U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ▪ Public Health Service
Centers for Disease Control ▪ National Institute for Occupational Safety and Health

NIOSH

Health Hazard Evaluation Report

HETA 84-166-1540
U.S. ENVIRONMENTAL PROTECTION AGENCY
LACKAWANNA REFUSE SITE
OLD FORGE, PENNSYLVANIA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 84-166-1540
DECEMBER 1984
U.S. ENVIRONMENTAL PROTECTION AGENCY
LACKAWANNA REFUSE SITE
OLD FORGE, PENNSYLVANIA

NIOSH Investigator
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I. SUMMARY

In February 1984, the National Institute for Occupational Safety and Health (NIOSH) was requested by the U.S. Environmental Protection Agency (as part of an Interagency Agreement) to evaluate the health and safety conditions for EPA employees and contract employees during site investigation at the Lackawanna Refuse site in Old Forge, Pennsylvania. Municipal and commercial waste, as well as industrial and hazardous waste, had been disposed at this site.

During the period April 23 to April 29, 1984, NIOSH monitored for acutely toxic concentrations of chemicals with direct reading instruments, filter and sorbent samples analyzed on site in the NIOSH mobile base, and collected samples for later analysis in off-site laboratories.

During the 4 sampling days between April 23, 1984 and April 29, 1984 NIOSH collected 94 full-shift air samples. Of the 94 air samples, 12 were personal air samples and 82 were fixed location samples. Air temperatures during the sampling days varied between 10° and 25° C (mean: 19.3°C) and winds were generally less than 6 miles per hour.

Only one of 30 air samples showed detectable levels of organic vapors: toluene at a concentration of 9.5 ug/m^3. Seventeen area and 2 personal samples were analyzed for 32 separate elements. Aluminum, calcium, iron, magnesium, sodium, phorphorus, and zinc were detected in these samples at very low levels. Ten samples contained chloride and sulfate anions at geometric mean concentrations of 10.5 ug/m^3 and 16.5 ug/m^3. Three personal and 17 area samples were analyzed for phenols, cresols, and xylenols, which were not found. The mean mass median aerodynamic particle diameter measured in 15 samples analyzed for particle size distribution was 13.2 microns and the standard deviation was 3.4. Less than 40% of the airborne dust particles were respirable. Results from the direct reading instruments were consistent with samples analyzed later.

It was concluded that the air sample results were all well below recognized occupational health criteria and standards. Recommendations to improve heat stress prevention are included in this report.

KEYWORDS: SIC 1794 (Miscellaneous Special Trade Contractors: Excavating and Foundation Work) Hazardous Waste Sites, Personal Protective Equipment, Air Sampling, Heat Stress

II. BACKGROUND

In February 1984, the National Institute for Occupational Safety and Health (NIOSH) was requested by the U.S. Environmental Protection Agency (as part of an Interagency Agreement) to evaluate the health and safety conditions for EPA employees and EPA contract employees at the Lackawanna Refuse site in Old Forge, Pennsylvania. An initial site visit was conducted on March 22, 1984 and air monitoring was conducted at a remedial site investigation on April 23, 1984 and between April 27th and April 29th, 1984. A letter detailing the preliminary sampling results was furnished to interested parties on June 15, 1984 and August 29, 1984.

The Lackawanna Refuse Site was a 259 acre inactive disposal site located in a hilly forested area. Most of the disposal activity had occurred in or near an open area at the center of the site. Materials disposed at this site included municipal and commercial waste as well as industrial and hazardous waste. It was known that drums had been buried on the site and it was believed that liquid wastes had been dumped into an open pit along the access road to the landfill area. Soil samples, groundwater samples, leachate, samples of drum contents, and air samples collected at the Lackawanna site by EPA personnel and contractors had all contained measurable levels of synthetic chemical contaminants.[1]

In August 1983, the U.S. Environmental Protection Agency initiated a Remedial Investigation aimed at designing a cleanup method for the Lackawanna Refuse Superfund Site. Since drums were known to be buried in one of the landfill pits, investigations were conducted to locate other deposits of buried metal. These results were positive and in April 1984, shallow trenches were excavated to determine whether buried drums were located in the deposits of buried metal identified. The study reported here was conducted during this activity.

III. METHODS

A. Evaluation of Existing Data

The Remedial Action Master Plan[1] indicated that metals, solvents, oils, paints and thinners, sludges, organic acids, rubber components, coolants, and other organic wastes had been identified in various media at this site. (Table I) 44 different chemicals had been measured in air, water, soil, and drum samples.[2] EPA air monitoring data indicated the presence of some volatile organics above background levels. Measured airborne contaminants included methyl isobutyl ketone (3.7 ug/m^3), 4-octene (6.8 ug/m^3), 2-octene (2.5 ug/m^3), 2,4-dimethyl hexane (2.4 ug/m^3), pentanal (4.9 ug/m^3), benzaldehyde (4.2 ug/m^3), trichlorofluoromethane (11 ug/m^3).

B. Study Strategy

The strategy used in this study is detailed in the "Protocol to Support an Interagency Agreement between NIOSH and the U.S. EPA".[3] The 44 chemicals previously identified at this site were classified into 5 groups (volatile organic substances; metals; polynuclear aromatic hydrocarbons (PNAs); phenolics; and acid anions). The PNA materials were eliminated from the sampling scheme because they were generally present only in low part per billion levels in soils. Acid mists and vapors were analyzed because they are acute irritants. Organic vapors were analyzed because they are ubiquitous at hazardous waste sites. Metals (elemental analyses) were performed because toxic metals had been identified at the Lackawanna Refuse Site and because the analytical technique used for this analysis also provided a broad spectrum screening for other elements of potential health concern. Specific sampling media and analytical methods were identified that would allow identification and quantification of all but two of the remaining substances (mercury and cyanides).

NIOSH investigators were prepared to monitor for acutely toxic concentrations of chemical substances with the SDRITS (The Simultaneous Direct Reading Indicator Tube System).[4] Acutely toxic agents are those substances that can produce death or serious irreversible injury in a short time frame (minutes). These measurements were supplemented with the use of portable or nearly portable gas chromatographs and analysis of sorbent collectors for volatile organic vapors and acid anions on site. On site chemical analysis was conducted in a trailer modified to serve as a mobile operational base. Additional filters and sorbents were analyzed in fixed laboratory facilities for low level volatile organic vapors, various elements, phenols, cresols, xylenols, and particle size distribution.

The use of direct reading instruments and on site screening of sorbent samples was intended to provide "near real time" identification and quantitation of volatile organic vapors for use in implementing site health and safety protocols. The samples analyzed in the laboratory were intended to document site conditions and illuminate exposures that may be significant only after more prolonged exposure.

In aggregate, the sorbent and filter samples attempted to bracket the maximum and minimum occupational exposures at the site by measuring maximum contaminant concentrations at the site of active materials handling (the personal samples) and measuring contaminant concentration at the point of least potential occupational exposure (the site boundary).

This distance between these points varied between 800 and 2400 feet. The samples collected at the site boundary also could be used to evaluate whether the site acts as an area source (which implies that some of the exposure measured in personal samples is not due solely to the unit operation or process involved) and to measure the migration of contaminants away from the site towards other workplaces. The samples collected at the site boundary were also used to determine whether exposures to the public existed.

The safety procedures contained in the EPA contractor's workplan for the remedial investigation Lackawanna Refuse Site were reviewed.

C. Process Description

The site operations consisted of reidentifiying the site areas suspected of overlying metal deposits based on previous studies, repositioning earthmoving equipment to the site, removing the cover material, probing the trench ahead of the backhoe with nonsparking tools, and backfilling the trench. Approximately 10 trenches were opened during the two days of active site operations. Decontamination, self-contained breathing apparatus (SCBA) recharging, weather monitoring, and administrative functions were also performed. Backhoe operators and workers whose jobs required proximity to the lip of the trench wore splash clothing (under Tyvek), hoods, boots, gloves, hard hats, and SCBAs. Personnel not in the immediate vicinity of the open trench wore Tyvek, boots, and gloves and carried escape masks.

D. Air Sampling Protocol

1. Samples Analyzed with Laboratory Instruments

Fixed location area sampling stands were erected at approximate breathing zone height (5 feet above ground level) at five locations along the boundary of the site (Figure 1). All sampling stands were positioned to avoid active roadways and to avoid interference with site activities.

Four samples were collected on April 23, 1984 at the site boundary, and were subjected to priority GC/MS analysis in a fixed base laboratory. These samples were collected to guide subsequent site monitoring for volatile organic vapors. Background samples for organic vapors, metals, acid anions, and particle size distribution were collected on April 27, 1984 before the site was disturbed by trenching. Samples for organic vapors; metals; acid anions; phenols, cresols, and xylenols; and particle size distribution were collected on April 28-29, 1984 during active site excavation (Table 2).

Personal samples which drew air from the breathing zone (the portion of the body roughly defined by the nose and the collar bone) were attached to individual workers whose activities were within the test area. These included laborers and foremen, heavy equipment operators, EPA employees, and NIOSH employees. 12 personal samples were collected during 3 separate sampling days. A battery operated pump, which was attached to the workman's belt or SCBA harness, drew air through the sample collection media. The sampling devices were removed during lunch breaks and when the workers left the site.

2. Samples Analyzed with Direct Reading Instruments

Additonal "near real time" measurements were attempted using a Photovac 10A10 Photoionization Gas Chromatograph, Xontech Electron Capture Gas Chromatograph, and the Micromonitor Thermal Conductivity Gas Chromatograph. The Photovac instrument was capable of detecting many organic contaminants in the part per billion level. A disadvantage of this instrument was that it operated at ambient temperatures and therefore retention times were quite long for less volatile compounds. The Xontech instrument was capable of detecting many organic contaminants, especially halogenated compounds, in the ppb level. It had a heated column oven as well as automated sampling capability. The sensitivity of the Michromonitor was in the ppm range and it operates at ambient tamperatures. It had shorter retention times than the Photovac, due to design differences, and had an automated sampling mode and the ability to store and process data.

The objective of using the direct reading instruments was to to provide information in near real time necessary to implement a site health and safety program. Included among these objectives were the need to locate work areas where contaminant concentrations were highest, to tentatively identify some of the materials in the samples, to quantitate identified compounds, and to evaluate the performance of these instruments.

E. Analytical Methods

The collection media, sample flow rate, analytical method, and limit of detection for samples collected during this study are given in Appendix I.

1. Volatile Organic Vapor Samples

Sorbent samples for volatile organic vapors were analyzed either in fixed base laboratories or on site. Four screening samples collected on April 23, 1984 were shipped by overnight courier for priority analysis by gas chromatography and mass spectrometry (GC/MS). 21 samples collected on April 27-29 were analyzed by gas chrmoatography (GC) on site. 9 additional samples collected on April 28-29 were analyzed in fixed base laboratories for "total hydrocarbons" only. One of these samples was also analyzed by mass spectrometry.

2. Elemental Analysis

Two personal and 17 area samples were collected on mixed cellulose polyester (Millipore AA) filters. Analysis was by Inductively Coupled Plasma Atomic Emission Spectrometry for a standard array of 32 elements. The following were determined: aluminum, calcium, iron, magnesium, sodium, phosphorus, titanium, thallium, zinc, silver, arsenic, barium, beryllium, cadmium, cobalt, chromium, copper, lanthanum, lithium, manganese, molybdenum, nickel, phosphosus, lead, platimum, antimony, selenium, strontium, tellurium, vanadium, ytrrium, and zirconium.

3. Acid Anions

10 area samples collected on April 27-28, 1984 were analyzed on site by ion chromatography. Because the results during the first two sampling days were near ambient levels, the samples collected on April 29, 1984 were not analyzed.

4. Phenols, Cresols, and Xylenols

3 personal and 17 area samples were analyzed in fixed laboratory facilities for phenols, cresols, and xylenols by GC with flame ionization detection.

5. Respirable Dust Samples

15 samples for measurement of particle size distribution were collected. Following equlibration, the total weight gain on each of the 4 preweighed stainless steel stages and on the preweighed PVC filter contained in each midget cascade impactor was determined by reweighing them with a balance.

IV. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to

10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

The OSHA Standards, NIOSH Criteria for Recommended Standards, and the Threshold Limit Values applicable to substances measured on this site are given in Appendix II.

V. RESULTS

During the 4 sampling days between April 23, 1984 and April 29, 1984 NIOSH collected 94 full-shift air samples. Of the 94 air samples, 12 were personal air samples and 82 were fixed location samples (Table 2). Because of the limited number of samples collected and because of the large number of samples that were below the analytical limit of detection, no statistical analysis of these data was attempted.

A. Volatile Organics

No volatile organic airborne contaminants were detected in the samples collected north, east, south, and west of the site on April 23, 1984. 26 additional samples were collected on April 27-29, 1984 and were analyzed for volatile organic vapors. Of the 26 additional samples, 7 were personal (breathing zone) samples. These samples were analyzed qualitatively for organic vapors. No volatile organics were detected in 26 of the 27 additional samples. A substance tentatively identified as toluene, at a concentration of 9.5 ug/m^3, was identified by chromatographic retention time in one personal sample,collected on April 29, 1984, which was worn by a NIOSH chemist while operating direct reading instruments near open trenches (Tables 3-4). [These results are consistent with the results of 15 ambient air grab samples collected by York Research Consultants during the same study period and analyzed on-site for volatile organic vapors by triple quadrupole mass spectrometry. The highest instantaneous volatile organic contamination detected was 500 parts per billion of xylene and toluene.][6]

B. Elements Aluminum, Calcium, Iron, Magnesium, Sodium, Phorphorus, and Zinc.

17 Area and 2 personal sample were analyzed for these elements. No metals of occupational health concern were detected. The elements aluminum, calcium, iron, magnesium, sodium, phorphorus, and zinc were detected in multiple samples (Table 5). The statistics describing these substances are reported in Table 6).

C. Acid Anions

All ten samples contained chloride and sulfate anions at geometric mean concentrations of 10.5 ug/m^3 and 16.5 ug/m^3 (Table 6-7). Azide, bromide, chromate, fluoride, nitrate, nitrite, oxalate, phosphate, and thiosulfate were not detected.

D. Phenols, Cresols, and Xylenols

3 personal and 17 area samples were analyzed for phenols, cresols, and xylenols. These substances were not detected in any of the samples (Table 8).

E. Particle Size Distributions

The cumulative weight increase for each stage of the miniature cascade impacters was calculated and the results plotted on log-probability paper. Samples with positive weight gains on less than three stages were discarded. The mass median aerodynamic diameter and its standard deviation was determined for each sample. The mean mass median aerodynamic particle diameter of 15 samples was 13.2 micrometers and the standard deviation was 3.4 (Table 9). Using a plot, on log probability paper, of a distribution with a geometric mean of 13.2 and a geometric standard deviation of 3.4, it was estimated that less than 40% of the airborne dust particles were respirable, that is, between 0.5 and 10 micronmeters in size at this site. The dust levels encountered are in the range generally associated with the ambient air enviornment.[5]

G. Weather Data

The field weather observations were made at 15 minute intervals and recorded on magnetic tape. The data was processed with computer assistance. Air temperatures during the sampling days varied between 10 °C and 25 ° C (mean: 19.3 °C) and winds were generally less than 6 miles per hour. Summaries of air temperatures, wind speed, and wind direction are presented in Table 10.

VI. DISCUSSION

The air sample results were all well below recognized occupational health criteria and standards. The concentration of all measured particulate contaminants (total particulate, aluminum, calcium, iron, magnesium, sodium, zinc, chloride anion, and sulfate anion) were comparable to contaminant levels in the ambient atmosphere. The only organic compounds not normally present in the atmosphere, detected in a single sample, (toluene) was present at a concentration about 1/100,000 of the 8-hr time weighted average occupational exposure limit. The use of self-contained breathing apparatus further reduced inhalation exposures, which were required by the Site Safety Protocol.

The direct reading instruments were used to take advantage of the desirable features of the instruments. The Photovac was the smallest and most easily transportable instrument in the hilly terrain of this site. Since it required manual sample injection, syringe samples were utilized. Samples were analyzed during the excavation of each pit, and the instrument was moved to the next test pit at the same time that the earth moving equipment was repositioned.

The experience of this survey suggests that existing "near real time" instruments are difficult to use under field conditions. The Photovac was the only instrument sufficiently portable to be positioned near active site operations and to detect peak levels of airborne contaminants generated by site activities. However, the clumsiness of syringe injection (in full protective equipment) and the time delay inherent in sample processing would preclude use of this device as a walk-around direct reading analyzer for detecting peak contaminant concentrations. No airborne contaminants were detected with the Photovac.

The Xontech and the Michromonitor were not sufficiently portable to be positioned close to the site of active excavation. These instruments did not detect any airborne contaminants during this study.

The overall site health and safety planning was exceptionally good in that air monitoring was used for documenting potential occupational and community exposures to chemicals by the air route. The industrial hygiene samples collected by NIOSH, the ambient air grab samples collected and analyzed on-site by an EPA contractor during the sample time period, and the on site collection of meterological data for dispersion estimates gave the On-Scene Coordinator positive assurance of the lack of significant exposure by the air route.

The health and safety procedures in the EPA contractor's workplan for the remedial investignation of the Lackawanna site were generally acceptable, although the heat stress control procedures needed improvement. The level of respiratory and skin protection was selected based on the site safety officer's evaluation of risk of inhalation and skin exposure after considering the site history and the site contaminants identified. Since the levels of personel protection were selected based on the presence of potentially toxic chemicals previously identified at the Lackawanna site and since workers were potentially at risk from these chemicals throughout the remdial investigation, the levels of respiratory and skin protection were not changed based on the low levels of contaminants detected by the air monitoring. While this may have resulted in overprotection of workers from chemical exposure by the air and skin routes, it was a conservative procedure whose only health drawback was the induction of heat stress (despite moderate air temperatures) by the extensive personal protective equipment worn. The procedure used by the Site Safety Officer for selecting respiratory and skin protection generally followed U.S. Environmental Protection Agency guidelines. The heat stress procedures used at this site failed to consider the stress induced by the wear of extensive protective clothing while engaged in vigorous physical activity and no monitoring of physiological parameters such as daily changes in body weight was accomplished. Procedures to control heat stress are provided by EPA guidance documents.

VII. CONCLUSIONS

1. No airborne contaminant in a concentration of occupational health significance was detected at the Lackawanna Refuse Site during exploratory trenching operations.

2. The procedures for selection of respiratory and skin protection followed U.S. Environmental Proctection Agency procedures. Heat stress induced by protective clothing was not controlled in accordance with U.S. EPA procedures and was a potential health risk to workers at this site.

VIII. Recommendations

1. Adherence to U.S. Environmental Protection Agency health and safety guidelines would reduce the potential for heat stress induced by personal protective clothing during future site activities.

IX. REFERENCES

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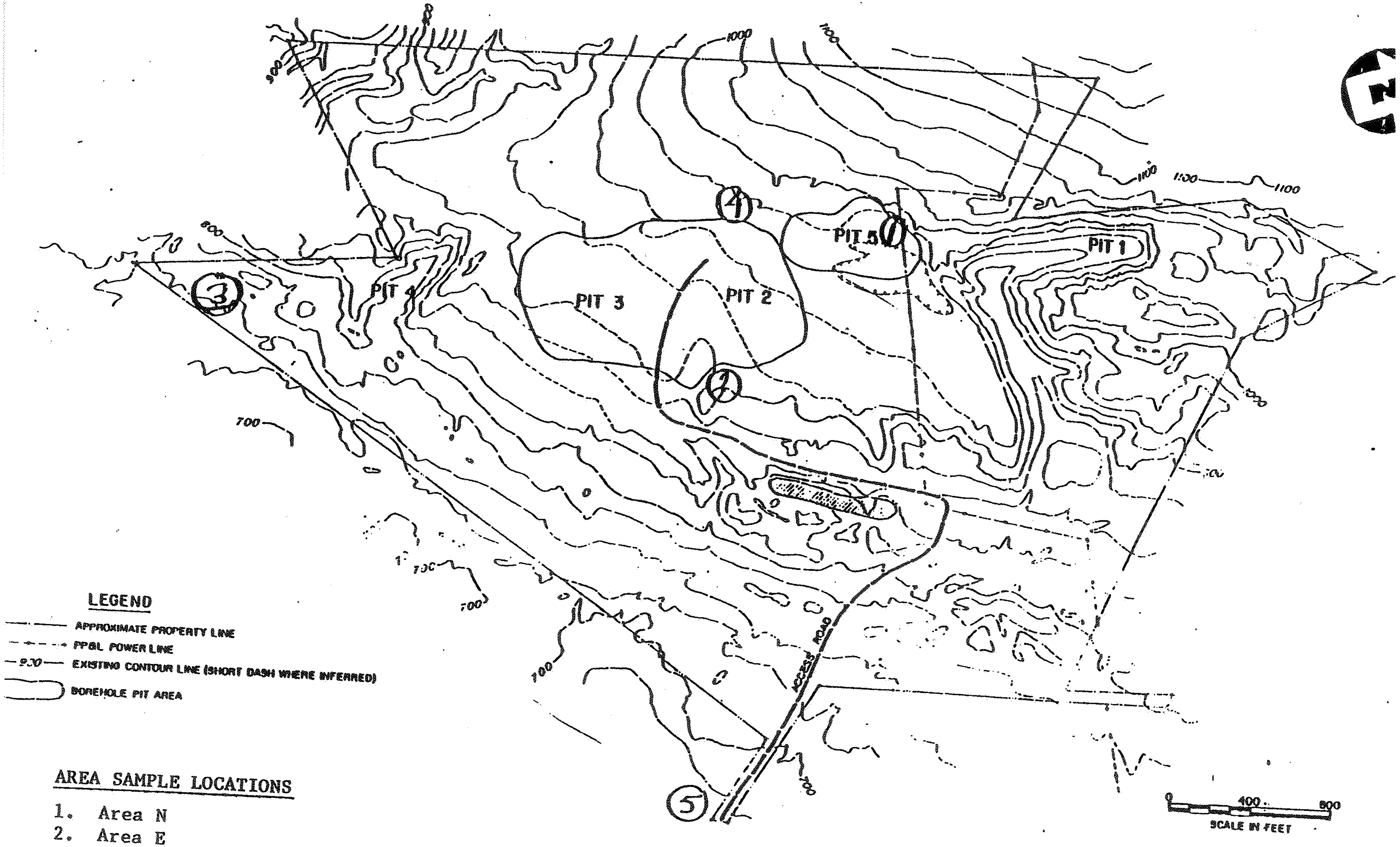
XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report have been sent to:

1. United States Environmental Protection Agency, 401 "M" Street S.W., Washington, D.C. 20460.
2. NIOSH Region III
3. OSHA Region III

Copies of this Determination Report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22151. Information regarding its availability through NTIS can be obtained from NIOSH publications at the Cincinnati address.



AREA SAMPLE LOCATIONS

1. Area N
2. Area E
3. Area S
4. Area W
5. Entrance

SITE PLAN
LACKAWANNA REFUSE SITE, OLD FORGE, PA
SCALE: 1" = 450'

FIGURE I-2

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FIGURE 1 Adapted from Reference 1. The position of the area sampling stands is approximate.

Table 1
Known Volatile Organic Substances
(Adapted from Reference 2)

Lackawanna Refuse Site
Old Forge, PA
April 1984

Substance	Environmental Sample Concentration
Acetone	Detected - air
Bis(2-ethylhexyl) phthalate	880 ppb - soil
Carbon Tetrachloride	120 mg/kg - drum
Chlorobenzene	3 g/kg - drum
Chlorethane	2 ppb - surface water
Chloroform	Detected - air
1,1 Dichloroethane	300 ppb - soil
trans - 1,2 Dichloroethylene	300 ppb - surface water
Di-n-butyl phthalate	395 ppb - soil
Di-n-octyl phthalate	170 ppb - soil
Ethyl benzene	72 g/kg - drum
Isophorone	Detected - surface water
Methylene chloride	180 mg/kg - drum 16 ppm surface water 68 ppb soil Detected - air
Tetrachloroethylene	220 mg/l - drum aequous
Toluene	92 g/kg - drum 51 ppm - surface water 67 ppb - soil Detected - air
1,1,1-Trichloroethane	730 mg/kg - drum
1,2,4-Trichlorobenzene	20 g/kg - drum

Table 1
(Continued)
Known PNAs, Phenols, and Cyanides
(Adapted from Reference 2)

Lackawanna Refuse Site
Old Forge, PA
April 1984

Substance	Environmental Sample Concentration
Acenaphthene	44 ppb - soil
Acenaphthylene	44 ppb - soil
Benzo(a)anthracene	480 ppb - soil
Benzo(a)pyrene	480 ppb - soil
Benzo(ghi)perylene	220 ppb - soil
Benzo(h)fluroantrene	880 ppb - soil
Chrysene	530 ppb - soil
Fluoranthene	1000 ppb - soil
Indeno(1,2,3-cd) pyrene	175 ppb - soil
Naphthalene	88 ppb - soil
Phenanthrene	700 ppb - soil
Pyrene	880 ppb - soil
Phenol	7350 ppb - surface water 9070 ppb - soil
4-Nitrophenol	230 ppb - soil
Pentachlorophenol	230 ppb - soil
Cyanide	1 mg/l - drum 2350 ppb - surface water

Table 1
(Continued)
Known Metals
(Adapted from Reference 2)

Lackawanna Refuse Site
Old Forge, PA
April 1984

Substance	Environmental Sample Concentration
Arsenic	66 ppb - surface water
Antimony	89 mg/kg - drums
Barium	1200 mg/kg - drums 6250 ppb - surface water
Cadmium	1.2 mg/l - drums 130 ppb surface water
Chromium	2300 mg/kg - drums 5940 ppb - surface water
Copper	18.99 ppm - surface water
Lead	12 g/kg - drum 2350 ppb - surface water
Mercury	1.1 mg.kg - drum
Nickel	2790 ppb - surface water
Silver	48 ppb - surface water
Zinc	7200 mg/kg - drum 86.1 ppm - surface water

Table 2
Sampling Protocol

Lackawanna Refuse Site
Old Forge, PA
April 1984

Date	Principal Site Activity	Air Samples For Elemental Analysis		Air Samples For Organic Vapors		Air Samples For Phenols, Cresols, Xylenols		Air Samples For Acid Gases	Air Samples For Particle Size	Total
		Personal	Area	Personal	Area	Personal	Area	Area	Area	
4/23/84	Site Undisturbed				4					4
4/27/84	Site Undisturbed		5		5		5	4	5	24
4/28/84	Exploratory Operations		6	6*	6	1	6	6	5	36
4/29/84	Exploratory Operations	2	6	1	8**	2	6	6	5	30
Total		2	17	7	23	3	17	10	15	94

NOTES: 1. *Includes 5 personal samples analyzed for "total hydrocarbons" only.
2. **Includes 4 area samples analyzed for "total hydrocarbons" only.

Table 3
On Site Sample Results
Organic Vapors

Lackawanna Refuse Site
Old Forge, PA
April 1984

Date	Sample Location	Sample Duration (Hr+Min)	Site Condition	Results ug/m^3
4/23/84	Area N	4+21	Site Undisturbed	ND
	Area E	5+16		ND
	Area S	4+20		ND
	Area W	4+48		ND
4/27/84	Area N	7+36	Site Undisturbed	ND
	Area E	7+19		ND
	Area S	7+15		ND
	Area W	7+33		ND
	Entrance	5+52		ND
4/28/84	Area N	7+45	Exploratory Operations	ND
	Area E	8+06		ND
	Area S	7+57		ND
	Area W	0+00		
	Backhoe	8+37		ND
	Entrance	9+26		ND
	Personal	3+04		ND
4/29/84	Area N	8+19	Exploratory Operations	ND
	Area E	8+32		ND
	Area S	8+35		ND
	Area W	8+25		ND
	Personal (No #)	7+00		9.5*

NOTE: *This substance was tentatively identified as toluene based on its chromatographic retention time.

Table 4
Laboratory Results
Organic Vapors
Analyzed as "Total Hydrocarbons"

Lackawanna Refuse Site
Old Forge, PA
April 1984

Date	Sample Location	Sample Duration (Hr+Min)	Site Condition	Results ug/m^3
4/28/84	Personal	4+21	Exploratory Operations	ND
	Personal	5+16		ND
	Personal	6+30		ND
	Personal	6+45		ND
	Personal	4+20		ND
	Blank			ND
4/29/84	Entrance	4+39	Exploratory Operations	ND
	Entrance	4+18		ND
	Backhoe	4+39		ND
	Backhoe	4+28		ND

Table 5
Laboratory Results
Elemental Analysis

Lackawanna Refuse Site
Old Forge, PA
April 1984

Date	Sample Location	Sample Duration	Site Condition	Al	Ca	Fe	Mg	Na	P	Zn
						(Concentrations are in ug/m^3)				
4/27/84	Area N	7+36	Site Undisturbed	ND	0.78	ND	ND	ND	1.13	0.06
	Area E	7+18		ND	0.82	ND	0.26	7.28	4.57	0.85
	Area S	7+15		ND	0.43	ND	0.26	ND	0.39	ND
	Area W	5+15		2.36	0.59	ND	ND	ND	1.81	ND
	Entrance	5+52		ND	1.18	ND	0.49	1.58	2.27	0.57
4/28/84	Area N	7+45	Exploratory Operations	ND	0.15	ND	ND	ND	0.37	ND
	Area E	8+06		ND	0.15	ND	ND	1.15	ND	ND
	Area S	7+57		ND	1.11	ND	0.48	5.13	ND	0.54
	Area W	7+42		1.98	1.64	3.47	ND	ND	1.73	0.31
	Backhoe	8+37		ND	0.36	1.55	ND	1.52	0.77	ND
	Entrance	9+26		ND	0.63	ND	0.40	3.71	0.71	0.05
4/29/84	Area N	8+19	Exploratory Operations	ND	0.49	ND	0.23	2.72	ND	ND
	Area S	8+35		ND	0.47	ND	ND	ND	1.0	ND
	Area E	8+32		ND	0.36	ND	ND	1.20	0.78	ND
	Area W	8+25		ND	0.59	ND	0.23	ND	1.02	ND
	Backhoe	9+07		ND	0.44	17.44	0.31	ND	1.44	ND
	Entrance	9+40		ND	0.81	ND	0.30	0.37	1.48	0.15
	Personal	8+08		ND	1.43	1.76	1.05	1.14	1.29	0.53
	Personal	3+25		ND	ND	ND	ND	ND	ND	ND

NOTE: The following elements were not detected: Ag, As, Ba, Be, Cd, Co, Cr, Cu, La, Li, Mn, Mo, Ni, Pb, Pt, Sb, Se, Sr, Te, Ti, Tl, Y, Zr. The analytical limit of detection was 1.0 ug/sample.

Table 6
Descriptive Statistics
for
Sample Results
(Particulate Species)

Lackawanna Refuse Site
Old Forge, PA
April 1984

Concentrations are expressed in units of ug/m3

Element	Number of Samples	Arithmetic Mean	Standard Deviation	Maximum Value	Minimum Value	Geometric Mean	Standard Deviation
Total Suspended Particulate	10	237.3	113.2	457	84	212.6	1.67
Aluminum	19	0.83	0.58	2.56	0.49	0.72	1.64
Calcium	19	0.76	0.51	2.02	0.15	0.61	2.03
Iron	19	1.84	3.85	17.44	0.49	0.95	2.44
Magnesium	19	0.58	0.41	2.02	.23	0.49	1.75
Sodium	19	1.73	1.82	7.28	0.37	1.18	2.32
Phosphorus	19	1.29	0.97	4.57	0.37	1.05	1.90
Zinc	19	0.59	0.41	2.02	0.05	0.45	2.41
Chloride Anion	10	10.9	3.14	16	7	10.51	1.33
Sulfate Anion	10	17.6	6.92	28	10	16.45	1.48

NOTE: A value equal to one-half of the limit of detection divided by the sample volume was used in calculating the arithmetic and geometric means when the result reported was below the limit of detection.

Table 7
On Site Sample Results
Acid Anions

Lackawanna Refuse Site
Old Forge, PA
April 1984

Date	Sample Location	Sample Duration (Hr+Min)	Site Condition	Results Cl^- ug/m^3	Results SO_4^{-2} ug/m^3
4/27/84	Area N	7+56	Site Undisturbed	15	28
	Area E	7+08		12	19
	Area S	7+12		16	22
	Area W	7+33		14	28
4/28/84	Area N	7+45	Operations Exploratory	9	15
	Area E	8+06		9	10
	Area S	7+57		9	19
	Area W	7+43		10	11
	Backhoe	8+37		8	10
	Entrance	9+26		7	14

NOTE: The following anions were not detected in any of the samples at the LOD given in parentheses :azide (3 ug/sample), bromide (1 ug/sample), chromate (13 ug/sample), fluoride (6 ug/sample), nitrate (3 ug/sample), nitrite (1.7 ug/sample), oxalate (7 ug/sample), phosphate (7 ug/sample), and thiosulfate (5 ug/sample).

Table 8
Laboratory Results
Phenol, Cresols (all)
and
Xylenols (all)

Lackawanna Refuse Site
Old Forge, PA
April 1984

Date	Sample Location	Sample Duration	Site Condition	Results ug/m^3
4/27/84	Area N	7+56	Site Undisturbed	ND
	Area E	7+08		ND
	Area S	7+12		ND
	Area W	7+33		ND
	Entran	5+52		ND
4/28/84	Area N	7+45	Exploratory Operations	ND
	Area E	4+18		ND
	Area S	7+57		ND
	Area W	7+42		ND
	Backhoe	8+37		ND
	Entrance	9+26		ND
	Personal	6+13		ND
4/29/84	Area N	8+18	Operations Exploratory	ND
	Area E	8+32		ND
	Area S	4+18		ND
	Area W	8+25		ND
	Backhoe	9+07		ND
	Entrance	9+40		ND
	Personal	8+25		ND
	Personal	8+05		ND

Table 9
Laboratory Results
Particle Size Distribution

Lackawanna Refuse Site
Old Forge, PA
April 1984

Date	Sample Location	Sample Duration (Hr+Min)	Site Condition	Particle Size Distribution MMAD[1]	Particle Size Distribution Std Dev	Total Suspended Particulate ug/m^3
4/27/84	Area N	7+56	Site Undisturbed	32	3.5	340
	Area E	7+08		12	3.5	457
	Area S	7+12		9.5	4.7	218
	Area W	7+33		No Result		
	Entrance	5+52		7	4.6	284
4/28/84	Area N	7+45	Exploratory Operations	17	2.4	216
	Area E	4+18		5	3.6	175
	Area S	7+57		No Result		
	Area W	7+42		13	2.2	84
	Backhoe	8+37		13	2	150
4/29/84	Area N	8+18	Exploratory Operations	15	6	320
	Area E	8+32		No Result		
	Area S	4+18		No Result		
	Area W	8+25		8	1.8	129
	Backhoe	9+07		No Result		

Note: [1] The geometric mean of the mass median aerodynamic diamter (MMAD), in microns, and the geometric standard deviation of the MMAD are reported.

Table 10
Weather Data

Lackawanna Refuse Site
Old Forge, PA
April 1984

Compass Point	No of Obs	% of Obs	Mean Velocity (Miles Per Hr)	Mean & Std Dev of Wind Direction	Max Temp (Degrees Celcius)	Min Temp (Degrees Celcius)	Mean Temp (Degrees Celcius)
4/23/84	No Observations						
4/27/84							
N	1	2.8	2.2	228.1/97.2	25	14.9	21.7
NE	1	2.8	1.5				
E	1	2.8	9.1				
ESE	3	8.3	2.4				
SE	9	25.0	2.6				
SSE	7	19.4	2.7				
WNW	2	5.6	2.5				
NW	12	33.3	2.5				
4/28/84							
W	5	13.9	3.4	297.6/41.3	19	10.3	15.9
WNW	21	58.3	3.3				
NW	10	27.8	2.7				
4/29/84							
NE	2	8.3	1.9	79.2/49.8	24.6	15.9	20.4
ENE	5	20.8	2.1				
E	10	41.7	1.3				
ESE	1	4.2	2.5				
SE	3	12.5	2.1				
S	1	4.2	1.4				
W	1	4.2	1.8				
NNW	1	4.2	2.3				

Appendix I
Sampling and Analysis Methodology

Lackawanna Refuse Site
Old Forge, PA
April 1984

Analyte	Collection Device	Flow Rate (lpm)	Duration (Hr)	Analytic Method	LOD ug
Acid Anions	Silica Gel	0.5	4-8	IC	1-2
Elemental Analysis	Mixed Cellulose Polyester Filter	1.75	4-8	ICP/AES	1
Organic Vapors	Charcoal Tube	0.2	4-8	GC/MS	2
Particle Size Distribution	Miniature Cascade Impacter	2.0	4-8	Gravimetric	10
Phenols, Cresols, and Xylenols	Silica Gel	0.5	4-8	GC/FID	10-30

NOTE: IC means ion chromatography. ICP/AES means inductively coupled plasma atomic emission spectrometry. GC/MS means gas chromatography/mass spectrometry. GC/FID means gas chromatography/flame ionization detection.

Appendix II
Evaluation Criteria

Lackawanna Refuse Site
Old Forge, PA
April 1984

COMPOUND	AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS		OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION			NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH	
	TWA	STEL	TWA	CEILING	PEAK	TWA	CEILING
Toluene	375,000	560,000	750,000	1,120,000	1,870,000	375,000	750,000

ALL UNITS ARE EXPRESSED IN UG/m^3