OB, OD and PIA at the Inner Range on Vieques Island, PR. The statistical evaluation identifies three constituents for which mean concentrations in OB or OD unit soils are higher (at the 95 percent confidence level) than those in the PIA.

If you have questions or comments, please call.

Very truly yours,

James N. Speakman, Ph.D., P.E.
Vice President; Engineering

Enclosures