904

DEPARTMENT OF THE NAVY
CRANE DIVISION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA 47522-5000

IN REPLY REFER TO:
5090
095/H11.9
4 SEP 1992

8-1-1992

U.S. Environmental Protection Agency, Region V
Region V Waste Management Division
Attn: Ms. Carol Witt-Smith (HRP-8J)
77 West Jackson Blvd.
Chicago, IL 60604

Dear Ms. Witt-Smith:

Crane Division, Naval Surface Warfare Center (NAVSURFWARCENDIV) submits, as enclosure (1), three copies of the Final Phase I Environmental Monitoring Reports for Solid Waste Management Units 19/00, 08/17, 12/14, and 13/14 (Pyrotechnics Test Area, Load and Fill Area B-106 Pond, Mine Fill A, and Mine Fill B, respectively). The required Certification Statement is included as enclosure (2).

NAVSURFWARCENDIV Crane point of contact is Mr. Thomas J. Brent, Code 09510, telephone 812-854-3233. Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) point of contact is Ms. Adrianne Wilson, Code 185ND, telephone 803-743-0582.

Sincerely,

G. K. [illegible]
Deputy Director, Public Works Directorate
By direction of the Commander

Encl:
(1) Final RCRA Facility Investigation Phase I Environmental Monitoring Reports for Solid Waste Management Units 19/00, 08/17, 12/14, and 13/14
(2) Certification Statement

Copy to: (w/o encl)
SOUTHNAVFACENGCOM, ADRIANNE WILSON (CODE 185ND)
COMNAVSEASYSCOM (SEA 654E)
DONOHUE AND ASSOCIATES, LORRAINE S. RANSOME

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

SIGNATURE

SEP 04 1992

DEPUTY DIRECTOR, PW DIRECTORATE

TITLE DATE

Enclosure (2)

SEC DONOHUE
Environment & Infrastructure

August 28, 1992
DNSB192-0069

Mr. Jim Hunsicker
Environmental Protection Branch Manager
Naval Weapons Support Center
Crane, IN 47522-5009

Re: Contract No. N62472-90-D-1298 "CLEAN"
Final Phase I Environmental Monitoring Report Submittal
CTO #0006, Naval Weapons Support Center, Crane, Indiana
SEC Donohue Project No. 20601

Dear Mr. Hunsicker:

Enclosed for your review are six copies of the Final RCRA Facility Investigation Phase I Environmental Monitoring Report for Solid Waste Management Units #19/00, #08/17, #12/14, and #13/14 for the Naval Surface Warfare Center, Crane Division, Crane, Indiana. Copies of this document have been distributed to all other Technical Review Committee members according to the enclosed Distribution List.

Sincerely,

Jeffrey D. Maletzke
Project Manager

LSR/tlw

enc: As Noted

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RP/6EMRF/ACS

Final
RCRA Facility Investigation Phase I
Environmental Monitoring Reports
Solid Waste Management Units
#19/00, #08/17, #12/14, #13/14
Naval Surface Warfare Center, Crane Division
Crane, IN

Northern Division
Naval Facilities Engineering Command
Contract No. N62472–90–D–1298
Contract Task Order 0006

August 1992

HALLIBURTON NUS
Environmental Corporation

EPA ID No. IN5 170 023 498

FINAL
RCRA FACILITY INVESTIGATION PHASE I
ENVIRONMENTAL MONITORING REPORT
SOLID WASTE MANAGEMENT UNITS
#19/00, #08/17, #12/14, AND #13/14
NAVAL SURFACE WARFARE CENTER, CRANE DIVISION
CRANE, INDIANA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Northern Division
Environmental Branch, Code 18
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop #82
Lester, Pennsylvania 19113-2090

Submitted by:
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993 Old Eagle School Road, Suite 415
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Contract No. N62472-90-D-1298
Contract Task Order 0006

August 1992

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PREFACE

This preface is to inform the reader of a name change which occurred at Naval Weapons Support Center Crane (NWSCC) during the preparation of this report. The new name for the Facility is Naval Surface Warfare Center, Crane Division (NAVSURFWARCENDIV).

To eliminate potential errors involving the referencing of sources and to maintain clarity in the report, the former facility title of NWSCC has been retained in the report text. The facility name on the cover of this report, however, has been changed to NAVSURFWARCENDIV to acknowledge that the name change has occurred.

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RP/6EMRF/AB0

LIST OF ACRONYMS/ABBREVIATIONS

ABG	Ammunition Burning Ground
ALPEC	Ammunition Loading Production Engineering Center
CAAA	Crane Army Ammunition Activity
CAD	Cartridge Activated Device
CAP	Corrective Actions Program
CASCO	Central Ammunition Supply Control Office
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CMI	Corrective Measure Implementations
CMS	Corrective Measures Study
CNO	Chief of Naval Operations
CSRS	Confirmation Study Ranking System
DDESB	Department of Defense Explosives Safety Board
DPDO	Defense Property Disposal Office
EAD	Explosive Activated Device
EMR	Phase I Environmental Monitoring Report
EOD	Explosive Ordnance Disposal
HMTC	Hazardous Material Technical Center
HMX	Cyclotetramethylene Tetranitramine
HSWA	Hazardous and Solid Waste Amendments
IAS	Initial Assessment Study
IRP	Installation Restoration Program
NACIP	Navy Assessment and Control of Installation Pollutants
NAD	Naval Ammunitions Depot
NAVCOMPT	Navy Comptroller
NAVFAC	Navy Facilities Engineering Command
NAVFACENGCOM	Naval Facilities Engineering Command
NCP	National Oil and Hazardous Substances Contingency Plan
NEESA	Naval Energy and Environmental Support Agency
NORTHDIV	Northern Division
NWSC	Naval Weapons Support Center
OTA	Ordnance Test Area
PEP	Propellants
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action
RDX	Cyclotrimethylene Trinitramine = Hexahydro-1,3,5-trinitro-1,3,5-triazine

LIST OF ACRONYMS/ABBREVIATIONS (Continued)

RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SARA	Superfund Amendments and Reauthorization Act
SCS	Soil Conservation Service
SWMU	Solid Waste Management Unit
TNT	2,4,6-Trinitrotoluene
TSD	Treatment, Storage, or Disposal
UIC	Underground Injection Control
USAE	United States Army Engineer
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USN	United States Navy
WES	Waterways Experiment Station

RP/6EMRF/AB0

EXECUTIVE SUMMARY

This Environmental Monitoring Report (EMR) is submitted for Solid Waste Management Units (SWMUs) #19/00, #08/17, #12/14, and #13/14 at the Naval Weapons Support Center, Crane (NWSCC), Indiana. This EMR is submitted to the Northern Division, Naval Facilities Engineering Command in response to Contract Task Order (CTO) No. 006 under CLEAN Prime Contract No. N62472-90-D-1298 and Subcontract No. GCPP-91-001-1298.

NWSCC is located in southwestern Indiana and provides naval support for equipment, shipboard weapons systems, and ordnance. In addition, NWSCC supports the Crane Army Ammunition Activity (CAAA), including production and renovation of conventional ammunition, storage, shipment, and demilitarization and disposal of conventional ammunition. From its inception in the early 1940s until the late 1970s and early 1980s, a variety of liquid wastes from both ordnance and nonordnance activities at NWSCC were disposed on-site without treatment. Ordnance contaminated wastewaters were discharged into unlined ponds or into storm drains; wastewaters generated from cleaning operations were discharged into unlined ponds; oily waters, battery acids, paint thinners, acetone, boiler blowdown, and solvents were dumped behind buildings or into ravines; and waste hydraulics oil was spread on dirt roads. More recently, treatment plants have been built, wastewater streams have been connected to the sanitary sewer, and oils and solvents have been collected, segregated, and either recycled, sold, or properly disposed.

Promulgation of the United States Environmental Protection Agency's (USEPA) Resource Conservation and Recovery Act (RCRA) hazardous waste regulatory program provided the impetus to identify and control environmental contamination from past practices at NWSCC. Corrective actions programs established as part of the RCRA Hazardous and Solid Waste Amendments (HWSA) required NWSCC to address past releases of hazardous waste or hazardous constituents at SWMUs. In order to identify and assess SWMUs posing potential threat to human health or the environment, this EMR has been prepared to address four designated SWMUs, including Pyrotechnic Test Areas (SWMU #19/00), Load and Fill Area and Building 106 Pond (SWMU #08/17), Mine Fill A (SWMU #12/14), and Mine Fill B (SWMU #13/14).

At the Pyrotechnic Test Areas, functional tests on flares, signals, other marking devices, and Rockeye bomblets are performed. Potential contaminants associated with operational practices at the Pyrotechnic Test Areas include chlorates, dyes, oxidizers, fuels, by-products of flares and smokes, explosive residues, jet fuel contaminated water, and phosphorous and cyanide contaminated water. Based on waste characteristics, visual evidence, operational

practices, and locational characteristics, potential releases to groundwater and surface water are likely. Based on analytical reports and direct visual observations, releases to soil and air have occurred.

The Building 106 Pond, located in the Load and Fill Area, is an unlined surface impoundment for surface waters generated in Buildings 106 and 107. Buildings 106 and 107 are equipped to recondition and test various types of cartridge cases, as well as to repair all types of ammunition containers. Throughout its operational history, Building 106 operations have included projectile casing cleaning processes (consisting of caustic wash, degreaser, and acid wash), steel projectile phosphatizing, and painting. Potential contaminants include acid and caustic wastewaters exhibiting extreme pH values and containing explosives, heavy metals, oil, and grease. Additional wastes of concern include mercury, chromium, phosphorus, trichloroethylene, floor drain discharges (TCE, PCP, paint residue, heavy metals), and oily wastewater. Based on waste characteristics related to historic introduction of mobile compounds, locational characteristics and operational characteristics potential releases to groundwater, soil, and air are likely. Based on analytical records and reports, releases to surface water have occurred.

Mine Fill A has been used to manufacture mines, depth charges, rocket heads, aerial bombs, and projectiles, as well as demilitarization activities. The major sources of contamination are from washdown operations and through the exhaust ventilation system. Potential contaminants include TNT, RDX, and HMX, as well as explosive contaminated wastewaters. Based on operational practices, locational characteristics, and waste characteristics, releases to groundwater are likely. Based on analytical records and reports, releases to surface water and air have occurred. Releases to soil were documented by analytical records and direct visual observation.

Mine Fill B has historically been operated similar to Mine Fill A, and is currently used for renovation and rework of munitions. Activities include application of enamel and bituminous solvent coatings, rotary grit blasting, spray painting, propellant removal, and fuse and configuration changes. Similar to Mine Fill A, explosive particulate matter was exhausted through the ventilation system. Rinse and wastewater containing TNT, Composition B, HBX-1, HBX-3, and H6 serve as potential contaminants. Based on operational history, physical condition, locational characteristics, waste characteristics related to historic introduction of explosive compounds, direct and indirect visual evidence, and analytical data, releases to groundwater, surface water, soil, and air have occurred.

The fact that releases to environmental media have occurred and that these releases pose a potential threat to environmental and human receptors, has indicated the need for continuing RFI Corrective Actions at each of the four SWMUs. At the Pyrotechnic Test Areas (SWMU #19/00), RFI Phase II Release Assessments for groundwater, surface

water, air, and soil are recommended. At the Load and Fill Area, Building 106 Pond (SWMU #08/17), Mine Fill A (SWMU #12/14), and Mine Fill B (SWMU #13/14), RFI Phase II Release Assessments are recommended for groundwater, surface water, and soil.

RP/6EMRF/AC2

1.0 INTRODUCTION

1.1 PURPOSE OF REPORT

This Environmental Monitoring Report (EMR) was completed as part of the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation being conducted for Solid Waste Management Units (SWMUs) #19/00, #08/17, #12/14, and #13/14 at the Naval Weapons Support Center, Crane, Indiana (NWSCC). This EMR is submitted to the Northern Division, Naval Facilities Engineering Command in response to Contract Task Order (CTO) No. 0006 under CLEAN Prime Contract No. N62472-90-D-1298 and Subcontract No. GCPP-91-001-1298.

On December 23, 1989, the U.S. Environmental Protection Agency (USEPA) issued the federal portion of the Final RCRA Permit for NWSCC to the U.S. Navy. This permit established the Hazardous and Solid Waste Amendments (HSWA) Corrective Action Requirements and Compliance Schedules obligating the U.S. Navy to perform RCRA Facility Investigations (RFIs) at 30 Solid Waste Management Units (SWMUs), to conduct Corrective Measures Studies (CMSs), and implement Corrective Measures if needed. The federal portion of the RCRA Permit consists of Permit Conditions and Attachments. Permit Condition contains the following sections: I. Standard Conditions, II. General Facility Conditions, III. Land Disposal Requirements, and IV. Corrective Action Requirements. The Attachments include: I. Waste Analysis Plan, II. Dioxin Management Plan, and III. RCRA Corrective Action Plan and Activities. Section IV of the RCRA Permit identifies the Corrective Action Requirements including the compliance schedule for newly identified and previously delineated SWMUs. Attachment III describes the phases and scopes of RFIs, CMSs, and Corrective Measure Implementations (CMIs).

The RCRA Permit for NWSCC requires that RFI Phase I EMRs be submitted for many of the SWMUs at NWSCC. The purpose of the EMR is to identify and assess Installation Restoration Program (IRP) Corrective Action SWMUs posing potential threat to human health or the environment due to contamination from past hazardous material operations. This EMR has been prepared in accordance with USEPA guidance documents, the RCRA Permit Section IV, and Attachment II. In response to CTO No. 0006, this EMR will address the following SWMUs at NWSCC:

<u>SWMU #19/00, Pyrotechnic Test Areas</u>

At the Pyrotechnic Test Areas, functional tests on flares, signals, other marking devices, and Rockeye bomblets are performed. These tests are conducted for quality assurance and quality control.

SWMU #08/17, Load and Fill Area, Building 106 Pond

The Building 106 Pond is an unlined surface impoundment for surface waters generated in Buildings 106 and 107. Wastewaters reportedly discharged to the pond include acid and caustic cleaning waters; zinc phosphate, chromic acid, and rinsewater wastewater streams; oily compressor water; and waters from floor drains.

SWMU #12/14, Mine Fill A

Mine Fill A has been used to manufacture mines, depth charges, rocket heads, aerial bombs, and projectiles. Currently, Mine Fill A is used for the production of 2,000-pound aerial bombs. Demilitarization activities also take place in Mine Fill A.

SWMU #13/14, Mine Fill B

Mine Fill B was an operation similar to Mine Fill A. Mine Fill B, however, has not loaded bombs since 1973. The site is currently used for renovation and rework of munition items.

To perform this work, Donohue acquired, reviewed, and evaluated background data relevant to the NWSCC facility and to the designated SWMUs. Donohue conducted site investigations on August 28, 29, and 30, and September 5 and 6, 1991, to identify the SWMUs, observe significant physical features, collect visual evidence of potential releases, assess conditions relevant to future sampling or remedial activities, record site features on maps, and assess the need for additional sampling visits.

1.2 HISTORY OF REGULATORY ACTIONS

Following promulgation of the United States Environmental Protection Agency's (USEPA) RCRA hazardous waste regulatory program, NWSCC filed notification and application to operate as a treatment, storage, or disposal facility in October 1980. Interim status was granted subject to operating requirements and applicable technical standards (40 CFR, Part 265).

In April 1981, the Navy implemented the Navy Assessment and Control of Installation Pollutants (NACIP), subsequently known as the Installation Restoration Program (IRP). The purpose of the IRP was to identify and control environmental contamination from past practices at NWSCC. As part of IRP, an Initial Assessment Study (IAS) was conducted in April and May 1981, by a team from the Naval Energy and Environmental Support Activity (NEESA), the Ordnance Environmental Support Office, and the Army Corps of Engineers. Based on information from historical records, aerial photographs,

field inspections, and personnel interviews, the IAS identified a total of 17 potentially contaminated sites at NWSCC. Fourteen of the 17 sites were recommended for confirmation studies to include sampling and monitoring. Prior to publication of the IAS (May 1983), confirmation studies were reportedly initiated by NWSCC (Initial Assessment Study, 1983).

Pursuant to the RCRA permit and the IRP, hydrogeologic investigations, including groundwater monitoring, were initiated at 10 sites in 1981. Eight of the 10 sites were identified in the IAS.

In November 1984, the Naval Facilities Engineering Command - Northern Division (NORTHDIV) contracted the Hazardous Material Technical Center (HMTC) to perform confirmation studies at several sites at NWSCC.

Corrective actions programs established as part of the RCRA Hazardous and Solid Waste Amendments (HWSA) required NWSCC to address past releases of hazardous waste or hazardous constituents at SWMUs. Accordingly, NWSCC submitted a Hazardous Waste Management Report to the USEPA in January 1985. The report listed the IAS-identified hazardous wastes sites as SWMUs. Following the Hazardous Waste Management Report, a RCRA Facility Assessment (A.T. Kearney, Inc., 1987) was conducted to characterize the potential for releases of hazardous waste or constituents from 100 SWMUs.

On December 23, 1989, the U.S. Environmental Protection Agency (USEPA) issued the federal portion of the Final RCRA Permit for NWSCC to the U.S. Navy. This permit established the HSWA Corrective Action Requirements and Compliance (RFIs) at 30 SWMUs, to conduct Corrective Measures Studies (CMSs) and implement corrective measures if needed. The RCRA permit for NWSCC requires that RFI Phase I EMRs be submitted for many of the SWMUs at NWSCC.

1.3 ORGANIZATION OF REPORT

Subsequent sections of this report document the results of these activities. Section 2 presents general background information regarding the NWSCC facility. Physical features, spills and releases, ownership and operation, waste descriptions, and site permits are summarized. Sections 3 through 6 present background information, assess existing data, and describe unit and waste characteristics pertinent to each of the four designated SWMUs. Section 7 presents recommendations for either continuing RFI Corrective Actions or ceasing RFI Corrective Actions at each SWMU, based on the information presented.

2.0 GENERAL CURRENT CONDITIONS

2.1 FACILITY BACKGROUND

This section presents general background information regarding the NWSCC facility. Regional and local features, spills and releases, facility ownership and operation, and facility waste descriptions are described. SWMU-specific background information is presented in subsequent sections of this report.

2.1.1 Physical Features

The general facility location, climate, topography, legal description, contiguous property, hydrology, geology, hydrogeology, and biology are presented in the following sections.

2.1.1.1 Location

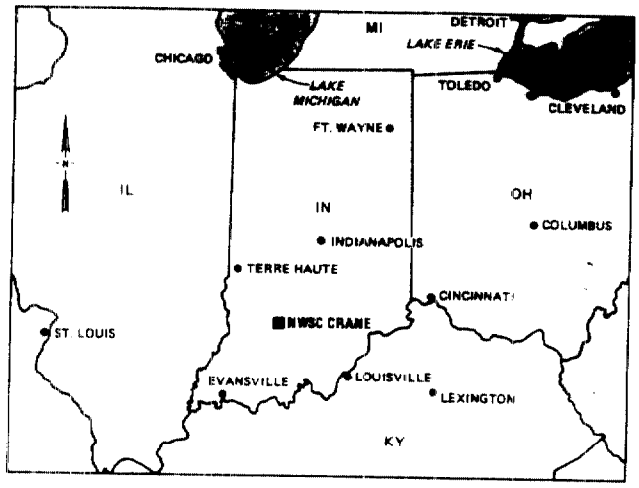
NWSCC is located in southwestern Indiana and occupies the northern half of Martin County (Figure 2-1). The site encompasses more than 100 square miles (62,463.46 acres), including 800-acre Lake Greenwood.

2.1.1.2 Climate

NWSCC is located in a temperate climate zone displaying a wide temperature range among seasons. The summers are warm and humid, and the winters are generally mild with short periods of very cold weather. The mean minimum temperature in January is 26° F, and the mean maximum temperature in July is 89° F. The area receives an average of 44 inches of precipitation annually, derived from 42 inches of rainfall and 15 inches of snowfall (NEESA, 1983).

2.1.1.3 Topography

The topography at NWSCC consists of undulating terrain dissected by many small drainageways. The elevation of the site ranges from 470 feet above Mean Sea Level (MSL) at a southern drainageway to 860 feet on a ridge in the west-central portion of the site. V-shaped drainageways in the north progress to 2,000 feet-wide floodplains in the south and rise to approximately 150 to 200 feet to the ridgelines.



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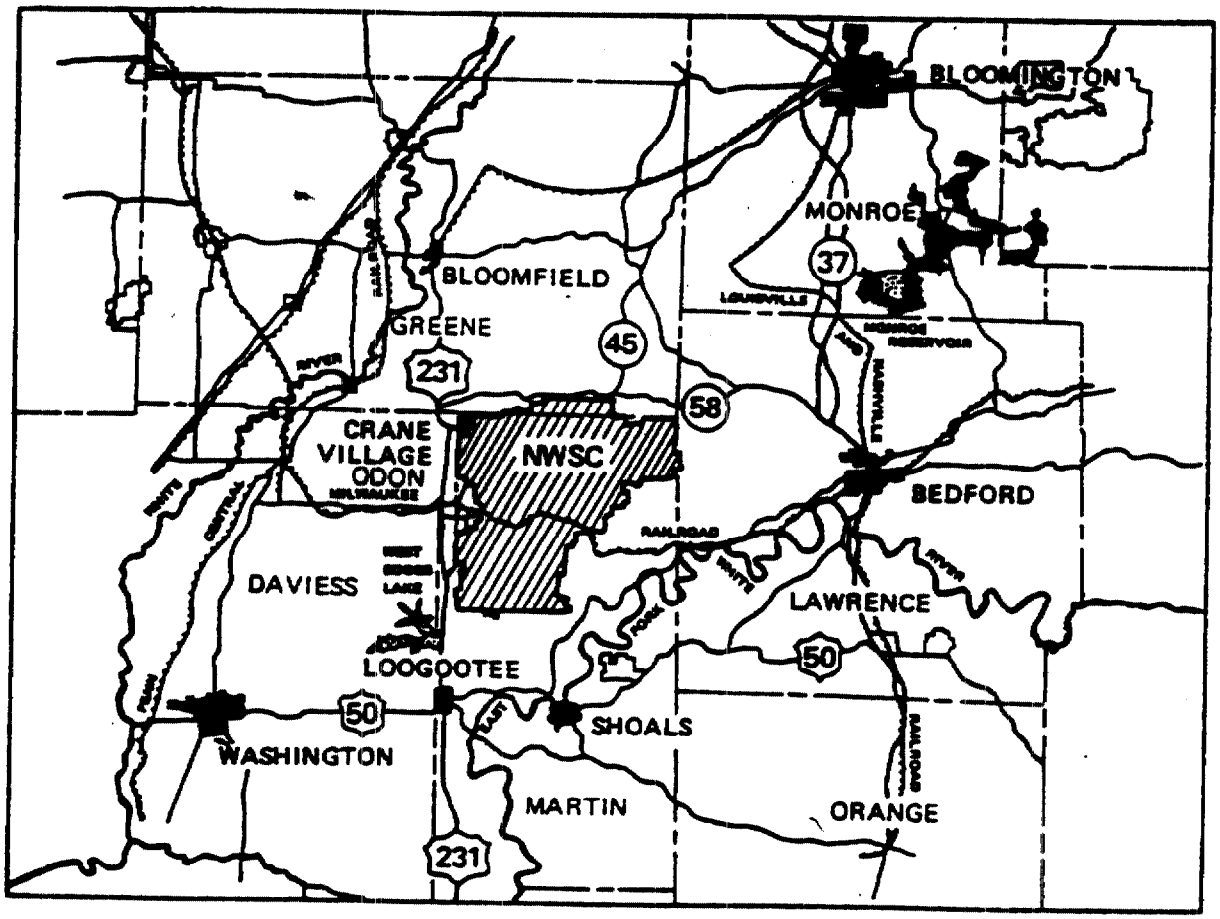

SOURCES: CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND, 1979 AND NAVAL ENERGY AND ENVIRONMENTAL SUPPORT AGENCY, 1983.

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FIGURE 2-1

NWSCC GENERAL LOCATION MAP

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CRANE, INDIANA

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2.1.1.4 Legal Description

NWSCC occupies portions of Townships 4 North, 5 North, and 6 North and portions of Ranges 2 West, 3 West, and 4 West. Legal descriptions for each of the four SWMUs covered in this report are given in subsequent SWMU-specific sections.

2.1.1.5 Contiguous Property

The Department of the Navy formerly owned Crane Village, which is located just outside the northwest corner of the facility. Crane Village was sold in 1984. Crane Village houses civil service employees.

2.1.1.6 Hydrology

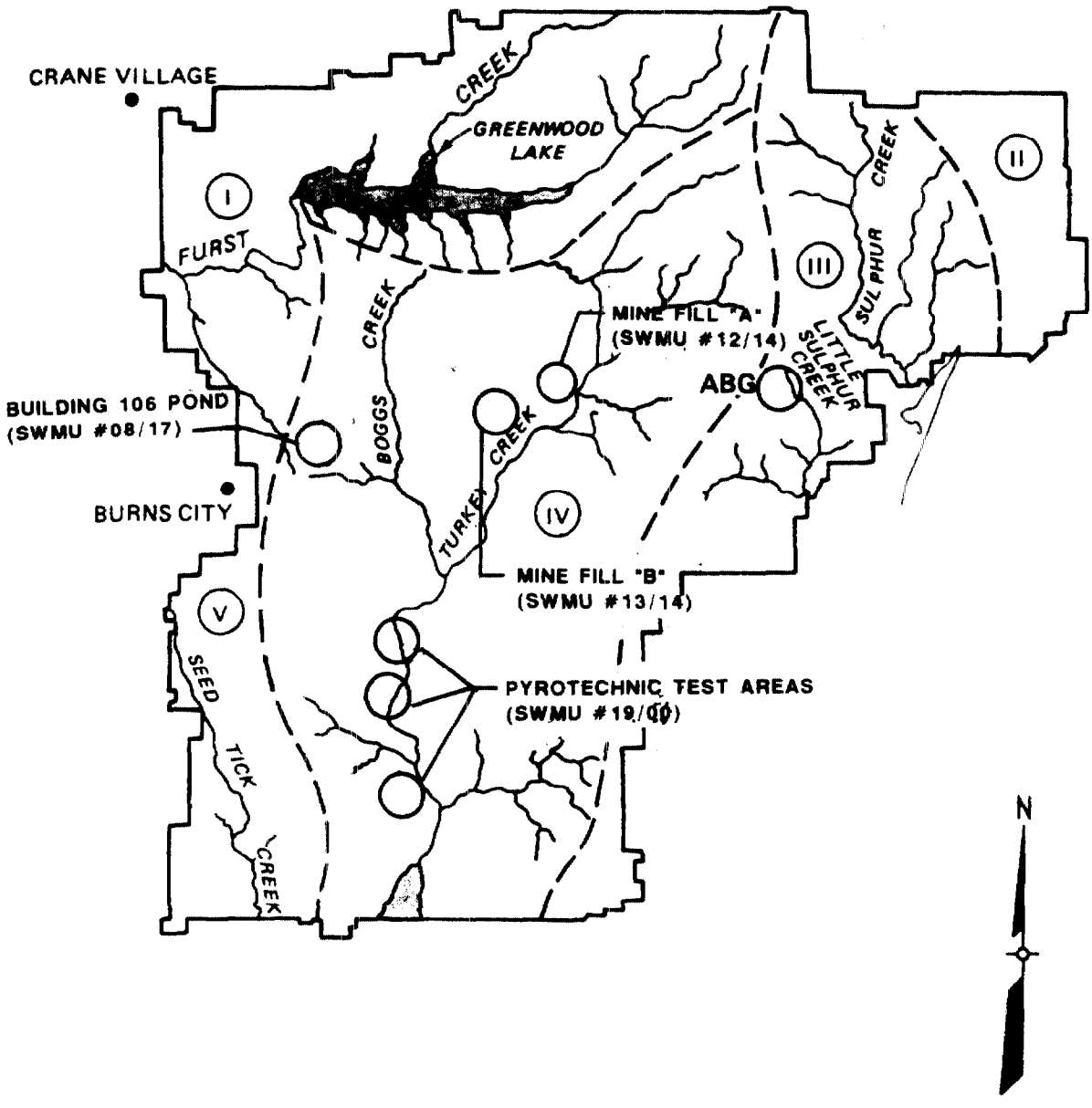
Six creeks discharge drainage from five separate drainage basins at NWSCC (Figure 2-2). The six creeks are: Furst Creek, Sulphur Creek, Little Sulphur Creek, Boggs Creek, Turkey Creek, and Seed Tick Creek. Drainage in the north and northwest drainage (Basin I) eventually empties into Furst Creek, which flows off the site in a westerly direction. Basin II, in the extreme eastern part of NWSCC, consists of several small unnamed drainageways which exit the facility to the east. Basin III occupies the eastern portion of the facility and contains Ruiney Hollow, Sulphur Creek, and Little Sulphur Creek. In the central portion of the site (Basin IV), Boggs Creek and Turkey Creek receive the surface water drainage and flow in a general southerly direction. Turkey Creek merges with Boggs Creek which exits the south-central boundary of the NWSCC. Basin V, in the extreme southwestern portion of NWSCC, contains Seed Tick Creek which exits the facility's southern boundary. All surface drainage from NWSCC eventually discharges into the east fork of the White River, south of the NWSCC. Surface water bodies within Crane include Lake Greenwood and several ponds. Lake Greenwood water is the main source of water at NWSCC and is also used for recreation.

2.1.1.7 Geology

The geology of NWSCC is discussed as surficial geology and bedrock geology in the following paragraphs. The distribution of the unconsolidated surficial deposits and bedrock units at NWSCC are presented in Figure 2-3.

Surficial Geology

Unconsolidated units beneath NWSCC are composed of alluvial and colluvial deposits. These deposits predominantly consist of silty and sandy clay and range in thickness from 1 to 15 feet. Alluvial and colluvial deposits on the floors of valleys at NWSCC contain occasional to numerous weathered sandstone fragments, cobbles, and boulders. Valley



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SOURCE: CHESAPEAKE DIVISION NAVAL FACILITIES COMMAND, 1979

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FIGURE 2-2
SURFACE DRAINAGE BASINS
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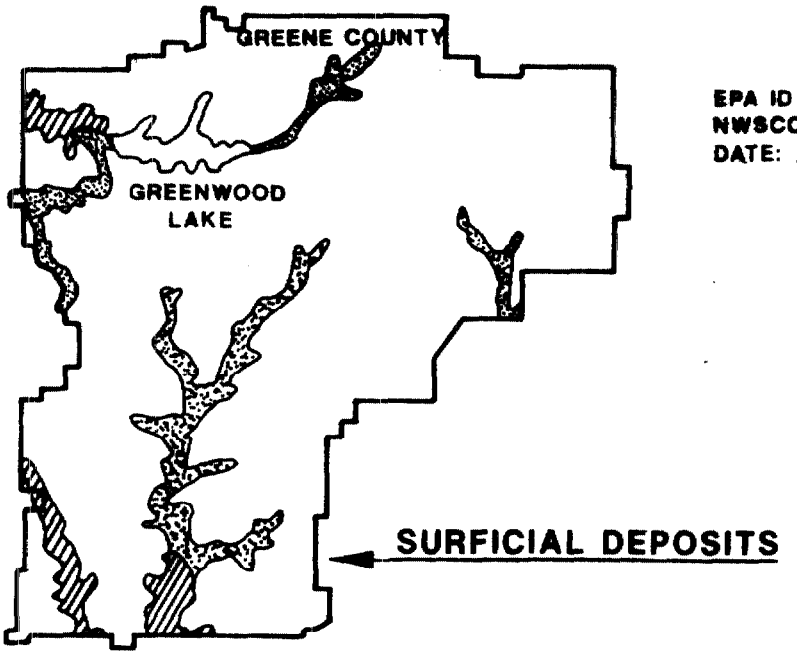
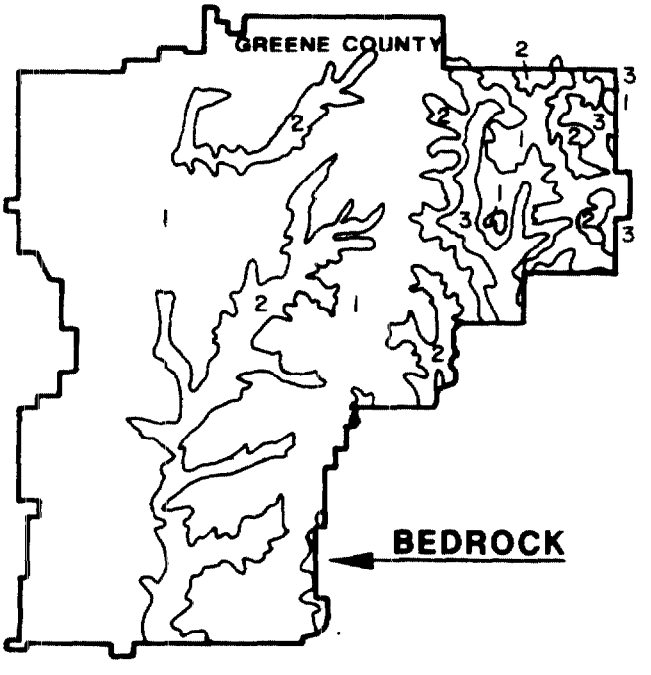
NWSCC EMR
DATE: AUGUST 1992





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LEGEND

- QUARTERNARY SILT, SAND, AND GRAVEL MOSTLY ALLUVIUM BUT INCLUDES SOME COLLUVIAL AND PALUDAL DEPOSITS.
- QUATERNARY CLAY, SILT AND SAND. LACUSTRINE DEPOSITS.
- RESIDUAL CLAYS AND SILT FROM PENNSYLVANIAN RACCOON CREEK GROUP AND MISSISSIPPIAN STEPHENSPORT AND WEST BADEN GROUPS.

1. RACCOON CREEK GROUP
2. STEPHENSPORT GROUP
3. WEST BADEN GROUP

SOURCE: NAVAL ENERGY AND ENVIRONMENTAL SUPPORT AGENCY, 1983.

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FIGURE 2-3

SURFICIAL AND BEDROCK GEOLOGIC MAPS

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deposits at NWSCC are generally thicker than the thin residual and colluvial silty clay deposits which cover the valley slopes. Valley slope deposits are commonly less than 5 feet thick (Hunt, 1988). Residual deposits were derived from the weathering of the underlying Pennsylvanian and Mississippian Bedrock (NEESA, 1983).

Four soils units have been mapped at NWSCC in the Soil Survey of Martin County, Indiana (McElrath, 1988). Soil units are summarized individually below.

Wellston-Gilpin Map Unit - Wellston-Gilpin soils are deep and moderately deep, gently sloping to very steep, well-drained soils. These soils formed in loess and material weathered from underlying sandstone, siltstone, and shale in upland areas. This unit is commonly found along ridgetops and sideslopes in the upland areas. These areas are generally large and are separated by long, narrow bottom land and ridges.

This soil unit is composed of 50 percent Wellston soils, 15 percent Gilpin soils, and 35 percent minor-extent soils. Wellston soils are deep, gently sloping to very steep silt loam. Gilpin soils are moderately deep and are strongly sloping to very steep. Gilpin soils are described as channery silt loam, channery loam, and loam.

Wellston-Berks-Gilpin Map Unit - This mapped soil unit is composed of deep and moderately deep, gently sloping to very steep, well-drained soils formed in loess and material weathered from underlying sandstone, siltstone, and shales in upland areas. This soil unit is on ridgetops and sideslopes in upland areas. Areas mapped with this unit are large and are separated by long, narrow bottom land and ridges. Of the areas mapped with this soil unit, 43 percent are Wellston soils, 15 percent Berk soils, 10 percent Gilpin soils, and 32 percent other minor soils.

Wellston and Gilpin soils are described above. Berk soils are moderately deep, and are moderately steep to very steep. The surface layer and subsoil in areas mapped as Berk soils consist of channery and channery loam. Friable sandstone bedrock is commonly encountered at an average depth of 38 inches in areas mapped as Berk soil.

Wellston-Berks-Ebal Map Unit - The Wellston-Berks-Ebal Unit is composed of deep and moderately deep, gently sloping to very steep, well-drained and moderately well-drained soils formed in loess and material weathered from underlying sandstone, siltstone, and shale bedrock in upland areas. Areas mapped with this unit are large and are separated by long, narrow bottom land and ridges. Of the area covered with this unit, the distribution of soil types is 35 percent Wellston, 30 percent Berk and similar soils, 15 percent Ebal, and 20 percent minor soil types.

Wellston and Berk soil types have been described in preceding paragraphs. Ebal soils are deep, moderately to strongly sloping, and moderately well-drained. The surface soil layer and subsoil in areas of Ebal soils consist of silt loam, channery silty clay, channery clay, mottled clay, and shaley clay.

Wakeland-Wilbur-Haymond Map Unit - Soils in this unit are described as deep, nearly level, somewhat poorly-drained to well-drained soils formed in alluvium on stream flood plains. Areas mapped with this unit are broad bottom land along meandering streams which generally vary in size and shape. The soil types in areas mapped as covered by this unit include 39 percent Wakeland, 13 percent Wilbur soils, 12 percent Haymond soils, and 36 percent miscellaneous soil types of minor extent.

Wakeland soils are poorly-drained soils located on broad flats and narrow floodplains along streams. Typically, these soils are silt loam, which formed from alluvial parent material. Wilbur soils are moderately well-drained, and are found along streams at slightly higher elevations than Wakeland soils. Wilbur soils are typically silt loam and formed in alluvial parent material washed from loess covered uplands. Haymond soils are well-drained and are commonly found along streams on the landscape above Wilbur soils. Haymond soils formed in parent materials similar to Wakeland and Wilbur soils and are classified as silt loam throughout the soil column.

Bedrock Units

NWSCC is located in the eastern flank Illinois Basin. Paleozoic age sedimentary rocks underlying NWSCC have been deformed to yield a gentle dip of 50 feet per mile towards the west-southwest. Rock units in the basin are reported to exceed a thickness of 13,000 feet in some areas (Murphy et al., 1990).

The bedrock surface at NWSCC is made up of lower Pennsylvanian and upper Mississippian age sandstones, limestones, and shales. A generalized stratigraphic column of bedrock units in the NWSCC area is shown in Figure 2-4.

In general, Mississippian Age Chester Series sandstones, shales, and limestones are exposed in the valley walls of eastern portions of NWSCC and in the lower elevations of deep valleys in the western portions. Pennsylvanian age, Mansfield Formation sandstone, siltstones, claystones, and shale are found at the crests of hills and ridges in eastern portions of NWSCC and as the surficial bedrock unit further west. The contact between the Mississippian units and overlying Pennsylvanian units is an unconformity formed by long-term erosion of the Mississippian surface. In the following paragraphs rock units shown on Figure 2-4 are discussed briefly to provide information potentially significant in evaluating the role these units may play on the fate of potential contaminants.

CTO #0096
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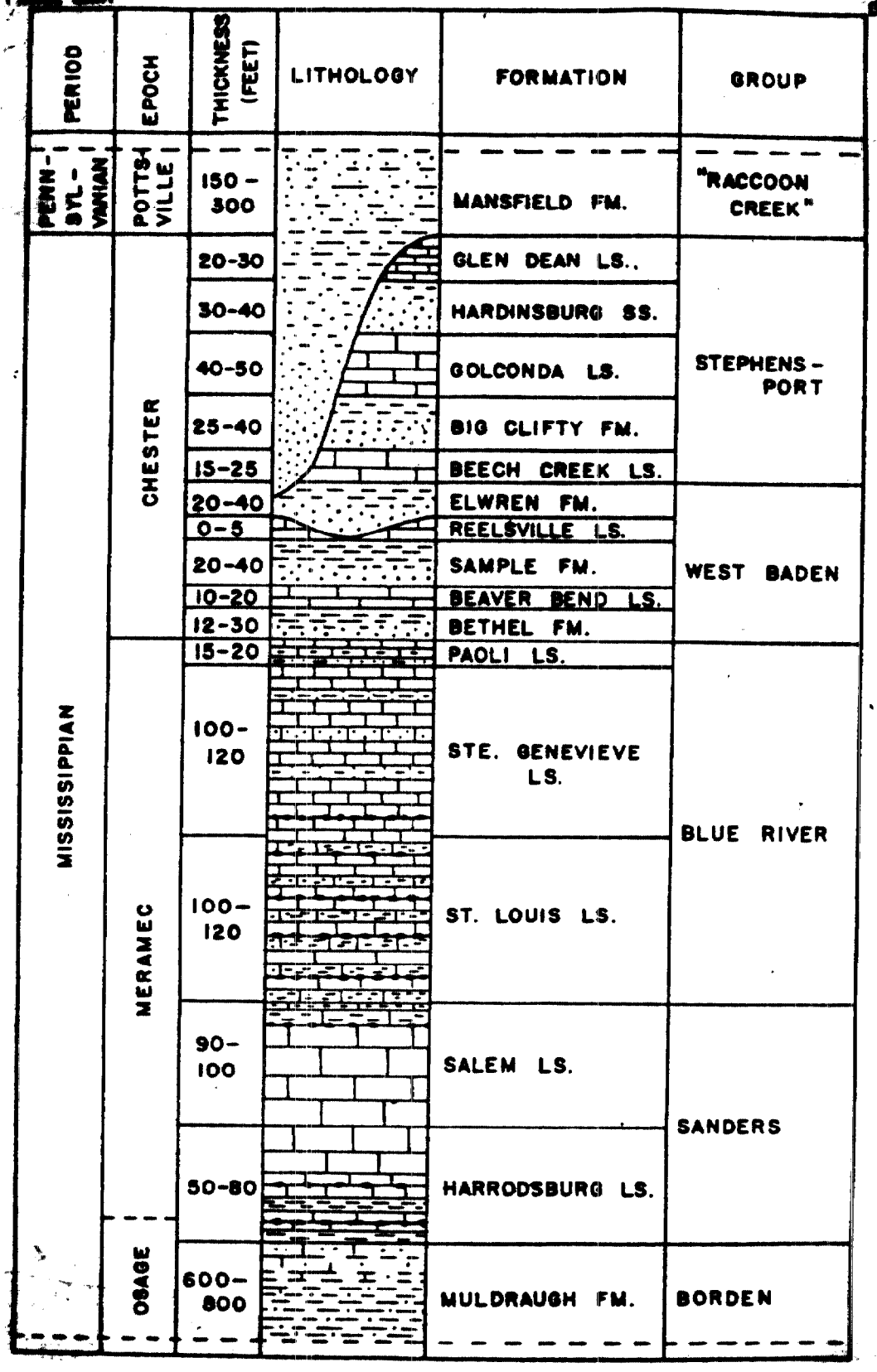

SOURCE: PALMER, 1969

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FIGURE 2-4
BEDROCK STRATIGRAPHIC COLUMN
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Mansfield Formation (Raccoon Creek Group) - The Pennsylvanian age, Mansfield Formation generally caps hills in the eastern portions of NWSCC and makes up the bedrock surface farther west. The unit generally consists of interfingered sandstones, siltstones, claystones, and shale with occasional coal beds deposited in cyclic seas and swamps. Individual strata pinch out laterally. Overall thickness of the Mansfield Formation at locations at the Ammunition Burning Grounds (ABG) in the eastern portion of NWSCC is reported to range from 0 to 65 feet (Murphy, 1990).

Hardinsburg Formation - This Mississippian age unit is encountered directly below the unconformity present between Pennsylvanian and Mississippian units. The formation consists of thick, laterally varying beds of fine-grained, friable sandstone, thickly bedded sandstone and shale, and carbonaceous shale. The maximum reported thickness of the Hardinsburg Formation in borings completed in the eastern portion of NWSCC is approximately 47 feet (Murphy, 1990).

Haney (Formerly Golconda) Formation - This formation underlies the Hardinsburg Formation or may directly underlie the Pennsylvanian/Mississippian unconformity where the former is absent. The Haney Formation consists of medium to thickly bedded, hard, crystalline limestone interbedded with shaley limestone. The Haney Formation is considered the uppermost aquifer in studies completed in the eastern portion of NWSCC (Hunt, 1988; Murphy, 1990).

Big Clifty Formation - The Big Clifty Formation is divided into two lithologic members. The upper member is the Indian Springs Shale which consists of 20 feet of dark gray carbonaceous shale. The Indian Springs shale is considered to act as an aquiclude at the base of the Haney Formation in portions of NWSCC but is absent in others. The lower member of the Big Clifty Formation consists of up to 40 feet of tan, massive, fine-grained sandstone. This sandstone is considered highly friable and is transcended by abundant intersecting joints. The lower member of the Big Clifty Formation and the underlying Beech Creek Limestone form the Middle Aquifer in the eastern portion of NWSCC.

Beech Creek Formation - This formation is a very hard, dense, fossiliferous limestone ranging in thickness from 18 to 22 feet in areas studied at the NWSCC. The Beech Creek Formation may be thinner where dissolution resulting from groundwater movement has removed upper portions of the formation. Core borings completed in earlier investigations at NWSCC (Hunt, 1988) encountered voids in the unit interpreted as solution cavities producing buried karst conditions. The lower portion of this limestone formation contains occasional to numerous shale partings. Rounded shale inclusions from the underlying Elwren Shale are often found in the extreme lower

portions of the formation. The Beech Creek Formation and overlying portions of the Big Clifty Formation comprise the Middle Aquifer previously reported in the eastern portion of NWSCC (Hunt, 1988).

Elwren Formation - The Elwren Formation is included in the Mississippi West Baden Group. The Elwren Formation consists of massive to thinly bedded, dark, gray-green shale interbedded with red-brown claystone. The average reported thickness of the formation is 20 feet in the eastern portion of NWSCC. The Elwren is considered relatively impervious and is reported to be an effective aquiclude at the base of the overlying Beech Creek Limestone (Hunt, 1988; Murphy, 1990).

Reelsville Formation - The Reelsville Formation consists of several zones. The upper zone consists of 1 to 3 feet of hard, sandy limestone which may grade laterally into calcareous sandstone. The middle zone consists of massive to thinly-bedded, dark gray to gray-green shale. The lower zone consists of 1 to 3 feet of fine-grained, locally calcareous sandstone. The Reelsville Formation averages 10 feet in thickness in the eastern portion of NWSCC.

Sample Formation - This formation consists of dark gray to black, thinly-bedded, platey to fissile shale with occasional thin to thick beds of light gray, massive, friable, fine-grained sandstone. During a previous investigation in the eastern portion of NWSCC, the average thickness of the Sample Formation was 40 to 45 feet and, at the surface, outcrop was observed to consist of 25 to 30 feet of sandstone (Hunt, 1988; Murphy et al., 1990).

Beaver Bend Formation - The Beaver Bend Formation consists of medium gray-brown fossiliferous, medium to coarsely-crystalline, very hard and dense limestone. The formation ranges from 10 to 12 feet thick in the eastern portion of the NWSCC and is reported to contain numerous intersecting joints. The Beaver Bend Formation is the lowest aquifer included in previous investigations at the facility (Hunt, 1988; Murphy et al., 1990).

Bethel Formation - The Bethel Formation was only partially penetrated in a limited number of borings during previous investigation at NWSCC. The upper portion of the formation consists of black, thinly bedded shale with occasional light gray sandstone with occasional shale lenses (Hunt, 1988).

2.1.1.8 Hydrogeology

Hunt (1988) discussed regional groundwater trends pertaining to the unglaciated southwest portion of Indiana. In general, groundwater is contained in joint openings of limestone and sandstone aquifers. Based on studies conducted in the eastern portion of NWSCC (Hunt,

1988 and Murphy et al., 1990), rock units considered to be aquifers and aquicludes are presented in Figure 2-5. Although unit thickness may vary, the distribution of bedrock units at NWSCC (Figure 2-3) suggests similar aquifer characteristics throughout NWSCC. Surficial unconsolidated aquifers are thin and have limited water supply potential.

NWSCC is located in the Crawford Uplands area. In the Crawford Uplands area, aquifers are considered vertically isolated from each other by interlayered shale beds which act as aquicludes. Groundwater recharge occurs where aquifer units outcrop. After entering an aquifer outcrop, groundwater flows by gravity down the dip of the aquifer unit. Since the regional dip of rock units is to the southwest, regional groundwater flow in all aquifers is directed towards the southwest.

Local variations in the bedding and dip associated with aquifers and aquitards, incision by surface drainage, and karstic conditions may cause local groundwater movement at NWSCC to differ from regional trends. Where erosion resulting from surface drainage has cut through aquifer units, springs and seeps are produced which locally complicate groundwater flow. Springs and seeps are prevalent at contacts between aquicludes and overlying aquifers. Groundwater flowing from springs and seeps into surface water can potentially re-enter the groundwater system as recharge to a lower aquifer which outcrops downstream.

Karstic conditions are produced when the movement of groundwater results in dissolution of materials along the preferred flow pathway. As dissolution continues, large interconnected conduits and caverns are created. Substantial dissolution in underlying rock units can cause instability resulting in the collapse of overlying materials. At NWSCC, Hunt (1988) hypothesized that karst conditions are present in the eastern portion of NWSCC primarily in major drainage valleys where erosion has cut into permeable sandstones overlying easily dissolved limestone units. Rapid infiltration within the Big Clifty Formation sandstone units has caused dissolution and weathering of the underlying Beech Creek Limestone. The result of this occurrence has been the creation of karst and collapse conditions along major drainageways within the eastern portion of NWSCC. Similar conditions may exist elsewhere at NWSCC since characteristics of the bedrock surface are generally continuous across the site (see Figure 2-3). In addition, karstic conditions have been documented in geographic regions adjacent to the Crawford Uplands region (Palmer et al., 1975 and Palmer, 1984).

2.1.1.9 Biology

The source of the biological information presented in this section is the Initial Assessment Study (NEESA, 1983). Eighty percent of NWSCC is classified as Central Hardwoods Forest. Also, some old agricultural fields are in various stages of biological succession.

GEOLOGIC UNIT	THICKNESS (FEET)	HYDROGEOLOGIC UNIT TYPE
Golconda/Haney Formation	Few – 14	Upper Aquifer
Big Clifty Formation – Indian Springs Shale	20	Aquiclude–Aquitard
Big Clifty Formation – Lower Member Beech Creek Formation	40 18 – 22	Middle Aquifer
Elwren Formation Reelsville Formation Sample Formation	20 10 40 – 45	Aquitard
Beaver Bend Formation	10 – 12	Lower Aquifer

SOURCE: MURPHY ET AL., 1990 AND HUNT, 1988

NOTE:
REPORTED UNIT THICKNESS AND TYPE ARE BASED ON STUDIES COMPLETED IN THE EASTERN PORTION OF NWSCC. THE DISTRIBUTION OF BEDROCK UNITS AT NWSCC SUGGESTS SIMILAR AQUIFER CHARACTERISTICS THROUGHOUT NWSCC.

FIGURE 2-5
HYDROSTRATIGRAPHIC UNITS
ENVIRONMENTAL MONITORING REPORT
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Although no threatened or endangered plant species are known to exist on-site, some local species are listed as rare by the Biological Survey Committee of the Indiana Academy of Sciences. Trees are commercially harvested on-site as a source of income for Crane.

A great variety of animal life is present at NWSCC. Deer, beaver, groundhogs, and hawks are among the vertebrates which inhabit the site. Two species listed by the Federal Government, the Indiana bat (Myotis sodalis) and the Peregrine falcon (Falco peregrinus), may potentially inhabit the NWSCC (NEESA, 1983). A single Indiana bat was caught on-site in 1987 (IDNR, 1987). Also, a pair of Bald Eagles (Haliaeetus leucocephalus) have nested at Lake Greenwood for the past year. Thus far, no eggs have been produced (NWSCC, 1991a).

Aquatic studies performed in 1971 and 1979 indicated that although stream water quality near pollutant sources is fair to poor, water quality at points where streams exit NWSCC are of good quality (NEESA, 1983). The 1979 study identified three sediment sites contaminated by PCBs above USEPA criteria for protection of freshwater biota for water samples and five stream water sites with cadmium above USEPA criteria for protection of freshwater biota. Analyses from 1981 did not demonstrate elevated levels of these contaminants.

A listing of plants and animals found at NWSCC (NEESA, 1983) is included in Appendix A.

2.1.1.10 Site Map

Figure 2-6 is a site map showing water features, general site layout, and SWMU locations.

2.1.2 Ownership and History

The following discussion is based on information obtained from the Installation Assessment Study (NEESA, 1983).

In 1940, Congress authorized construction of a Naval Ammunition Depot (NAD) in southern Indiana, and in late 1941 the Burns City Ammunition Depot was commissioned. In 1943, NAD Burns City was renamed NAD Crane, and the Town of Crane was built to house the rapidly growing number of civil service employees. NAD Crane's overall mission was to load, prepare, renovate, receive store, and issue ammunition to the fleet.

During World War II (WWII), NAD Crane's mission expanded to include pyrotechnics production, mine filling, rocket assembly, field storage, torpedo storage, and ordnance spare parts and mobile equipment storage. After WWII, NAD Crane supplied ammunition to the fleet during the Korean and Vietnam conflicts. During the 1950s, several new

departments were created, the Ammunition Loading and Production Engineering Center (ALPEC) was transferred to Crane, and the central Ammunition Supply Control Office (ASCO) was established. During the southeast Asia Crisis, the number of full-time employees at NAD Crane grew to 6,800.

In 1976, NAD Crane was designated NWSCC. Its new mission was to provide support for ships and crafts equipment, shipboard weapons systems and assigned ordnance items, and to perform additional functions as directed.

In 1977, the Single Manager Concept was implemented. The Crane Army Ammunition Activity (CAAA) was created, and the Army assumed ordnance production, storage, and related responsibilities as a tenant organization. Other functions remain Navy, and the Navy retains ownership of all real estate and facilities at Crane. Responsibility for overall station safety, security, and environmental protection remains with the Commanding Officer, NWSCC.

Until the late 1970s and early 1980s, a variety of liquid wastes from both ordnance and non-ordnance activities were disposed on-site without treatment. For example, ordnance-contaminated wastewaters were discharged into unlined ponds or into storm drains; wastewaters generated from cleaning operations were discharged into an unlined pond; oily waters, battery acids, paint thinner, acetone, boiler blowdown, and solvents were dumped behind buildings or into ravines; and waste hydraulics oil was spread on dirt roads. Since that time, treatment plants have been built, wastewater streams have been connected to the sanitary sewer, and oils and solvents have been collected, segregated, and either recycled, sold, or properly disposed.

Air pollution control devices were not installed until the late 1970s. Therefore, ventilation systems at bomb loading facilities and the incinerator had no scrubber systems until the 1970s. Waste management activities included the burning of solid wastes and subsequent disposal of ash in unlined pits or gullies. Also, dye and dye-contaminated materials have been disposed in on-site trenches.

Operations at NWSCC also included radiological activities. Some radioactive materials were disposed on-site during the early 1950s. Known burial grounds were excavated, decontaminated, and released for unrestricted use in 1974.

Past and curr waste management practices for the four SWMUs addressed in this report are discussed in further detail in subsequent sections. More detailed waste management information for other SWMUs and on-site activities at NWSCC can be found in other reports and permit applications.

2.1.3 Waste Descriptions

A description of known wastes managed in the Pyrotechnic Test Areas, Building 106 Pond (Load and Fill Area) and Mine Fills A and B are provided in the SWMU-specific sections of this report.

2.2 IDENTIFICATION AND SUMMARY OF PERMITS

NWSCC currently operates under a series of environmental permits. These permits limit releases to the air and surface water. Permits identified and reviewed for NWSCC include the following: 1) Resource Conservation and Recovery Act (RCRA) permit, 2) National Pollutant Discharge Elimination System (NPDES) permit, and 3) Clean Air Act permit. Additional permits are not required at NWSCC according to the Navy (NWSCC, 1991a). Individual permits are discussed in detail below.

2.2.1 RCRA Permit

A federal RCRA permit was issued to NWSCC on December 23, 1989. This permit will remain in effect for five years, whereupon it must be renewed. The federal RCRA permit allows NWSCC to manage hazardous waste in accordance with the conditions of the permit. Copies of the RCRA permit transmittal letter, cover page, and signature page are included in Appendix B. The state portion of the RCRA permit allows NWSCC to manage and store hazardous waste.

As part of the conditions of the federal RCRA permit, individual SWMUs within the facility boundaries must satisfy detailed Corrective Action Requirements. NWSCC is obligated under the conditions of the Permit to complete these Corrective Action Requirements. A total of 30 SMWUs are listed in the RCRA permit as requiring corrective action. Those SWMUs requiring corrective action activities that are specifically addressed in this report are: 1) Pyrotechnic Test Areas (SWMU #19/00); 2) Load and Fill Area, Building 106 Pond (SWMU #08/17); 3) Mine Fill A (SWMU #12/14); and 4) Mine Fill B (SWMU #13/14). The first required corrective action activity for all four SWMUs is completion of an RFI Phase I Environmental Monitoring Report (EMR). The purpose of an EMR is to document past and present monitoring requirements under Federal, State, and local authorities, known releases of hazardous waste or hazardous constituents, and Corrective Measures (CMs) taken and to recommend whether CMs should be continued at each SWMU. This report has been prepared to satisfy the EMR requirements for the four SWMUs listed above.

2.2.2 NPDES Permit

An NPDES permit (Permit No. IN 0021539) was issued to NWSCC effective November 1, 1989, and will remain in effect until August 31, 1994. A portion of this permit was amended effective January 1, 1990.

The NPDES permit issued to NWSCC authorizes discharges from the facility to Turkey Creek and Boggs Creek. Discharges are required to be consistent with the terms and conditions of the permit. The permit specifies discharge requirements for 12 outfalls. Outfalls addressed in the permit and their locations are listed in Table 2-1.

Of the permitted outfalls in Table 2-1, only one is located in a SWMU undergoing investigation as part of the EMR for the four SMWUs addressed in this report. Outfall 301, located at Building 3110 in Mine Fill A, is the treatment facility for wastewater from demilitarization operations. Review of analytical data has shown that Outfall 006, in the area of the Pyrotechnic Test Area, was monitored under an earlier version of NPDES permit No. IN 0021539. Information on the outfalls associated with SWMUs addressed in this report will be discussed later in sections specific to the SWMUs.

2.2.3 Clean Air Act Permit

NWSCC currently operates under four air pollution variances and six Air Pollution Operation Permits. The variances are listed and described below.

Variance APC-4811

Covers burning of explosive contaminated waste, waste explosives, pyrotechnics-contaminated waste, and waste pyrotechnics at the Ammunition Burning Ground.

Variance APC-4812

Covers burning of explosive-contaminated materials at the Old Rifle Range.

Variance APC-4813

Covers burning of explosives, lithium batteries, ordnance items, and gas cylinders at the Demolition Range.

Variance APC-4873

Covers testing of munition items at the Ordnance Test Area.

TABLE 2-1

**OUTFALLS TO BE MONITORED
IN ACCORDANCE WITH NPDES PERMIT NO. 0021539*
NWSCC
CRANE, INDIANA
AUGUST 1992**

Outfall Number	General Location
001	Sewage Treatment Plant
002	Demolition Ground Sedimentation Ponds
003	Demolition Ground Sedimentation Ponds
004	Demolition Ground Sedimentation Ponds
008	Demolition Ground Sedimentation Ponds
009	Scrapyard Oil/Water Separator
101	Building 3064
107	Building 3044 (Rockeye Bomblet)
201	Building 3074
301	Building 3110 (Demilitarization)
401	Building 38
501	Building 2521

*Effective November 1, 1989, through August 31, 1994.

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The Indiana Air Pollution Control Board has issued the following Operation Permits to NWSCC:

No. 51-05-88-0028
No. 51-05-88-0029
No. 51-05-88-0030
No. 51-05-88-0031
No. 51-05-88-0032
No. 51-05-88-0033

These permits authorize various surface coating and degreasing operations, rotary deactivation furnaces, grit blasting operations, and boiler operations. The Operation Permits expired May 1, 1988. NWSCC submitted renewal applications in 1988. Because the state has not acted upon the new applications, the specified operations are allowed to continue operation under the existing permits.

Air permit and variance information specific to the SWMUs discussed in this report are presented in the SWMU-specific sections.

RP/6EMRF/AA1

3.0 SWMU #19/00, PYROTECHNIC TEST AREAS

3.1 BACKGROUND

This section will present background information specific to SWMU #19/00, the Pyrotechnic Test Areas.

At the Pyrotechnic Test Area, functional tests on flares, signals, other marking devices, and Rockeye bomblets are performed. These tests are conducted for quality assurance and quality control.

3.1.1 Physical Features

3.1.1.1 Location

The Pyrotechnic Test Areas included in this SWMU include the Pyrotechnic Test Range (also known as the Ordnance Test Area (OTA), the Annex, and the Rocket Range. The Ordnance Test Area and the Annex are located in the lower central portion of NWSCC. On Figure 2-5, they are located near map coordinates VV-19 along the northern edge of Navy-designated Section 20. The Rocket Range is located near the south-central boundary of the site. This test range is situated in Navy-designated Section 23 at map coordinates HHH-18 (Figure 2-5). The Pyrotechnic Test Areas and nearby structures are shown on Figures 3-1, 3-2, and 3-3.

3.1.1.2 Legal Description

The Ordnance Test Area is located at N 1/2, SW 1/4, S10, T4N, R4W. Latitude and longitude for the OTA are 38° 47'47"N and 86° 50'38"W.

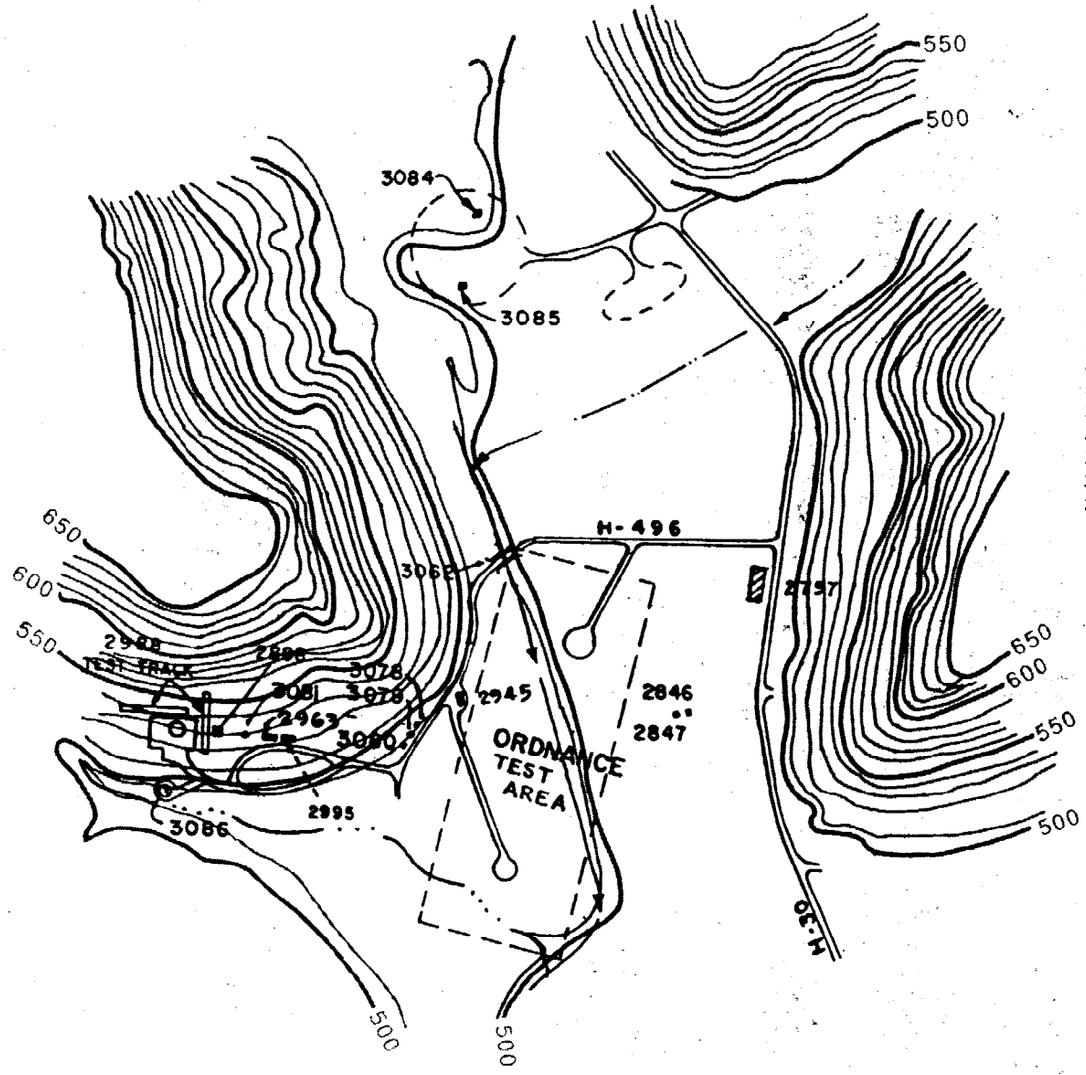
The Annex is located at W 1/2, NW 1/4, S15, T4N, R4W. Latitude and longitude for the Annex Area are 38° 47'10"N and 86° 50'44"W.

The legal description of the Rocket Range is: SW 1/4, SW 1/4, S27, T4N, R4W,
SE 1/4, SE 1/4, S28,
NE 1/4, NE 1/4, S33,
NW 1/4, NW 1/4, S34.

Latitude and longitude for the Rocket Range are 38° 45'38"N and 86° 50'51"W.

CTO #0006
FINAL EMR

EPA ID NO. IN5 170 023 498
NWSCC EMR
DATE: AUGUST 1992



Ordnance Test Area

2797 - Range Office
2846 - Test tower
2847 - Test Tower
2888 - Centrifuge building
2945 - Ammunition breakdown preparation building
2963 - Pyrotech preparation facility
2988 - Test track
2995 - Test and ammunition breakdown building
3062 - Vehicular bridge
3078 - Ready magazine
3079 - Ready magazine
3080 - Ready magazine
3081 - Ready magazine
3084 - Test tower
3085 - Test tower
3086 - Test tower

N

APPROXIMATE SCALE: 1"=250'
CONTOUR INTERVAL = 10'

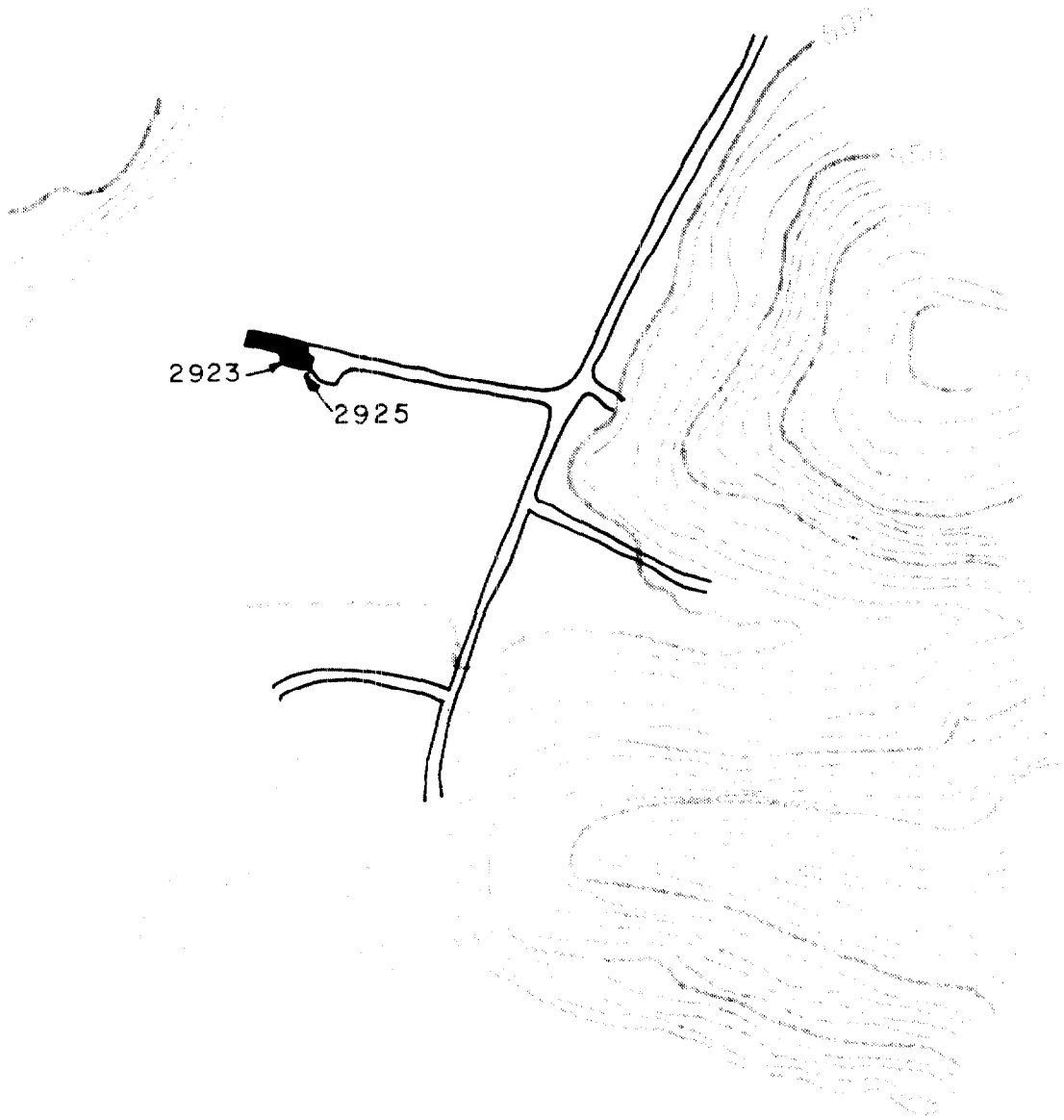
ADAPTED FROM:
NAVAL FACILITIES ENGINEERING COMMAND, 1982
AND UNITED STATES GEOLOGICAL SURVEY, 1978.

AUGUST 1992

FIGURE 3-1
SWMU #19/00 PYROTECHNIC TEST AREAS
OTA
ENVIRONMENTAL MONITORING REPORT
NWSCC
CRANE, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

20601



Annex Area

2923 - Air launch facility
2925 - Instrument building

APPROXIMATE SCALE: 1"=250'
CONTOUR INTERVAL = 10'

ADAPTED FROM:
NAVAL FACILITIES ENGINEERING COMMAND, 1962
AND UNITED STATES GEOLOGICAL SURVEY, 1978.

AUGUST 1992

FIGURE 3-2
SWMU #19/00 PYROTECHNIC TEST AREAS
ANNEX AREA
ENVIRONMENTAL MONITORING REPORT
NWSCC
CRANE, INDIANA

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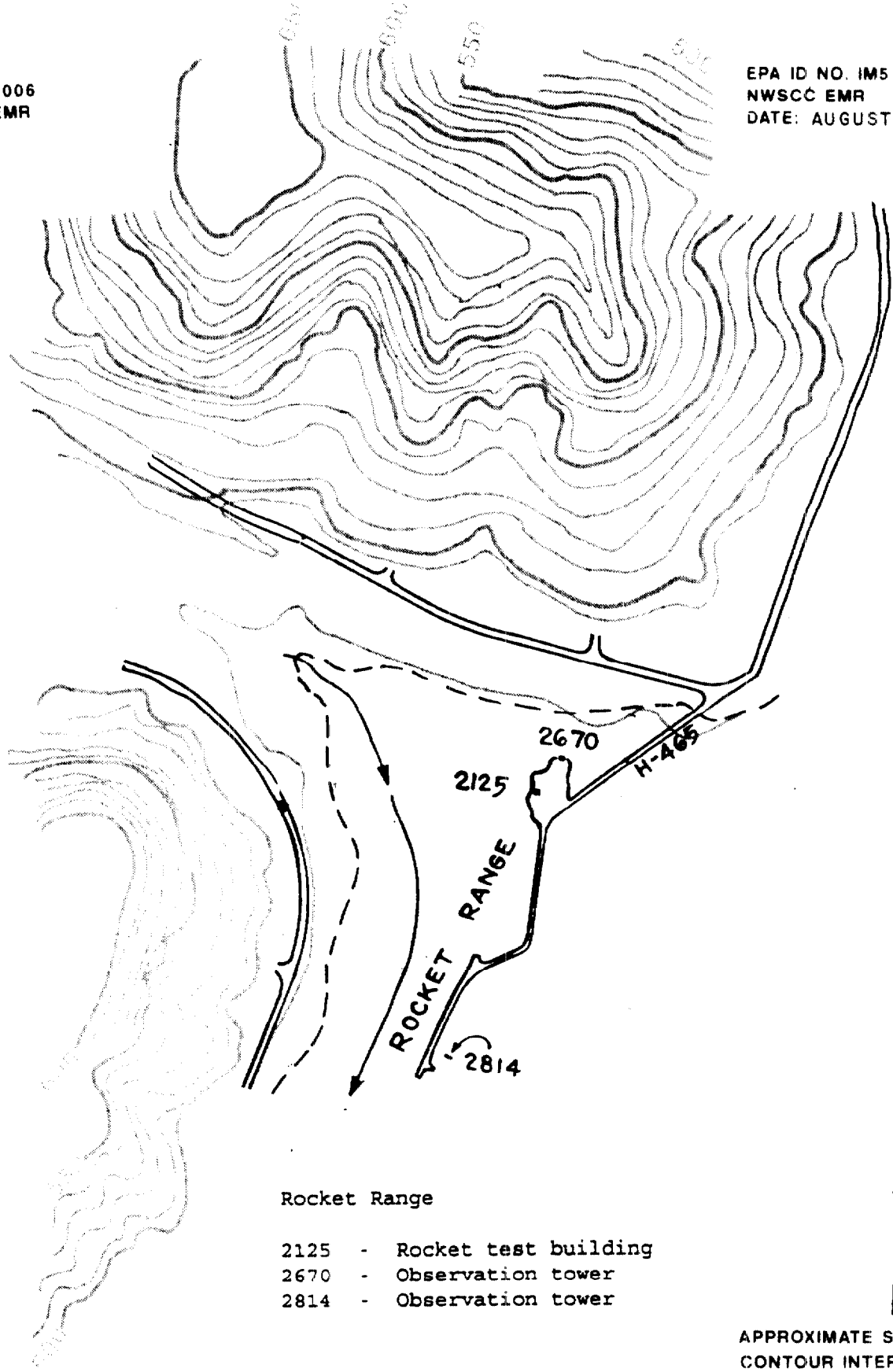
CTO #0006
FINAL EMR

EPA ID NO. IM5 170 022 498
NWSCC EMR
DATE: AUGUST 1992



Rocket Range

2125 - Rocket test building
2670 - Observation tower
2814 - Observation tower

APPROXIMATE SCALE: 1"=250'
CONTOUR INTERVAL = 10'

ADAPTED FROM:
NAVAL FACILITIES ENGINEERING COMMAND, 1962
AND UNITED STATES GEOLOGICAL SURVEY, 1978.

AUGUST 1992

FIGURE 3-3
SWMU #19/00 PYROTECHNIC TEST AREAS
ROCKET RANGE
ENVIRONMENTAL MONITORING REPORT
NWSCC
CRANE, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

20601

3.1.1.3 Contiguous Property

High explosive magazines are situated east, west, south, and north of the Pyrotechnic Test Range and the Annex Area. High explosive magazines are situated to the north and west of the Rocket Range, and a restricted explosive area lies to the east. The Lake Gallimore conservation dam is south of all three Pyrotechnic Test Areas.

3.1.1.4 Topography

Topography of the OTA is relatively flat (Figure 3-1). Elevations at the OTA range from approximately 500 feet to 470 feet MSL; however, relief is less than 10 feet over the majority of the area. Relief greater than 10 feet occurs adjacent to Boggs Creek and in the extreme northwest corner of the OTA.

The Annex Area is located in an area with a maximum relief of no greater than 10 feet (Figure 3-2). Elevations within the Annex Area range from 480 feet MSL to 490 feet MSL.

The Rocket Range is located in an essentially flat area where the maximum relief is less than 5 feet (Figure 3-3). Elevations at the Rocket Range range from approximately 485 feet MSL to 490 feet MSL.

3.1.1.5 Surface Drainage and Hydrology

All Pyrotechnic Test Areas lie within the Boggs Creek Watershed. All surface drainage from the test areas eventually enters Boggs Creek. Boggs Creek bisects the OTA into a western half and an eastern half. U.S. Navy Northern Division staff calculated the 100-year flood level of Boggs Creek to be at an elevation of 489.5 feet (NAVFAC, 1989). Approximately 85 to 90 percent of the OTA lies within the 100-year flood plain.

Two intermittent drainageways flow west towards Boggs Creek from the eastern half of the OTA. A single intermittent drainageway enters Boggs Creek from the western half of the OTA. NWSCC staff indicated that it is common for portions of the OTA to flood during rain events (NWSCC, 1991b).

A meandering, intermittent, west-flowing drainageway lies directly north of the Annex Area. Another west-flowing intermittent drainageway lies 500 feet south of the Annex Area.

A south-flowing, intermittent drainageway lies west of the Rocket Range. This drainageway continues past the Rocket Range for approximately two-thirds of a mile before entering Lake Gallimore. Lake Gallimore is a surface water impoundment created by a conservation dam on Boggs Creek. During an interview, NWSCC personnel stated that it is not uncommon for the Rocket Range to flood to depths as great as 3 feet during rain events (NWSCC, 1991b).

After entering Boggs Creek, drainage from the Pyrotechnic Test Areas continues to flow south, exiting NWSCC. Boggs Creek continues to flow south, eventually entering the East Fork of the White River.

3.1.1.6 Geology

The regional geology of NWSCC, which includes SWMU #19/00, was presented previously in Section 2, General Current Conditions. The following geologic information deals specifically with the Pyrotechnic Test Areas, including: 1) the OTA, 2) the Annex Area, and 3) the Rocket Range.

Soils

Soil information discussed below for the Pyrotechnic Test Areas was obtained from the Soil Survey of Martin County, Indiana, which was prepared by the Soil Conservation Service (SCS) in 1988.

The majority of the OTA is mapped with frequently flooded Wakeland silt loam soil. Wakeland soils are generally nearly level, somewhat poorly drained, and commonly occur in flood plains. Permeability in the Wakeland silt loam is moderate, ranging from 4.2×10^{-4} to 1.4×10^{-3} cm/sec, and surface runoff is slow. Organic matter content in the Wakeland silt loam surface is moderate (1-3 percent). The USCS Classification for Wakeland silt loam soil is silt (ML).

The second most common soil in the OTA is the frequently flooded Birds silt loam. The Birds silt loam found in the northeastern portion of the OTA is generally considered to be very level, poorly drained soil which is commonly found in bottom land. Permeability of the Birds silt loam is moderately slow, ranging from 4.2×10^{-4} to 1.4×10^{-3} cm/sec, and runoff is slow. The organic matter in the surface layer is moderate (1 to 3 percent). The USCS Classification for the Birds silt loam is clay (CL). Characteristics of the Birds silt loam make it subject to flooding for long periods and ponding.

In the northeastern portion of the OTA, small areas are covered by the eroded Wellston silt loam and occasionally flooded Burnside loam. Wellston silt loam soils within the OTA are steeply sloping (12 to 18 percent) and are well drained. Permeability of the Wellston soil is moderate, ranging from 4.2×10^{-4} to 1.4×10^{-3} cm/sec, and runoff is rapid due to the steep slopes. The surface layer of the Wellston silt loam contains a moderate amount of organic matter. USCS classifications for Wellston soils include silt (ML), clay (CL), silty-clay (CL-ML), sandy-clay (SC), and silty-sand (SM).

The Burnside loam commonly occurs as a nearly level, well drained soil on flood plains. Permeability of the Burnside loam is moderate and ranges from 4.2×10^{-4} to 1.4×10^{-3} cm/sec, and surface runoff is slow. USCS classifications for the Burnside silt loam are silt (ML), clay (CL), and clayey-silt (ML-CL). Organic matter content for the Burnside loam is moderately low. Due to soil characteristics, areas covered by the Burnside loam are occasionally flooded for brief periods.

The Annex Area is completely covered by Wakeland silt loam. Wakeland silt loam has been described in the preceding section discussing soils in the OTA.

The Rocket Range is completely covered by Birds silt loam. The characteristics of the Birds silt loam are presented in the preceding discussion of soils in the OTA.

Bedrock

The bedrock surface in the Pyrotechnics Test Areas is comprised of limestones and sandstones of the Mississippian Age Stephensport Group (Department of the Army, 1978).

More detailed unit-specific geologic data were not discovered during the record search for the EMR. No monitoring wells or soil borings were found to exist, however, two water supply wells are known to exist on the OTA. An additional water supply well is located at the Rocket Range.

Water supply wells are located near the OTA office (Building 2797), ammo breakdown and prep building (Building 2942), and a hydrant is located at the marine testing pad. These wells are currently operational and are used for washing purposes (grey water). They are not used for drinking purposes since the well water is not chlorinated and Indiana requires that all drinking water supplies are chlorinated. General water quality data indicate that if the wells were chlorinated, the water would be suitable for drinking. A copy of a water quality report for the well supplying Building 2797 is included in Appendix C. A 200-foot deep water supply well is also present at the Rocket Range.

Drillers' logs for the wells at the OTA and Rocket Range are possible sources of geologic information on Pyrotechnic Test Areas, however, these were not located during research for the EMR.

3.1.1.7 Hydrogeology

The general geologic setting of the NWSCC was described in Section 2. This regional hydrogeologic setting is considered representative of hydrogeology in the Pyrotechnic Test Areas. SWMU-specific information on the hydrogeology of the Pyrotechnic Test Areas is not available due to the absence of soil borings and monitoring wells.

3.1.2 Spills or Releases

A review of spill records revealed that no spills or releases have been reported in the Pyrotechnic Test Areas. However, a memorandum (NWSCC, 1989) documenting the findings of a Command Audit by Environmental Division Staff states that phosphorus-contaminated water from the testing of Mk58 and Mk25 location markers was released directly to the gravel pad at the Rocket Range. Water used in similar testing at the OTA was analyzed and shown to contain phosphorus and cyanide. Procedures were established to eliminate disposal of test waters to the environment and sewer system. Therefore, it has been concluded that prior to 1989, water used in the testing of location markers at the OTA and Rocket Range was discharged directly on the ground.

During a walkover of the OTA on September 5, 1991, it was noted that water from the tanks in the "fast burn" or "cook-off" area in the northeastern corner of the OTA was being drained to a ditch leading to Boggs Creek. During the fast burn test completed that day, JP5 jet fuel had been placed on top of the water in the tank and burned. This is the procedure used to quickly heat test ordnance suspended in the tank. Tank water was observed to be covered with an oily film, and petroleum type residues were present in the tank. In addition, stained soils are noted around the test area. Photographs of observations made in the OTA are included in Appendix D.

3.1.3 Ownership and History

3.1.3.1 OTA

In the Pyrotechnic Test Range, functional tests on flares, signals, and other marking devices are performed. The tests are conducted for quality assurance and quality control. Testing of ordnance has reportedly occurred at the OTA for more than 30 years (NWSCC, 1991b).

Pyrotechnic ordnance tested at the OTA include hand-held, marine, and aerial devices. A list of ordnance potentially tested at the OTA and Rocket Range is included in Appendix E. These are tested under simulated conditions. Hand-held devices are tested in

areas throughout the OTA using manual and mechanical methods. Marine devices are tested in 55-gallon drums containing saltwater or in a 20-foot deep, 5-foot diameter below-ground saltwater tank. Aerial devices are operated as directed and fired into the air or suspended from towers located on several test pads at the OTA.

Pyrotechnic ordnance testing at the OTA generally occurs on gravel pads without special engineering features to collect wastes generated during destructive testing. Smoke warheads and the 5-inch rocket are tested in the circular area in the southwest corner of the OTA. A grenade test area is in the southern portion of the OTA. Vegetation in these test areas is controlled through the use of herbicides.

Explosive ordnance is tested in test chambers constructed using fully enclosed or partially enclosed former gun turrets. The chambers limit the dispersion of explosive contaminant remnants generated in them.

3.1.3.2 The Annex

Testing of the Rockeye bomblet was initiated at the Annex Area in 1972 and continues today. Rockeye bomblets were initially loaded with Octol (HMX-TNT mixture). Bomblets have subsequently been filled with Comp-B (RDX-TNT mixture) (NEESA, 1983). Since 1981, the Annex has been used for periodic surveillance and lot testing of the Rockeye bomblet and other explosive devices. Rockeye bomblet testing at the Annex includes penetration testing and spin testing.

Testing facilities at the Annex include a Control Room, Air Launch Building, two test chambers (constructed of former gun turrets), a metal test platform, and a wooden wall. An old blast furnace present in the Annex Area was reportedly removed 3 years ago (NWSCC, 1991b).

3.1.3.3 Rocket Range

The Rocket Range has reportedly been in operation for over 30 years. Past operations involve the testing of ordnance and rocket motors constructed at NWSCC. Rocket motors carrying dummy loads were reportedly tested during the 1950s and early 1960s (NWSCC, 1991b). Current operations are similar to those previously discussed for the OTA.

Facilities at the Rocket Range include: 1) an observation tower (Building 2670), 2) observation/test platform and remote operated lathe, 3) temperature chambers (Building 2125), 4) three converted gun turrets/test chambers, 5) a concrete slab with concrete saltwater wave tank, and 6) steel test pedestal. The ground surface in areas around these facilities is covered with gravel. In addition to those facilities currently present, a dye test tank was located at the Rocket Range during the 1950s and 1960s.

Pyrotechnics are fired down range or tested at the facilities at the Rocket Range. Explosive ordnance cook-off tests are reported to have occurred in two of the gun turret test chambers at the Rocket Range. The third former gun turret is used as a shield when firing ordnance. The wave tank is used for simulation testing of marine markers and signal flares.

3.1.4 Waste Descriptions

Contaminants likely present at the OTA are chlorates, dyes, oxidizers, fuels, inorganic salts, and other by-products of flares and smokes. Waste characteristics are discussed in Sections 3.4 and 3.5 and are presented in tables in those sections. Pyrotechnic compositions, products, residues, and their toxicities are listed in Appendix F. As of 1978, no tests had been made to document contamination in this area. Also, jet fuel contaminated water is discharged onto the ground after cook-off tests, and phosphorus and cyanide contaminated water was discharged prior to 1989.

The Annex Area has been used almost exclusively for testing of the Rockeye bomblet and other explosives. Contaminants likely to be present are explosive residues and their by-products.

Rockets tested in the Rocket Range were reportedly dummy loaded. Little hazard, therefore, should be associated with them. However, the Rocket Range is also used for testing pyrotechnic devices, and the contaminants listed for the OTA may also be present. It was also reported that a few rounds had been found as a result of excavations at this range (Department of the Army, 1978). As at the OTA, phosphorus and cyanide contaminated saltwater may have been discharged at the Rocket Range as well.

3.2 PERMITS

3.2.1 Air

The OTA currently has one variance, APC-4873, issued by the Indiana Department of Environmental Management, which expires September 15, 1992. This variance was issued to allow cook-off tests of ordnance items at the OTA. Cook-off tests consist of suspending a munition over a container of water and JP5 jet fuel. The fuel is then ignited to simulate a JP5 fire on the flight deck of an aircraft carrier. Approximately 15 of these tests were conducted under the 1988-89 variance, and about 35 were conducted under the 1989-90 variance.

No other air permits or variances have been issued for the Pyrotechnic Test Areas.

3.2.2 Groundwater

As far as the Navy knows, no groundwater permits are required for the OTA, Annex, or Rocket Range (NWSCC, 1991a).

3.2.3 Surface Water

NWSCC is covered by NPDES Permit No. IN0021539, which currently covers 12 outfalls. Outfall 006 was located in Boggs Creek. Outfall 006 was monitored from October 1979 through October 1989. Outfall 006 was not monitored after 1989 because it was no longer required under NWSCC's NPDES permit.

3.2.4 Soil

According to the Navy, no soil permits are required for the Pyrotechnic Test Areas (NWSCC, 1991a).

3.3 EXISTING DATA ASSESSMENT

3.3.1 Monitoring Devices

Monitoring devices designed specifically to monitor environmental conditions in the Pyrotechnic Test Areas are not known to exist. However, the surface water in Boggs Creek was monitored near the OTA under the requirements of NWSCC's NPDES permit from October 1979 until October 1989. The NPDES monitoring point, Outfall 006, was originally located on Boggs Creek south of the OTA but was later relocated within the OTA at the vehicular bridge (3062) shown in Figure 3-1. Information collected at Outfall 006 is discussed in the following subsection.

3.3.2 Analytical Data

A review of analytical data for NPDES monitoring of Outfall 006 revealed that single-analysis discharge limits were exceeded twice during the period between October 1984 and October 1989. Exceedances and the dates on which they occurred are presented in Appendix G, Table G-1 along with discharge requirements. Discharge limits were exceeded more frequently during the permit covering October 1979 through September 1984. These exceedances are presented in Appendix G, Table G-2.

No other analytical information for the Pyrotechnic Test Area was found.

3.3.3 Migration Pathways/Impacts

Migration pathways associated with the Pyrotechnic Test Areas are air, surface water, soil, and groundwater. Smokes and contaminants are released to the atmosphere during the testing procedures. These releases could be inhaled by NWSCC personnel or could be blown into Boggs Creek or off-site to nearby receptors. The Rocket Range is only about 2,500 feet from the southern boundary of NWSCC. Other Pyrotechnic Areas are at least 3 miles from site boundaries.

Boggs Creek flows through the center of the OTA and along the western edge of the Rocket Range. It was stated that both the OTA and Rocket Range are prone to flooding (NWSCC, 1991b). Particulates released during testing could be washed into Boggs Creek during rain events, or picked up by the creek during high water events. Contaminated surface waters could flow across the southern boundary of the site.

Pyrotechnic material could also leach from contaminated soil into groundwater. Contaminated groundwater could then move downgradient where the following may potentially occur: 1) contaminated groundwater may be intercepted by a water supply well, 2) contaminated groundwater may enter the surface water system as recharge, or 3) contaminated groundwater may continue to migrate downward, contaminating deeper aquifer systems. Currently, water supply wells at the OTA are not used as a drinking water source. The potential for contact and ingestion, however, still exists.

3.4 UNIT CHARACTERISTICS

3.4.1 Operations

3.4.1.1 OTA

The OTA is located in the southern portion of NWSCC, west of Roadway H30 and north of H-540. The OTA is used during lot and surveillance testing of pyrotechnic and explosive ordnance. The pyrotechnics in Table 3-1 are tested on a regular basis at the OTA. Explosive devices occasionally tested at the OTA are given in Table 3-2. A listing of ordnance potentially tested at the OTA is found in Appendix E. Testing of ordnance has reportedly occurred at the OTA for over 30 years (NWSCC, 1991b). The OTA has operated continually since that time.

Pyrotechnic ordnance tested at the OTA include hand-held, marine, and aerial devices. These are tested under simulated conditions. Hand-held devices are tested in areas throughout the OTA using manual and mechanical methods.

TABLE 3-1

PYROTECHNIC ORDNANCE REGULARLY TESTED AT THE OTA NWSCC CRANE, INDIANA AUGUST 1992

Identify Number	Use
Mk 80 (red) Mk 110 (green) Mk 134 (white)	Hand Fired Flare
Mk 124	Swimmer Signal Smoke and Flare
Mk 99	Swimmer Signal Smoke and Flare
Mk 131/132	New Version Swimmer Signal/Flare
Mk 120 (yellow) Mk 121 (green)	Marine Smoke and Illumination Signal
Mk 117 (white) Mk 118 (yellow) Mk 66 (red)	Submarine Smoke and Illumination Signal
Mk 4 - 3	Practice Bomb Signal Cartridge
Mk 31	Propellent Charge
CXU-A/B	Practice Bomb Cartridge

Source: NWSCC, 1991b.

RP/6EMRF/AA3

TABLE 3-2

EXPLOSIVES OCCASIONALLY TESTED AT THE OTA NWSCC CRANE, INDIANA AUGUST 1992

Identify Number	Use
Mk 67 MOD I	2.75-inch Smoke Warhead (8 lbs. Red Phosphorous)
Mk 34 MOD II	5-inch Rocket (~20 lbs. Red Phosphorous)
Mk 25 MOD III & IV	Location Marker
Mk 58	Marine Location Marker

Source: NWSCC, 1991b.

RP/6EMRF/AA3

Marine devices are tested in 55-gallon drums containing saltwater or in a 20-foot deep, 5-foot diameter below-ground saltwater tank. Aerial devices are operated as directed and fired into the air or suspended from towers located on several test pads at the OTA.

Pyrotechnic ordnance testing at the OTA generally occurs on gravel pads without special engineering features to collect wastes generated during destructive testing. Explosive ordnance is tested in test chambers constructed using fully enclosed or partially enclosed former gun turrets. These chambers limit the dispersion of explosive contaminant remnants generated in them.

Operating procedures for the OTA, dated June 1989, state that materials remaining after testing which contain explosive, pyrotechnic, or propellant residues will be managed as hazardous and stored in containers that prevent the entry of rainwater. Spent test ordnance is stored in garbage cans placed on pallets in a fenced area near the center of the OTA. The ground beneath the storage area is covered with gravel. Containers are reportedly emptied every 30 days and their contents are sent to the NWSCC Ammunition Burning Grounds (ABG) for flashing (reburning) and then disposal (NWSCC, 1991b).

3.4.1.2 Annex Area

The Annex Area is located south of the OTA on Roadway H-540 which extends west from H-30. The Annex Area is used for testing of the Rockeye bomblet and other explosives. Rockeye bomblet testing at the Annex includes penetration testing and spin testing. During penetration testing, Rockeye bomblets are air-fired from the Air Launch Building into penetration test blocks set up in the first gun turret. Both dummy and live bomblets are used during testing. The gun turret is cut away on one side to accommodate test firings and is intended to contain test blasts.

The second turret, which is used as a test chamber, is located further west in the Annex Area and is used during spin testing of Rockeye bomblets. "Spin testing" involves dropping a bomblet into a penetration test block placed on a steel platform in the base of the turret. Both dummy and live bomblets are tested in this facility. A portion of the western side of the turret test chamber is cut away to allow for observation during testing.

A 10- to 12-foot high earthen berm is located west of the Annex spin test chamber to help contain the effects of blasting in the chamber. This berm is approximately 35 to 40 feet long and 10 to 15 feet wide.

A 5-foot long, 4-foot high wall constructed of 4-inch by 4-inch wooden posts is located west of the earthen berm. A steel test platform and a 3-foot by 3-foot concrete pad are located southwest of the wooden wall. This equipment is reportedly used in the testing of plastic

and sheet explosives. No engineered controls besides the earthen berm are present to restrict the effects of explosive testing at this location.

3.4.1.3 Rocket Range

The Rocket Range is located in the extreme southern portion of the NWSCC and north of Lake Gallimore. The Rocket Range lies at the southern end of Roadway H-465, south of H-161. This location lies within the emergency spillway flood crest line (Elevation 481 OMSL) for Lake Gallimore.

The Rocket Range has reportedly been in operation for over 30 years. Past operations involve the testing of ordnance and rocket motors constructed at NWSCC. Rocket motors carrying dummy loads were reportedly tested during the 1950s and early 1960s (NWSCC, 1991b). Current operations are similar to those previously discussed for the OTA.

Pyrotechnics are fired down range or tested at the facilities at the Rocket Range. Explosive ordnance cook-off tests are reported to have occurred in two of the gun turret test chambers at the Rocket Range. The third former gun turret is used as a shield when testing ordnance. The wave tank is used for simulation testing of marine markers and signal flares.

3.4.2 Observations

3.4.2.1 OTA

Smoke warheads and the 5-inch rocket are tested in the circular test area in the southwest corner of the OTA. The grenade test area is in the southern portion of the OTA. Vegetation in the test area is removed through the use of herbicides and grading. No information was obtained on the types of herbicides used to defoliate test areas. No engineered features are used to control runoff from the majority of test locations on the OTA. Table 3-3 presents a list of herbicides used at NWSCC.

A gravel pad is present beneath tanks used in the cook-off test facility at the northwest corner of the OTA. Water contained in the test tanks is drained after testing and diverted through an unlined ditch to Boggs Creek. See Appendix D for photographs.

On September 5, 1991, staining was noted on several of the test pads used for testing pyrotechnics. Residues from the burning of pyrotechnic devices were present on the ground in several of the test areas. Small components and fragments left from the operation of pyrotechnic devices are scattered across the OTA. See Appendix D for photographs.

TABLE 3-3

**HERBICIDES USED AT NWSCC
CRANE, INDIANA
AUGUST 1992**

Herbicides

Current	Manufacturer
Ureabor	U.S. Borax and Chemical Company
Oust	DuPont
Roundup	

Reported

2,4-D(Tordon)
2,4,5-T
MH30 (maleic, hydrazide, and dietnanolamine
salt of 6-hydroxy-3-(24) pyridazinone)
Telvan (80% monuraon (3-(p-chloropheryl)-1,1-dimethylurea)
Silvex
Diuron
Monuron

Sources:
NWSCC, 1991b.
NEESA, 1983.
Department of the Army, 1978.

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Vegetation appeared stressed or absent in several test areas within the OTA where vegetation is not intentionally controlled. At places, stressed vegetation appeared to extend from test areas along drainageways.

In marine test areas, residues and stains were present on the exterior of saltwater containers used during testing and the ground adjacent to them. These observations suggest that spills of container contents have occurred. Previous analysis of the water used during testing of marine devices showed elevated levels of phosphorus and cyanide to be present (NWSCC, 1989).

At the cook-off test areas, stains and residues were noted on the gravel pad. Water draining from the large testing tank to Boggs Creek via an unlined drainageway exhibited an oily film, and oil residues were present inside the tank. A strong petroleum odor was present in the area. See Appendix D for photographs.

Holes were noted in the storage containers in the spent ordnance storage area. In addition, covers were ajar on several containers, and empty containers were upside down and uncovered. See Appendix D for photographs.

3.4.2.2 Annex Area

Observations made during the September 1991 SMWU reconnaissance suggest that testing activities at the Annex Area have impacted the environment. Fiberglass shards were observed throughout the Annex Area. These shards are reportedly remnants of Rockeye bomblets tested in the area (NWSCC, 1991b). Staining was noted near each of the test chambers and westernmost explosive testing area. Vegetation on the eastern side of the earthen berm exposed to testing in the spin test chamber was stressed. Vegetation in a 50-foot diameter area southwest of the explosive test location appeared to be dead. This area accepts runoff from the explosive test area. Puddles in the runoff area were discolored a coffee color and at least one puddle had an oily surface sheen. See Appendix D for photographs.

3.4.2.3 Rocket Range

Two dumpsters are used for the disposal of spent test ordnance at the Rocket Range. One dumpster is used for phosphorus and the other holds pyrotechnic residue and hardware.

Observations made at the Rocket Range during the September 1991 site visit include numerous burn marks, residues, and small operational components which were present down range where pyrotechnic devices have landed and burned. See Appendix D for photographs.

Near the sand pit at the southern end of the range, a parachute type pyrotechnic device was observed hanging in a bush (see Appendix D). Previous investigations at the OTA and Rocket Range noted pyrotechnic devices hanging in trees.

Burn marks and residues were observed near the test pedestal near the center of the facility. Yellow staining, potentially from dyes used in pyrotechnics tested at the facility (NWSCC, 1991b), were discovered at the ground surface adjacent to Building 2670. Unclassified pyrotechnic items which contain yellow dyes include marine smoke signals (Mk2 Mods 0 and 1); M22A2 smoke rifle grenade; M64 ground smoke signal; marine smoke and illumination signals Mk 99 Mods 0, 1, and 2, Mk 117 Mod 0; Mk 118 Mod 0; Mk 119 Mod 0, Mk 121 Mod 0; Mk 115 Mods 0 and 1; Mk 116 Mods 0 and 1; Mk 52 Mod 0 (obsolete); Mk 53 Mod 0 (obsolete); Mk 67 Mod 0 (obsolete); Mk 68 (obsolete); M18 smoke hand grenade, submarine location markers (Mk 23 Mod 0, Mk 23 Mod 0, Mk 77 Mod 0, Mk 78 Mod 0); marine location markers (Mk 38 Mod 1, Mk 1 Mod 3) (obsolete); Mk 8 Mod 0 (obsolete); Mk 38 Mod 0 (obsolete); color burst units (Mk 3 Mod 1, Mk 6 Mod 0); Mk 20 Mod 0 location marker; Mk 89 Mod 0 aircraft smoke signal; smoke streamer rifle grenades (M23 and M23A1); Mk 2 Mods 1, 2, and 3 marine smoke signal (obsolete); and Mk 7 Mod 0 aircraft smoke signal (obsolete) (NAVSEA, 1985). The yellow dyes used in these pyrotechnic items are auramine and Vat Yellow 4.

3.4.3 Maintenance and Schedules

3.4.3.1 OTA

During a search of files containing information on the Pyrotechnic Test Areas, a preliminary version of standard operating procedures (SOP) for disposal of test materials was obtained. This single page of the SOP document, entitled "Method Description (SOP) NAVSEA 5220/15, Procedure Serial No. 000-0189-CR," specifies the storage methods and disposal procedures for expended test ordnance, ordnance containers, and by-products of the testing process (i.e. saltwater used during simulation testing, pyrotechnic/explosive sludge, etc.).

In summary, this SOP requires that materials containing no explosive residue will be disposed of by shipping the materials to the Crane Army Ammunition Activity (CAAA) treatment facility. Expended test items and materials containing residual explosive material are to be considered hazardous materials and transferred to CAAA under a contaminated scrap manifest. Expended test items disposed of as hazardous waste are to be stored in containers which prevent the entry of rainwater. Expended test items are to be accumulated for a period which assures that testing goals are met and that sufficient quantity exists for pickup.

By-products of the testing process including contaminated saltwater or pyrotechnic explosive sludge are to be tested by the Environmental Protection Division to determine the hazard level and disposal method.

During the walkover of the Pyrotechnic Test Area, the waste storage area was viewed (see Appendix D). Galvanized steel garbage cans are used to store wastes in the disposal area. Space was provided on each can for labelling. At the time of the walkover, covers on several of the containers were ajar, and several containers had rusted through in areas. During personal communication with NWSCC personnel (1991b), it was stated that can contents are shipped for processing at CAAA facilities approximately every 30 days.

Current procedures for disposing of waste test water used during simulation testing of pyrotechnics involves several steps. First, waste test water is poured through a cloth filter to remove the solids. The contaminated filter cloth and solids are placed in a container, labeled, and disposed of at the Ammunition Burning Ground. After filtering, waste test water is sampled by the Environmental Protection Branch to determine the method of disposal (NWSCC, 1991b).

Review of records pertaining to the OTA produced information stating that wastewater from the simulation testing of marine markers (Mk58 and Mk25) containing detectable levels of phosphorus and cyanide was discharged directly to the ground surface prior to 1989 (NWSCC, 1989). According to referenced documents and personal interviews (NWSCC, 1991b) these discharges generally occurred in marine marker test areas. Wastewaters from testing of marine markers at the Rocket Range is likely to have similar chemical composition.

During the walkover, it was observed that water used during fast burn cook-off tests was discharged directly to Boggs Creek.

During the SWMU reconnaissance of areas used to test signalling devices containing phosphorus, NWSCC testing staff stated that it was common for fragments of molten burning phosphorus to spatter across the area. These fragments will either burn completely or crust over at the surface before being completely consumed. If disturbed, unburned phosphorus particles can re-ignite. Testing staff explained that phosphorus test areas are "flashed" with a torch following testing to assure all phosphorus is fully consumed (NWSCC, 1991b).

No information beyond that described above was obtained on inspection activities or the scheduling of maintenance in the OTA.

3.4.3.2 Annex Area

Maintenance and maintenance schedules in the Annex Area are considered to be similar to those presented for the OTA. No additional information on maintenance in the Annex Area was obtained.

3.4.3.3 Rocket Range

Maintenance and maintenance schedules at the Rocket Range are considered to be similar to those presented for the OTA. However, during a personal interview with NWSCC personnel (1991b), it was learned that gravel had been added to the Rocket Range test area to allow white phosphorus residues to percolate down in the gravel to minimize exposure. The gravel became so inundated with phosphorus that it began to become cemented with crusted-over phosphorus and was easily ignitable in the open air. This area is flashed after each test and the gravel excavated and disposed of at the ABG (NWSCC, 1991a and 1991b).

3.5 WASTE CHARACTERISTICS

3.5.1 Types of Wastes Placed in the Unit

3.5.1.1 Hazardous Classification

The only reported RCRA classified hazardous wastes generated at the Pyrotechnic Test Areas are heavy metals-contaminated ash from open detonation wastes. These are listed as D008 wastes (toxicity characteristic hazardous waste for lead) and are considered toxic. The residue and debris reportedly are flashed and collected into roll-off boxes at the ABG. The boxes are then transferred off-site by a disposal company. Should the need arise, NWSCC is permitted to transfer D008 wastes to the central storage facility (NWSCC, 1991a).

Materials remaining after testing which may contain explosive, pyrotechnic, or propellant residue are also considered by Navy to be hazardous. Materials of this type include used rounds and misfires. These materials are stored at the test area in containers which prevent entry of rainwater for a period up to 30 days. They are then disposed by EOD or at the Navy burning grounds as appropriate.

3.5.1.2 Quantity

Lot tests are generally performed on 150 units at a time. Lot tests are conducted on an as-needed basis by the Navy when new shipments arrive.

Surveillance tests are periodically performed on stored materials. These tests are conducted to ascertain effectiveness of stored materials.

The type and amount of pyrotechnic and ordnance items tested in a typical year are presented in Table 3-4 (Kramer, 1983). Generally, 26 different types of items are tested during 231 days of testing per year. A total of 21,352 units are tested in a typical year. The air emissions released during testing activities are summarized in Table 3-5 (Kramer, 1983). A total of 22,023 pounds of contaminants and particulates are typically released during testing each year.

3.5.2 Physical and Chemical Characteristics

The general types of chemicals likely to be in the Pyrotechnic Test Areas are explosives, oxidizers, fuels, and phosphorus. The characteristics of the most prevalent components of the pyrotechnics tested are listed in Table 3-6.

Explosive compounds may either be primary or secondary. Primary explosives detonate suddenly from a very short duration pre-explosion reaction. Primary explosives are used to create the detonation wave in the less sensitive secondary explosives. Lead azide, a primary explosive, is highly toxic (Sax and Lewis, 1987). Primary explosives create a severe explosion risk and are normally handled while submerged in water. TNT, a secondary explosive, is toxic to fish and other aquatic fauna, inhibitive to plant growth, and potentially mutagenic to microorganisms (Pennington, 1990). TNT also causes adverse effects in humans when inhaled, ingested, or when direct contact occurs (OSHA, 1978). Ingestion or inhalation of RDX causes toxic effects on the central nervous system (USEPA, 1988a), and HMX can be a skin irritant (USEPA, 1988b).

Pyrotechnic items are comprised of various combinations or oxidizers, fuels, binding and waterproofing agents, color intensifiers, dyes, coolants, friction igniters, quickmatch, and primary charges. Appendix F presents the compounds used in and generated by Navy-approved, hand-manipulated signaling devices (NAVSEA, 1985). The tables also indicate the toxicity hazard associated with each compound. Similar composition and product or residue compounds are associated with other types of pyrotechnic items. As the tables show, the toxic hazards of many of the compounds may be significant. Furthermore, the toxicity of many residue compounds is unknown. Characteristics of some general classes of materials used to produce pyrotechnic items are further discussed below.

An oxidizing material is any compound that permits oxidation to take place by acting as an electron acceptor. The term includes such chemicals as peroxides, chlorates, perchlorates, nitrates, and permanganates. These can react vigorously when stored near or in contact with reducing materials.

TABLE 3-4

TYPICAL FISCAL YEAR WORKLOAD FOR PYROTECHNIC TEST AREA NWSCC CRANE, INDIANA AUGUST 1992

1. Mk 13 Mod 0 Marine Smoke & Illumination Signal
   - 900 units/yr (200/day)

2. M129A1 Ground Smoke Signal (RP)
   - 200 units/yr (200/day)

3. Mk 1 Mod 0 Marine Illumination Signal (RS)
   - 200 units/yr (200/day)

4. Mk 1 Mod 0 Marine Illumination Signal (GS)
   - 200 units/yr (200/day)

5. Mk 1 Mod 0 Marine Illumination Signal (YS)
   - 200 units/yr (200/day)

6. AN-M7A1 Smoke Pot, SGF2
   - 400 units/yr (80/day)

7. Mk 3 Offensive Hand Grenade
   - 300 units/yr (150/day)

8. M34 WP Smoke Grenade (Hand or Rifle)
   - 300 units/yr (150/day)

9. M18 Hand Smoke Grenade (GN)
   - 200 units/yr (200/day)

10. M18 Hand Smoke Grenade (YW)
    - 200 units/yr (200/day)

11. M18 Hand Smoke Grenade (RD)
    - 200 units/yr (200/day)

12. M18 Hand Smoke Grenade (V)
    - 200 units/yr (200/day)

13. Mk 45 A/C Parachute Flare
    - 100 units (100/day)

14. Mk 58 Marine Location Marker
    - 960 units/yr (40/day)

TABLE 3-4 (Continued)

**TYPICAL FISCAL YEAR WORKLOAD
FOR PYROTECHNIC TEST AREA
NWSCC
CRANE, INDIANA
AUGUST 1992**

15. Mk 25 Mod 3 Marine Location Marker
    - 560 units/yr (40/day)

16. CXU-3A/B Practice Bomb Signal Cartridge
    - 8,000 units/yr (140/day)

17. Mk 4 Mod 3 Practice Bomb Signal Cartridge
    - 5,600 units/yr (240/day)

18. Mk 22 Submarine Location Marker
    - 120 units/yr (60/day)

19. Mk 117 Mod 0 Marine Smoke & Illumination Signal
    - 600 units/yr (100/day)

20. Mk 118 Mod 0 Marine Smoke & Illumination Signal
    - 600 units/yr (100/day)

21. Mk 2 Mod 0 Cutting Torch
    - 120 units/yr (20/day)

22. Mk 23 Mod 0 Powder Actuated Cutter
    - 260 units/yr (13/day)

23. Mk 24 Mod 0 Powder Actuated Cutter
    - 260 units/yr (13/day)

24. Mk 407 Mod 1 Point Detonating Fuze Booster
    - 32 units/yr (16/day)

25. Mk 379 Mod 1 Auxiliary Detonating Fuze Booster
    - 160 units/yr (40/day)

26. Mk 118 Rockeye Bomblet
    - 480 units/yr (20/day)

Summary: 26 Explosive Components
21,352 units/yr
231 days of testing

Source: Kramer, 1983.

TABLE 3-5

CALCULATED AIR POLLUTION EMISSION FACTORS
PYROTECHNIC TEST AREAS
NWSCC
CRANE, INDIANA
AUGUST 1992

Item	Unit/ Day	CO_2	H_2O	NO_2	HCl	CO	O_2	HNO_3	H_3PO_4	DYE	F*	PART **	TOT/ Day	TOT/ Hr	TOT/ Yr
Mk13 SSIM	200	6.6	1.6	4.2	3.3	0.2	1.3	--	--	0.5	--	9.1	26.8	4	120.6
M129A1 Sig	200	43.9	16.5	--	--	--	--	--	--	38.7	--	25.6	124.7	16	124.7
Mk1 Sig (RS)	200	38.3	--	--	1.2	--	--	7.9	--	--	--	52.2	99.6	12	99.6
Mk1 Sig (GS)	200	3.2	--	13.3	--	4.1	--	--	--	--	--	56.2	76.8	10	76.8
Mk1 Sig (Y)	200	5.7	--	--	3.6	2.7	--	--	--	--	--	50.0	62.0	9	62.0
AN-M7 Pot	80	--	--	--	--	--	--	--	--	--	--	1080	1080	135	5400
Mk3 Grenade	150	94.4	14.9	45.6	--	4.6	--	--	--	--	--	--	159.5	20	319
M34 WP Gren	150	--	--	--	--	--	--	--	445	--	--	--	445.3	57	891
MK18 Gren-G	200	45.7	17.1	--	--	--	--	--	--	55.0	--	25.7	143.5	18	143.5
MK18 Gren-Y	200	39.7	14.9	--	--	3.2	--	--	--	41.7	23.1	21.1	143.7	18	143.7
MK18 Gren-R	200	45.7	17.1	--	--	--	--	--	--	55.0	--	25.7	143.5	18	143.5
MK18 Gren-V	200	45.7	17.1	--	--	--	--	--	--	55.0	--	25.7	143.5	18	143.5
Mk45 Flare	100	--	--	--	--	--	--	--	--	--	--	3.9	3.9	1	3.9
Mk58 Marker	40	--	--	--	--	--	--	--	278	--	--	69.6	348	44	8352
Mk25 Marker	40	--	--	--	--	--	--	--	113	--	--	24.2	137.3	17	1922
CXU3 PBC	140	--	--	--	7.4	--		--	--	--	--	4.1	11.5	1	657
Mk4/3 PBC	240	--	--	--	--	--		--	35.2	--	--	--	35.2	5	821.3
MK22 S Mkr	60	10.6	4.0	--	--	0.4	--	--	--	11.1	6.2	5.6	37.9	5	75.8
Mk117 SSIM	100	14.9	5.7	2.5	--	0.8	--	--	--	13.2	--	48.5	85.6	11	513.6
Mk118 SSIM	100	8.6	3.2	--	--	1.3	--	--	--	14.7	5.3	36.8	69.9	9	419
Mk2 Torch	20	--	--	--	--	--	--	--	--	--	--	23.8	23.8	3	142.8

TABLE 3-5 (Continued)

CALCULATED AIR POLLUTION EMISSION FACTORS
PYROTECHNIC TEST AREAS
NWSCC
CRANE, INDIANA
AUGUST 1992

Item	Unit/ Day	CO_2	H_2O	NO_2	HCl	CO	O_2	HNO_3	H_3PO_4	DYE	F*	PART **	TOT/ Day	TOT/ Hr	TOT/ Yr
Mk23 Cutter	13	2.0	0.9	4.2	--	0.6	--	--	--	--	--	--	7.7	1	154
Mk24 Cutter	13	0.9	0.4	2.0	--	0.3	--	--	--	--	--	--	3.6	1	72
Mk407 PDF B	1[illegible]	0.2	0.1	0.5	--	.05	--	--	--	--	--	--	0.8	.1	1.6
Mk397 ADF B	[illegible]	7.7	4.7	24.2	--	2.5	--	--	--	--	--	--	39.1	5	156.4
Mk118 Reye	20	14.8	4.5	19.8	--	2.0	--	--	--	--	--	--	41.1	5	986.4
											TOTALS:		3494	443	22023

NOTE:

All products are expressed in pounds per day.
* Fluoranthene - Product of benzathone oxidation
** Particulates of all other constituents not previously defined (Total in Pounds)

Source: Kramer, 1983.

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TABLE 3-6

**CHARACTERISTICS OF CHEMICALS OF CONCERN
PYROTECHNIC TEST AREAS
NWSCC
CRANE, INDIANA
AUGUST 1992**

Chemical	Physical Form	General Chemical Class	Physical Descript.	Molec. Weight (g/mole)	Density (g/cm3)	Soluh. in Water	Vapor Press. (mm Hg)	Biodegradability
Ammonium Nitrate (NH4N03)	Solid	Oxidizing Agent	White Crystals	80	1.725	high	N/A	N/A
Hydrogen Chloride (HCl)	Liquid/ Gas	Acid Corrosive	Colorless Liquid or	36.5	1.187 1.00045	high	N/A	N/A
Tetryl (Nitramine, Tetranitromethylamine CAS 479-45-8 (NO2)3 C6H2NMe.NO2)	Solid	Explosive	White Crystals	287	1.73	low	6E-09	NA
Diphenylamine (C12H11N)	Solid	Stabilizer	White Crystals	169	1.16	Moderate	N/A	NA
Nitro-Cellulose (C6H705(NO2)3)	Solid	Explosive	Yellow Crystals	297	1.67	low	N/A	NA
Lead Azide (PbN6)	Solid	Explosive	White Crystals	291	4.38	low	N/A	N/A

TABLE 3-6 (Continued)

**CHARACTERISTICS OF CHEMICALS OF CONCERN
PYROTECHNIC TEST AREAS
NWSCC
CRANE, INDIANA
AUGUST 1992**

Chemical	Physical Form	General Chemical Class	Physical Descript.	Molec. Weight (g/mole)	Density (g/cm3)	Solub. in Water	Vapor Press. (mm Hg)	Biodegradability
Lead Styphnate, or Lead Trinitroresorcinate (PbC6HN3O8)	Solid	Explosive	White Crystals	468	3.02	low	N/A	NA
Aluminum Nitrate (AlNO3)	Solid	Oxidizing Agent	Colorless Crystals	103	1.725	high	N/A	N/A
Potassium Nitrate (KNO3)	Solid	Explosive Oxidizing Agent	Colorless Powder	101	2.1	high	N/A	N/A
Sulfur (S)	Solid	Non-Metal Fuel	Yellow Powder	32	2.07	low	N/A	N/A
Carbon Dioxide (CO2)	Liquid/ Gas	Pollutant	Colorless Liquid or Gas	44	1.977	high	NA	N/A
Magnesium (Mg)	Solid	Heavy Metal, Fuel	Silver/ White Metal	24	1.74	low	N/A	N/A

TABLE 3-6 (Continued)

**CHARACTERISTICS OF CHEMICALS OF CONCERN
PYROTECHNIC TEST AREAS
NWSCC
CRANE, INDIANA
AUGUST 1992**

Chemical	Physical Form	General Chemical Class	Physical Descript.	Molec. Weight (g/mole)	Density (g/cm3)	Solub. in Water	Vapor Press. (mm Hg)	Biodegradability
Manganese (Mn)	Solid	Metal	Gray/ Pink Metal	55	7.2	low	N/A	N/A
Potassium Perchlorate (KClO4)	Solid	Explosive	Colorless Crystals	138	2.52	moderate	NA	N/A
Potassium Chlorate (KClO3)	Solid	Explosive	Colorless Crystals	122	2.32	high	NA	N/A
Strontium Nitrate (Sr(NO3)2)	Solid	Explosive	White Powder	212	2.986	high	NA	N/A
Barium Nitrate (Ba(NO3)2)	Solid	Explosive	Crystal Powder	261	3.24	high	NA	N/A
Lead Chromate (PbCrO4)	Solid	Heavy Metal	Yellow Solids	323	6.12	low	N/A	N/A
Acetone (CH3COCH3)	Liquid	Solvent	Colorless Liquid	58	0.791	high	89 mm @ 5°C	NA

TABLE 3-6 (Continued)

**CHARACTERISTICS OF CHEMICALS OF CONCERN
PYROTECHNIC TEST AREAS
NWSCC
CRANE, INDIANA
AUGUST 1992**

Chemical	Physical Form	General Chemical Class	Physical Descript.	Molec. Weight (g/mole)	Density (g/cm3)	Solub. in Water	Vapor Press. (mm Hg)	Biodegradability
Tetranitro-Carbazole (C12H5N408)	NA	Explosive	NA	351	NA	low	NA	NA
1-Methyl-Aminoanthra quinone (C15H11NO2)	NA	NA	NA	238	NA	low	NA	NA
Benzanthrone (C17H200)	Solid	Explosive	Yellow Needles	230	NA	low	NA	NA
Sodium Oxalate (Na2C2O4)	Solid	Oxidizing Agent	White Powder	134	2.34	high	N/A	NA
Lead Oxide (PbO2)	Solid	Oxidizing Agent	NA	239	9.375	low	N/A	N/A
Copper (Cu)	Solid	Heavy Metal	Reddish Metal	63	8.92	low	N/A	N/A
Hexafluoro-propylene (C3F6)	Gas		Colorless Gas	150	1.583	low	N/A	NA

TABLE 3-6 (Continued)

**CHARACTERISTICS OF CHEMICALS OF CONCERN
PYROTECHNIC TEST AREAS
NWSCC
CRANE, INDIANA
AUGUST 1992**

Chemical	Physical Form	General Chemical Class	Physical Descript.	Molec. Weight (g/mole)	Density (g/cm3)	Solub. in Water	Vapor Press. (mm Hg)	Biodegradability
Cellulose Nitrate (C12H17N3016)x	Solid	Explosive	White Crystals	(459)x	1.66	low	N/A	NA
Diphenylamine ((C6H5)2NH)	Solid	Accelerator Stabilizer Anti-Oxidant	Colored Crystals	169	1.16	high	N/A	NA
Anthracene (C14H10)	Solid	Used in Dyes	White Powder	178	1.28	low	N/A	NA
Aluminum Nitrate (A1(NO3)3.9H20	Solid	Explosive Fuel	White Powder	375	NA	high	N/A	N/A
Ammonium Perchlorate (NH4Cl04)	Solid	Explosive	White Powder	117	1.95	high	N/A	N/A
Cupric Oxide (CuO)	Solid	Oxidizing Agent	Red Powder	143	6.01	low	N/A	N/A
Manganese Dioxide (MnO2)	Solid	Oxidizing Agent	Black Powder	87	5.02	low	N/A	N/A

TABLE 3-6 (Continued)

CHARACTERISTICS OF CHEMICALS OF CONCERN
PYROTECHNIC TEST AREAS
NWSCC
CRANE, INDIANA
AUGUST 1992

Chemical	Physical Form	General Chemical Class	Physical Descript.	Molec. Weight (g/mole)	Density (g/cm3)	Solub. in Water	Vapor Press. (mm Hg)	Biodegradability
Zinc Oxide (ZnO)	Solid	Neutraliz. Agent	White Powder	81	5.6	low	N/A	N/A
Sodium Nitrate (NaNO3)	Solid	Explosive	Colorless Crystals	85	2.267	high	N/A	N/A
Iron (Fe)	Solid	Metal Reducing Agent	Silver Metal	26	NA	low	N/A	N/A
Arsenic Sulfide (AsS2)	Solid	Pigment	Orange Powder	NA	2.6-3.4	low	N/A	N/A
Perchloric Acid (HClO4)	Liquid	Corrosive Liquid, Acid	Colorless Liquid	52	1.764	high	N/A	N/A
Hydrogen Peroxide (H202)	Liquid	Oxidizing Agent	Colorless Liquid	34	1.45 (l)	high	N/A	N/A

TABLE 3-6 (Continued)

**CHARACTERISTICS OF CHEMICALS OF CONCERN
PYROTECHNIC TEST AREAS
NWSCC
CRANE, INDIANA
AUGUST 1992**

Chemical	Physical Form	General Chemical Class	Physical Descript.	Molec. Weight (g/mole)	Density (g/cm3)	Solub. in Water	Vapor Press. (mm Hg)	Biodegradability
Phosphorous "White"	Solid	Non-Metal	Transp. Crystals	31	1.828	Low	N/A	N/A
"Red"	Solid	Non-Metal	Violet - Red Powder	31	2.2	Low	N/A	N/A
TNT (Trintro-toluene) CAS 118-96-7 (C7HN306)	Solid	Explosive	Yellow Crystals	227	1.654	Low	6E-06 torr	Low to Moderate
RDX (Cyclotrimethylenetrinitramine) CAS 121-82-4 (C3H6N606)	Solid	Explosive	White Crystals	222	1.824	Low	4E-09 torr	Low to Moderate

TABLE 3-6 (Continued)

**CHARACTERISTICS OF CHEMICALS OF CONCERN
PYROTECHNIC TEST AREAS
NWSCC
CRANE, INDIANA
AUGUST 1992**

Chemical	Physical Form	General Chemical Class	Physical Descript.	Molec. Weight (g/mole)	Density (g/cm3)	Solub. in Water	Vapor Press. (mm Hg)	Biodegradability
HMX (Cyclotetramethylenetetranitramine) CAS 2691-41-0 (C4H8N808)	Solid	Explosive	White Crystals	296	1.9	Low	3E-14	NA

Legend

NA: Data not available.
N/A: Data not applicable.

Sources:
NAVSEA, 1985.
Verschueren, 1983.
Lidde, 1991.
Perry et al., 1984.
Dean et al., 1985.
Layton et al., 1987.

A fuel is defined as any substance that evolves energy in a controlled chemical or nuclear reaction. The most common type of chemical reaction is combustion. Rapid oxidation, approaching the rate of an explosion, takes place in rocket fuels (Sax and Lewis, 1987). Metallic fuels present dangerous fire hazards.

Both white and red phosphorus are used in pyrotechnic materials. White phosphorus ignites spontaneously in air at 86° F and is toxic by ingestion and inhalation (Sax and Lewis, 1987). Although less reactive than white phosphorus, red phosphorus can also ignite spontaneously. Red phosphorus is used mainly in burning-type munitions utilized for signaling purposes.

3.5.3 Migration and Dispersal Characteristics

The chemical class presented in the previous section most likely to persist in the environment is secondary explosives. Primary explosives, oxidizers, and fuels tend to be very unstable. Most will react with ambient air, water, or sunlight. The compounds left after these chemicals react will be metals and other inorganics. Inorganic compounds will tend to adsorb onto soil and may slowly leach into the underlying groundwater.

Overall, sorption to soil will not effectively prevent mobility of secondary explosive compounds through surface soils. Sorption of TNT onto soil is most closely correlated with extractable iron, cation exchange capacity, and percent clay. Also, sorption and desorption appear to occur to the same extent, suggesting that continued desorption, or leaching, may effectively remove all TNT from soils unless more strongly adsorbed products are formed (Pennington, 1990). TNT is more readily sorbed than HMX, which is in turn sorbed more readily than RDX (Leggett, 1985). The explosive compounds of concern released from the Pyrotechnic Test Areas, therefore, will not be completely immobilized by surface soils. Contaminants in soils will be slowly solubilized by precipitation or infiltration of surface water and will percolate into the groundwater.

Microbial cleavage of the TNT ring structure has only been reported once in the literature. TNT, however, can be transformed by micro-organisms. The predominant changes are the reduction of nitro side groups into amino groups and the coupling of rings to product azoxy compounds (Pennington, 1990). The similarity of TNT to other easily biodegradable cyclic organics, however, suggests that TNT may be completely biodegradable.

Unlike TNT, the ring structure of RDX completely breaks down with anaerobic biodegradation during composting (Doyle, 1986). Aerobic biodegradation of RDX is not known to occur (USATHAMA, 1988). The complete biodegradation of HMX has not been observed, however, anaerobic conditions enhance HMX decomposition (USATHAMA, 1988).

TNT has been observed to photodecompose; 1,3,5-trinitrobenzene is the principal product formed in natural waters (Pennington, 1990). The rate of photochemical transformation of munitions in environmental waters is often significantly higher than biodegradation.

The primary transformation products (both biotic and abiotic) of TNT are 4-amino-2,6,-dinitrotoluene (4ADNT) and 2-amino-4,6-dinitrotoluene (2ADNT). These compounds tend to be more persistent in soils, with 4ADNT more resistant than 2ADNT (Pennington, 1990).

3.6 CONCLUSIONS

Background data and site observations were reviewed to determine the likelihood of a release posing a potential threat to human health or the environment. Data and observations pertinent to the Pyrotechnic Test Range (OTA), the Annex, and the Rocket Range were reviewed to assess the potential for contaminant releases to groundwater, surface water, air, and soil. Data were interpreted and release determinations were made according to the approach described in RCRA Facility Assessment Guidance (USEPA, 1986).

At the OTA, potential releases to groundwater were determined to be likely based on unit characteristics including unit type and design, unit operation, locational characteristics, waste characteristics, and visual evidence (i.e., direct discharge of cook-off test water) of contamination. Groundwater analytical data for the OTA, however, were not obtained. Releases to surface water were determined to be likely based on unit design and physical characteristics (including lack of engineered features to prevent releases to surface water, operational history, and physical condition), the release migration potential posed by the terrain, and direct and indirect visual evidence of release to surface water. Releases to air were determined to have occurred based on unit operating characteristics, waste characteristics exhibiting potential for vapor and particulate releases, and direct visual evidence of particulate release. Releases to soil were identified based on the unit type and design, lack of engineered structures to prevent releases to the soil, unit operating characteristics and procedures, and stained soils observed.

At the Annex Area, potential releases to groundwater were determined to be likely based on unit type, ineffective engineered structures to prevent releases, unit operating characteristics and physical condition, locational characteristics, waste characteristics, and visual evidence of contamination. No groundwater analytical data for the Annex, however, were obtained. Releases to surface water were determined to be likely based on the same features summarized above for the OTA. Releases to air were determined to occur based on unit operating characteristics and waste characteristics exhibiting potential for

particulate releases. Releases to soil were identified based on unit type, lack of engineered structures designed to control releases to soil, unit operating characteristics and procedures, and stained soils observed.

At the Rocket Range, potential releases to groundwater were determined to be likely based on unit type, ineffective structures intended to prevent releases to groundwater, unit operating characteristics and physical condition, locational characteristics, waste characteristics, and visual evidence of soil contamination. No groundwater analytical data for the Rocket Range, however, were available. Releases to surface water were concluded to be likely based on the same features summarized above for the OTA. Releases to air were determined to occur based on unit operating characteristics and waste characteristics exhibiting the potential for vapor and particulate releases. Releases to soil were identified based on unit type and design, unit operation, site characteristics, and visual observation. Table 3-7 summarizes these conclusions.

Recommendation for continuing or ceasing of RFI Corrective Actions based on the information reviewed will be presented for each of the Pyrotechnic Test Areas in Section 7.

RP/6EMRF/AA7

TABLE 3-7

**POTENTIAL RELEASES
PYROTECHNIC TEST AREAS
NWSCC
CRANE, INDIANA
AUGUST 1992**

Media	Release	Suspected Contaminants*
		OTA
Groundwater	Likely	Explosives and pyroytechnic components, products, and residues
Surface Water	Likely	Explosives and pyroytechnic components, products, and residues
Soil	Occurred[1]	Explosives and pyroytechnic components, products, and residues
Air	Occurred[1]	Explosives and pyroytechnic components, products, and residues
		Annex
Groundwater	Likely	Explosives components, products, and residues
Surface Water	Likely	Explosives components, products, and residues
Soil	Occurred[1]	Explosives components, products, and residues
Air	Occurred[2]	Explosives components, products, and residues
		Rocket Range
Groundwater	Likely	Explosives and pyroytechnic components, products, and residues
Surface Water	Likely	Explosives and pyroytechnic components, products, and residues
Soil	Occurred[1]	Explosives and pyroytechnic components, products, and residues
Air	Occurred[2]	Explosives and pyroytechnic components, products, and residues

NOTE:

1 Observed.
2 Reported.
* See Table 3-7 for individual compounds.

4.0 SWMU #08/17, LOAD AND FILL AREA, BUILDING 106 POND

4.1 BACKGROUND

This section will present background information specific to SWMU #08/17, the Building 106 Pond.

The Building 106 Pond is an unlined surface impoundment for surface waters generated in Buildings 106 and 107. Wastewaters reportedly discharged to the pond include acid and caustic cleaning waters; zinc phosphate, chromic acid, and rinsewater wastewater streams; oil compressor water; and water from floor drains.

4.1.1 Physical Features

4.1.1.1 Location

The Building 106 Pond is located in the Load and Fill Area near the western boundary of NWSCC, approximately midway between the north and south boundaries of the site. On Figure 2-5, Building 106 is situated in the lower portion of Navy-designated Section 11, near the section's eastern edge at coordinates EE-13. Figure 4-1 shows the Load and Fill Area and the Building 106 Pond.

4.1.1.2 Legal Description

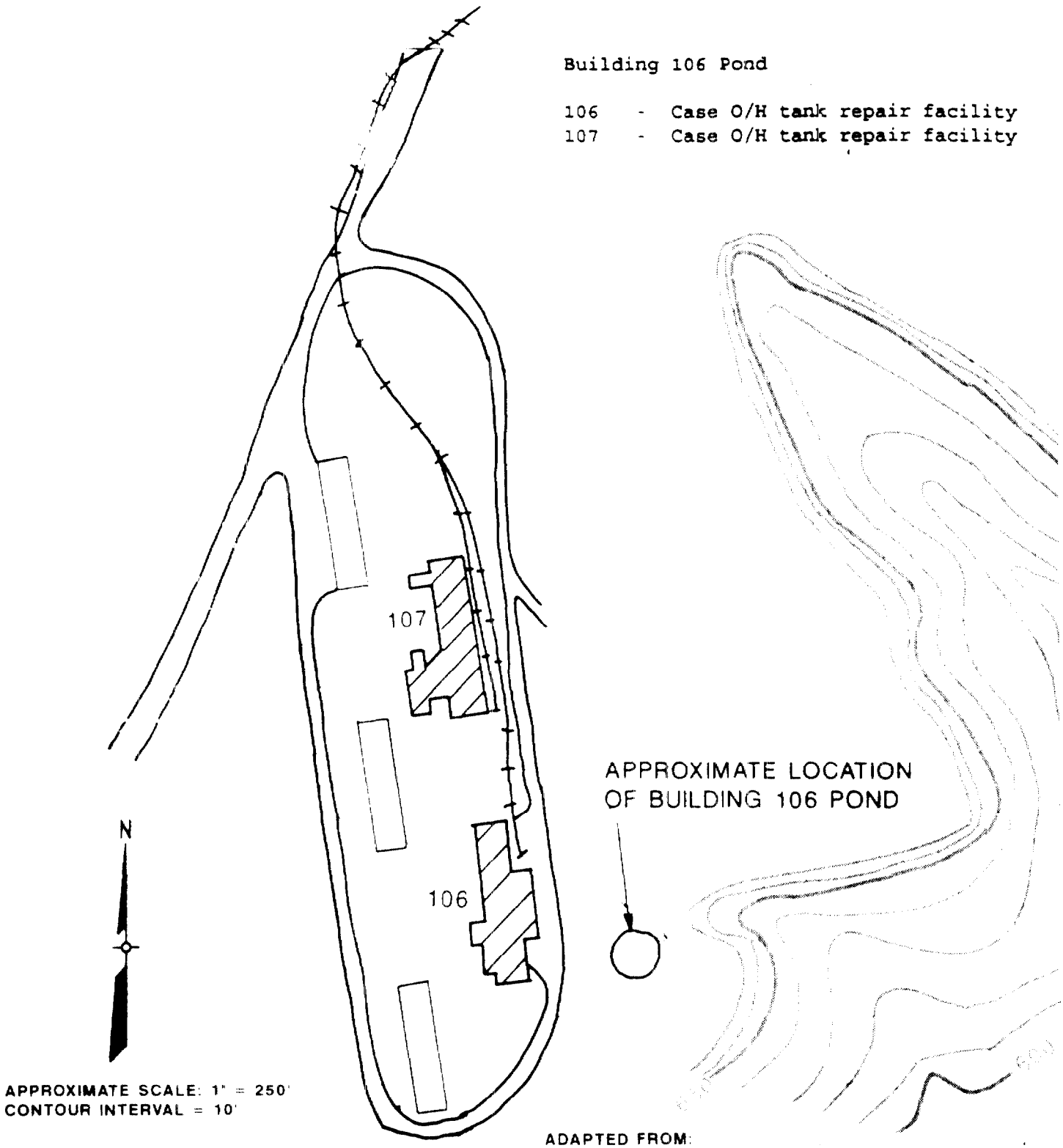
This SWMU is located in the NW 1/4 of the SW 1/4 of Section 28; T5 N, 4W. Latitude and longitude of the Building 106 Pond are 38° 50'09"N and 86° 51'52"W.

4.1.1.3 Contiguous Property

Building 106 is located in the Load and Fill Area, which extends eastward into Navy-designated Section 12. The following is a list of buildings in the Load and Fill Area that have housed significant explosive operations (NEESA, 1983). The present building title is listed with the past title or function and ordnance material handled enclosed in parentheses.

Building Number	Current Building Title (Previous Building Title - Ordnance Material)
101	Underwater Sound Signal Assembly (Case Filling - smokeless powder)
102	Equipment Test and Development (Bag Loading - smokeless powder)

EPA ID NO. IM5 170 022 498
NWSCC EMR
DATE AUGUST 1992



ADAPTED FROM:
NAVAL FACILITIES ENGINEERING COMMAND, 1962
AND UNITED STATES GEOLOGICAL SURVEY, 1978.

AUGUST 1992

FIGURE 4-1
SWMU #08/17 -
LOAD AND FILL AREA, BUILDING 106 POND
ENVIRONMENTAL MONITORING REPORT
NWSCC
CRANE, INDIANA

20601

Donohue ENGINEERS ARCHITECTS SCIENTISTS

103	Bag Charge Filling Plant (Ignition Assembly - black powder)
104	Medium Calibre Loading Plant (Projectile Loading - Explosive D, Comp A-3)
105	Warhead Loading Plant (Major Calibre Loading - Explosive D, PBXN-3 and 4)
108	General Warehouse - Build (Breakdown and Overhaul, Target Loading - smokeless powder, explosives comps)
119	Ammo Rework & Overhaul (Segregation and Plastic Beading - smokeless powder)
142	20mm Loading Plant (Breakdown and Overhaul - smokeless powder, explosives comps)
189	Guided Missile Maintenance Facility (Sifting building for Building 104 - Explosive D, Comp A-3)
190	Photometric Lab (Sifting building for Building 198 - Explosive D)
198	R&D Test Facility (Medium Calibre Loading - Explosive D)
200	Pyrotechnic Loading Building (Major Calibre Load - Explosive D)
2518	Accumulator Building (Dry collector for Building 105 - Explosive D, PBXN-3 and 4)
2519	Accumulator Building (Wet exhaust system for Building 104 - Explosive D, Comp A-3)

Powder projectile magazines are situated west and north of the Load and Fill Area. Mine Fill B lies to the east, and inert storage buildings and fuse and detonator buildings are located south of Building 106.

4.1.1.4 Topography

The Building 106 Pond occurs in a gently sloping area at an approximate elevation of 685 feet MSL. The area east of the pond gently slopes towards the east-southeast. North and east of the pond the topographic relief changes rapidly. The high point of a northwest-

southeast trending ravine is located just north of the pond. The area east of the pond slopes to intersect this same ravine. Elevation of the base of the ravine adjacent to the Building 106 Pond is approximately 590 feet MSL.

4.1.1.5 Surface Drainage and Hydrology

The areas around the Building 106 Pond drain to the ravine located north and east of the pond. After entering the ravine, surface drainage flows towards the southeast where it intersects an intermittent drainageway feeding Boggs Creek. Boggs Creek is a perennial drainageway which flows north-south across NWSCC. Near the southern border of NWSCC, Boggs Creek is dammed to create Lake Gallimore. Beyond Lake Gallimore, Boggs Creek continues to flow south, exits NWSCC, and enters the East Fork of the White River.

4.1.1.6 Geology

Soils

The following of soil near the Building 106 Pond was prepared using information obtained from the Soil Survey of Martin County, Indiana, prepared by McElrath (1988) and published and distributed by the Soil Conservation Service (SCS) of the USDA. The Load and Fill Area, including the Building 106 Pond, lies in an area mapped by the USDA as the Wellston-Gilpin Soil Unit. Minor soil types within this unit include the well-drained and moderately well-drained Zanesville soils.

Detailed mapping around Building 106 including the discharge pond show the area as covered with the Zanesville-Udorthents soil complex (ZnB) at 2 to 6 percent slopes. USCS classifications for Zanesville-Udorthents complex soils are clay, silt, and silty clay. Hydraulic conductivities reported by the USDA for these soils range from 4.2×10^{-5} to 1.4×10^{-3}cm/sec. Generally, Zanesville-Udorthent complex soils are less than 40 inches thick and directly overlie bedrock.

The shallow nature and high end of the hydraulic conductivity range for Zanesville-Udorthent complex soils are reasons for environmental concern because of the increased probability of percolation through soils. The moderately steep slopes found in this area may result in rapid run-off, decreasing the potential for contamination to infiltrate into bedrock and groundwater. Rapid runoff, however, increases concerns involving the potential for contamination of surface waters and drainageways.

Bedrock

The bedrock surface beneath the Building 106 Pond is reported to be composed of sandstones, shale, and limestone of the Pennsylvanian Age Raccoon Group (Department of the Army, 1978). During soil mapping in the area it was determined that bedrock was present at depths of less than 5.0 feet below the surface.

Detailed information on the bedrock geology at the Building 106 Pond was not found. No monitoring wells or water supply wells could be located in the area.

4.1.1.7 Hydrogeology

Regional hydrogeology of the NWSCC was presented in Section 2. Information specific to the hydrogeology of the Building 106 Pond SWMU was not found. The absence of boring information and well data in the area precludes hydrogeologic interpretation.

4.1.2 Spills or Releases

Prior to 1972, untreated wastewater from cleaning processes was discharged into the pond from Building 106 (NEESA, 1983). During the 1987 Visual Site Inspection (VSI) by A.T. Kearney, Inc., the edges of the pond were oil-stained and the surface of the pond exhibited an oily sheen. Reportedly, malfunction of the pumping system has caused overflow of the pond (NWSCC, 1991e and A.T. Kearney, 1987). Subsequently, oily water has been released down the slope and into an intermittent stream.

According to Environmental Protection Division Spill Response Logbooks, oil was released into the ditch located between Buildings 106 and 107 in June 1991. Oily water reportedly leaked from a compressor in Building 107 and flowed through a floor drain into a clay storm drain pipe leading to the ditch. Oil in the compressor room and the ditch was reportedly cleaned up using absorbent brooms and pads (NWSCC Environmental Protection Division File 5090/5.9.1).

4.1.3 Ownership and History

During World War II, dyeing operations were conducted in Buildings 105 and 106 (the ignition ends on smokeless powder bag charges were colored red). Usage rate for the red dye (sodium salt of ditolyl-diazo-bis-xnaphthylamine-4-sulfonic acid, sodium salt of 4-sulfoaphthalene-aza-naphthol, or a dispersion of 6-methyl-sulfonyl-z_1, -benzothiazoleazo-N, -cyanoethyl-N-acetoxyethyle aniline or equivalent) was about 1/4-pound per 110 yards of silk cloth. Toxicity data for most of the naphthalene sulfonic acid sodium salt family of

compounds indicates that the dyes used in Building 106 may be ranked as moderately to very toxic (NEESA, 1983). However, the small usage rate should preclude significant environmental impact in the area.

In the load and fill complex, Buildings 106 and 107 are equipped to recondition and test various types of cartridge cases, as well as to repair all types of ammunition containers.

4.1.4 Waste Description

Acid and caustic wastewaters were discharged from Building 106 into the retention pond which flowed into surface drainage. Sometime after 1972, the pond was connected to a neutralizing system which subsequently discharged to the sanitary sewer (NEESA, 1983). The discharge solutions from the pond had an extremely high pH and contained explosives, heavy metals, oil, and grease. The Initial Assessment Study (NEESA, 1983) identifies mercury, chromium, phosphorus, and trichloroethylene as the wastes of concern. Additionally, the floor drains in Building 107 previously discharged to the pond (Reid, Quebe, Allison, Wilcox, and Associates, Inc. (RQAW), 1987). Floor drain discharges may contain TCE, PCP, paint residue, and heavy metals. Finally, oily wastewater from compressors in Building 107 enters the pond via several drainage pipes (A.T. Kearney, 1987). It is not known if these pipes have been plugged.

4.2 PERMITS

4.2.1 Air

Surface coating, degreasing, and grit blasting activities in Buildings 106 and 107 are authorized to operate under Operation Permits issued by the Indiana Air Pollution Control Board. These permits expired May 1, 1988. NWSCC submitted new applications in 1988, but the state has not acted upon them. Under state law, operations are allowed to continue under previous permit conditions if the state does not respond to applications. The permits are described below.

Operation Permit No. 16944 covers one wet paint booth in Building 106, and two wet paint booths, two dry paint booths, and a degreaser in Building 107. Particulates from these activities are controlled by water washes and dry filters. Operation Permit No. 16947 authorizes one shotblast operation in Building 106 and three shotblast operations in Building 107. The permit requires that particulate matter from these operations be collected by baghouses with 99 percent efficiencies.

4.2.2 Groundwater

According to the Navy (NWSCC, 1991a), no permits pertaining to groundwater use or monitoring in the vicinity of the Building 106 Pond are required.

4.2.3 Surface Water

No outfalls monitored for the NPDES permit requirements are located near the Building 106 Pond.

4.2.4 Soil

Soil sampling or use is not required under permit (NWSCC, 1991a).

4.3 EXISTING DATA ASSESSMENT

4.3.1 Monitoring Devices

There are no devices in or near the Building 106 Pond which regularly monitor its water quality or its impact upon surrounding environmental media. Data have been periodically collected and are discussed below.

4.3.2 Analytical Data

Samples from effluent discharging from the settling pond, collected in 1972, revealed high heavy metals concentrations. Table 4-1 presents a summary of the 1972 analytical data. Values as high as 20 ppm lead, 3.5 ppm chromium, 1 ppb mercury, 20 ppm zinc, and 0.2 ppm cadmium were recorded.

The IAS (NEESA, 1983) recommended that two soil samples from the Building 106 Pond be collected and analyzed for mercury, chromium, phosphorus, and TCE. Accordingly, in 1985, two soil samples were analyzed for heavy metals via the EP toxicity test and for oil/grease content and TCE. Phosphorus was not an analytical parameter. The results of these analyses are presented in Table 4-2. All concentrations are below known action levels. The samples, however, were collected from the sediment surface and probably contained a large amount of leaves and sediment which accumulated on the bottom over time. Therefore, significant contamination may be present even though the 1985 data do not confirm this. The oil/grease data and the oily sheen observed on the pond surface during the 1987 VSI are potentially significant.

TABLE 4-1

**SUMMARY OF EFFLUENT ANALYTICAL RESULTS, 1972
BUILDING 106 POND
NWSCC
CRANE, INDIANA
AUGUST 1992**

	Count	Minimum Concentration[1]	Maximum Concentration[1]	Average Concentration[1]	Federal Drinking Water Maximum Contaminant Level[1,4]
TEMP	47	7.000 (° C)	27.200 (° C)	18.291 (° C)	-
DISSOLVED OXYGEN	47	4.000	10.200	7.647	-
PHF	46	9.200 (SU)	11.800 (SU)	11.028 (SU)	6.5 - 8.5[2] (SU)
PHL	47	7.000 (SU)	11.700 (SU)	10.311 (SU)	6.5 - 8.5[2] (SU)
LTURBIDITY	47	1.300 (JTU)	89.000 (JTU)	25.845 (JTU)	PS
DISSOLVED OXYGEN (LAB)	46	4.400	10.200	7.659	-
BOD	27	0.000	29.000	12.296	-
COD	42	8.000	7820.000	988.786	-
SETTLEABLE SOLIDS	2	0.000	2.000	1.000	-
TOTAL SUSPENDED SOLIDS	37	1.000	118.000	28.186	-
TOTAL DISSOLVED SOLIDS	40	64.000	4382.000	1010.500	500[2]
N-AMMONIA	35	.100	2.250	.667	-
N-NITRATE	33	.040	2.770	.905	10
N-NITRITE	41	.050	8.100	1.098	1
TOTAL NITROGEN	18	.500	6.630	2.245	10
FLOWRATE	36	.021	.339	.051	-
TOTAL PHOSPHORUS	30	0.000	1.150	.306	-
CHLORIDE	33	2.000	317.000	43.788	-
OIL GREASE	21	1.000	141.000	47.571	-
PHENOLS	2	0.000	.030	.015	-
COPPER	34	0.000	.700	.159	1.3[3]
ZINC	40	.020	20.000	3.464	5[2]
MAGNESIUM	35	.400	4.100	2.237	-
POTASSIUM	34	.800 (ppb)	2.350	1.519	-
MERCURY	8	0.000	1.000 (ppb)	.125 (ppb)	0.002 (ppb)
CHROMIUM	33	0.000	3.500	.700	0.1
TOTAL COLIFORM	8	0.000 (MPN)	9300.000 (MPN)	1278.750 (MPN)	5
FECAL COLIFORM	8	0.000 (MPN)	1500.000 (MPN)	187.500 (MPN)	-
TOC	2	0.000	0.000	0.000	-

TABLE 4-1 (Continued)

SUMMARY OF EFFLUENT ANALYTICAL RESULTS, 1972
BUILDING 106 POND
NWSCC
CRANE, INDIANA
AUGUST 1992

	Count	Minimum Concentration[1]	Maximum Concentration[1]	Average Concentration[1]	Federal Drinking Water Maximum Contaminant Level[1,4]
CALCIUM	32	11.000	28.500	19.750	-
IRON	43	0.000	100.000	19.044	0.3[2]
SILVER	3	0.000	0.000	0.000	0.10[2]
CADMIUM	34	0.000	.200	.009	0.005
MANGANESE	33	0.000	0.000	.141	0.05[2]
SODIUM	32	4.800	1500.000	298.181	-
LEAD	33	0.000	20.000	2.322	0.005[3]
TNT	7	0.000	0.000	0.000	0.1[6]
CYANIDE	3	0.000	0.000	0.000	0.2
RDX	5	0.000	0.000	0.000	0.03[6]
HMX	6	0.000	0.000	0.000	-

NOTES:

° C = Degrees Celsius
SU = Standard Units
JTU = Jackson Turbidity Unit
MPN = Most probable number

1 All concentrations in ppm, except where otherwise noted.
2 Secondary MCL.
3 Proposed MCL.
4 USEPA, 1991.
5 No more than 5% of the samples collected per month may be positive. For systems collecting fewer than 40 samples/month, no more than 1 sample per month may be positive.
6 1991 Drinking Water Health Advisory, 10^{-4} cancer risk for 70 kg adult.
PS Performance Standard 0.5-1.0 Nephlometric Turbidity Units.

Source: Kent et al., 1973.

RP/6EMRF/AA9

TABLE 4-2

SOIL ANALYTICAL RESULTS, 1985
BUILDING 106 POND
NWSCC
CRANE, INDIANA
AUGUST 1992

	Detected Concentrations, ppm		
Sample:	B106-1	B106-1A	TCLP/EP Toxicity Regulatory Action Levels*
EP Toxicity Tests:			
Arsenic	<0.004	<0.004	5
Barium	2.80	<1.0	100
Cadmium	<0.01	<0.01	1
Chromium	<0.10	<0.10	5
Lead	0.30	<0.10	5
Mercury	<0.003	<0.003	0.2
Selenium	<0.004	<0.004	1
Silver	<0.01	<0.01	5
Oil/Grease	76	1680	-
Trichloroethylene	<0.1	<0.1	-

* As set forth under 40CFR261.24. No action levels for trichloroethylene or oil/grease content were found.

Source: Laboratory data sheets provided by NWSCC (no accompanying text provided).

RP/6EMRF/AA3

4.3.3 Migration Pathways/Impacts

Groundwater and surface water are the main migration pathways of concern. Heavy metals and organic solvents discharged to the settling pond could have percolated into the underlying sediments, soil, and groundwater. Also, until approximately 1972, pond water flowed into nearby surface water.

Additionally, cooling water from degreasers was temporarily discharged to a storm drain until the discharge was connected to the sanitary sewer in 1982 (NEESA, 1983). The pond has reportedly overflowed on occasion into the adjacent ravine (NWSCC, 1991e and A.T. Kearney, 1987). This discharge may have potentially contaminated nearby surface waters, sediments, and/or groundwater. Contaminated surface water and groundwater could potentially migrate off-site to receptors or could come in contact with on-site personnel.

4.4 UNIT/DISPOSAL AREA CHARACTERISTICS

4.4.1 Operations

The Building 106 Pond is located in the southeast corner of the Load and Fill area in the west central section of NWSCC. The pond is an unlined surface impoundment for wastewaters generated in Buildings 106 and 107. Buildings 106 and 107 have historically been involved with the overhaul of casings.

Building 106 used a cleaning process, consisting of a caustic wash, a degreaser, and an acid wash. First, burnt casings were brushed clean. Then the casings entered the cleaning process. The process consisted of soaking projectile casings in a hot caustic bath for 10 to 30 minutes and rinsing the casings for one minute. The casings were then degreased with trichloroethylene (TCE), soaked in hydrochloric acid for 3 minutes, and rinsed again (NEESA, 1983). The casings were repainted after cleaning. Approximately 1,000 projectiles were overhauled during an 8-hour shift. Two shifts operated each day.

Prior to 1972, splash dragout and overflows of wastewaters were discharged into a small unlined pond which subsequently drained into ditches. Plans were drafted in 1972 (NAVFAC Drawing No. 2005677, 1972) for proposed pond alterations to prevent discharge into the ditches. The plans show the pond overflowing into a neutralizing system and subsequently into the sanitary sewage system. In 1981, cooling water from degreasers was discharged to a storm drain until the discharge was connected to the sanitary sewer in 1982. Flow rates averaged about 20,000 to 25,000 gallons per day. Superimposed on this flow were periods of batch discharge from the batch overhaul process (Kent et al., 1973).

According to CAAA staff, Building 106 operations switched to phosphatizing activities in the early to mid 1970s (NWSCC, 1991c). Phosphatizing operations at Building 106 were not confirmed by information collected during the site visit. It is assumed that the proposed activities were implemented. The following process information was obtained from NWSCC files. The operation consisted of a five-stage process for phosphatizing steel projectiles. The first stage utilized the existing vapor degreaser to degrease projectiles with TCE. The second stage was a rinse cycle to assist removal of any particulates present after degreasing. The actual phosphatizing took place in the third step. This consisted of applying a zinc phosphate coating to the projectiles. The fourth stage was a cold water rinse, and the final stage was a conditioning rinse containing a dilute solution of chromic acid or chromic and phosphoric acids. Phosphatizing no longer takes place in Building 106.

The wastewater pretreatment system for the reported phosphatizing facility provided chrome reduction, metal precipitation, phosphate removal, clarification, and sludge dewatering. The pretreatment facility consisted of two 200-gallon collection sumps, a 500-gallon chrome reduction tank, a 500-gallon neutralization tank, a 200-gallon flocculation tank, a lamella clarifier, a filter press for sludge dewatering, chemical feed system, process controls, mixers, pumps, and related piping. Zinc phosphate, chromic acid, and rinsewater wastewater streams were reportedly discharged to the Building 106 Pond prior to entering the pretreatment system. Clarified effluent was further treated in NWSCC's existing wastewater treatment plant. The phosphatizing wastewater pretreatment system is no longer present at Building 106.

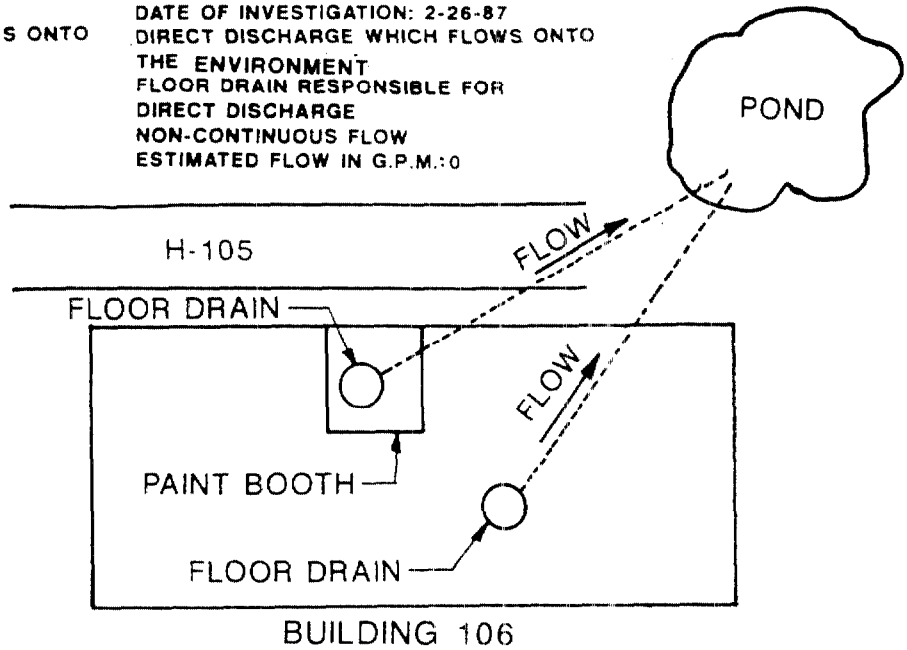
The Building 106 Pond received oily wastewater from compressors in Building 107. Work orders #77-09V-009-0-3 to plug off this drainage was filed. It is not known whether this request was ever carried out. The pond is periodically pumped into the sanitary sewer system via a concrete sump and pump.

Current activities in both Buildings 106 and 107 consist of intermittent repair operations. Information on recent operations in Buildings 106 and 107 was found in 1983 Operation Permit applications. Building 106 houses two paint booths. Paint booth number one applied a zinc chromate coating which is 42 percent by weight toluene. Paint booth number two applied an olive drab coating which is 22 percent naphtha. Each booth applied approximately 500 gallons coating material per year. Painting operations took place 4 days per week, 10 hours per day, 25 weeks per year. Building 106 operations also included silica sandblasting of Hawk missile containers. Approximately 800 to 1,000 pounds of dust were removed from the baghouse per day. Documentation shows that floor drains from the paint booth area discharged to the pond as recently as 1987 (Reid, et al., 1987). Drainage to the pond from Building 106 is shown in Figure 4-2.

Building 107 activities (in 1983) included refinishing of metal boxes. The refinishing process involves the following steps: 1) Boxes are cleaned, 2) Boxes are grit blasted,

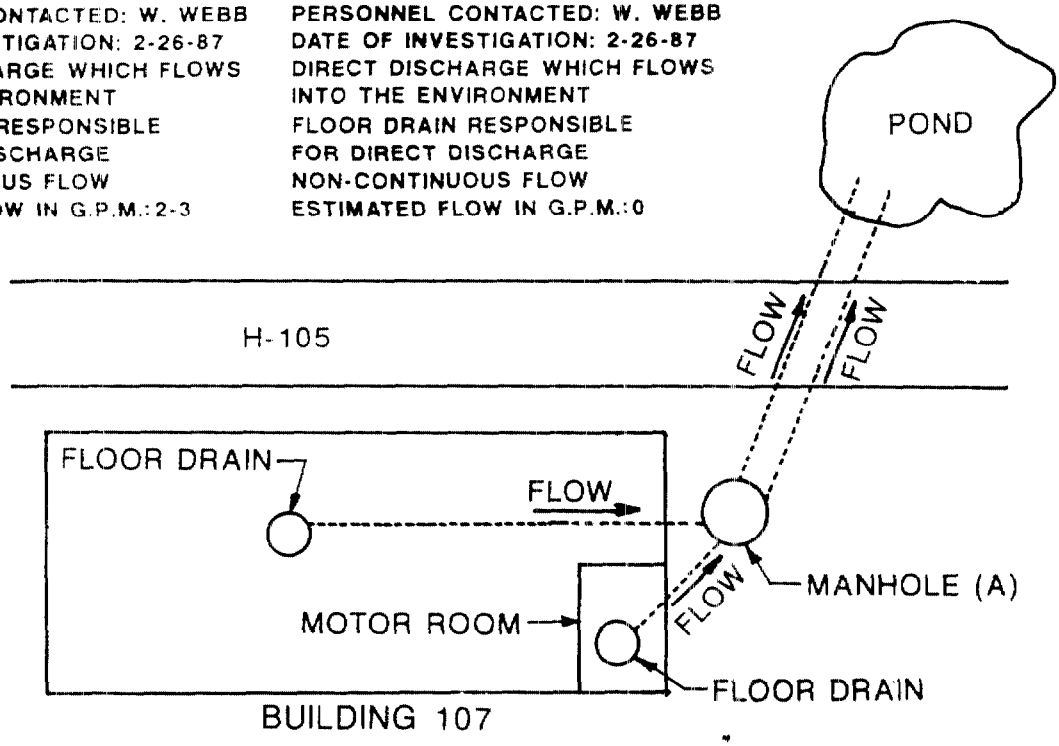
BUILDING NO. 106
PERSONNEL CONTACTED: C. SORRELLS
DATE OF INVESTIGATION: 2-26-87
DIRECT DISCHARGE WHICH FLOWS ONTO THE ENVIRONMENT
PAINT BOOTH RESPONSIBLE FOR DIRECT DISCHARGE
NON-CONTINUOUS FLOW
ESTIMATED FLOW IN G.P.M.: 0

BUILDING NO. 106
PERSONNEL CONTACTED: C. SORRELLS
DATE OF INVESTIGATION: 2-26-87
DIRECT DISCHARGE WHICH FLOWS ONTO THE ENVIRONMENT
FLOOR DRAIN RESPONSIBLE FOR DIRECT DISCHARGE
NON-CONTINUOUS FLOW
ESTIMATED FLOW IN G.P.M.: 0



BUILDING NO. 107
PERSONNEL CONTACTED: W. WEBB
DATE OF INVESTIGATION: 2-26-87
DIRECT DISCHARGE WHICH FLOWS INTO THE ENVIRONMENT
MOTOR ROOM RESPONSIBLE FOR DIRECT DISCHARGE
NON-CONTINUOUS FLOW
ESTIMATED FLOW IN G.P.M.: 2-3

BUILDING NO. 107
PERSONNEL CONTACTED: W. WEBB
DATE OF INVESTIGATION: 2-26-87
DIRECT DISCHARGE WHICH FLOWS INTO THE ENVIRONMENT
FLOOR DRAIN RESPONSIBLE FOR DIRECT DISCHARGE
NON-CONTINUOUS FLOW
ESTIMATED FLOW IN G.P.M.: 0



SOURCE: REID, QUEBEC, ALLISON AND WILCOX AND ASSOCIATES, INC., 1987

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FIGURE 4-2

INFLUENT SOURCES TO BUILDING 106 POND

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3) Boxes are primed and painted, 4) Painted boxes are dried in an oven, and 5) Completed boxes are put in storage until reuse. Painting is accomplished in four paint booths which are equipped with water washes for particulate control. Approximately 300 to 400 pounds of dust are collected from the accumulator/baghouse per day. The air from the ovens is exhausted outside. Box cleaning activities consumed approximately 712 gallons TCE per year. Box refinishing activities operated 10 hours per day, 4 days per week, 13 weeks per year.

The 1983 Building 107 Operation Permit Applications show that Building 107 activities also included treating wood boxes with pentachlorophenol (PCP). Wooden boxes were dipped in a tank containing 5 percent PCP for five minutes and then allowed to partially dry in a drip pan adjacent to the dip tank. The tank and drip pan are located beneath a hood which exhausts to the outside of the building. Approximately 8,800 gallons of wood preservative were used annually. This activity operated 10 hours per day, 4 days per week, 20 weeks a year. Building 107 floor drains also discharged to the Building 106 Pond as recently as 1987. Drainage from Building 107 to the pond is shown in Figure 4-2.

4.4.2 Observations

Plan sheets obtained to evaluate potential pond contaminant sources document that the pond existed prior to 1972 (NAVFAC Drawing No. 2005677). It is assumed that the pond was in service when operations were started at Buildings 106 and 107. Waste, however, was not confirmed in the documents available. Plan sheets for updating industrial waste treatment facility show that prior to the end of 1972 the pond overflowed into a corrugated metal pipe on its eastern bank to the ravine east of the pond. Drawings specified that the overflow pipe was to be filled with concrete during renovation of the treatment facility in the load and fill area Building 106 Pond. The overflow pipe was not located during the Building 106 Pond walkover.

During the site visits on August 27 to 29, 1991, the pond was approximately 40 feet in diameter. Water levels in the pond were low due to the dry period prior to the site visit. The baffle at the incoming line discharge point was visible below the water surface at the northwest corner of the pond. The berm along the bank of the pond was eroded in the northeast corner. Water had apparently flowed through the eroded point in the past to the adjacent ravine (see Appendix D). Environmental Protection Division staff present during the SWMU reconnaissance stated that an absorbent boom was usually present at the point of erosion on the bank to skim oils from water potentially passing over the bank. No boom was in place during the unit inspection. No oils were observed to be present on the surface of the water during the unit inspection. Globules of whitish material, however, were noted just below the surface.

A neutralization plant was constructed sometime after October 1972 (NAVFAC Drawing No. 2005677) to neutralize pond effluent. The neutralization plant is directly connected to the pond (see Appendix D). Floats activate pumps in the neutralization plant when the water in the pond reaches a certain level. Water is pumped from the neutralizing system to the sanitary sewer line for further treatment. The pumps were tested during the unit inspection and found to be inoperable. Water cannot be transferred to the sanitary sewer when pumps are not operable.

4.4.3 Maintenance and Schedules

No routine inspection or maintenance activities are known to be performed at the Building 106 Pond.

4.5 WASTE CHARACTERISTICS

4.5.1 Types of Wastes Placed in the Unit

4.5.1.1 Hazardous Classification

Specific information concerning the classification of wastes discharged to the Building 106 Pond was not found. Hazardous wastes potentially discharged to the pond at one time or another are listed in Table 4-3.

4.5.1.2 Quantity

Flow rates from the cleaning process averaged about 20,000 to 25,000 gallons per day. Superimposed on this flow were periods of batch discharge from the case overhaul process (Kent et al., 1973). The proposed phosphatizing process was estimated to generate approximately 14 gallons per minute wastewater flow. The amount of wastewater which entered or is entering the pond from the Building 107 compressor room was estimated in 1987 by Reid, Quebe, Allison, Wilcox and Associates (RQAW) to be 2 to 3 gallons per minute. The flow entering the pond from the Building 106 floor drain was reported to be noncontinuous and was not estimated (RQAW, 1987).

4.5.1.3 Chemical Composition

The main chemicals of concern in the acid and caustic wastewaters generated by Building 106, as identified in the IAS (NEESA, 1983), are mercury, chromium, phosphorus, and trichloroethylene. Zinc phosphate, chromic acid, and rinsate wastewater streams may have been discharged to the pond during later phosphatizing operations. Also, PCP-containing solutions may have entered the pond via Building 107 floor drains.

TABLE 4-3

POTENTIAL HAZARDOUS WASTES*
BUILDING 106 POND
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Waste	Hazardous Constituent	Hazardous Waste Number	Hazard Code
Caustic Cleaning	Sodium Hydroxide	D002	C
	Chromium	D007	T
	Lead	D008	T
Spent Halogenated Solvents, including Degreasers	TCE	F001	T
Paint Waste	Chromium	D007	T
	Lead	D008	T
	Dichloromethane	F002,U080	T
	Acetone	F003,U002	T
	Ethanol	D001	I
	Isopropanol	D001	I
	Methanol	D001,U154	I
	Methyl ethyl Ketone	F005	I,T
	Naphtha	D001	I
	Toluene	F005,U220	I,T
	Xylene	F003	I
Pentachlorophenol Contaminated Wastes	Pentachlorophenol	F027	T
Waste Oils		D001	I
	Barium	D005	T
	Chromium	D007	T
Plating and Coating Wastes and Sludges including Caustic Cleaning	Boric Acid	D002	C
	Cadmium	D006	T
	Chromic Acid	D007,D002	T,C
	Chromium	D002	T
	Hydrofluoric Acid	D002	C

TABLE 4-3 (Continued)

POTENTIAL HAZARDOUS WASTES*
BUILDING 106 POND
NWSCC
CRANE, INDIANA
AUGUST 1992

Waste	Hazardous Constituent	Hazardous Waste Number	Hazard Code
Solution	Lead	D008	T
	Nitric Acid	D002	C
	Selenium	D010	T
	Sodium Hydroxide	D002	C
Grit Blast Residue	Cadmium	D006	T
	Chromium	D007	T
	Lead	D008	T
	Barium	D005	T

NOTE:

C: Corrosivity hazard.
T: Toxicity hazard.
I: Ignitability hazard.
*: Adapted from RCRA Facility Permit No. IN5 17023498.

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4.5.2 Physical and Chemical Characteristics

The characteristics of the identified chemicals of concern are listed in Table 4-4.

4.5.3 Migration and Dispersal Characteristics

Mercury (Hg) may occur in more than one oxidation state. It may occur in subsurface in mercuric form (Hg^{2+}), mercurous form (Hg_2^{2+}), elemental form (Hg°), and in alkylated form (e.g., methyl and ethyl mercury). Hg_2^{2+} and Hg^{2+} are more stable under oxidizing conditions and are strongly adsorbed by soils. Hg° and alkylated forms are more stable under reducing conditions. Conversion to alkylated forms may occur under reducing conditions. Hg° and alkylated-Hg forms are volatile, toxic, and may not be as strongly adsorbed by soils (USEPA, 1990).

Chromium (Cr) may occur in more than one oxidation state in subsurface. Trivalent form (Cr III) is dominant under pH and redox conditions generally present in subsurface. Cr III may be converted to the more mobile and toxic hexavalent form (Cr VI) under oxidizing conditions. Cr III is readily adsorbed in the subsurface while Cr VI is not (USEPA, 1990).

Traditionally, phosphorus compounds have been key components of cleaning compounds and degreasers (Considine et al., 1984). Phosphorus compounds can act as fertilizers and may contribute to eutrophication of surface waters.

Trichloroethylene present in a settling pond will rapidly evaporate due to its high volatility. Evaporation half-life will range from minutes to hours, depending upon temperature and turbulence. Biodegradation, hydrolysis, and photooxidation are extremely slow by comparison. Sorption to sediment or soil and bioconcentration in aquatic organisms are not important processes (Howard, 1991).

Zinc phosphate is a white powder which is insoluble in water (Sax and Lewis, 1987). Although no other information was found, zinc phosphate will probably sorb onto pond sediment and remain immobile because of its low solubility.

Chromic acid is soluble in water. It is corrosive to skin and a known human carcinogen (Sax and Lewis, 1987). Because chromic acid is water soluble, it may percolate into groundwater through the bottom of the pond. Once solubilized in water, however, the ions may be immobilized through cation exchange in soil.

If released in water, PCP will sorb to sediment, photodegrade (especially at higher pHs) and slowly biodegrade. Bioconcentration in fish will be moderate. PCP released to the pond via Building 107 floor drains, therefore, will probably not enter groundwater. It will

TABLE 4-4

**CHARACTERISTICS OF CHEMICALS OF CONCERN
BUILDING 106 POND
NWSCC
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AUGUST 1992**

Chemical	Physical Form	General Chemical Class	Physical Descript.	Molec. Weight (g/mole)	Density (g/cm3)	Solub. In Water	Vapor Press. (mm Hg)	Biodegradability
Mercury (Hg)	Liquid	Heavy Metal	Silver-White Liquid	201	13.594	No	0.002	NA
Chromium (Cr)	Solid	Heavy Metal	Gray Solid	52	7.2	Low(III) High (VI)	N/A	NA
Zinc (Zn)	Solid	Heavy Metal	Grayish-White Solid	97.43	4.08	No	N/A	NA
Lead (Pb)	Solid	Heavy Metal	Silver-Bluish Metal	207	11.34	Low	N/A	NA
Cadmium (Cd)	Solid	Heavy Metal	Silver-White Metal	112.4	8.64	No	N/A	NA
Trichloro ethylene (TCE)	Liquid	Volatile Organic Solvent	Colorless Liquid	131	1.462	Moderate	58.7	High (aerob.)

TABLE 4-4 (Continued)

CHARACTERISTICS OF CHEMICALS OF CONCERN
BUILDING 106 POND
NWSCC
CRANE, INDIANA
AUGUST 1992

Chemical	Physical Form	General Chemical Class	Physical Descript.	Molec. Weight (g/mole)	Density (g/cm3)	Soluh. In Water	Vapor Press. (mm Hg)	Biodegradability
PCP	Solid	Semi-Volatile	White Powder or Crystals	266.35	1.978	Low	0.00011	Low

Legend: NA: Data not available.
N/A: Date not applicable.

Sources: Verschueren, 1983.
Lidde, 1991.
Perry et al., 1984.
Dean et al., 1985.

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either photodegrade (half-life hours to days, more rapid at the surface) or sorb to sediments. Hydrolysis and volatilization are not important processes in water (Howard, 1991).

Oil on water is not only aesthetically objectionable but is a fire risk, and has adverse biological effects. Oil hinders diffusion of oxygen into water and may interfere with fish respiration by coating their gills. A prevalent view is that the constant spillage of small amounts of oil is more harmful to organisms than an equivalent amount spilled in a single event (Kent et al., 1973).

4.6 CONCLUSIONS

Background data and site observations were reviewed to determine the likelihood of a release posing a potential threat to human health or the environment. Data and observations pertinent to SWMU #08/17, the Load and Fill Area Building 106 Pond, were reviewed to assess the potential for contaminant releases to groundwater, surface water, air, and soil. Data was interpreted and release determinations were made according to the approach described in RCRA Facility Assessment Guidance (USEPA, 1986).

At the Building 106 Pond, potential releases to groundwater were determined to be likely based on unit characteristics including unit type, ineffective, inoperative, or absent structures designed to prevent releases to groundwater, unit operation, physical condition, locational characteristics, and waste characteristics especially related to historic introduction of mobile compounds. No groundwater analytical data, however, were obtained. Releases to surface water were determined to have occurred since the Building 106 Pond is considered a surface water body. Furthermore, unit design and physical characteristics (including inoperative or ineffective engineered features to prevent releases to surface water, operational history, and physical condition), as well as the release migration potential posed by the terrain, waste characteristics, discharge characteristics, and visual evidence of release indicate releases have occurred from the pond to other surface water bodies. Releases to air were determined to be possible based on unit operating characteristics and unit surface area for exposure, and waste characteristics exhibiting potential for vapor releases (historically but not currently), but direct and indirect visual evidence of vapor or particulate release to the atmosphere were not obtained. Potential releases to soil beneath and around the Building 106 Pond were identified based on the unit type and design, inoperative or inefficient engineered structures to prevent releases to the soil, unit operating characteristics and procedures, physical condition, waste characteristics, and site characteristics. Available sediment data, however, do not conclusively support that soil contamination has occurred. Table 4-5 summarizes these conclusions.

TABLE 4-5

POTENTIAL RELEASES
BUILDING 106 POND
NWSCC
CRANE, INDIANA
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Media	Release	Suspected Contaminants*
Groundwater	Likely	Volatile Organics, Metals
Surface Water**	Occurred[2,3]	Oil, Metals, Volatile Organics
Soil	Likely	Metals, Semivolatile Organics
Air	Potential	Volatile Organics

NOTE:

[1] Observed.
[2] Reported.
[3] Analytical Records.

* See Table 4-4 for individual compounds.
** The pond is considered a surface water body.

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Recommendations for continuing or ceasing of RFI Corrective Actions based on the information reviewed will be presented for the Building 106 Pond in Section 7.

RP/6EMRF/AA8

5.0 SWMU #12/14, MINE FILL A

5.1 BACKGROUND

This section will present background information specific to SWMU #12/14, Mine Fill A.

Mine Fill A has been used to manufacture mines, depth charges, rocket heads, aerial bombs, and projectiles. Currently, Mine Fill A is used for the production of 2,000-pound aerial bombs. Demilitarization activities also take place in Mine Fill A.

5.1.1 Physical Features

5.1.1.1 Location

Mine Fill A is located in the west-central portion of NWSCC. As shown on Figure 2-5, it occupies the northeastern corner of the Navy-designated Section 12 near map coordinates Z-25. The entrance to the area is off of H-45.

Figure 5-1 shows significant features within Mine Fill A. Mine Fill A consists of 29 buildings situated along H-17. H-500 also runs through Mine Fill A. Railroads 74, 75 and 100 have access to the area. The following is a list of buildings in Mine Fill A that have housed significant amounts of various explosive compositions (NEESA, 1983).

Building Number	Building Title
151	Cooling and Temporary Storage
152	Bomb and Mine Filling
153	Box Emptying
154	Receiving Building, Explosives
155	Inert Preparation
157	Bomb and Mine Filling
158	Box Emptying
159	Receiving Building, Explosives
160	Cooling and Temporary Storage

5.1.1.2 Legal Description

This SWMU is located at SW 1/4, S23, T5N, R4W. Latitude and longitude for Mine Fill A are 38° 51'06"N and 86° 49'23"W.

5.1.1.3 Contiguous Property

Nearby facilities near Mine Fill A include: to the southwest, Mine Fill B; to the west, an inert storage area; to the north, the pyrotechnics production; and to the northeast, the Supply Department, a restricted explosive area, and high explosive magazines.

5.1.1.4 Topography

Mine Fill A occupies approximately 70 acres of upland area at NWSCC. Elevations range from approximately 745 feet MSL at the northernmost corner of Mine Fill A to approximately 725 feet MSL along its western edge. The gentle topography of the mine fill is contrasted by the sharp slopes along its eastern, western, and southern boundaries. The minimum elevation at the base of the valleys adjacent to Mine Fill A is 540 feet MSL. This minimum elevation occurs near the southeast corner of Mine Fill A.

5.1.1.5 Surface Drainage and Hydrology

Surface drainage at Mine Fill A is routed via ditches and culverts to intermittent drainageways transcending slopes on the eastern and western borders of the Mine Fill. Intermittent drainage from these slopes flows into larger intermittent drainageways which flow south-southeast into Turkey Creek. Turkey Creek flows south-southwest to merge with Boggs Creek which continues south beyond the southern boundary of NWSCC. Boggs Creek eventually empties into the East Fork of the White River.

5.1.1.6 Geology

Soils

The following discussion of soil in Mine Fill A was prepared using information obtained from the Soil Survey of Martin County, Indiana, prepared by McElrath (1988) and published by the SCS of the USDA.

Detailed soil mapping by the USDA shows the area encompassed by Mine Fill A to be the Zanesville-Udorthents soil complex. At Mine Fill A, these soils are gently to moderately sloping. The Zanesville-Udorthents complex is characterized well drained to moderately well-drained soil, which occurs on the tops of ridges in upland areas. Udorthents occur in areas which have been affected by earthmoving activities. Commonly, the Zanesville soil and Udorthents are so intricately intermixed that separating them is impractical. USCS classifications for the upper portions of Zanesville-Udorthents complex soils are clay, silt, and silty clay. At depth, USCS classifications include clay, sandy clay, silty sand, and silty gravel.

Permeability of the Zanesville-Udorthents complex varies with depth. Zanesville soils are moderately permeable above a fragipan, which occurs at a depth of approximately 27 inches, and slowly permeable in the fragipan. Udorthents are considered moderately permeable. Hydraulic conductivities reported for the soil complex range from 4.2×10^{-5} to 1.4×10^{-3} cm/sec (McElrath, 1988). Surface runoff is medium for both soil types and along with erosion is a significant concern at Mine Fill A. In areas mapped as covered by these soils, depth to bedrock ranges from 45 to greater than 65 inches. Depth to bedrock is generally at the shallower end of this range where earth moving activities have taken place.

Bedrock

The bedrock surface beneath Mine Fill A is composed of sandstones, shale, and limestone of the Pennsylvanian Age Raccoon Group. In areas of lower elevation, eroded by Turkey Creek, the bedrock surface is composed of limestones and sandstones of the Mississipian Age Stephensport Group (Department of the Army, 1978).

Detailed information of the bedrock geology at Mine Fill A was not found. Water supply well WO39 is located approximately 2,100 feet west of Mine Fill A. WO39 is a 6-foot deep hand dug well (Kent et al., 1972). A geologic log for well WO39 was not found but it is not thought to have penetrated bedrock.

A lineation study conducted by the U.S. Army Corps of Engineers, St. Louis (undated), showed two lineations to be present in the vicinity of Mine Fill A. These north-south trending lineations occur west and east of Mine Fill A. Lineations are interpreted from aerial photographs and indicate the potential presence of structural geologic controls. Structural geologic controls include features such as faults, joints, foliation, and bedding planes. Lineations were not field verified.

5.1.1.7 Hydrogeology

Regional hydrogeology of NWSCC was presented in Section 2. Information specific to the hydrogeology of Mine Fill A was not found. Sampling was conducted on well WO39 (Kent et al., 1972), however, depths to water were not recorded. It is assumed that the water table is present above a depth of 6 feet (total depth of WO39) since a groundwater sample was recovered. The absence of boring information and water level data in the area precludes hydrogeologic interpretation.

5.1.2 Spills or Releases

The major sources of contamination from Mine Fill A are from washdown operations and through the exhaust ventilation system. In the past, the exhaust system released explosive

dust that settled on the roofs of the buildings adjacent to the facilities. Reportedly, an explosive dust layer accumulated on the roof and would require hosing down once a week. The explosive dust would be washed onto the surrounding ground. The wash water ran into ditches, Turkey Creek, and eventually Boggs Creek and off-station. Estimates of dust through the exhaust system was approximately 40,000 pounds per year (NEESA, 1983). Documented evidence (see Section 5.3.2) shows significant contamination in the Mine Fill area. The contaminants identified include TNT, RDX, and HMX.

A detailed history of wastewater handling at Mine Fill A, prior to installation of the wastewater treatment system, is unknown. However, wastewater was discharged to surface drainage before 1982 when a treatment facility was completed.

Spills which have reportedly occurred in Mine Fill A since 1987 are described below. Spill information was obtained from the Navy Environmental Protection Division files.

1. On April 19, 1989, between 1 and 100 pounds of TNT explosive (flake) powder was spilled outside the Building 153 screening room onto the ground and concrete pad. The powder may also have entered an intermittent drainage ditch in the area. The area was reportedly cleaned up by Navy personnel (NWSCC Environmental Protection Division File 5090/5.0).

2. An unknown amount of pink water (TNT-contaminated water) was released at the Building 160 treatment plant on June 19, 1989. A pumper truck unloading wastewater to the treatment plant from other Mine Fill A buildings leaked wastewater from a discharge valve as it was leaving. Reddish discoloration was observed on the gravel and across the driveway and roadway. No pooled water was observed. Contaminated rock was reportedly removed and flashed at the ammunition burning ground (NWSCC Environmental Protection Division File 5090/5.9.2).

3. On July 13, 1989, an estimated 20 gallons of pink water was released from a holding tank at Building 151. The tank reportedly overflowed when heavy rains caused an automatic sump pump to be activated. The pink water flowed in an L-shaped pattern from the holding tank to a low spot where it puddled, covering approximately 1,200 square feet. The pink water was collected by a pumper truck. Seepage was collected in a plastic-lined pit and the area was flushed with approximately 3,000 gallons of clean water (NWSCC Environmental Protection Division File 5090/4.9.8.3). A similar release previously occurred in May 1984 (NWSCC Environmental Protection Division File 5090/5.9.2).

4. On July 19, 1989, another release of pink water from the Building 151 holding tank occurred. It was concluded that releases of this type have regularly occurred at this

tank. An electrical relay switch has been installed to shut the sump pump off when the holding tank approaches capacity (NWSCC Environmental Protection Division File 5090/5.9.2).

5. Approximately 50 gallons of pink water were released on August 8, 1989, when a pipe joint failed on the explosive wastewater transfer line from Building 152 to a railroad tank car. The transfer line valve was immediately closed. Contaminated gravel and soil were excavated to a 1-foot depth over the 40 square foot spill area. The excavated materials were reportedly flashed at the ammunition burning ground and disposed of as hazardous waste (NWSCC Environmental Protection Division File 5090/5.4).

6. On October 16, 1989, an undetermined amount of pink water was released from the demilitarization operations in Building 160. A hot water tap was inadvertently left on inside Building 160 four days beforehand. Water flowed to contaminant sumps at Building 3110, filled them, and then began filling the below-ground pump room. Water eventually filled the pump room and flowed out of the building door. Water which flowed out of the door was unrecoverable. Spill information provided did not specify why the pink water which flowed out the door was unrecoverable. It is assumed that the water leached into the soil or was collected and transported from the area via surface drainage. Samples were taken from the pump room basement and a nearby ditch. The samples contained HMX (0.32 and 0.11 ppm), RDX (4.46 and 1.36 ppm), and TNT (6.12 and 1.55 ppm) (NWSCC Environmental Protection Division File 5090/5.9.2).

7. An explosive powder container was dumped over, spilling powder in the tunnel area by Building 152 on June 25, 1991. The powder was picked up and residue was flushed back into Building 152. Reportedly, no powder was released to the environment (NWSCC Environmental Protection Division File 5090/5.9.1).

8. On July 15, 1991, 40 gallons of pink water were released near the Building 152 wastewater collection tank. An operator turned on the pumps not knowing the receiving railroad tank car was not in place. The spilled pink water flowed into the gravel between the railroad tracks. No cleanup actions were taken since the area is considered contaminated and scheduled for cleanup under the Installation Restoration Program (NWSCC Environmental Protection Division File 5090/5.9.1).

5.1.3 Ownership and History

In September 1942, the Mine Fill A complex began production with the cast loading (melt pouring of explosives) of depth charge bombs. Numerous other items have also been produced at Mine Fill A. A partial list and production totals of items during World War II are listed below (NEESA, 1983).

Item	Total Production
4-in. 5 Rocket Heads	963,000
5-in. Rocket Heads	570,000
Depth Charges	134,000
Projector Charger	364,000
3-in./50 Ammunition	540,000

The area was utilized during the Korean War when aerial depth bombs were loaded by the Army with TNT, and later HBX. Prior to 1957, when the Navy decided to load its own low drag bombs, these were the only bombs loaded here. Up to that time, the Army had loaded all bombs.

Prior to the Southeast Asia conflict, Mine Fill A had the capability of handling TNT only. During the Vietnam War, the mine filling complex (both A and B) manufactured over 6,000,000 bombs. Types of explosives processed included TNT, Comp B, H-6, Tritanol, and Minol (NEESA, 1983).

The Mine Fill A production facilities were inactive for a period after the close of the Southeast Asia conflict. A wet scrubber exhaust ventilation system and a contaminated water collection system for the production line at Mine Fill A were installed in the late 1970s. Mine Fill A houses a steamout/washout demilitarization system in Building 160, which reportedly started in 1969. The demilitarization facility was modified in 1982 with a water treatment system to eliminate effluent pollutants. The exhaust systems built for Building 160 in the 1970s are housed in Buildings 160 and 3111. The particulate abatement program consists of six independent exhaust systems consisting of an exhaust hood over the specific processes in Building 160, connecting ductwork, and a scrubber with a blower and exhaust stack in Building 3111 (Department of the Navy, 1984).

Currently, mines and bombs are loaded with explosives, and munitions items are demilitarized at this site. The bomb-mine loading process is detailed in Section 5.4.1.

In 1987, Building 151 was reportedly retrofitted to fill 40,000-pound shock charges because the casings were too large to be loaded in Building 151. The floor drains in Building 151 were consequently connected to an aboveground holding tank.

Heat necessary for the various melting and steamout operations conducted in Mine Fill A is provided by steam. The steam is generated by boilers which burn No. 2 fuel oil. The boilers are located in Building 150 outside of Mine Fill A.

5.1.4 Waste Descriptions

Buildings 153 and 158 house explosive powders such as TNT. Wastewater from Building 153 was previously discharged to surface drainage. The railroad lines by the box houses, the shaker rooms, and magazines were hosed down once per day. Also prior to installation of the particulate abatement system, explosive waters were hosed off the roofs once a week. The rinsewater was not collected or treated. As described above, waste rinsewater contaminated with TNT, RDX, and HMX is now collected and treated via carbon adsorption, and treated wastewater is discharged to the sanitary sewer system under an NPDES permit. The drainage lines from the buildings, however, have a bypass switch so water can be directly released to a drainage ditch. Since 1982, sludges generated by this treatment are taken to the Ammunitions Burning Ground. Aluminum powder is stored in Building 2714 and is used in load and fill operations. The railroad areas, where bombs and explosives are unloaded, drain to the surface water system.

5.2 PERMITS

5.2.1 Air

Five paint booths in Mine Fill A are authorized to operate under Operation Permit Identification No. 51-05-88-0028, Indiana Air Pollution Control Board, 1985. These paint booths are located in Building 155 and are equipped with dry filters for particulate control. This permit expired on May 1, 1988. The specified painting activities, however, are allowed to continue operation because the state has not acted upon new applications submitted in 1988.

Other operations in Mine Fill A were registered by the Indiana Department of Environmental Management in 1987. These activities were: 1) the screening and weighing of aluminum powder in Building 2714, 2) the screening and weighing of TNT in Building 153, 3) Tritanol melt, mix, and pour activities in Building 155, and 4) asphalt coating of bombskins in Building 155. Grit blasting activities in Building 155 were exempt from registration and permitting.

5.2.2 Groundwater

The Navy stated that no special groundwater permits were required for operations at Mine Fill A (NWSCC, 1991a).

5.2.3 Surface Water

Outfall 301, located at the demilitarization wastewater treatment facility in Mine Fill A, is monitored under NWSCC's current NPDES permit.

5.2.4 Soil

According to a Navy representative (1991a), no soil permits are required for operations at Mine Fill A.

5.3 EXISTING DATA ASSESSMENT

5.3.1 Monitoring Devices

No permanent monitoring devices are located in Mine Fill A. However, an outfall located at Building 3110 is regularly monitored and other samples have been periodically collected and analyzed. The data are discussed below.

5.3.2 Analytical Data

Surface water and effluent collected at various times around the mine fill area reveal a degree of explosives contamination. Some data are presented in Table 5-1.

In 1979, a combined water quality engineering and biological study was performed by the U.S. Army Environmental Hygiene Agency (AEHA) (Department of the Army, 1980). The AEHA study was conducted to characterize wastewaters from industrial operations and to determine the biological impact of discharges upon receiving streams. Water and sediment samples were collected from the two major drainage channels which carry runoff from Mine Fill A to Turkey Creek. The samples were collected from storm ditches at considerable distances from the facilities. The sample from the east ditch was collected approximately 1,300 feet east-southeast of Building 151, and the sample from the west ditch was taken approximately 2,800 feet south of Building 151 (estimated from figures in the AEHA study). Surface water sample locations are presented in Appendix H. Significant dilution of wastewater is probable. A sample was also collected from the recently completed scrubber wastewater collection basin (which has never been used). Data for the aqueous samples are presented in Table 5-1. TNT and RDX were not detected in sediment samples. HMX was detected in sediment in the 1 ppm range (Department of the Army, 1980).

As part of a 1980 design analysis for waste treatment facilities, Building 160 effluent quality was estimated. The estimates are presented in Table 5-2. As the table shows, the influent to the then-proposed treatment facility had a very high explosive (i.e., nitrobody) content.

Under the NPDES permit, the outfall carrying effluent from the wastewater treatment facility (Outfall 301) is regularly monitored for oil and grease content, nitrate content, and total explosives concentration. The only discharge limit exceeded since December 1986 is the total explosives concentrations. These exceedances are listed in Table 5-3.

TABLE 5-1

**DISCHARGE/DRAINAGE ANALYTICAL RESULTS
MINEFILL A
NWSCC
CRANE, INDIANA
AUGUST 1992**

	Concentrations, mg/l		
1972 Samples (average concentrations)	TNT	RDX	HMX
Demil (Bldg 160) Effluent	5.8	0.0	0.0
Ground Runoff (From Bldg 157)	0.175	3.55	0.0
Plant (Bldg 152) Effluent	27.9	35.3	3.7
1979 Samples[1]			
East Ditch (No. 1)	<0.005	<0.02	<0.1
West Ditch (No. 2)	<0.005	0.05	0.1-0.5
Sediment Pond[2]	<0.005	<0.02	<0.1
1991 Drinking Water Health Advisories[3]			
10-kg Child One Day	0.02	0.1	5
10-kg Child Ten Day	0.02	0.1	5
10-kg Child Longer Term	0.02	0.1	5
70-kg Adult Longer-Term	0.02	0.4	20
70-kg Adult Lifetime	0.002	0.002	0.4
70-kg Adult 10^{-4} Cancer Risk	0.1	0.03	--

NOTE:

1 Samples were collected from storm ditches at considerable distances from the facilities. Significant dilution of wastewater is anticipated.

2 Aqueous sample from wastewater collection basin. The basin had not been used prior to or during samples.

3 USEPA, 1991.

Sources: Kent et al., 1973.
Department of the Army, 1980.

RP/6EMRF/AA3

TABLE 5-2

ESTIMATES OF BUILDING 160 TREATMENT FACILITY INFLUENT AND EFFLUENT QUALITY, 1980 MINE FILL A NWSCC CRANE, INDIANA AUGUST 1992

	Influent		Effluent to Sewer	
Parameter	Average	Maximum	Average	Maximum
Total Solids, mg/l	1,750	6,875	202	2,005
Dissolved Solids, mg/l	2,250	4,875	200	2,000
Suspended Solids, mg/l	500	2,000	2	5
Chlorides, mg/l	100	1,240	100	1,240
Temperatures, ° F	140	170	70	80
Oil & Grease, mg/l	20	100	3	5
Wax, mg/l	30	1,000	0	0
Nitrobodies, mg/l	2,000	3,875	1.0	1.0
pH Range			6.5 to 8.0	

Source: MHSM, 1980.

RP/6EMRF/AA3

TABLE 5-3

**OUTFALL 301 DISCHARGE EXCEEDANCES
DECEMBER 1986 THROUGH JUNE 1991
MINE FILL A
NWSCC
CRANE, INDIANA
AUGUST 1992**

Date	Concentration of Total Explosives (ppm)[1]
11-13-89	4.46
10-23-89	3.41
10-31-89	3.44
09-06-89	2.62

[1]NPDES Discharge Limit is 2 ppm total explosives.

Source: NWSCC laboratory reports for State of Indiana NPDES Permit No. IN0021539.

RP/6EMRF/AA3

In 1972, an open well (W039) west of Mine Fill A (location: Z-22) was sampled. The well depth was 6 feet. Analytical data for the 1972 sampling event, presented in Table 5-4, show no explosive pollution. Groundwater flowing beneath Mine Fill A, however, may not migrate directly west towards W039.

The IAS recommended that eight core soil samples be collected in Mine Fill A and analyzed for explosive compounds. In 1985, four soil samples were collected from around Building 153, and three soil samples were collected around Building 158. Both buildings are used for box emptying. The sample results are presented in Table 5-5. The results indicate "hot spot" (heterogeneous) distribution of explosive contaminants around both buildings. The highest concentrations were detected in sample MFA-2, collected near Building 153. A sample location sketch, provided by the Navy, is included in Appendix I.

Also in 1985, a soil sample was collected from the area around Building 169. The sample was tested using the EP Toxicity Test for the susceptibility for contaminants to leach. The sample results (metals, cyanide, methylene chloride, and PCBs) are all below the 1990 TCLP Action Levels.

During August 1989, a sample of Building 151 wastewater was collected and analyzed. This building had reportedly been retrofitted in 1987 to fill 40,000-pound shock charges. The sample contained 0.314 ppm HMX, 4.20 ppm RDX, and 124.23 ppm TNT (NWSCC Environmental Protection Division File 5090/4.9.8.3).

In May of this year (1991), a wastewater sample was collected from a tetrytol steamout operation that went on-line in Building 160 at the end of the month. The sample was collected to determine if the existing carbon treatment system could effectively treat the new waste stream. The steamout solution contained 77 ppm tetryl and 237 ppm TNT.

Fifteen samples of Building 160 scrubber blowdown were collected and analyzed for TNT at an unknown date. The samples contained levels of TNT ranging from 284.3 ppm to 555 ppm with an average concentration of 420.7 ppm.

In 1984, a stationary Air Pollution Source Assessment was performed on the exhaust systems Nos. 1 and 6 of the Building 160 demilitarization waste treatment facility (Department of the Navy, 1984). The results of this test are presented in Table 5-6. The particulate and visible emissions from both systems, as tested, were in compliance with the applicable Indiana Air Pollution Control Board Standards.

5.3.3 Migration Pathways/Impacts

Migration pathways historically existing at Mine Fill A include air, surface water, and groundwater. Air is considered a contaminant migration pathway since, prior to the

TABLE 5-4

ANALYTICAL RESULTS FOR W039, 1972 (WEST OF MINE FILL A) NWSCC CRANE, INDIANA AUGUST 1992

Parameter	Unit	Results	Federal Drinking Water Maximum Contaminant Level[1]
pH	SU	7.0	6.5 - 8.5[2]
Turbidity	JTU	52.0	PS
Total Suspended Solids	mg/l	28.0	-
Settleable Solids	mg/l	24.0	-
Total Dissolved Solids	mg/l	205.0	500[2]
COD	mg/l	18.0	-
Oil and Grease	mg/l	68.0	-
N-Ammonia	mg/l	-	-
N-Nitrate	mg/l	3.91	10
N-Nitrite	mg/l	0.00	1
Total N (Kjeldahl)	mg/l	-	10
Total Phosphorus	mg/l	0.135	-
Chloride	mg/l	5.7	-
Cadmium	mg/l	0.00	0.005
Calcium	mg/l	-	-
Chromium	mg/l	0.0	0.1
Copper	mg/l	0.0	1.3[3]
Iron	mg/l	10.2	0.3[2]
Lead	mg/l	-	0.005[3]
Magnesium	mg/l	3.7	-
Manganese	mg/l	1.16	0.05[2]
Mercury	ug/l	-	0.002
Potassium	mg/l	-	-
Silver	mg/l	-	0.10[2]
Sodium	mg/l	42.0	-
Zinc	mg/l	0.4	5[2]
Total Coliform	MPN	-	4
Fecal Coliform	MPN	-	-
TNT	mg/l	0.0	0.1[5]
RDX	mg/l	0.0	0.03[5]
HMX	mg/l	0.0	-

TABLE 5-4 (Continued)

ANALYTICAL RESULTS FOR W039, 1972
(WEST OF MINE FILL A)
NWSCC
CRANE, INDIANA
AUGUST 1992

NOTE:

SU = Standard Units.
JTU = Jackson Turbidity Units.
mg/l = Milligrams per liter.
ug/l = Micrograms per liter.
MPN = Most Probable Number.

1 USEPA, 1991.
2 Secondary MCL.
3 Proposed MCL.
4 No more than 5% of the samples per month may be positive. For systems collecting fewer than 40 samples/month, no more than 1 sample per month may be positive.
5 1991 Drinking Water Health Advisory, 10^{-4} Cancer risk for 70 kg adult.

PS Performance standard 0.5-1.0 Nephlometric Turbidity Units.

Source: Kent et al., 1973.

RP/6EMRF/AA3

TABLE 5-5

SOIL ANALYTICAL RESULTS, 1985
MINE FILL A
NWSCC
CRANE, INDIANA
AUGUST 1992

	Detected Concentrations, ppm		
Samples	TNT	HMX	RDX
MFA-1	69	292	2,620
MFA-2	3,790	1,340	15,300
MFA-3	8	908	8,150
MFA-4	<3.6	64	374
MFA-5	64	99	906
MFA-7	<3.6	<5.0	<7.2
MFA-8	5.2	52	349

NOTE:

No data were found for MFA-6.

Source: Laboratory data sheets provided by NWSCC
(No accompanying text provided).

RP/6EMRF/AA3

TABLE 5-6

**PARTICULATE EMISSIONS FROM BUILDING 160
EXHAUST SYSTEMS NOS. 1 AND 6, 1984
MINE FILL A
NWSCC
CRANE, INDIANA
AUGUST 1992**

Run	Exhaust System	Particulate Concentration (gr/dscf)	Particulate Rate of Emission Measured (lbs/hr)	Process Weight (lbs/hr)	Allowable Particulate Rate of Emission (lbs/hr)
1-1	Steam Cabinet/ Kernelling Machine	0.00299	0.0757	100	0.551
1-2	Steam Cabinet/ Kernelling Machine	0.00215	0.0487	100	0.551
1-3	Steam Cabinet/ Kernelling Machine	0.00542	0.140	100	0.551
1-4	Steam Cabinet/ Kernelling Machine	0.00389	0.101	100	0.551
6-1	Kettle A	0.00310	0.101	233	0.970
6-2	Kettle A	0.00320	0.106	233	0.970
6-3	Kettle A	0.00299	0.101	233	0.970

Source: Department of the Navy, 1984.

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installation of a particulate abatement system was installed, explosive dust was released from building ventilation systems. Explosive dust collected on nearby rooftops and was likely blown to other portions of NWSCC.

Surface water is a migration pathway since explosive dust was washed off roof-tops to the surrounding ground. The washdown ran into nearby surface waters. In addition, washdown may have percolated into groundwater.

Additionally, before installation of the carbon treatment system, wastewater from Building 153 was previously discharged to a settling pond. This pond may have been unlined, allowing contaminants to percolate through the vadose zone and into groundwater. The wastewater flowed from the pond to the north drain, potentially further contaminating nearby surface waters.

5.4 UNIT CHARACTERISTICS

5.4.1 Operations

Mine Fill A is located near the center of NWSCC, east of Highway 45. Mine Fill A can be divided into two halves along a central east-west line. Manufacturing/processing operations and facilities in each half are identical. Mine Fill A began operations when NWSCC was commissioned in December 1941. Mine Fill A continued to produce ordnance until 1975 when production in Mine Fill A was suspended. Production was resumed in 1980 and the Mine Fill is considered active today.

Mine Fill A has historically been used to manufacture mines, depth charges, rocket heads, aerial bombs, and projectiles. Most recently, Mine Fill A has been used in the production of 2,000-pound aerial bombs. During the SWMU reconnaissances on August 27 to 29, and September 5 to 6, 1991, Mine Fill A was active, but between bomb production runs. In addition to production, demilitarization activities take place at Building 160 located within Mine Fill A. Engineering features, however, to control or eliminate emissions to the air, water and soil, have been added and modified at the facility throughout its life.

The following bomb-mine loading process description references the activities and facilities in the southern half of Mine Fill A. Similar activities and facilities occur in the northern half of Mine Fill A. Since Mine Fill A is similar to Mine Fill B, the processes occurring at Mine Fill A are considered to be similar to those which occurred at Mine Fill B while it was actively involved in mine/bomb production.

The details of processing at Mine Fill A-South were obtained using information obtained from review of Standard Operating Procedures (SOPs) and the interview with a former worker (NWSCC, 1991f) on the Mine Fill A production line. The SOP and the personal interview outlined the steps involved in the production of the 2,000-pound aerial bomb most recently produced at Mine Fill A.

Bomb production begins with inert preparation of bomb casing. Inert preparation takes place in Building 155, the Empty Mine Storage Building. Bomb casings are received from the supplier and stored prior to production in Building 155. Casings selected for production are first inspected for defects and prepared for hot melt application in Building 155. Preparation includes removing all plugs and shipping features from the bomb shell. Next the interior of the bomb shell is cleaned with solvents to remove materials that may inhibit adherence of the "hot melt" mix to the interior of the bomb. The bomb shell is then moved to the hot melt fill station of process control area in Building 155. At this location, the "hot melt," a bituminous asphalt-type compound, is applied to the interior of the bomb and allowed to drain. Following application of the hot melt, the bomb casing is moved to the grit blast chamber where the exterior of the bomb casing is cleaned with solvents to remove excess hot melt compounds. If necessary, the bomb casing is then grit blasted to prepare the metal for painting.

After preparation, some bomb casings are moved to the painting booth in Building 155 and painted. Other bombs are covered with a thermal coating called AVCO which is known to have previously contained asbestos. AVCO no longer contains asbestos. After painting and any additional touch-up or detail work, the bomb casing is allowed to cure. Once the prepared and painted bomb casing has cured, it is loaded onto pouring cars and moved to the loading process area or sent to storage.

Explosive preparation and bomb casing preparation are conducted simultaneously during bomb production runs. The following steps detail the procedures followed in the preparation of explosives. First, explosives are brought in by rail car to explosives receiving building, Building 154, which is used as a temporary magazine. Explosives are taken from Building 154 to the box emptying building, Building 153. Boxes of explosives are emptied and the explosives are sifted and scanned with magnets to remove any metallic fragments. Used explosive shipping containers are placed on conveyors at the ends of the box emptying building which transport them to one of two storage bins (box house) adjacent to the box emptying building. Discarded containers remain in these storage bins (Buildings 2193 and 2195) until they are removed for disposal in areas outside of the Mine Fill.

After the explosives are sifted and scanned for metals, they are poured into covered containers and sent by conveyor to the powdered metal storage building (Building 2714) where specified quantities of metals, i.e., aluminum or other materials, are added as required for the explosive being manufactured. After ingredients are added and the cover replaced, the containers continue to move along the conveyor line to the upper level of the bomb-mine fill building (Building 152). In the upper level of Building 152, containers carrying explosive ingredients are emptied into a melting kettle. The ingredients in the kettle are heated to a molten state at a temperature range of 190 to 203 degrees.

Prepared bomb casings are transported from the preparation area or storage area by rail car to the lower level of Building 152, the mine-bomb fill building. Molten explosives are poured from the upper level of Building 152 into the empty bomb casings below. After filling, bombs are transported by rail to the cooling and temporary storage area (Building 151). After cooling, void space left in the cooling explosive is filled and the bomb is sealed. After sealing, bombs undergo final quality assurance testing and inspection. Repairs, if necessary, are done prior to shipping the bombs to storage or into service. Between 85 and 120 2,000-pound bombs are produced during a 10-hour shift.

Five paint booths in Building 155 are used to prepare the bomb casings. The 1983 permit applications submitted to the Indiana Air Pollution Control Board revealed the following information: 1) two of the booths apply an intumescent coating which contain 5 percent toluene by weight, 2) one booth applies polyurethane containing 20 percent toluene, and 3) two booths apply an enamel coating which contains 37 percent naphtha by weight. In 1982, approximately 51,300 gallons intumescent coating material, 3,900 gallons polyurethane, and 400 gallons enamel were used. Solvents are used to clean up the Building 155 painting equipment. Approximately 100 gallons methyl ethyl ketone, 200 gallons toluene, and 50 gallons naphtha are used annually for cleaning. The asphaltic bomb coating material is a mixture of wax, bituminous asphalt, and bituminous oil. Specifically, the mixture contains 7 percent No. 225 melt point wax (N,N-ethylene bis-stearamide), 74.4 percent bituminous asphalt, and 18.6 percent bituminous oil (microcrystalline wax). The material is stockpiled outside prior to use and approximately 170 pounds per hour of this material is used during coating operations.

Demilitarization of warheads is accomplished by a steam-out and flaking process in Building 160. The flaking process is used to reclaim TNT from mines or depth charges. The steamout process is used to remove H-6, HBX, Tritanol, and Composition B from various munitions. Also, a new tetrytol (TNT and Tetryl) steamout operation started May 30, 1991. Two different methods of demilitarization operations are conducted at NWSCC. One is a steam or water-washout and the other is incineration. The washout method utilizes a stainless steel probe connected to a steam line. The probe is inserted into the warhead to melt out the contents. Melted ammonium nitrate powder was reportedly turned into pellets and sold as fertilizer. Remaining explosive debris is then steamed out of the casing and the contents are sluiced to a catch pan. The water is drained from the catch pan to an aluminum holding pan. This aluminum pan is emptied several times per shift into a floor drain from which the water flows into a portable baffled tank. Overflow from the baffled tank presently flows via floor drains to an existing closed pit outside the building. The TNT left in the catch pan is placed in the TNT flaker where it is packaged for shipment to a storage magazine. The residual TNT solids recovered in the aluminum pan and baffled tank are collected and disposed of at the open burning area or demolition area.

Other warheads are demilitarized in a similar manner, with the steamed-out contents being sluiced to a kettle where the explosives are separated from water. The explosives are sent to the open burning area or the demolition area. The water removed from the kettle flows by gravity to the same aluminum pans used in the TNT operations.

Wastewater from air pollution abatement scrubbers within Mine Fill A is collected and stored in sumps. These sumps are periodically pumped. Pumped wastewater is transported to Building 3110 or the Rockeye Facility for treatment.

As previously mentioned, a wastewater treatment facility was completed in 1982. Reportedly, the facility was not actually brought on-line until 1986 or 1987 (NWSCC, 1991d). The pollution abatement project for Mine Fill A operations included a documentation of flow rate estimates (MSHM, 1980). For Building 160, a flow of 2,630 gallons of wastewater was estimated for an 8-hour shift. Average daily flow rate of 45,000 gallons for Building 160 and 20,000 gallons for Building 152 were estimated during the Pilot Test Program (Kent et al., 1973).

The wastewater treatment system consists of collection sumps and four carbon adsorption columns for treatment of explosive contaminated rinse waters. The sludge is collected from the sumps and taken to the Ammunition Burning Grounds for treatment. Contaminated water is currently held in holding tanks and tank cars (depending upon the origin) prior to treatment. After treatment, the wastewater is tested for explosives. If the explosive compound concentration is less than 2 ppm, the water is dumped into the sanitary sewer. If the concentration is greater than 2 ppm, then the carbon columns are changed and the water is run through the treatment system again. The columns are changed approximately once a month.

The 1983 projected usage of the Building 160 demilitarization operations, contained in the 1983 Operation Permit Application, was 24 hours per day, 5 days per week, 26 weeks per year. Other Mine Fill A activities were registered, permitted, or exempted to operate 10 hours per day, 4 days per week, 52 weeks per year.

5.4.2 Observations

During the unit inspection, the southern half of Mine Fill A was viewed. Conditions observed in this area are considered to be similar to those present in the northern half of Mine Fill A.

Engineering features at the explosives receiving building (154) and box emptying building or shaker house (153) include a concrete pad along the rail line in the unloading area. Drains are present at all four corners of the pad. Staining was noted in low spots on the pad. Drains at the south end of the pad appeared to drain into a surface drainage system.

A drain at the northeast end of the pad appeared to drain into a piping network connected to a containment tank. Enroute, however, piping connected to a manhole containing a valve. It appeared that this valve could be adjusted to route water to the containment tank or divert north into another pipeline discharging to a drainage ditch. The unloading area is periodically washed to clear away explosive dust which presents a health and safety hazard. A review of plan sheets with information on sewer connections at Mine Fill A was conducted. Drawings prepared in 1941 show no sewers or drains present in the concrete railroad unloading area. A single 6-inch vitrified clay pipe (VCP) sewer line is shown carrying wastes northwest. A plan sheet dated 1953 diagrams the same information as shown on the 1941 plan, however, the 6-inch VCP line extending from Building 153 is connected to a subsurface sewer system.

A drawing approved September 24, 1990, and entitled Holding Tank Building 153 Site Plan, specifies details for reconditioning of the concrete swale (gutter) in the railroad unloading area. This swale leads to an existing catch basin/drain at the northeast corner of the concrete unloading area. Plans further show piping to a 3-way ball valve (see Appendix D) which diverts drain water to either a new concrete containment tank detailed on the plan sheet or a pipeline discharging to a drainage ditch.

Improvements to contain drainage from the concrete loading area were not made until 1990. Therefore, it was concluded that prior to 1990, drainage from the loading area was discharged directly to surface drainageways.

Red-pink colored water was observed puddled on the concrete near Building 153 during the unit inspection. Soils adjacent to the explosive receiving building, box emptying building, and storage bins for emptied explosive boxes (Buildings 2793 and 2195) were visibly stressed and almost void of vegetation in areas (see Appendix D). It is reported that prior to the installation of scrubbers, up to 40,000 pounds of explosive dust was vented to the roof of box emptying houses (NEESA, 1983). Explosive dust was washed off the roofs with water and onto adjacent soils. The open conveyor line for carrying empty explosive boxes to the empty box storage bin allowed explosive dusts and residues left in the containers to escape to the environment. The storage bins are constructed of spaced wooden planks which allow the wind and precipitation to carry residues from the containers to the adjacent soil and drainageways.

Scrubbers added in the late 1970s now cleanse air vented from the box emptying house. An Environmental Division staff member (1991e) stated water used in the scrubbers is conveyed to containment areas and later treated at either the Rockeye Treatment Facility or Building 3110 Treatment Facility in Mine Fill A.

The conveyors used to transport containers of explosives from the box emptying house to the melt room of the Mine Filling Building (Building 152) are covered. However, the area beneath the slotted conveyor belt is open. Explosive residues on the outside of containers or the conveyor belt are able to fall to the ground below. Moreover, containers on the conveyor may have tipped and spilled substantial quantities of explosives. Other concerns include the presence of stains resulting from lubrication of the conveyor system. These stains are especially obvious near the box emptying building end of the conveyor system. See Appendix D for photograph.

Stains were obvious on the concrete below at the Bomb-Mine Filling Building end of the conveyor (Building 152). In addition, a chute had been constructed to catch spillage at the end of the conveyor. This chute emptied into a 30-gallon drum. A grate-covered concrete drainage basin was located directly beneath the 30-gallon drum. The grated basin extended around the base of the Bomb-Mine Fill Building. Water from either precipitation or rinsing of the Bomb-Mine Fill Building collects in this basin and is carried to a settling basin. Reportedly, a valve at the end of the sump is in place to prevent surface discharge. A pump is in place to pump the contents to a rail car (NWSCC, 1991e).

Bomb shells are prepared in the empty Mine Storage Building (Building 155). Preparation of bomb shells was discussed previously. Materials used in bombshell preparation include paints, solvents, asphalt (hot melt) materials, and grit blasting materials. These materials are stored at Building 155 or in buildings nearby.

During the SWMU reconnaissance staining was noted on the ground around the paint locker (Building 196) located south of Building 155 (see Appendix D). Stains were apparently the result of spilled liquids. Runoff from these areas was collected in a grated drainage basin which discharged to surface drainage ditches.

East of the paint locker is a small building called the Filter Building (Building 2960) thought to contain compressors. A small opening at the base of Building 2960's east wall was used to drain liquids from the building. Liquids including oils and compressor fluids were being piped or flowing freely from this opening. The wall around to the opening and soils in the adjacent area were extensively stained with an oil-like substance and oily products were puddled in areas (see Appendix D). Runoff from this area is collected in a grated basin and piped towards the east. The discharge point of runoff collected from this area is unknown.

Preparation operations inside Building 155 include painting and hot melt applications. Vapors and particulates resulting from these processes were vented to the atmosphere without control prior to the late 1970s. Scrubbers were added to control releases of vapors and particulates to the atmosphere.

Also noted during the unit inspection of Mine Fill A was a spill of bituminous liquid around a utility pole south of Building 196. This spill covered an area approximately 10 feet in diameter and continued 1.5 feet up the side of the adjacent enclosed Mine Fill Production line (see Appendix D). Environmental Protection Division staff indicated that this was a contractor spill. In addition, stock piles of "hot melt" materials left exposed were in poor condition. Fragments of the hot melt mix had apparently melted on the ground surface.

Conditions on the north portion of Mine Fill A are assumed to be similar since operations are identical to the southern half.

5.4.3 Maintenance and Schedules

Information on maintenance activities including inspections and scheduling was obtained from file information and a personal interview with a former long-time NWSCC employee (1991f) who worked at Mine Fill A from 1965 through 1969.

Maintenance at Mine Fill A included hosing down of the railroad track unloading area near the box emptying house. This area was rinsed with water at least once per day to prevent an accidental explosion resulting from ignition of explosive dust in the area. Rinsing was required prior to moving rail cars in the area; this may have occurred more than once per day. Additionally, rinse water draining from the loading pad is diverted to catch basins, and prior to 1990, discharged directly to surface drainage as previously discussed.

The roof of the box emptying houses were previously reported to collect a large quantity of explosive dust (up to 40,000 pounds per year as reported in NEESA, 1983) as a result of venting of screening activities inside. To minimize the potential of accidental explosion, the roof and area around the box emptying buildings were rinsed with water to remove explosive dust. Rinse water was discharged directly to the ground surface. The need for this type of rinsing was eliminated in the late 1970s when scrubbers were added to the stack vents.

Facilities in the melt and pour room of the bomb-mine fill building were periodically rinsed with water to minimize the potential for an accidental explosion. It is assumed that rinsing operations were completed on a schedule similar to that for the box emptying building. Water used during the wash down of the bomb-mine fill building is collected by a series of drainage basins and routed to a settling basin. Settling basins were potentially constructed with gravel bottoms. A work order dated May 27, 1987, requests that the conditions of basins be checked and construction materials confirmed. No follow-up report on this work order was found. Other work orders, memoranda, and inspection sheets note cracks in the drainage systems and containment basins at Buildings 152 and 153. Documents confirming repairs at these locations could not be located.

Containment and settling sumps/pits were periodically drained and cleaned. Solids or sludges present in the pits were removed and sent to the Ammunition Burning Grounds for disposal. Schedules of inspections and cleanings for Mine Fill A sumps and containment basins could not be determined from available records.

Kettles used to melt explosives were reportedly cleaned once per week. The cleaning process involved boiling water in the kettles to remove explosive residues. After cleaning, cleaning water was conveyed from the building through a network of troughs and pits and discharged to the environment. The waste water drainage network was concrete lined.

Additional maintenance included periodic cleaning of mine cars and loading racks used to transport bombs and materials on the production line. These carts were cleaned in a washing area in Building 155. Notes of a meeting discussing updates to take place at the south end of Mine Fill A dated March 9, 1987, (NWSCC, 1987) discusses improvements to the production car cleaning area. Improvements include closing off car washdown pit drains so contaminated water will not discharge to the ground. Instead, water will be collected and hauled to a treatment facility.

Wastewaters held in containment structures or collected along the production line, which are potentially contaminated with explosives, have been transferred to a railroad tanker car for storage and shipment to wastewater treatment facilities at Building 3110 (in Mine Fill A) or the Rockeye Treatment Facility since 1980. Spills associated with the transfer to and storage of pink water in the railroad tanker have periodically occurred. Spills and releases were discussed in a preceding section of this section. Prior to 1980, wastewaters were pumped and transported for treatment from individual containment structures, discarded in the sanitary sewer, or discharged to the environment.

Treatment of explosive-contaminated wastewaters at Building 3110 was initiated 4 or 5 years ago (NWSCC, 1991a and 1991d). Prior to this time, wastewater was shipped to the Rockeye Treatment Facility. Treatment at Building 3110 involves filtering and carbon sorption. Facilities at the plant include filters, carbon columns, and four concrete sumps. The four concrete sumps are used to hold water during various phases of the treatment process.

Concrete holding sumps are drained and inspected every week to evaluate their condition and determine if solids need to be removed from the sump bottoms. Sumps are cleaned as needed, and the recovered solids sent to the Ammunition Burning Grounds for disposal. Records indicate that sumps have overflowed in the past, releasing wastewater to the adjacent area. Spills at the Building 3110 Treatment Facility were discussed in a previous section of this section.

Carbon in the treatment columns is changed when analyses of discharge water samples indicate a change is necessary. In general, carbon in the treatment columns is changed at approximately 4-week intervals (NWSCC, 1991d). Spent carbon was burned at the Ammunition Burning Grounds until approximately 1988. During 1988 and 1989, spent carbon was stored at NWSCC awaiting recycle. Beginning in 1989, carbon has been shipped off-site, reclaimed, and returned to the wastewater treatment facility at NWSCC.

5.5 WASTE CHARACTERISTICS

5.5.1 Type of Waste Placed in the Unit

5.5.1.1 Hazardous Classification

Specific information regarding hazardous wastes generated at Mine Fill A was not found. RCRA hazardous wastes stored at NWSCC, however, are listed in the RCRA Permit. Based on permit information, hazardous wastes potentially generated in Mine Fill A are listed in Table 5-7.

5.5.1.2 Quantity

Measured estimates of explosive dust through the exhaust system was approximately 40,000 pounds per year during peak production periods before the particulate abatement system was installed (NEESA, 1983). The 1984 testing of exhaust systems Nos. 1 and 6 in Building 160 reveal that a total of 0.6734 pounds per hour (Department of the Navy, 1984), or about 5,900 pounds per year, are released from these two stacks.

Average flows of explosive contaminated wastewater from various Mine Fill A buildings, estimated in 1972 (Kent et al., 1973), were:

Building Number	Average Flow (GPD)
160	45,000
157	52,000
152	20,000

The Building 160 wastewater treatment facility design analysis (MSHM, 1980) was based upon an estimated 2,630 gallons maximum of wastewater per shift, or an average of 5.5 gallons per minute. This estimate was based upon the following volumes generated each shift:

TABLE 5-7

POTENTIAL HAZARDOUS WASTES[1]
MINE FILL A
NWSCC
CRANE, INDIANA
AUGUST 1992

Waste	Hazardous Constituent	Hazardous Waste Number	Hazard Code
Sludge	RDX	D003	R
	TNT	D003	R
	PETN	D003	R
Pink Water	TNT	K047/D003	R
Grit blast residue	Cadmium	D006	T
	Chromium	D007	T
	Lead	D008	T
	Barium	D005	T
Paint waste	Chromium	D007	T
	Lead	D008	T
	Dichloromethane	F002,U080	T
	Acetone	F003,U002	T
	Ethanol	D001	I
	Isopropanol	D001	I
	Methanol	D001,U154	I,T
	Methyl Ethyl ketone	F005	I,T
	Methy Isobutyl Ketone	F005	I,T
	Naphtha	D001	I
	Toluene	F005,U220	I,T
	Xylene	F003	I
Spent Carbon	Spent carbon from the treatment of wastewater containing explosives	K045	R

NOTE:

R Reactivity hazard.
T Toxicity hazard.
I Ignitability hazard.
1 Adapted from RCRA Facility Permit No. IN5 17023498.

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Aluminum Catch Pans	250 gallons
Cabinet Exhaust Condensate	110 gallons
Condensate from Other Operations	550 gallons
Bomb Casing Cleanout and Kernelling	1,000 gallons
General Washdown	720 gallons

The 5.5 gpm estimate, therefore, does not include wastewater generated in other buildings which is currently treated in the same plant.

5.5.1.3 Chemical Composition

The wastes generated in Mine Fill A consist mainly of TNT, RDX, and HMX in varying compositions. Aluminum powder was also stored and used in the area. Primary chemical constituents and explosive compositions are listed in Table 5-8.

5.5.2 Physical and Chemical Characteristics

The properties for the chemicals of concern in Mine Fill A are listed in Table 5-9. The type of explosives used in Mine Fill A are secondary high explosives. These explosives are less sensitive than primary explosives and require a detonator to be set off. Once set off, however, they are very powerful (Considine et al., 1984).

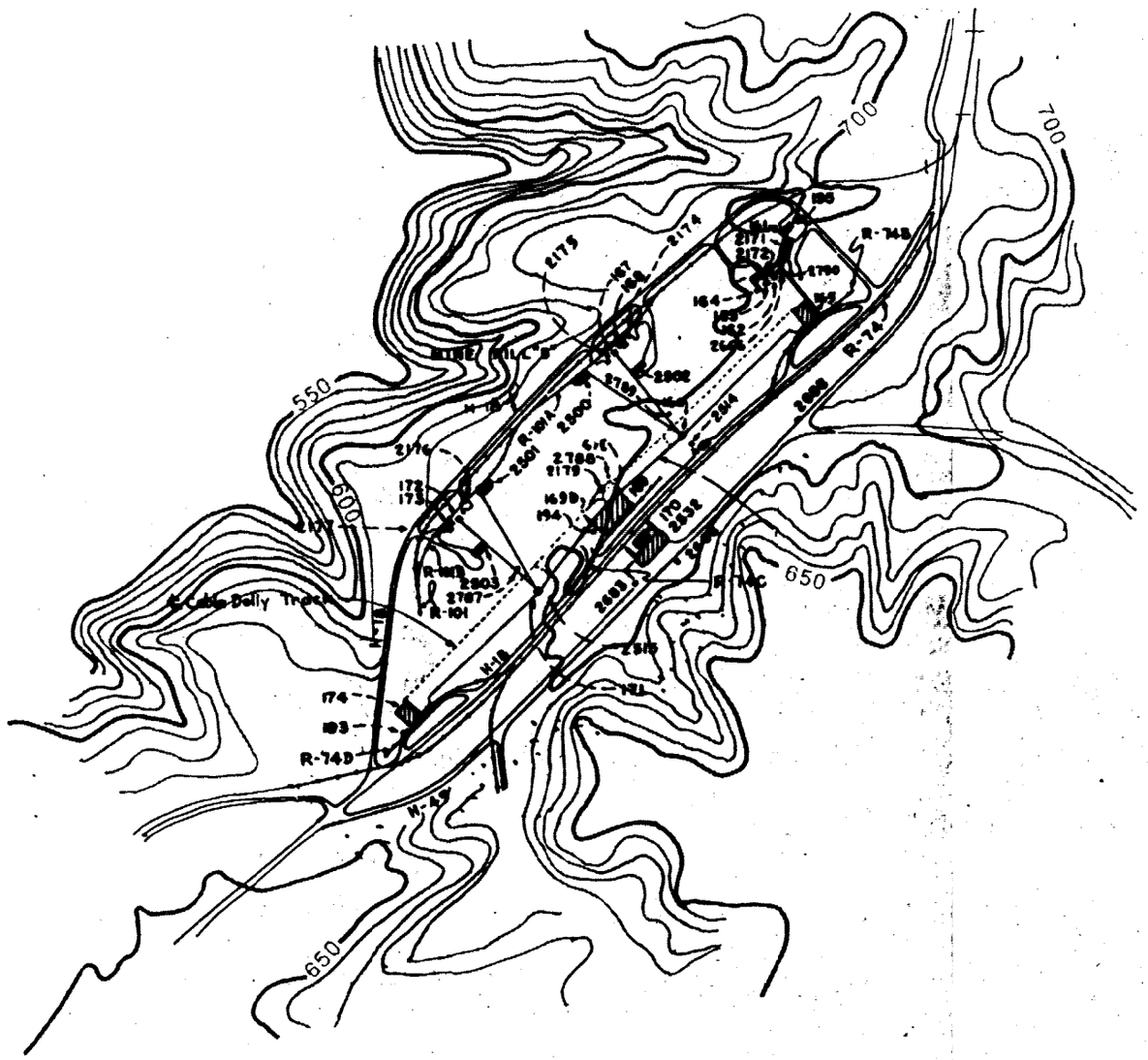
TNT and several of its transformation products are known to be toxic to fish and other aquatic fauna, inhibitory to plant growth, and in some areas, mutagenic to microorganisms (Pennington, 1990). In humans, TNT can affect the body if it is inhaled, comes into contact with the eyes or skin, or if it is swallowed. It may be absorbed into the body through skin. TNT can cause liver damage with yellow jaundice and anemia which may be fatal. It can also cause: irritation of the eyes, nose, and throat; skin rash; staining of skin, hair, and nails yellow; limited ability of blood to carry oxygen; muscular pains; heart irregularities; kidney irritation; cataracts of the eyes; menstrual irregularities; and nerve damage (OSHA, 1978).

TNT will detonate only if vigorously shocked or heated (Sax and Lewis, 1987). TNT will ignite upon contact with strong oxidizers. In addition, contact with ammonia or strong alkalies may increase the sensitivity of TNT to shock (OSHA, 1978).

RDX has toxic effects on the central nervous system. Inhalation of dust has caused nausea, irritability, convulsions, unconsciousness, and amnesia. Ingestion of RDX has caused similar effects (USEPA, 1988a). HMX has not been found to be mutagenic, but is a human skin irritant (USEPA, 1988b).

CTO #0006
FINAL EMR

EPA ID NO. IN5 170 023 498
NWSCC EMR
DATE: AUGUST 1992



Mine Fill B

161 - Crate - painting
162 - Drilling building
163 - Drilling building
164 - Drilling building
165 - Cooling and temporary storage
166 - Bomb-mine fill building
167 - Box emptying building
168 - Explosive receiving building
169 - Empty mine storage building
170 - Lunch-locker building
171 - Bomb-mine filling building
172 - Box emptying building
173 - Explosive receiving building
174 - Cooling temporary storage building
193 - Oil-paint locker
194 - Oil-paint locker
195 - Oil-paint locker

1690 - High explosive magazine
2171 - Fuse house
2172 - Transfer dock
2174 - Storage bin
2175 - Storage bin
2176 - Storage bin
2177 - Storage bin
2179 - Car shelter
2500 - Nitrate preparation
2501 - Nitrate preparation
2502 - Powdered metal building
2503 - Powdered metal building
2514 - Safety boot and shoe building
2515 - Safety boot and shoe building
2532 - LUnch and locker building
2666 - Air compressor house
2683 - Shelter-bus stop
2787 - Pump house
2788 - Pump house
2790 - Pump house

N

APPROXIMATE SCALE: 1"=250'
CONTOUR INTERVAL = 10'

ADAPTED FROM:
NAVAL FACILITIES ENGINEERING COMMAND, 1962
AND UNITED STATES GEOLOGICAL SURVEY, 1978.

AUGUST 1992

FIGURE 6-1
SWMU #13/14 - MINE FILL "B"

ENVIRONMENTAL MONITORING REPORT
NWSCC
CRANE, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

20601

TABLE 5-8

**CHEMICAL COMPOSITION OF WASTES
MINE FILL A
NWSCC
CRANE, INDIANA
AUGUST 1992**

Chemical/Mixture	Constituents
TNT	2,4,6-Trinitroluene
RDX	Cyclotrimethylenetrinitramine
HMX	Cyclotetramethylenetetranitramine
HBX	RDX/TNT/Aluminum/Wax/Calcium Chloride
Composition B	RDX (60%)/TNT (40%)/WAX (1%)
H-6	RDX(45%)/TNT (30%)/Aluminum (20%)/D-2 Wax (5%)
Tritanol	TNT(80%)/Aluminum (20%)
Minol	TNT/Ammonium Nitrate/Aluminum
Tetryl	Trinitrophenylmethylnitramine
Tetrytol	Tetryl/TNT

Source: Department of the Army, 1984.

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TABLE 5-9

CHARACTERISTICS OF CHEMICALS OF CONCERN
MINE FILL A
NWSCC
CRANE, INDIANA
AUGUST 1992

Chemical	Physical Form	General Chemical Class	Physical Descript.	Molec. Weight (g/mole)	Density (g/cm3)	Solub. in Water	Vapor Press. (mm Hg)	Biodegradability
TNT (Trintro-toluene) CAS 118-96-7 (C7HN306)	Solid	Explosive	Yellow Crystals	227	1.654	Low	6E-06 torr	Low to Moderate
RDX (Cyclotrimethylenetrinitramine) CAS 121-82-4 (C3H6N606)	Solid	Explosive	White Crystals	222	1.824	Low	4E-09 torr	Low to Moderate
HMX (Cyclotetramethylenetetranitramine) CAS 2691-41-0 (C4H8N808)	Solid	Explosive	White Crystals	296	1.816	Low	3E-14	NA
Tetryl ($C_7H5N5O8$)	Solid	Explosive	Yellow Crystals	287	1.57	Low	NA	NA
N-N' Ethylene bis-Stearamide (CAS No. 110-30-5)	Solid	Wax	Waxy Powder or Flakes	NA	0.885	Low	Negli-gible	NA

TABLE 5-9 (Continued)

**CHARACTERISTICS OF CHEMICALS OF CONCERN
MINE FILL A
NWSCC
CRANE, INDIANA
AUGUST 1992**

Chemical	Physical Form	General Chemical Class	Physical Descript.	Molec. Weight (g/mole)	Density (g/cm3)	Solub. in Water	Vapor Press. (mm Hg)	Biodegradability
Bituminous Asphalt	Liquid	Residual Fuel	Dark or Black	600-1000	0.95-1.05	No	<10	Yes
Micro-crystalline Wax	Solid	Heavy Oil Black	Brown to	500-800	0.93	No	Negli-gible	NA
Toluene (C6H5CH3)	Liquid	Solvent	Colorless	92.13	0.866	Moderate	22	Yes
Naphtha								
Petroleum Naphtha	Liquid	Thinner	Liquid	NA	0.6	NA	NA	NA
Coal-tar Naphtha	Liquid	Solvent	Water-White Liquid	NA	0.862-0.872	NA	NA	NA
Methylethyl ketone (CH3COO(H2CH3))	Liquid	Paint Remover	Colorless Liquid	72	0.8255	High	NA	NA

TABLE 5-9 (Continued)

CHARACTERISTICS OF CHEMICALS OF CONCERN
MINE FILL A
NWSCC
CRANE, INDIANA
AUGUST 1992

Chemical	Physical Form	General Chemical Class	Physical Descript.	Molec. Weight (g/mole)	Density (g/cm3)	Solub. in Water	Vapor Press. (mm Hg)	Biodegradability
Aluminum	Solid	Metal	Silvery-White Crystalline Solid	27	2.699	NA	NA	NA

Legend:

NA: Data not available
N/A: Data not applicable

Sources: Verschueren, 1983.
Lidde, 1991.
Perry et al., 1984.
Dean et al., 1985.
Layton et al., 1987.

5.5.3 Migration and Dispersal Characteristics

Overall, sorption to soils will not effectively prevent mobility through surface soils of secondary explosive compounds. Sorption of TNT to soils is most closely correlated with extractable iron, cation exchange capacity, and percent clay. Also, sorption and desorption appear to occur to the same extent, suggesting that continued desorption, or leaching may remove TNT from soils unless more strongly adsorbed products are formed (Pennington, 1990). TNT is more readily sorbed than HMX, which is in turn, sorbed more readily than RDX (Leggett, 1985). The explosive compounds of concern released from Mine Fill A, therefore, will not be immobilized by surface soils. Contaminants in soil will be slowly solubilized by precipitation or infiltration of surface water and will percolate into the groundwater.

Microbial cleavage of the TNT ring structure has only been reported once in the literature. TNT, however, can be transformed by bio-organisms. The predominant changes are the reduction of nitro side groups into amino groups and the coupling of rings to product azoxy compounds (Pennington, 1990). The similarity of TNT to other easily biodegradable cyclic organics, however, suggests that TNT may be completely biodegradable.

Unlike TNT, the ring structure of RDX completely breaks down with anaerobic biodegradation during composting (Doyle, 1986). Aerobic biodegradation of RDX is not known to occur (USATHAMA, 1988). The complete biodegradation of HMX has not been observed, however, anaerobic conditions enhance HMX decomposition (USATHAMA, 1988).

TNT has been observed to photodecompose. The principal product formed in natural waters is 1,3,5-trinitrobenzene (Pennington, 1990). The primary environmental loss mechanism for RDX and HMX is photolysis (USEPA, 1988a and 1988b).

The primary transformation products (both biotic and abiotic) of TNT are 4-amino-2,6,-dinitrotoluene (4ADNT) and 2-amino-4,6-dinitrotoluene (2ADNT). These compounds tend to be more persistent in soils, with 4ADNT more resistant than 2ADNT (Pennington, 1990).

5.6 CONCLUSIONS

Background data and site observations were reviewed to determine the likelihood of a release posing a potential threat to human health or the environment. Data and observations pertinent to SWMU #12/14, Mine Fill A, were reviewed to assess the potential for contaminant releases to groundwater, surface water, air, and soil. Data was interpreted and release determinations were made according to the approach described in RCRA Facility Assessment Guidance (USEPA, 1986).

At Mine Fill A, potential releases to groundwater were determined to be likely based on unit characteristics including unit type, ineffective, inoperative, or absent structures designed to prevent releases to groundwater, unit operation, physical condition, locational characteristics, and waste characteristics. Releases to surface water were determined to have occurred based on unit design and physical characteristics (including the absence of engineered features to prevent releases to surface water in the past, operational history, and physical condition), as well as the release migration potential posed by the terrain, waste characteristics, discharge characteristics, visual evidence of release to surface water, and analytical data. Releases to air were determined to have occurred based on unit operating characteristics and unit surface area for exposure, waste characteristics exhibiting potential for vapor and particulate releases (historically but not currently) and historical records. Direct visual evidence of vapor or particulate release to the atmosphere, however, were not obtained. Releases to soil were identified based on the unit type and design, absence or inefficiency of engineered structures to prevent releases to the soil, unit operating characteristics and procedures, physical condition, and analytical data. Table 5-10 summarizes these conclusions.

Recommendations for continuing or ceasing of RFI Corrective Actions based on the information reviewed will be presented for Mine Fill A in Section 7.

RP/6EMRF/AA5

TABLE 5-10

**POTENTIAL RELEASES
MINE FILL A
NWSCC
CRANE, INDIANA
AUGUST 1992**

Media	Release	Suspected Contaminants[4]
Groundwater	Likely	Explosive components
Surface Water	Occurred[3]	Explosive components
Soil	Occurred[3,1]	Explosive comopnents
Air	Occurred[2]	Explosive components

NOTE:

1 Observed.
2 Reported.
3 Analytical Records.
4 See Table 5-9 for individual compounds.

RP/6EMRF/AA3

6.0 SWMU #13/14, MINE FILL B

6.1 BACKGROUND

This section will present background information specific to SWMU #13/14, Mine Fill B. Mine Fill B was an operation similar to Mine Fill A. Mine Fill B, however, has not loaded bombs since 1973. The site is currently used for renovation and rework of munition items.

6.1.1 Physical Features

6.1.1.1 Location

Mine Fill B is located in the west-central portion of NWSCC. On Figure 2-5, it occupies the east-central area of Navy-designated Section 12, near map coordinates CC-22. The entrance to Mine Fill B facilities is off of H-45.

Mine Fill B buildings and significant structures are presented in Figure 6-1.

6.1.1.2 Legal Description

This SWMU is situated at: NE 1/4, S27, T5N, R4W. Latitude and longitude for Mine Fill B are 38° 50'37"N and 86° 50'04"W.

6.1.1.3 Contiguous Property

Mine Fill B consists of 39 buildings and is situated along H-18. Railroads 74 and 101 have access to the area. The following is a list of buildings in Mine Fill B that have housed significant explosives operations (NEESA, 1983). The building number and title are listed, along with the ordnance material handled, enclosed in parentheses.

Building Number	Building Title
161	Insert Prep
162	Storage Prep
163	Storage Prep
164	Storage Prep
165	Temporary Storage and Cooling
166	Bomb and Mine Filling
167	Box Emptying
168	Receiving Building (Explosives)
169	Empty Mine Storage

Building Number	Building Title
171	Bomb and Mine Filling
172	Box Emptying
173	Receiving Building (Explosives)
174	Cooling and Temporary Storage
2171	Storage
2500	Nitrate Preparation and Storage (Ammonium Nitrate)
2502	Powdered Metal (Aluminum)
2503	Powdered Metal (Aluminum)

Nearby structures include magazines and loading and filling buildings to the west, bomb proof group and demolition area to the south, supply department to the east, and Mine Fill Area A to the northeast.

6.1.1.4 Topography

Mine Fill B occupies approximately 62 acres of upland area at NWSCC. The topography at Mine Fill B is gently sloping from the northeast towards the southwest. Elevations within Mine Fill B range from approximately 715 feet MSL in the northeast to approximately 657 feet MSL near the southwestern boundary. Topography changes sharply beyond the boundaries of Mine Fill B. The land surface slopes sharply along the southeastern and northwestern boundaries of Mine Fill B. Elevation of the slope along the southeastern boundary ranges from 700 feet MSL near the crest to 530 feet near the base. Relief along the northwestern boundary is less; elevations on the slope northwest of Mine Fill B range from approximately 680 feet MSL at the crest to 550 feet MSL at the base.

6.1.1.5 Surface Water and Hydrology

Surface drainage is routed via ditches and culverts to intermittent drainageways transcending slopes on the northwestern and southeastern boundaries of Mine Fill B. The majority of surface drainage is collected and drained towards the northwest. Surface drainage flowing towards the northwest enters a southwest flowing intermittent tributary to Boggs Creek. Boggs Creek flows in a general southward direction and exits the southern boundary of NWSCC. After exiting NWSCC, Boggs Creek continues to flow south eventually discharging to the East Fork of the White River.

Surface drainage flowing down the slope southeast of Mine Fill B enters intermittent drainageways which converge into two larger intermittent drainageways. These larger intermittent drainageways flow into Turkey Creek which flows south-southwest to merge with Boggs Creek. The distance between Mine Fill B and Turkey Creek is approximately 1 mile.

6.1.1.6 Geology

Soils

The following discussion of soil in Mine Fill B was prepared using information obtained from the Soil Survey of Martin County, Indiana by McElrath (1988) which is published by the SCS of the USDA.

Detailed soils mapping of Mine Fill B by the USDA, Soil Conservation Service (SCS) show the area to be covered by Zanesville-Udorthents complex soil. Zanesville soil is commonly found on ridge tops in upland areas. Udorthents occur in areas which have been affected by earth moving activities. In general, the Zanesville soil and Udorthents are so intricately intermixed that separating them is impractical. The soils at Mine Fill B are gently to moderately sloping (2 to 12 percent slopes). Soil of the Zanesville-Udorthents complex is characteristically well-drained to moderately well-drained.

USCS classifications for the upper portions of the Zanesville-Udorthents complex soils are clay (CL), silt (ML), and silty clay (ML-CL). At depth, USCS classifications include clay (CL), sandy clay (SC), silty sand (SM), and silty gravel (GM).

Permeability in the Zanesville-Udorthents complex varies with depth. Zanesville soil has moderately hydraulic conductivity above the fragipan (generally found at a depth of 2.5 to 4.0 feet). Hydraulic conductivities in this zone range from 4.2×10^{-4} to 1.4×10^{-3} cm/sec. Within the fragipan, hydraulic conductivity is low, reportedly ranging from 4.2×10^{-5} to 1.4×10^{-4} cm/sec. Below the fragipan, hydraulic conductivity increases to the range found above the fragipan. Hydraulic conductivities in Udorthents are considered moderate and similar to those found above the fragipan in Zanesville soils. Surface runoff is described as medium by the USDA for soils in the Mine Fill B area. Erosion and runoff are considered significant environmental concerns at Mine Fill B.

Depth to bedrock, in areas covered by Zanesville and Udorthent soils, generally ranges from 45 to greater than 65 inches. Depth to bedrock is often at the lower end of this range where earth moving activities have occurred.

Bedrock

The bedrock surface beneath Mine Fill B is composed of sandstone, shale and limestone of the Pennsylvanian Age Raccoon Group. At lower elevations resulting from erosion within drainageways, the bedrock surface is composed of limestone and sandstone of the Mississippian Age Stephensport Group (Department of the Army, 1978).

Information specific to the bedrock geology at Mine Fill B was not found. Three water supply wells are present in the vicinity of Mine Fill B. Well W039 lies approximately 2,200 feet north and is reported to be a 6-foot deep, hand dug well. Well W036 lies approximately 1,100 feet west of Mine Fill B and is reported to be a 12-foot deep hand dug well. Two shallow soil borings (maximum depth 11 feet) were completed adjacent to W036 during groundwater sampling in 1972 (Kent et al., 1972). Well W030 lies approximately 4,800 feet southeast of Mine Fill B and is reported to be a 15-foot deep hand dug well.

Geologic boring logs exist for W036 and adjacent borings (WA36 and WB36); however, none of these installations encountered bedrock. Soils descriptions in these borings include clays and sandy clays. Geologic logs for Wells W030 and W039 were not provided; however, these installations are not considered to have encountered bedrock (Kent, 1972).

The lineation study completed by the Army Corps of Engineers (undated) at NWSCC shows a northeast-southwest trending lineation approximately 1,000 feet northwest of Mine Fill B. A north-south trending lineation occurs approximately 1,500 feet east, and another northwest-southeast trending lineation 4,000 feet south.

6.1.1.7 Hydrogeology

Regional hydrogeology of NWSCC was presented in Section 2. Information on hydrogeology specific to Mine Fill B was not obtained. Chemical sampling was previously completed at water supply wells W030, W036, and W039 as well as at borings WA36 and WB36 (Kent, et al., 1972). Depths to water were not recorded during sampling and no groundwater flow evaluations were made. The absence of geologic boring information and water level information precludes a hydrogeologic evaluation of Mine Fill B.

6.1.2 Spills or Releases

The major sources of contamination from Mine Fill B facilities resulted from washdown operations and exhausts vented from facility ventilation systems. The exhaust system released dust that settled on the roofs of the buildings adjacent to the facilities. It was reported that an explosive dust layer would accumulate on the roof of the box emptying buildings (Buildings 153 and 167) and would require hosing down. The explosive would then be washed onto the surrounding ground. Measured estimates of dust released through the exhaust system was approximately 40,000 pounds per year during peak production periods (NEESA, 1983). Documented evidence (see Section 6.3.2) shows significant contamination in the mine fill area. The contaminants documented are TNT, RDX, and HMX.

Additionally, the unit formerly managed explosive contaminated water that was allowed to enter surface drainage (A.T. Kearney, 1987).

Mine Fill B formerly utilized therminol boilers located near Buildings 171 and 166, the two mine and bomb filling buildings. It is assumed that PCB oils were heated in these boilers and then transported to the melt building where the oil was used as a heat transfer medium in the melting of explosive mixtures. PCB oils leaked or spilled from the boilers and conveyance system, contaminating soil. The therminol boilers and known PCB-contaminated soil were removed in the Summer of 1989. Information concerning the exact location or quantity of excavated soil was not available. Subsequent soil analyses were done to verify that the two areas had been cleaned up to acceptable levels. The analytical results indicate that further excavation will be necessary to remove soils that have PCB concentrations greater than 10 ppm (NAVFAC, undated).

According to Navy Environmental Protection Division files (File 5090/4.9.3), 10 to 15 gallons of titanium tetrachloride were spilled in Mine Fill B at Building 169 on November 10, 1987. A cylinder depressurized and spilled the material when an employee was clearing an obstruction of a valve. The material was reportedly neutralized and disposed as a hazardous waste. The area was later covered with sodium bicarbonate and the residue disposed in a sanitary landfill.

6.1.3 Ownership and History

Mine Fill B was an operation similar to Mine Fill A, except that it has larger melt kettles. The line, however, has not been in operation since 1973.

In September 1942, the Mine Fill complex began production with the cast loading of depth charge bombs. Numerous items were produced. A partial list and production totals of each item during World War II is listed below.

Item	Total Production
4"5 Rocket Heads	963,000
5" Rocket Heads	570,000
Depth Charges	134,000
Projector Charger	364,000
3"/50 Ammunition	540,000

The cast loading of 3-inch projectiles was transferred to another area (Building 146) in December 1943. Mine Fill B originally had the capability of handling TNT only. Mine Fill B was modified to process Torpex, Minol, HBX, and Amatol. Fertilizers (ammonium nitrate) were also melted into bombs.

The area was utilized to some extent during the Korean War. Aerial depth bombs were loaded with TNT and HBX. During the 1950s, this area also reportedly filled ash-can type depth bombs and mine casings. Prior to 1957, these were the only bombs loaded here. Up to that time, the Army had loaded all bombs. Between 1958 and 1960, the Navy decided to load its own low drag bombs, and a small-scale operation loaded low drag bombs of 250-, 500-, 1,000-, and 2000-pound weight with H6. In Mine Fill B, 7.2 projectile heads, the Hedge Hog, and anti-submarine depth charges were loaded. Production rates were not obtained.

During the Vietnam War, the mine filling complex manufactured over six million bombs. Types of explosives processed included TNT, Comp B, H-6, Tritanol, and Minol. Mine Fill B is currently used for renovation/rework of munition items.

Explosive production equipment at Mine Fill B has been cannibalized since production was stopped. Some engineering features to control emissions to the air, water, and soils added at Mine Fill A were not added at Mine Fill B.

6.1.4 Waste Descriptions

Similar to Mine Fill A, the exhaust ventilation system in Mine Fill B released large quantities of explosive particulate matter to the surrounding area. This particulate matter collected on rooftops during peak filling periods and had to be hosed down to prevent buildup of explosive material. Particulate control equipment and wastewater treatment programs were never constructed in Mine Fill B.

Large quantities of TNT, Composition B, HBX-1, HBX-3, and H6 were reportedly collected in the sumps in this area. Sumps released explosive-contaminated wastewater directly to surface drainage which flows into the Boggs Creek Watershed. Thus, the entire ground area, particularly the drainage ditches, may be heavily contaminated with explosives as a result of past operations.

Other materials previously stored and used in Mine Fill B included powdered aluminum and nitrate.

6.2 PERMITS

6.2.1 Air

Two paint booths in Mine Fill B are authorized to operate under Operation Permit Identification No. 51-05-88-0028 (Indiana Air Pollution Control Board, 1985). These paint booths are located in Building 169 and are equipped with dry filters for particulate control.

All of NWSCC's Operation Permits expired May 1, 1988. Operations are allowed to continue, however, because the State has not acted upon new applications submitted in 1988.

6.2.2 Groundwater

According to the Navy (NWSCC, 1991a), no groundwater permits are required in this area.

6.2.3 Surface Water

No outfalls monitored for current or past NPDES permits are located in the Mine Fill B area.

6.2.4 Soil

No permits pertaining to soil use or monitoring are required according to Navy sources (1991a).

6.3 EXISTING DATA ASSESSMENT

6.3.1 Monitoring Devices

No monitoring devices are located in Mine Fill B. Data, however, have been collected in the area at various times and are discussed in the next section.

6.3.2 Analytical Data

There is documented trace contamination of the soils surrounding the site. The potential for release to surface water due to run-off of contaminated soils is high.

The boiler system at Mine Fill B in Buildings 166 and 171, which used PCB oils, released PCBs into nearby soils. The boilers and known PCB contaminated soil were removed from the area. Subsequent confirmational sampling, however, revealed that soils with PCB concentrations greater than 10 ppm still remain (NAVFAC, undated).

Surface water and effluent collected at various times around the mine fill area reveal a degree of explosives contamination. Some data are presented in Table 6-1. In particular, a combined water quality engineering and biological study was performed by the U.S. Army Environmental Hygiene Agency (AEHA) in 1979 (Department of the Army, 1980). The AEHA study was conducted to characterize wastewaters from industrial operations and to

TABLE 6-1

SURFACE WATER ANALYTICAL RESULTS
MINE FILL B
NWSCC
CRANE, INDIANA
AUGUST 1992

	Concentrations, ppm		
	TNT	RDX	HMX
1972 Samples (average concentrations)			
North Drain (Bldgs. 166, 167, 168, 2502)	10.1	0.4	0.26
Central Drain (Bldgs. 166, 2502)	15.4	1.6	0.0
South Drain (Bldgs. 171, 174, 2501, and 2503)	13.2	20.4	2.4
1978 Samples			
North Drain	0.24	0.865	0.46
Runoff, South	7.7	16.0	
1979 Samples[1]			
North Ditch	<0.005	<0.1	<0.1
Central Ditch	0.253	2.7	0.3
South Central Ditch	<0.001	0.6	0.3
South Ditch	<0.005	<0.1	<0.1
1991 Drinking Water Health Advisories[2]			
10-kg Child, One-Day	0.02	0.1	5
10-kg Child, Ten-Day	0.02	0.1	5
10-kg Child, Longer Term	0.02	0.4	5
70-kg Adult, Longer-Term	0.02	0.4	20
70-kg Adult, Lifetime	0.002	0.002	0.04
70-kg Adult, 10^{-4} Cancer Risk	0.1	0.03	--

NOTE:

1 Samples collected at considerable distances from the facilities. Significant dilution of wastewater is expected (NEESA, 1983).

2 USEPA, 1991.

Sources: Kent et al., 1973.
Department of the Army, 1980.
Dodohara and Davis, 1978.

determine the biological impact of discharges upon receiving streams. During this study, Mine Fill B was inactive. Because historical records indicated large quantities of explosives may have passed through the drainage sumps and subsequently contaminated the ditches draining towards Boggs Creek, four samples were collected and analyzed. Sample locations are provided in Appendix H. Runoff and sediment samples were collected in April 1979. These four points were resampled in June 1979. The aqueous data are included in Table 6-1 and the sediment data are summarized in Table 6-2 (maximum detected concentration or maximum detection limit from both sampling events is presented for each sample). Data from both sampling events exhibited the same pattern: samples from the north ditch had no detectable munitions; samples from the central and south-central ditches had measurable concentrations in both the aqueous and sediment fractions; and samples from the south ditch had no detectable munitions in the water but high levels of RDX and HMX were found in the sediment. As Table 6-1 shows, 1991 TNT and RDX Drinking Water Health Advisories for both children and adults were exceeded in the majority of the samples collected in 1972, 1978, and 1979. The adult lifetime health advisory for HMX was also exceeded in several of the samples.

In 1972, three hand-dug wells (W030, W036, and W039) located in the vicinity of Mine Fill B were sampled as part of a pilot test study (Kent et al., 1972). W036 was the only well which contained detectable levels of explosives. This well is located west of Mine Fill B at coordinates CC-20 (Figure 2-5). The well is also located about 15 feet from an intermittent stream originating in Mine Fill B. W036 is not used as a water source and there was no indication of direct surface run-off into the well during the study. Two borings, 11 feet deep and 1.5 feet in diameter, were drilled on a line parallel to the stream 15 feet (WA36) and 28 feet (WB36) downstream from the wells.

A chronological account of Well W036 sampling techniques and analytical data is given in Table 6-3. Raw analytical results for W036 and the two observation wells are summarized in Table 6-4. The data indicate that the explosives concentrations decrease downgradient from W036. However, all three wells contained levels of RDX above the 1991 Drinking Water Health Advisory for 10^{-4} excess adult cancer risk.

Also, during the 1972 pilot test study, soil samples were collected from drainage ditches in the vicinity of Mine Fill B and from the stream near W036. These samples also exhibited TNT and TDX contamination (Table 6-3).

According to Kent et al. (1973), soil samples were collected from ditches near Building 172 in August 1970. The samples showed a high explosives content. Contaminated soil was removed in 1970, but the pilot test studies indicated that explosive contamination still existed since drainage from this area was contaminated in 1973.

TABLE 6-2

**SEDIMENT ANALYTICAL RESULTS, 1979
MINE FILL B
NWSCC
CRANE, INDIANA
AUGUST 1992**

	Detected Concentrations, ppm		
	TNT[1]	RDX	HMX
North Ditch	<0.5	<2	<0.2
Central Ditch	2.0	20	36
South-Central Ditch	0.9	<2	9
South Ditch	0.1	28	3.4

[1] Dry weight basis.

Source: Department of the Army, 1980.

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TABLE 6-3

WELL W036 SAMPLING CHRONOLOGY AND ANALYTICAL RESULTS, 1972
MINE FILL B
NWSCC
CRANE, INDIANA
AUGUST 1992

Location	Date	TNT	RDX
SOIL SAMPLES			
North earth bank Bldg. 172	8/18/72	19%	47%
Soil from ditch northeast of Bldg. 2501	8/18/70	25%	58%
Soil from ditch northwest of Bldg. 172	8/18/72	19%	46%
Soil from stream near W036, Well 12 inches into bank	3/9/72	1.2 mg/g of dry soil	0.5 mg/g of dry soil
Soil from stream near W036, Well 6 inches into bottom	3/9/72	1.2 mg/g of dry soil	0.5 mg/g of dry soil
WATER SAMPLES		PPM	PPM
Well W036	3/8/72	0.1	2.1
Stream beside Well W036	3/8/72	1.0	3.0
Well W036	3/14/72	0.0	2.6
Stream beside Well W036	3/16/72	1.0	3.0
Well W039	3/21/72	0.0	0.0
WA36 Test hole 15 feet from Well W036	4/4/72	0.0	1.2
WA36 Test hole 15 feet from Well W036	4/6/72	0.0	0.8
WB36 Test hole 28 feet from Well W036	4/6/72	0.0	0.1
Stream beside Well W036	4/6/72	Not sampled	
Water running into Well 5 feet below surface after pumping	4/24/72	0.0	0.9
Stream beside Well W036	4/24/72	Not sampled	
Well W036 after refilling	4/25/72	0.0	0.8
Well W036	6/15/72	0.0	7.9
WA36 Test hole 15 feet from Well W036	6/15/72	0.0	1.6
WB36 Test hole 28 feet from Well W036	6/15/72	0.0	0.4

TABLE 6-3 (Continued)

WELL W036 SAMPLING CHRONOLOGY AND ANALYTICAL RESULTS, 1972
MINE FILL B
NWSCC
CRANE, INDIANA
AUGUST 1992

Location	Date	PPM	PPM
WATER SAMPLES			
Stream beside Well W036	6/15/72	5.8	10.0
Well W036 before pumping	6/21/72	0.8	7.5
Well W036 after pumping	6/21/72	3.0	5.4
Bottom sample-Well W036 water and solids	6/21/72	.55	2.1
Stream beside Well W036	6/21/72	Dry stream	
Well W036 after filling for 48 hours	6/23/72	0.8	9.7

Source: Kent et al., 1973.

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TABLE 6-4

RAW DATA FOR W036 AND ADJOINING AREAS
MINE FILL B
NWSCC
CRANE, INDIANA
AUGUST 1992

Description		W036		WA36 15 feet from W036		WB36 28 feet from W036		70-yr Adult
Parameter	Unit	Ave.	No. of Samples	Ave.	No. of Samples	Ave.	No. of Samples	10^{-4} Cancer Risk[1]
TNT	mg/l	0.58	13	0.0	3	0.0	2	0.1
RDX	mg/l	4.1	13	1.2	3	.24	2	0.03
HMX	mg/l	0.0	12	0.0	0	0.0	2	--

NOTE:

1 1991 Drinking Water Health Advisories.

Source: Kent et al., 1973.

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As part of the IAS, sampling recommendations were made for each potentially contaminated SWMU. For Mine Fill B, it was recommended that four samples be collected around both box emptying buildings (Building 167 and Building 172) and analyzed for explosive compounds. This recommendation was carried out in 1985, and the results are presented in Table 6-5. Samples MFB-1 through MFB-4 were collected near Building 167 and samples MFB-4 through MFB-8 were collected around Building 172. Sample locations are given in sketches provided by the Navy and are included in Appendix I. All samples were core soil samples collected to a 20-inch depth. Table 6-5 indicates that the area surrounding Building 172 is much more heavily contaminated with TNT, RDX, and HMX than Building 167. Significant concentrations of all three compounds were detected, particularly in sample MFB-5.

6.3.3 Migration Pathways

The main migration pathways existing at Mine Fill B are surface water, soil, and groundwater. Explosive dust released from the ventilation system collected on nearby rooftops and was hosed down onto nearby ground and drainageways. Additionally, explosive-contaminated wastewater was released to surface drainage ditches. Historical data presented in the previous section indicate that groundwater was already acting as a migration pathway in the early 1970s. Groundwater remains a potential migration pathway. Contaminated sediment in the drainage ditches and nearby streams will continue to act as a contaminant source to the surface water pathway.

Because of the exhaust ventilation system, air was a migration pathway when Mine Fill B was still in operation. Since operations ceased in 1973, air is no longer a major migration pathway. Contaminated particulate material, however, could be resuspended by wind.

6.4 UNIT CHARACTERISTICS

6.4.1 Operations

Mine Fill B is located near the center of NWSCC, southwest of Mine Fill A along H-45. Access to the mine fill area is provided by H-45, and railroad facilities at Mine Fill B are similar to those at Mine Fill A. However, additional nitrate preparation buildings (Buildings 2500 and 2501) are located next to the box emptying buildings. As at Mine Fill A, facilities at Mine Fill B can be divided into two halves in which identical activities took place.

Operations at Mine Fill B began when NWSCC was commissioned in December 1941. Mine Fill B has historically been used to manufacture mines, depth charges, rocket heads,

TABLE 6-5

SOIL ANALYTICAL RESULTS, 1985
MINE FILL B
NWSCC
CRANE, INDIANA
AUGUST 1992

	Detected Concentrations, ppm		
Samples	TNT	HMX	RDX
MFB-1	<3.6	10.8	20.6
MFB-2	<3.6	<5.0	<7.2
MFB-3	<3.6	<5.0	<7.2
MFB-4	<3.6	<5.0	<7.2
MFB-5	2410	2020	24,100
MFB-6	44	91	851
MFB-7	4.8	70	555
MFB-8	7.2	331	2060

Source: Laboratory data sheets provided by NWSCC (no accompanying text provided).

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aerial bombs, and projectiles. Production of explosive ordnance occurred at Mine Fill B from 1941 until 1973. Since 1973, the facilities at Mine Fill B have been used for renovation of ordnance and equipment.

Renovation work in Building 169 includes two paint booths. The 1983 Operation Permit application contained the information on these activities. Paint booth No. 1 applies an enamel coating which contains 22 percent naphtha by weight. Paint booth No. 2 applies a bituminous solvent type coating which contains 30 percent naphtha by weight. In 1982, approximately 700 gallons of each type of coating material were used.

Loading of bullets also reportedly took place in Building 169. Bullets were loaded with titanium tetrachloride and vanadium oxytrichloride or dummy loaded with sands and salts. Renovation of mortars and bullets reportedly takes place in Building 165. Activities include rotary grit blasting, spray painting, propellant removal, and fuse and configuration changes. Building 173 is used to degrease mines (NWSCC, 1991c).

The processes generally involved in bomb-mine production have been described in the section pertaining to Mine Fill A. Since production activities at both Mine Fill A and Mine Fill B were similar prior to 1973, actions resulting environmental impacts at Mine Fill A are thought to have occurred at Mine Fill B.

6.4.2 Observations

Observations made during the SWMU reconnaissance at buildings used exclusively for processing of explosives in the past were similar to those detailed in Mine Fill A. Water draining from the explosive unloading area near the explosive receiving and box emptying buildings is diverted to drains which empty into containment sumps or discharged directly to surface drainageways. Water collected at the unloading area adjacent to the nitrate preparation and storage buildings (Buildings 2500 and 2501) is discharged to surface drainageways.

Utility drawings dated 1941 (Bureau of Yards and Docks, Drawing No. 176272), 1942 (Bureau of Yards and Docks, Drawing No. 180524), and 1953 (Bureau of Yards and Docks, Drawing Nos. 571929 and 571930) do not show sewers or drains to collect drainage from unloading areas near the box emptying, explosive receiving, or nitrate preparation/storage buildings. Plan sheets showing improvements to the drainage collection systems in these areas were not found; therefore, it has been concluded that updates have not occurred. However, during the unit inspection, it was noted that recent repairs have been made to the concrete drainage features in these areas. Nevertheless, cracks were present in the concrete and settling had occurred which has allowed water to collect in low areas.

Vegetation adjacent to the explosive receiving buildings, box emptying buildings, and empty box storage bins was visibly stressed or absent (see Appendix D). Soil sampling conducted in 1970 (Kent et al., 1973) resulted in the removal of soils adjacent to the box emptying building (Building 172). The extent of excavation near Building 172 was not determined. It was noted that the surface of soil impoundments surrounding the explosive receiving and box emptying buildings in Mine Fill B were covered with crushed rock. The reason for this occurrence was not determined. Soil impoundments adjacent to the explosive receiving and box emptying buildings in Mine Fill A are not covered with stone.

At the box emptying buildings, soils in the vicinity of the exit point of the conveyor to the bomb-mine filling building were extensively stained and void of vegetation (see Appendix D for photographs). Impacts to the soil in this area were most extreme near box emptying Building 173 located at the southern end of Mine Fill B. A petroleum-type odor was noted while observing stained soils near Building 173.

Slotted, chain-type conveyors were used to transport explosives and nitrates from the receiving and processing buildings to bomb/mine fill and melt buildings. These conveyors are covered; however, the area beneath the conveyor is open, potentially allowing material to fall to the ground below. Both explosive materials carried by the conveyor system and lubricants used during this operation may have dropped to the ground below. Staining of soils and stressed vegetation were most obvious near the box emptying house end of the conveyor system (see Appendix D).

Stains were noted on the concrete around the bomb/mine filling buildings in Mine Fill B. Water from precipitation or past washdown operations at the bomb/mine filling buildings is collected in concrete troughs and diverted to a settling basin similar to Mine Fill A. Utility plan sheets for Mine Fill B dated 1953 show overflow from settling basins discharging directly to surface drainage. Drainage troughs and settling basins were partially filled or clogged with sediment during the unit inspection on September 6, 1991.

Excavations are present north of Building 171 and south of Building 166. Buildings 171 and 166 are bomb-mine filling buildings (see photographs in Appendix D). Excavations at these locations are the result of PCB-contaminated soil removal completed in the Summer of 1989. Soils were contaminated during the operation of therminol boilers formerly located in these areas. Boilers were used to heat liquids used as a heat transfer medium in the melt kettles in bomb-mine filling buildings. Boilers were removed at the time of soil removal activities. Excavations appeared to extend to the bomb-mine filling buildings where it is assumed piping connecting the boilers and melt kettles formerly existed. A memorandum in regards to the Therminol Boiler Removal Site Cleanup (NWSCC, undated) states that confirmational sampling determined that PCBs were still present in these areas. The memorandum goes on to outline possible remedial actions. During

personal communication with NWSCC, Environmental Division staff (1991a and 1991e), it was determined that the contaminated area has been placed into the IRP for further sampling and remediation. Water collected in these excavations overflows into surface drainageways. Drainage from the northern excavation directly enters a "wetland type" area within Mine Fill B.

Five 55-gallon steel drums labeled as containing debris from PCB verification sampling are stored at the southeast corner of Building 166. These drums had fastened covers and did not appear to be breeched. Particle board sheeting is present beneath the drums.

The remaining observations were made during the unit inspection in the area where buildings are currently used for renovation activities. Renovation activities include metal preparation, welding, and painting. Buildings currently used for renovation activities include the following: empty mine storage building (Building 169), cooling and temporary storage buildings (Buildings 165 and 174), drilling buildings (Building 162, 163, and 164), oil and paint lockers (Buildings 193, 194, and 195), fuse house (Building 2171), and air compressor house (Building 2666).

Waste particles and residues were noted beneath and adjacent to the exhaust stack on the north side of Building 2171 (see photographs in Appendix D). These residues and particles are thought to occur as a result of grit blasting operations in Building 2171. Particles and residues were also present in concrete lined drainageways around Building 2171 (see photographs in Appendix D). Soils and materials in contact with the residues have been stained.

A disposal bin labeled as "Hazardous Waste" is located south of Building 2171. This container appears to contain paint-type wastes. Soils in the vicinity of the container were stained with a paint-type substance. Refer to Appendix D for photograph.

A shaft used to access an underground pipeline is located between Building 2171 and 165 at the north end of Mine Fill B. The shaft is using a drainage culvert approximately 4 feet wide and 10 feet deep. Soils at the bottom of the shaft are stained, and liquids have puddled in areas (see photograph in Appendix D). A strong petroleum odor was noted at the surface of the shaft.

A small structure covering a compressor or generator is located north of Building 169. The hut was labeled as Building 69, however, no such structure is diagrammed in the General Development Maps for Mine Fill A. Machinery inside the structure was operating during the unit inspection. The concrete pad beneath the machinery was coated with oil which had flowed beneath the structure walls onto surrounding soils. The soils surrounding the structure are extensively stained with oils (see photograph in Appendix D).

A bag house knock out-type filter vent is located on the south side of Building 169. Residues and staining were observed on the ground surface near the filter/vent. Extensive staining was observed beneath an exhaust stack on the south side of Building 169 east of the bag house filter/vent. The exhaust vent had substantial surface corrosion (see photograph in Appendix D).

6.4.3 Maintenance and Schedules

During explosive ordnance production at Mine Fill B, maintenance activities and schedules are reported to have been similar to those used in Mine Fill A. The reader is referred to the maintenance activities and schedules in the section on Mine Fill A to learn more on maintenance in Mine Fill B during explosives production.

No information on maintenance activities was obtained for Mine Fill B after termination of explosive ordnance production.

6.5 WASTE CHARACTERISTICS

6.5.1 Type of Waste Place in the Unit

6.5.1.1 Hazardous Classification

Table 6-6 lists RCRA classified wastes which may have been, or are currently, generated in Mine Fill B.

6.5.1.2 Quantity

Measured estimates of explosive dust released through the exhaust ventilation system was approximately 40,000 pounds per year during peak production periods (NEESA, 1983). Average flows of explosive contaminated wastewater from various Mine Fill B buildings, estimated in 1972 (Kent et al., 1973) were as follows:

Building Numbers	Average Flow (GPD)
166, 2502	21,000
171, 174, 2501, 2503	8,700
166, 167, 168, 2502	28,000

TABLE 6-6

POTENTIAL HAZARDOUS WASTES[1]
MINE FILL B
NWSCC
CRANE, INDIANA
AUGUST 1992

Waste	Hazardous Constituent	Hazardous Waste Number	Hazard Code
Sludge	RDX	D003	R
	TNT	D003	R
	PETN	D003	R
Pink Water	TNT	K047/D003	
Grit blast residue	Cadmium	D006	T
	Chromium	D007	T
	Lead	D008	T
	Barium	D005	
Paint waste	Chromium	D007	T
	Lead	D008	T
	Dichloromethane	F002,U080	T
	Acetone	F003,U002	T
	Ethanol	D001	I
	Isopropanol	D001	I
	Methanol	D001,U154	I,T
	Methyl Ethylketone	F005	I,T
	Methy Isobutyl Ketone	F005	I,T
	Naphtha	D001	I
	Toluene	F005,U220	I,T
	Xylene	F003	I

NOTE:

R: Reactive
T: Toxic
I: Ignitable

[1]Adapted from RCRA Facility Permit INS 170023498.

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6.5.1.3 Chemical Composition

The wastes generated in Mine Fill B consist mainly of TNT, RDX, and HMX in varying compositions. Aluminum powder and ammonium nitrate were also stored and used in the area. Primary chemical constituents and explosive compositions are listed in Table 6-7.

6.5.2 Physical and Chemical Characteristics

The properties for the chemicals of concern are listed in Table 6-8. The type of explosives used in Mine Fill B are secondary high explosives. These explosives are less sensitive than primary explosives and require a detonator to be set off. Once set off, however, they are very powerful (Considine et al., 1984).

TNT and several of its transformation products are known to be toxic to fish and other aquatic fauna, inhibitory to plant growth, and, in some cases, mutagenic to microorganisms (Pennington, 1990). In humans, TNT can affect the body if it is inhaled, comes into contact with the eyes or skin, or if it is swallowed. It may be adsorbed into the body through skin. TNT can cause liver damage with yellow jaundice and anemia which may be fatal. It can also cause irritation of the eyes, nose, and throat; skin rash; staining of skin, hair, and nails yellow; limited ability of blood to carry oxygen; muscular pains; heart irregularities; kidney irritation; cataracts of the eyes; menstrual irregularities; and nerve damage (OSHA, 1978).

TNT will detonate only if vigorously shocked or heated (Sax and Lewis, 1987). TNT will ignite upon contact with strong oxidizers. In addition, contact with ammonia or strong alkalies may increase the sensitivity of TNT to shock (OSHA, 1978).

RDX has toxic effects on the central nervous system. Inhalation of dust has caused nausea, irritability, convulsions, unconsciousness, and amnesia. Ingestion of RDX has caused similar effects (USEPA, 1988a). HMX has not been found to be mutagenic, but is a human skin irritant (USEPA, 1988b).

PCBs are highly toxic and suspected human carcinogens. PCBs tend to accumulate in the fatty tissues of fish and other organisms. Ammonium nitrate may explode under confinement and high temperatures, but is not readily detonated (Sax and Lewis, 1987).

Aluminum can ignite violently in powder form. Fine powder forms flammable and explosive mixtures in air. Powdered aluminum is attacked by dilute or concentrated acids and strong alkalies (Sax and Lewis, 1987).

TABLE 6-7

CHEMICAL COMPOSITION OF WASTES
MINE FILL B
NWSCC
CRANE, INDIANA
AUGUST 1992

Chemical/Mixture	Constituents
TNT	2,4,6-Trinitrotoluene
RDX	Cyclotrimethylenetrinitramine
HMX	Cyclotetramethylenetetranitramine
Ammonium Nitrate	NH_4NO_3
Powdered Aluminum	Al
Torpex	RDX/TNT/Aluminum
Minol	Paraffin Liquid
HBX	RDS/TNT/Aluminum/Wax/Calcium Chloride
Amatol	Ammonium nitrate (50% or 80%)/TNT (50% or 20%)
H-6	RDX (45%)/TNT (30%)/Aluminum (20%)/D-2 Wax (5%)
Tritanol	TNT (80°)/Aluminum (20%)
Composition B	RDX (60%)/TNT (40%)/Wax (1%)
PCBs	Aroclor 1242/Aroclor 1254/Aroclor 1260

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TABLE 6-8

**CHARACTERISTICS OF CHEMICALS OF CONCERN
MINE FILL B
NWSCC
CRANE, INDIANA
AUGUST 1992**

Chemical	Physical Form	General Chemical Class	Physical Descript.	Molec. Weight (g/mole)	Density (g/cm3)	Solub. in Water (mg/l)	Vapor Press. (mm Hg)	Biodegradable
TNT (Trinitro-toluene) CAS 118-96-7 (C7H5N306)	Solid	Explosive	Yellow Crystals	227	1.654	Low	6E-06 torr	Low to Moderate
RDX (Cyclotrimethylenetrinitramine) CAS 121-82-4 (C3H6N606)	Solid	Explosive	White Crystals	222	1.824	Low	4E-09 torr	Low to Moderate
HMX (Cyclotetramethylenetetranitramine) CAS 2691-41-0 (C4H8N808)	Solid	Explosive	White Crystals	296	1.9	Low	3E-14	Low

TABLE 6-8 (Continued)

CHARACTERISTICS OF CHEMICALS OF CONCERN
MINE FILL B
NWSCC
CRANE, INDIANA
AUGUST 1992

Chemical	Physical Form	General Chemical Class	Physical Descript.	Molec. Weight (g/mole)	Density (g/cm3)	Solub. in Water (mg/l)	Vapor Press. (mm Hg)	Biodegradable
PCBs:								
Aroclor 1242	Liquid	Coolant Lubricant	Brown Oil	224 plus	1.385	Low	0.00041	Insign.
1254	Liquid	Coolant Lubricant	Brown Oil	224	1.538	Low	0.00008	Insign.
1260	Liquid	Coolant Lubricant	Brown Oil	224	1.44	Low	0.00004	Insign.

Legend: NA: Data not available.
N/A: Data not applicable.

Sources: Verschueren, 1983. Lidde, 1991. Layton et al., 1987. Perry, et al., 1984. Dean, et al., 1985.

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Vanadium oxytrichloride is a strong irritant to tissue. It dissolves most non-metals and dissolves or reacts with many organic compounds (Sax and Lewis, 1987). Titanium tetrachloride is toxic by inhalation and is a strong irritant to skin and tissue (Sax and Lewis, 1987).

6.5.3 Migration and Dispersal Characteristics

Overall, sorption to soils will not effectively prevent mobility through surface soils of secondary explosive compounds. Sorption of TNT onto soils is most closely correlated with extractable iron, cation exchange capacity, and percent clay. Also, sorption and desorption appear to occur to the same extent, suggesting that continued desorption, or leaching, may remove all TNT from soils, unless more strongly sorbed products are formed (Pennington, 1990). TNT is more readily sorbed than HMX, which is, in turn, sorbed more readily than RDX (Leggett, 1985). The explosive compounds of concern released from Mine Fill B, therefore, will not be immobilized by surface soils. Contaminants in soil will be slowly solubilized by precipitation or infiltration of surface water and will percolate into the groundwater.

Microbial cleavage of the TNT ring structure has only been reported once in the literature. TNT, however, can be transformed by bio-organisms. The predominant changes are the reduction of nitro side groups to amino groups and the coupling of rings to produce azoxy compounds (Pennington, 1990). The similarity of TNT to other easily biodegraded cyclic organics, however, suggests that TNT may be completely biodegradable.

Unlike TNT, the ring structure of RDX completely breaks down with anaerobic biodegradation during composting (Doyle, 1986). Aerobic biodegradation of RDX is not known to occur (USATHAMA, 1988). The complete biodegradation of HMX has not been observed, however, anaerobic conditions enhance HMX decomposition (USATHAMA, 1988).

TNT has been observed to photodecompose. 1,3,5-trinitrobenzene is the principal product formed in naturals waters (Pennington, 1990).

The primary transformation products (both biotic and abiotic) of TNT are 4-amino-2,6-dinitrotoluene (4ADNT) and 2-amino-4,6-dinitrotoluene (2ADNT). These compounds tend to be more persistent than TNT in soils, with 4ADNT more resistant than 2ADNT (Pennington, 1990). The primary environmental loss mechanism for RDX and HMX is photolysis (USEPA, 1988a and 1988b).

PCBs exhibit low potential for subsurface mobility due to relatively low water solubility, low vapor pressure, moderate Henry's Law constants, and high Kow and Koc values. PCBs,

which exist as mixtures of isomers, are virtually chemically inert. Most PCBs are virtually insoluble in water and are highly resistant to biodegradation. No information is available on photodecomposition of PCBs. PCBs sorb strongly to soil organic matter and tend to be highly persistent. PCBs spilled from the therminol boilers, therefore, are likely to remain in the surficial soils. Potentially, PCBs attached to soils may be transported as fugitive dust emissions by physical processes.

Ammonium nitrate is highly soluble in water (Sax and Lewis, 1987). Therefore, it will either be quickly leached into groundwater or dissolved into nearby surface waters. Ammonium nitrate will dissociate, increasing nitrogen levels (as ammonia and as nitrate) in water.

Aluminum tends to be strongly sorbed to soils. Therefore, any spilled powdered aluminum should remain immobilized by surface soils.

6.6 CONCLUSIONS

Background data and site observations were reviewed to determine the likelihood of a release posing a potential threat to human health or the environment. Data and observations pertinent to SWMU #13/14, Mine Fill B, were reviewed to assess the potential for contaminant releases to groundwater, surface water, air, and soil. Data were interpreted and release determinations were made according to the approach described in RCRA Facility Assessment Guidance (USEPA, 1986).

At Mine Fill B, releases to groundwater were determined to have occurred based on unit characteristics including unit type, design of sumps, basins, and drainageways, ineffective structures designed to prevent releases to groundwater, unit operation, physical condition, locational characteristics, waste characteristics related to historic introduction of explosive compounds, direct and indirect visual evidence of contamination, and analytical data. Releases to surface water were determined to have occurred based on unit design and physical characteristics (including ineffective engineered features to prevent releases to surface water, operational history, and physical condition), as well as the release migration potential posed by the terrain, waste characteristics, and visual and analytical evidence of release to surface water. Releases to air were determined to have occurred based on unit surface area for exposure, and waste characteristics exhibiting potential for vapor and particulate releases (historically but not currently), and historical direct and indirect visual evidence of vapor or particulate release to the atmosphere. Releases to soil were identified based on the unit type and design, absence or inefficient engineered structures to prevent releases to the soil, unit operating characteristics and procedures, physical condition, and analytical data. Table 6-9 summarizes these conclusions.

TABLE 6-9

POTENTIAL RELEASES
MINE FILL B
NWSCC
CRANE, INDIANA
AUGUST 1992

Media	Release	Suspected Contaminants[4]
Groundwater	Occurred[3]	Explosives
Surface Water	Occurred[3]	Explosives
Soil	Occurred[3,1]	Explosives, Semivolatile Organics
Air	Occurred[2]	Explosives

NOTE:

1 Observed.
2 Reported.
3 Analytical Records.
4 See Table 6-8 for individual compounds.

RP/6EMRF/AA3

Recommendations for continuing or ceasing of RFI Corrective Actions based on the information reviewed will be presented for Mine Fill B in Section 7.

RP/6EMRF/AA6

7.0 RECOMMENDATIONS

Based upon the information and conclusions presented in the preceding sections, the following recommendations are made concerning the need for continuing RFI Corrective Actions at the four SWMUs discussed in this report.

Pyrotechnic Test Areas - SWMU #19/00

At the OTA, Annex Area, and Rocket Range, RFI Phase II Release Assessments for groundwater, surface water, and soil are recommended. An air pathway investigation consisting of modeling rather than field monitoring activities is recommended. This recommendation is based upon information indicating that releases to these media have occurred and these releases pose a potential threat to environmental or human receptors.

Load and Fill Area, Building 106 Pond - SWMU #08/17

RFI Phase II Release Assessments for groundwater, surface water, and soil are recommended. Information received concerning current and past operational history of the Building 106 Pond indicate that contaminants have been released to these three media and may pose a threat to environmental and downstream receptors. An RFI Phase II Release Assessment for air is not recommended because significant quantities of volatile compounds are not known to be currently discharged to Building 106 Pond.

Mine Fill A - SWMU #12/14

For Mine Fill A, RFI Phase II Release Assessments are recommended for groundwater, surface water, and soil. Historical and current practices at this SWMU indicate that contaminant releases to these environmental media potentially posing a threat to receptors have occurred. An RFI Phase II Release Assessment for air is not recommended because permitted air pollution control devices are currently in place.

Mine Fill B - SWMU #13/14

RFI Phase II Release Assessments are recommended for the groundwater, surface water, and soil at Mine Fill B. Past operations conducted at Mine Fill B indicate that contaminant releases posing a threat to human or environmental receptors have occurred. Because bombs are no longer filled in this area and renovation and rework activities are permitted, an RFI Phase II Release Assessment for air is not recommended.

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RP/6EMRF/AB6

APPENDIX A

BIOLOGICAL FEATURES

Major Tree Species at NWSC Crane

Black Ash
White Ash
Large-toothed Aspen
Baldcypress
Basswood
Beech
River Birch
Boxelder
Ohio Buckeye
Butternut
Black Cherry
Black Maple
Red Maple
Sugar Maple
Yellow Poplar
Black Oak
Chestnut Oak
Chinquapin Oak
Pin Oak
Red Oak
Scarlet Oak
Shingle Oak
Cottonwood

American Elm
Red Elm
Hackberry
Bitternut Hickory
Monhernut Hickory
Pignut Hickory
Shagbark Hickory
Honeylocust
Black Locust
White Oak
Austrian Pine
Jack Pine
Pitch Pine
Scotch Pine
Shortleaf Pine
Virginia Pine
White Pine
Yellow Poplar
Sweetgum
Black Walnut
Sycamore
Willow

Partial List of Rare Plants at NWSC Crane
(Not listed as threatened or endangered)

Showy Orchis	Sessile Trillium
Lesser Fringed Orchis	Twinleaf
Ginseng	Sullivantia sullvantii
Nodding Trillium	Asplenium penvatifidum
Large White Trillium	Asplenium trechomanes
Yellow Trillium	Vittaria lineata

Partial List of Fauna at NWSC Crane

Reintroduced Mammals

White-tailed deer
Beaver

Small Mammals

Opossum
Mice
Raccoon
Cottontail rabbit
Red fox
Gray fox
Long-tailed weasel
Striped skunk
Mink
Coyote

Larger Rodents

Muskrat
Woodchuck (Groundhog)
Gray squirrel
Fox squirrel
Eastern chipmunk
Flying squirrel

Water Fowl and Shore Birds

Canada goose
Mallard duck
Ringnecked duck
Lesser scaup
Hooded mergansers
Black duck
Redhead
Common merganser
Bufflehead
Common loon

Game Birds

Wild turkey
Ruffed grouse
Bobwhite quail
Woodcock

Raptors that Rest on Center

Red-tailed hawk
Red-shouldered hawk
Broad-winged hawk
Sparrow hawk
Coopers hawk
Sharp-shinned hawk
Great horned owl
Barred owl
Screech owl
Turkey vulture

Fall and Winter Raptor Visitors

Rough legged hawk
Marsh hawk
Short-eared owl
Long-eared owl
Saw-whet owl
Bald eagle
Golden eagle

Other Birds

American cooc
Rock dove
Common flicker
Yellow-bellied sapsucker
Blue jay
Tufted titmouse
Red-breasted nuthatch
Mockingbird
Golden-crowned kinglet
House sparrow
Rufous-sided towhee
Field sparrow
Red-winged blackbird
Song sparrow
Killdeer
Mourning dove
Hairy woodpecker
Downy woodpecker
Common crow
Brown creeper

Partial List of Fauna at NWSC Crane (Continued)

Other Birds (Continued)

Winter wren
American rober
Cedar waxwing
Cardinal
Dark-eyed junco
Whippoorwill
Swamp sparrow
Great blue heron
Herring gull
Belted kingfisher
Red-bellied woodpecker
Horned lark
Carolina chickadee
White-breasted nuthatch
Carolina wren
Eastern bluebird
Starling
American goldfinch
Tree sparrow
Purple martin
White-throated sparrow
Ruby-throated hummingbird

Salamanders

Eastern newt
Redbacked salamander
Two-lined salamander

Frogs and Toads

Fowlers toad
Chorus frog
Cricket frog
Spring frog
Grey tree frog
Leopard frog
Bull frog
Green frog

Turtles

Spring softshell turtle
Snapping turtle
Box turtle
Painted turtle

Lizards

Five lined skink
Fence lizard
Ground skink

Snakes

Garter snake
Bended water snake
Dekays snake
Black racer
Black rat snake
Milk snake
Rough green snake
Hognose snake
Copper head
Rattle snake

Aquatic Animals

Crayfish
Freshwater mussels
Golden shiner
Redear sunfish
Channel catfish
Spotted sucker
Carp
Yellow perch
Warmouth
Largemouth bass
White bass
Brown bullhead
Bluegill sunfish
Walleye pike
White crappie
Yellow bullhead
Longear sunfish

APPENDIX B

DECEMBER 20, 1989 FINAL RCRA PERMIT TRANSMITTAL LETTER, TITLE PAGE, AND SIGNATURE PAGE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

REPLY TO ATTENTION OF:
5HR-13

20 [illegible]

CERTIFIED MAIL: P 611 589 516
RETURN RECEIPT REQUESTED

Captain C.E. Johnson
Commanding Officer
Department of the Navy
Naval Weapons Support Center
Crane, Indiana 47522-5000

RE: Final RCRA Permit
Naval Weapons Support Center
Crane, Indiana
IN5 170 023 498

Dear Captain Johnson:

Enclosed is a copy of the Federal Portion of the final permit issued under the Resource Conservation and Recovery Act (RCRA) as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984. Any noncompliance with this permit constitutes a violation of HSWA, and is grounds for enforcement action, permit termination, or other appropriate action.

The duration of this permit is five (5) years. However, the United States Environmental Protection Agency (U.S. EPA) may modify, revoke and reissue, or terminate this permit based on causes specified in Title 40 of the Code of Federal Regulations (40 CFR) Sections 270.41, 270.42, and 270.43, and in Section 3005(c)(3) of the amended RCRA.

This permit is effective as issued, as of the date indicated on the cover page of the permit. 40 CFR 124.19 explains the rights of appeal concerning this permit.

A copy of U.S. EPA's Response to Comments has also been enclosed, explaining all changes made between the draft permit and the final permit.

If you have any questions, please contact Ms. Carol Ann Witt of my staff, at (312) 886-6146, for assistance.

Sincerely,

Basil G. Constantelos, Director
Waste Management Division

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V

Name of Permittee: Owner: United States Department of Navy
Operator: United States Department of Navy

Facility Location: Street Address: (None)
City, State: Crane, Indiana

EPA Identification Number: IN5 170 023 498

Issuance Date: 20 DEC 1989

Authorized Activities:

Pursuant to the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (RCRA) of 1976, and the Hazardous and Solid Waste Amendments (HSWA) of 1984, (42 U.S.C. §6901, et seq.), and regulations promulgated thereunder by the United States Environmental Protection Agency (U.S. EPA) (codified in Title 40 of the Code of Federal Regulations (CFR)), Federal permit conditions (hereinafter called the permit) of the RCRA permit are issued to United States Department of Navy (USN) (hereinafter called the Permittee), for the facility Naval Weapons Support Center (NWSC) located at Crane, Indiana.

The RCRA permit contains both the effective Federal permit conditions (contained herein) and the effective State permit conditions issued by the State of Indiana's RCRA program authorized under 40 CFR Part 271 (hereinafter called the State permit). When both this permit and the State permit are effective, the Permittee has an effective RCRA permit which authorizes the Permittee to conduct hazardous waste management activities as specified in the RCRA permit.

Permit Approval:

On January 31, 1986, the State of Indiana received final authorization pursuant to Section 3006 of RCRA, 42 U.S.C. §6926, and 40 CFR Part 271, to administer the pre-HSWA RCRA hazardous waste program. Since the State of Indiana has not yet received authorization to administer the entire hazardous waste program requirements of HSWA, additional permit conditions must be issued by the U.S. EPA to address these new requirements. These additional conditions are contained in this permit.

The Permittee must comply with all terms and conditions of this permit. This permit consists of the conditions contained herein (including those in any attachments) and the applicable regulations contained in 40 CFR Parts 260, 261, 262, 264, 266, 268, 270, and 124, and applicable provisions of HSWA.

This permit is based on the assumption that the information submitted in the permit application attached to the Permittee's letter, dated October 12, 1984, and in any subsequent amendments (hereinafter referred to as the application), and in the certification regarding potential releases from solid waste management units, dated June 13, 1985, is accurate. Any inaccuracies found in this information may be grounds for the termination, revocation and reissuance, or modification of this permit (see 40 CFR §270.41, §270.42 and §270.43) and potential enforcement action. The Permittee must inform U.S. EPA of any deviation from or changes in the information in the submitted information.

Effective Date:

The RCRA permit is effective when both this permit and the State permit are effective. This permit is effective as of thirty days after service of notice, unless a review is requested under 40 CFR §124.19 (unless no comments requested a change in the draft permit in which case the permit shall become effective immediately upon issuance), and shall remain in effect for 5 years, unless revoked and reissued, or terminated (40 CFR §270.41, §270.42, and §270.43), or continued in accordance with 40 CFR §270.51.

Issued this 20th day of Dec. 1989,

by _____.
for Basil G. Constantelos, Director
Waste Management Division

APPENDIX C

WATER QUALITY REPORT FOR BUILDING 2797 WELL

WELL @ OTA OFFICE
BLDG 2797

REPRODUCED AT GOVERNMENT EXPENSE

DO NOT WRITE IN THIS SPACE

Ship No. 82776

Date Rep. MAY 0 2 1991

INDIANA STATE BOARD OF HEALTH
Environmental Laboratory Division
1330 West Michigan Street
P.O. Box 1964
Indianapolis, Indiana 46206-1964

PUBLIC WATER SUPPLY BACTERIOLOGICAL REPORT FORM

DO NOT WRITE IN THIS SPACE

013671

Lab No. B

APR 3 0 1991

Date Received

22 - 27

FILL IN THIS SPACE. USE SOFT PENCIL OR BLACK INK
Indiana State Board of Health is to mail report to

COMMANDING OFFICER (CODE 09725)
(Name)

NAVAL WEAPONS SUPPORT CENTER BLDG 4
(Street)

CRANE, IN 47522-5009
(City or Town) (Zip)

SAMPLE DATA

(To Be Completed By Supplier)

PLEASE read instructions on back of last copy

PWS ID

2	5	1	0	0	3	0	5	3	0	0	0
1 - 7						8 - 9		10 - 13			

Name of Organization NAVAL WEAPONS SUPPORT CENTER
City or Town CRANE
County MARTIN Phone 854-1238
Superintendent ROBERT HERMAN
Collected by ROBERT SELF
Sampling Address OTA WELL, BLDG. 2797
Which tap BATHROOM
Chlorine residual NOT CHLORINATED

LOCATION CODE: 0 1 9 (28 - 30)

DATE (Mo. Day Yr.): 0 4 2 9 9 1 (31 - 36)

TYPE (Check appropriate circle)

- D — *Distribution Sample*
- ○ P — *Plant Tap Sample*
- ○ R — *Raw Water Sample*
- ☒ S — *Special Purpose Sample*
- ○ C — *Check Sample (EFA)*

37

TIME: 1 0 3 0 (38 - 41)

REMARKS SERVES LESS THAN 10 PEOPLE

An Additional Copy of Results Should Be Sent To:

NORTHERN DIVISION
(Name)

NAVFAC U.S. NAVAL BASE Attn. CODE 11
(Street)

PHILADELPHIA, PA IN 19112
(City or Town) (Zip)

ANALYSIS DATA

(To Be Completed By Lab)

Portions in Ml	LST Broth Positive Tubes		B.G.B. Positive Tubes				Coliform Confirmed
	24 Hr.	48 Hr.	On 24 Hr LST		On 48 Hr LST		
			24 Hr. B.G.B.	48 Hr. B.G.B.	24 Hr. B.G.B.	48 Hr. B.G.B.	
5-10	—	—					—

METHOD (Check appropriate circle)

- ○ MF: 3 0 3 (14 - 16)
- ○ MPN - 10 ml.: 3 0 5 (14 - 16)
- ☒ MPN - 100 ml.: 3 0 7 (14 - 16)

RESULT: (17 - 20)

0 (21)

DATE RECEIVED: See above (22 - 27)

If MF is checked (14-16), the RESULT (17-20) is COLIFORM PER 100 ml.
If MPN is checked (14-16), the RESULT (17-20) is NUMBER OF POSITIVE TUBES.

REPORT OF SAMPLES

- ☒ *SATISFACTORY*
- ○ *WATER QUALITY QUESTIONABLE*
- ○ *UNSATISFACTORY*
  - ○ SUBMIT TWO CHECK SAMPLES FROM THIS SAME SAMPLING POINT. (ONE EACH DAY FOR TWO DAYS IN A ROW.)
- ○ *NOT VALID BECAUSE*
  - ○ There was too long a time between collection of sample and receipt for examination.
  - ○ The water sample bottle was broken in shipment.
  - ○ The water sample contained Cl^2 residual.
  - ○ There was an overgrowth in MF test.
  - ○ Other
  - ○ WE ADVISE T[illegible] ANOTHER SAMPLE BE SUBMITTED.

LAB ID: 5 2 4 9 2 (42 - 46)

ANALYZED BY

Do Not Write In This Space

(Name)

(Street)

IN
(City or Town) (Zip)

APPENDIX D

SWMU RECONNAISSANCE PHOTOGRAPHS

SWMU RECONNAISSANCE PHOTOGRAPHIC RECORD

Photo Number	Description
1	Water draining from cook-off tanks at the OTA.
2	Water in cook-off tank.
3	Staining near cook-off tank.
4	Pyrotechnic residues at the OTA.
5	Pyrotechnic residues at the OTA.
6	Pyrotechnic residues and stressed vegetation at the OTA Mk 3-4 test area.
7	Staining and stress vegetation in the phosphorus test area of the OTA.
8	Spent ordnance storage area at the OTA.
9	Stressed vegetation on berm east of Rockeye spin test chamber at the Annex area.
10	Stressed vegetation adjacent to sheet and plastic explosive test area at the Annex area.
11	Burned areas and residues at the rocket range.
12	Spent pyrotechnic device in bush.
13	Eroded section of Building 106 pond bank suggesting overflow.
14	Building 106 pond neutralization plant.
15	Three-way valve on drain line from Building 153 unloading pad in Mine Fill A.
16	Red colored water puddled in Mine Fill A.
17	Stressed vegetation near box emptying building and empty box storage bins in Mine Fill A. Note stains by conveyor.
18	Staining around Building 196, paint locker in Mine Fill A.
19	Staining near Compressor Room, Building 2960, in Mine Fill A.

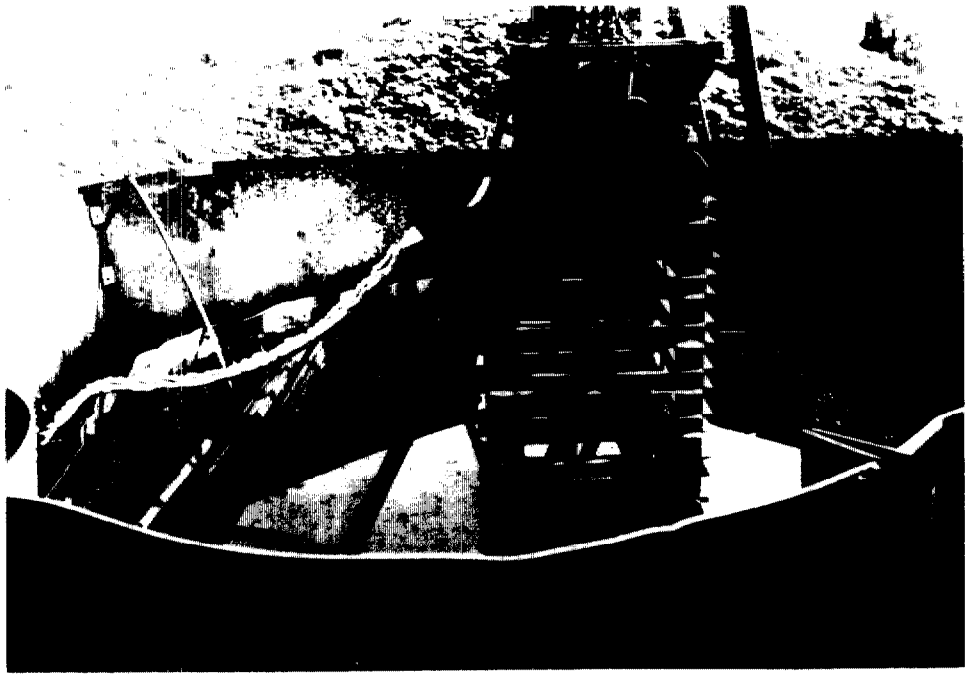
SWMU RECONNAISSANCE (Continued)
PHOTOGRAPHIC RECORD

Photo Number	Description
20	Staining and residue near utility pole in Mine Fill A.
21	Hot melt stockpile at Mine Fill A.
22	Stressed/absent vegetation near the box emptying building in Mine Fill B.
23	Stressed and stained soils near box empty building at Mine Fill B.
24	PCB contaminated soil excavation, south production line at Mine Fill B.
25	PCB contaminated soil excavation, north production line at Mine Fill B.
26	Residues and staining nearing Building 2171 in Mine Fill B.
27	Disposal bin and staining near Building 2171 in Mine Fill B.
28	Contamination in utility shaft at north end of Mine Fill B.
29	Staining and spills near compressor hut (Building 69) at Mine Fill B.
30	Staining and corrosion near Building 169 at Mine Fill B.

Note: Original color photographs listed here and others are contained in project files.

RP/6EMRF/AB9

1



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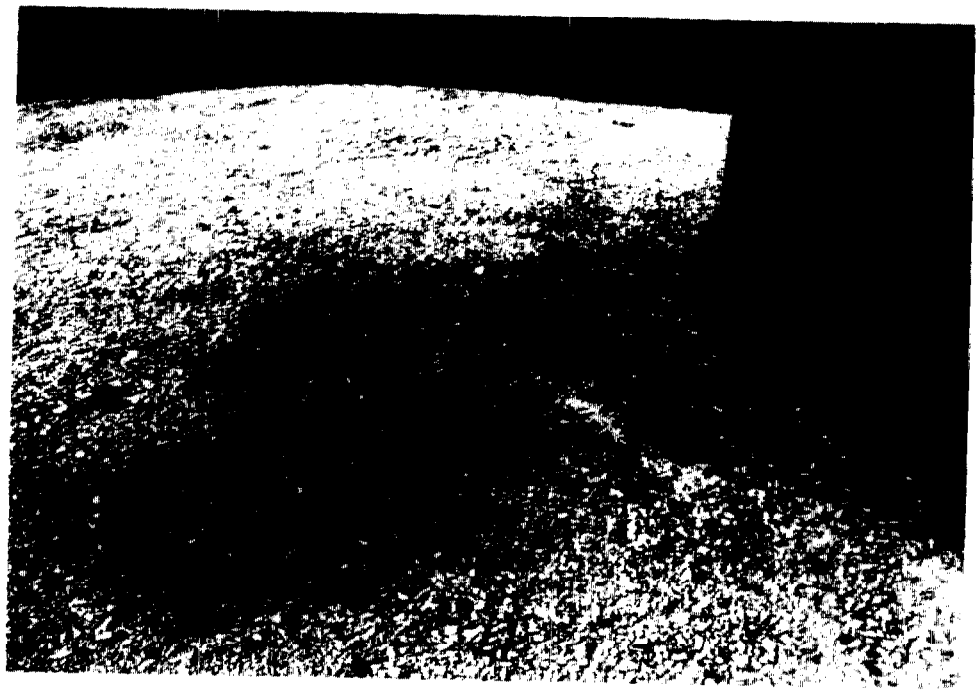

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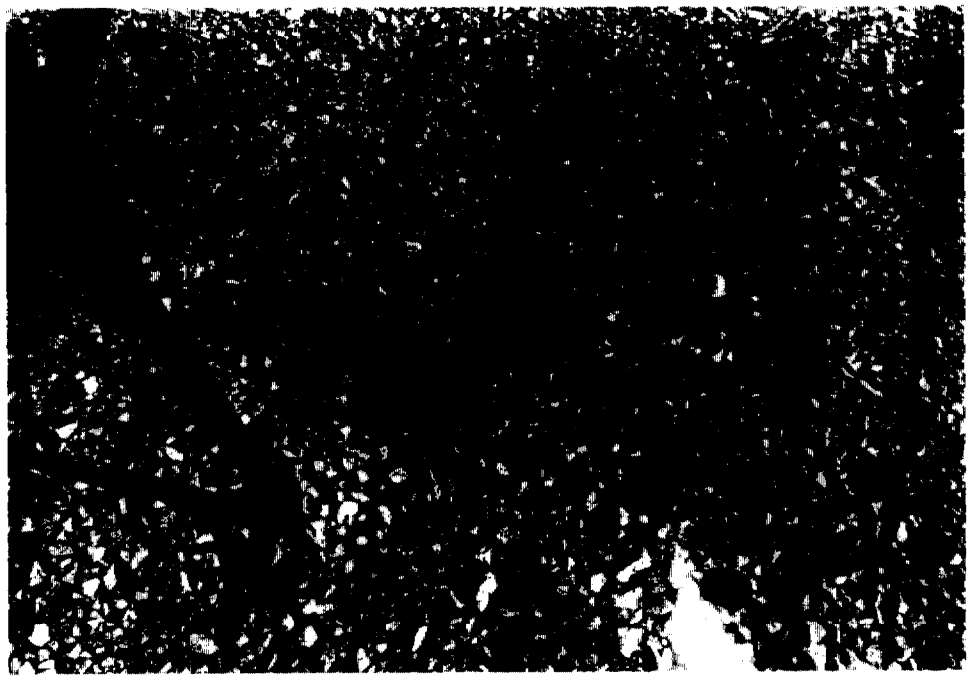

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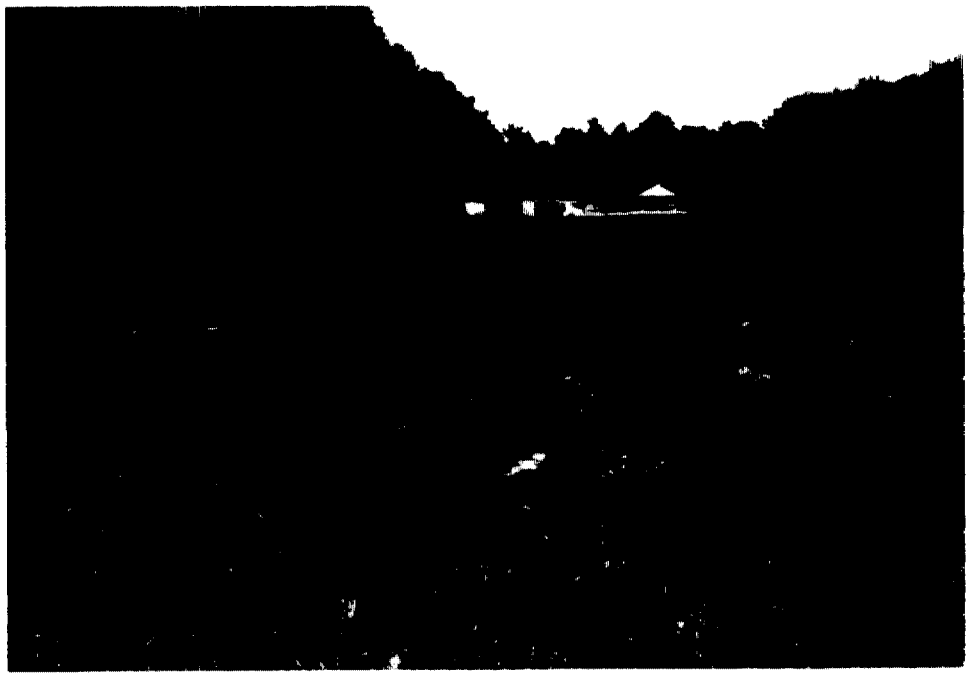

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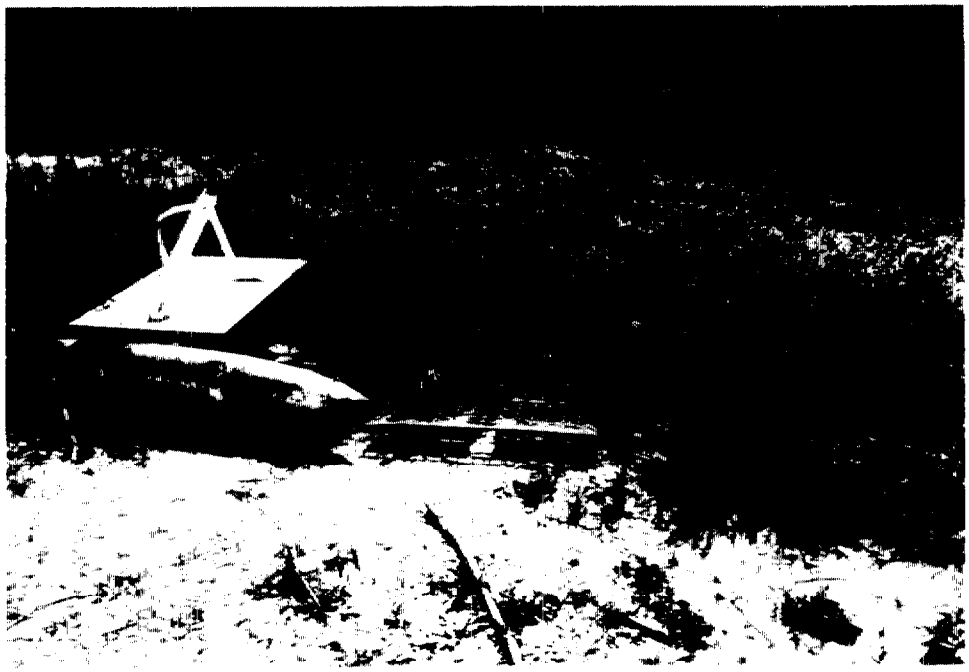

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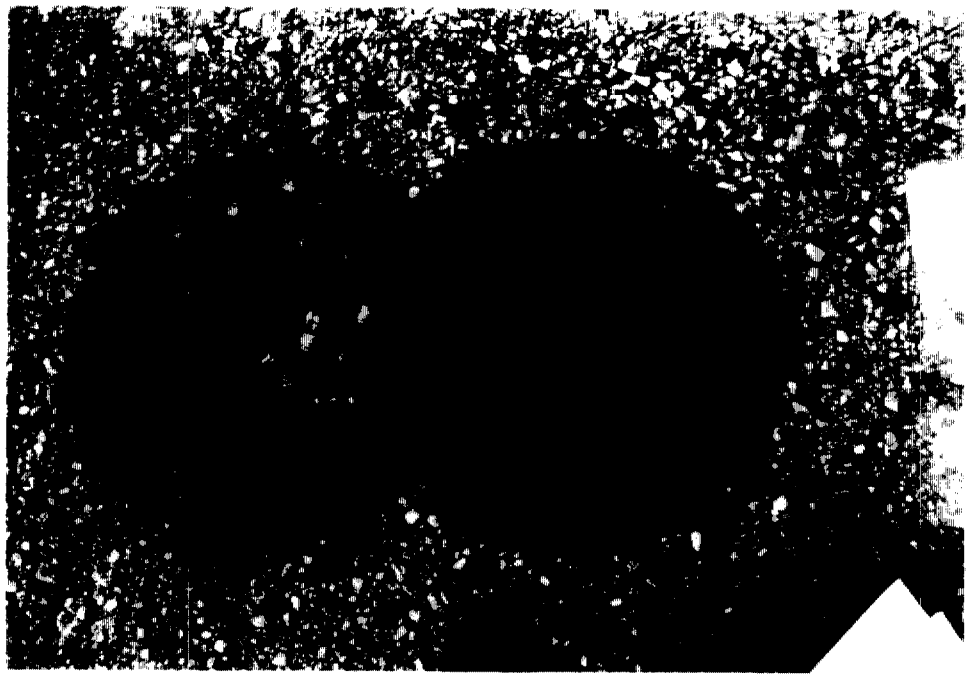

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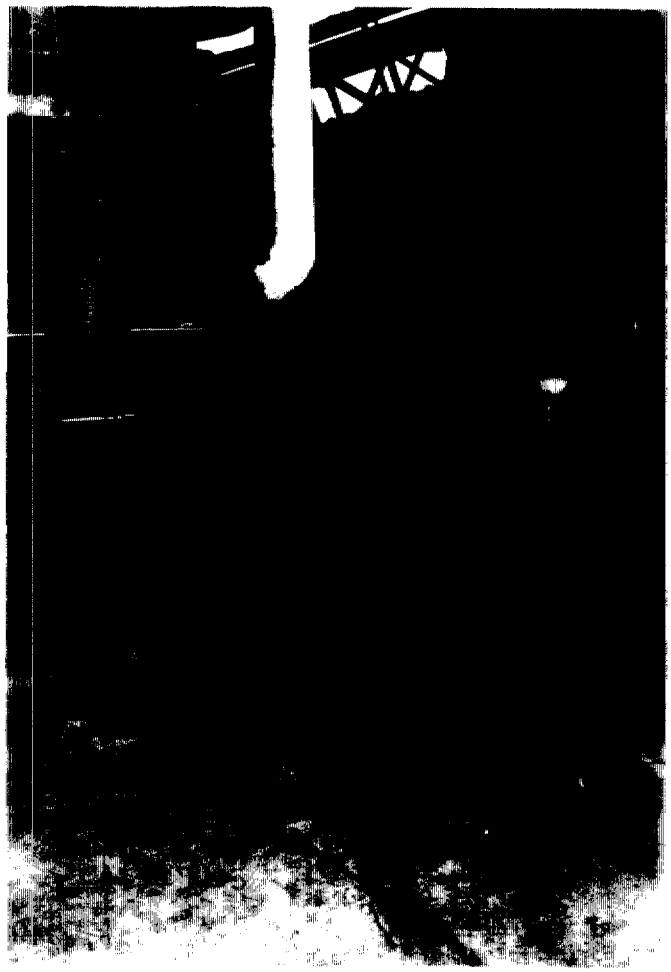

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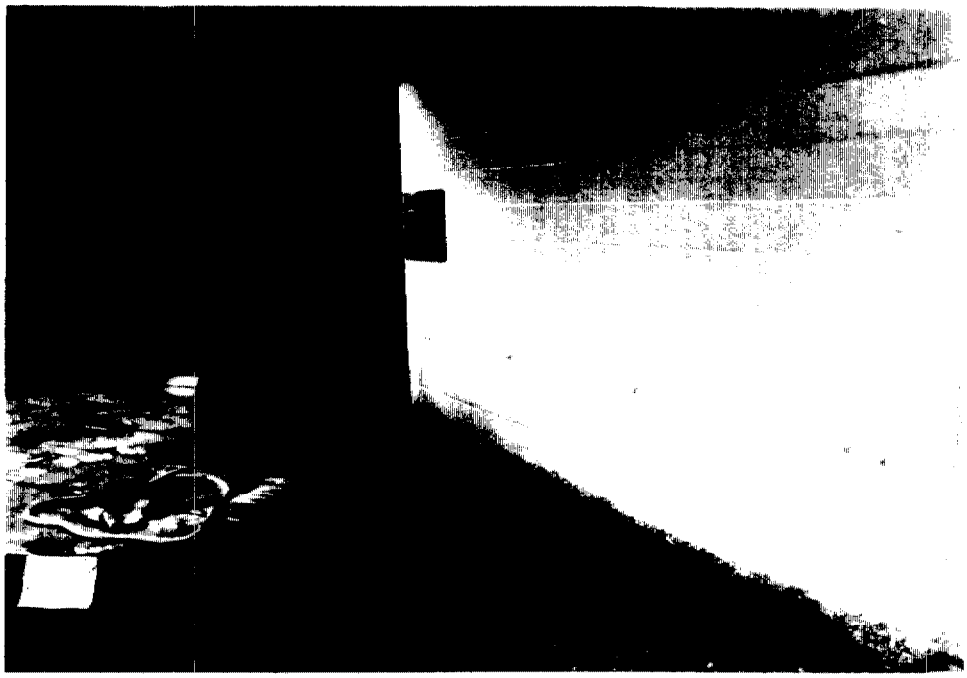

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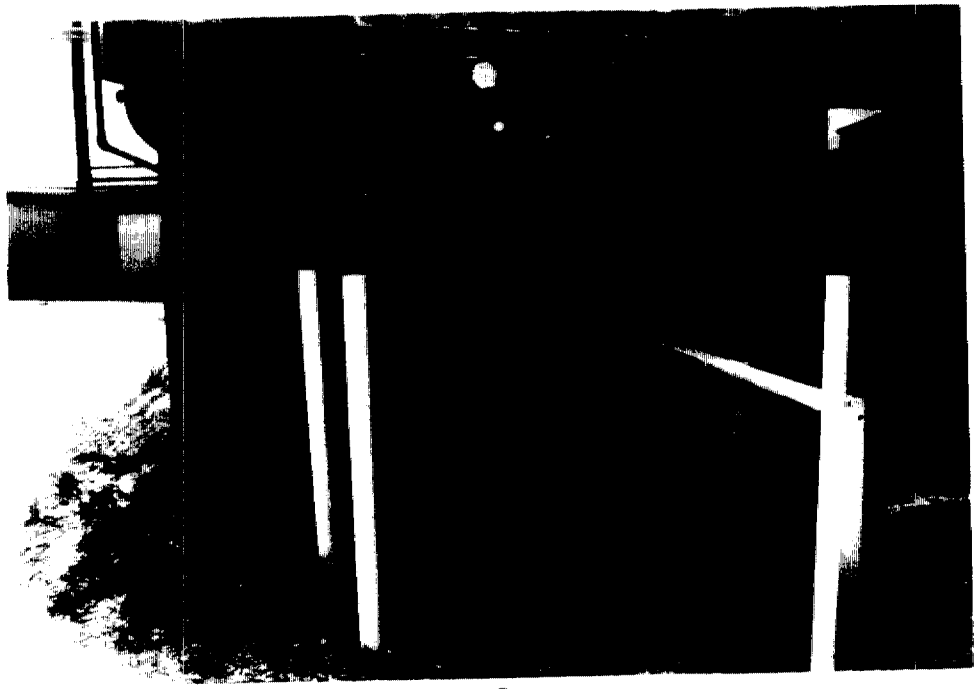

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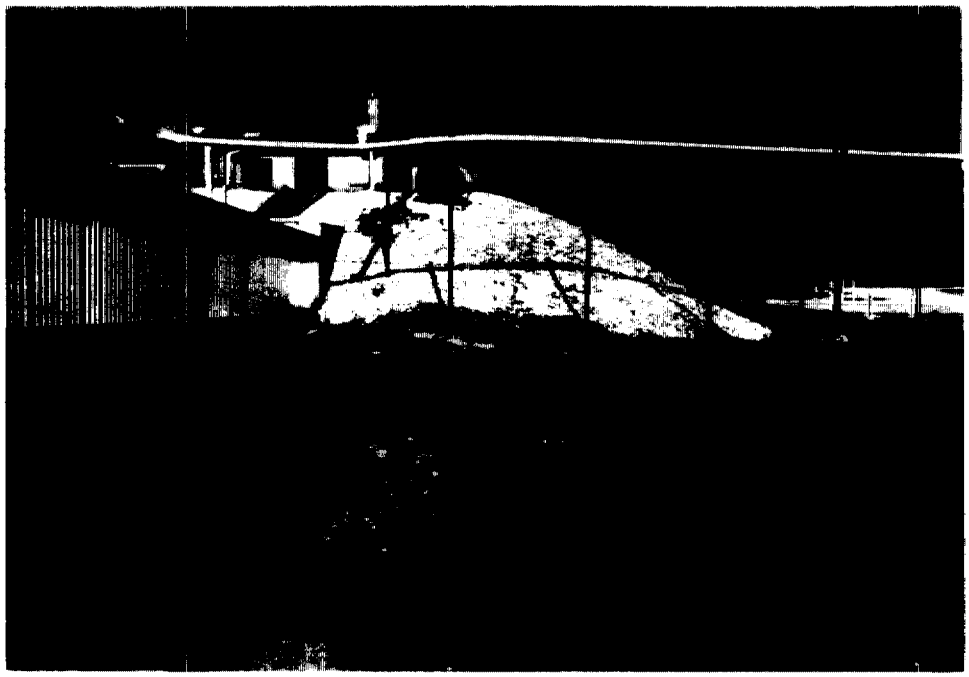

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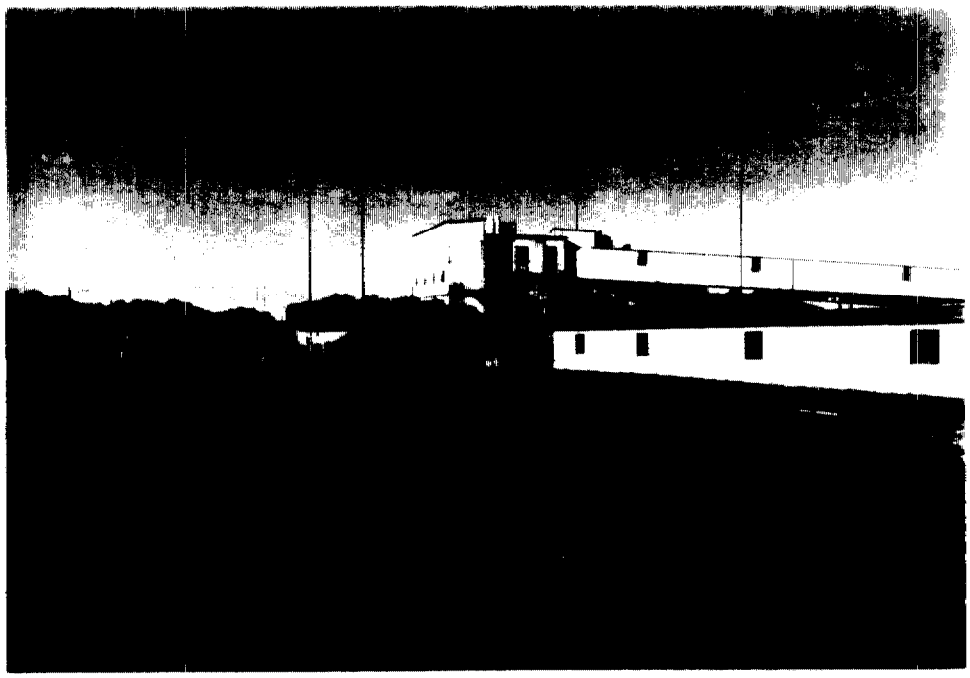

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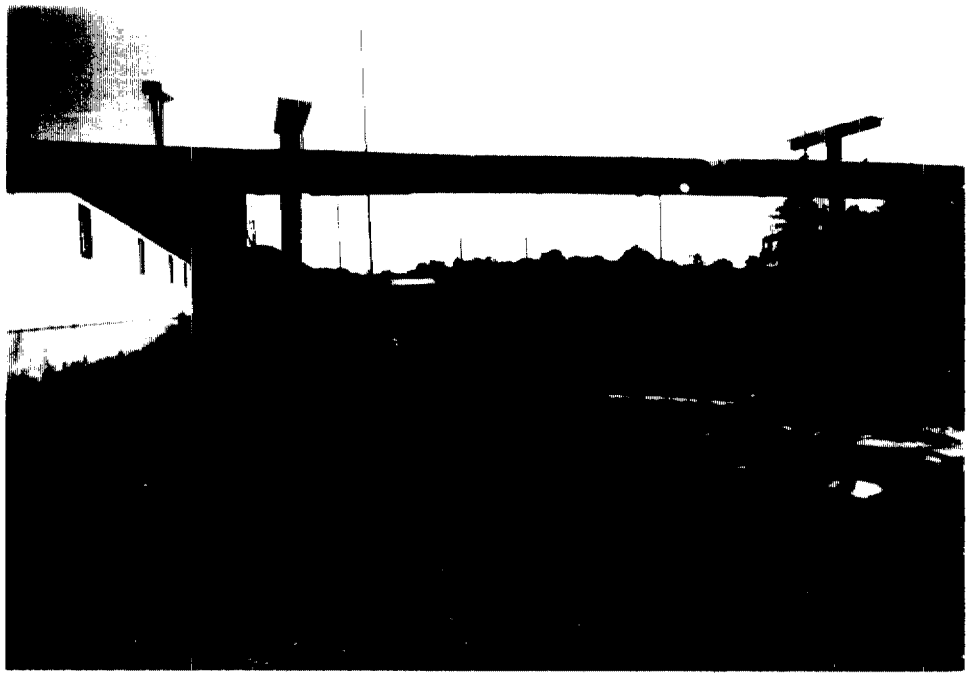

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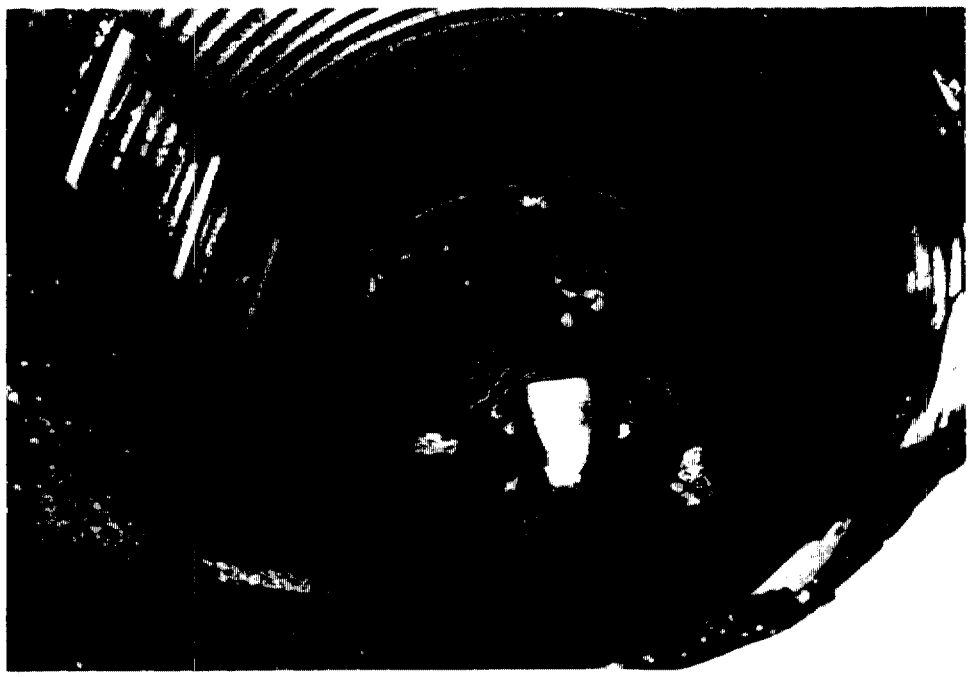

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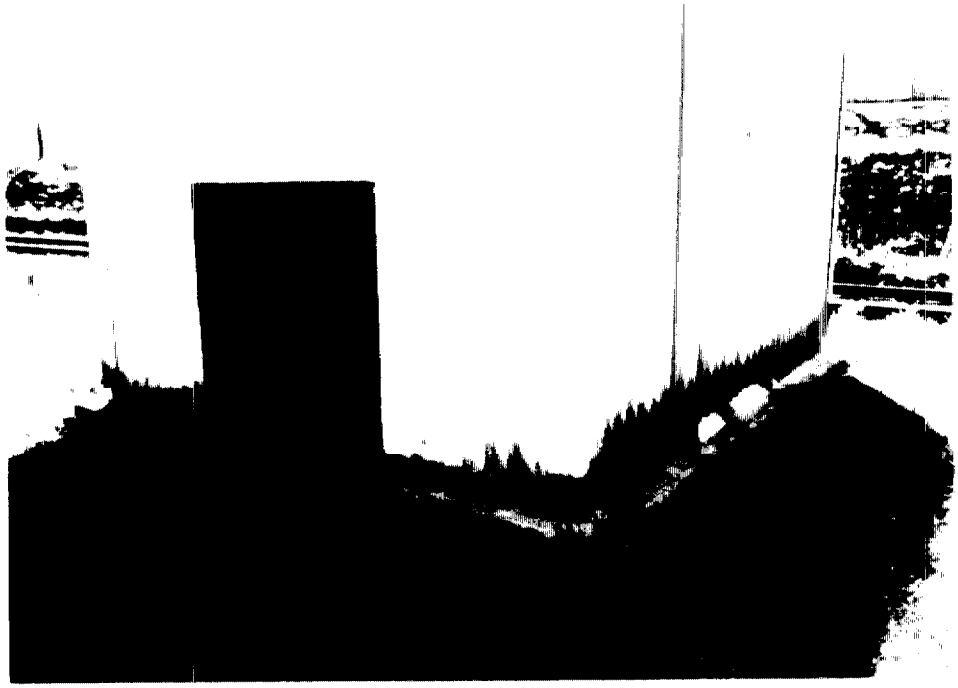

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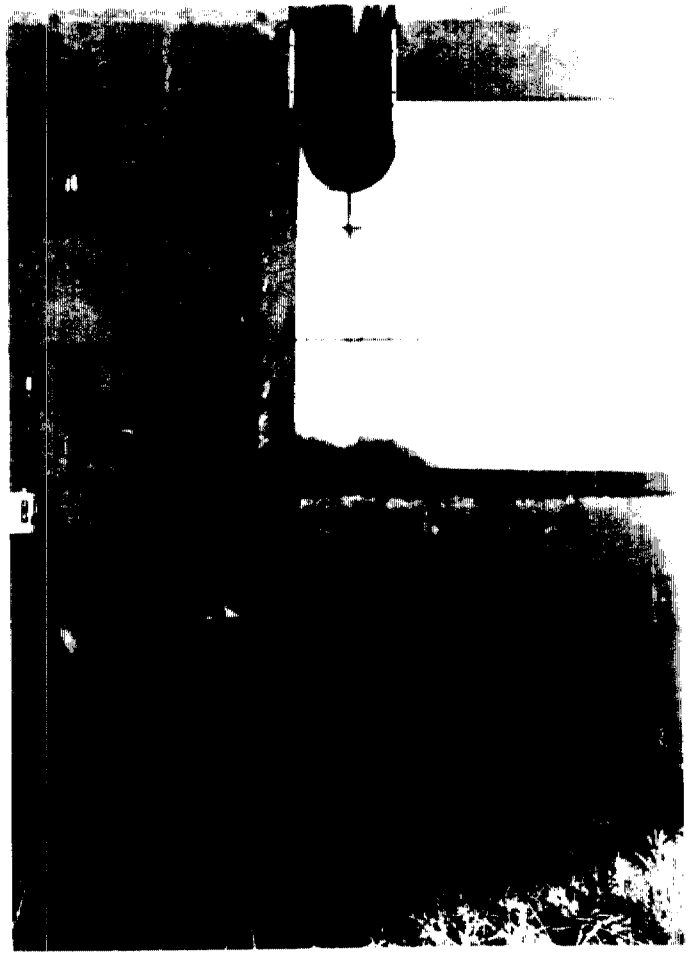

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APPENDIX E

ORDNANCE TESTED AT THE OTA

Source: Kramer, 1983.

LIST OF ITEMS TESTED OUTSIDE (SPECIFICATION REQUIRED)

DODIC	NOMENCLATURE
LW21	Signal, Distress, Personnel, Mk 130-0, Red, Caliber 38
LW26	Signal, Distress, Personnel, Mk 121-0, Red, 9MM
LW27	Signal, Distress, Personnel, Mk 122-0, Green, 9MM
LW28	Signal, Distress, Personnel, Mk 123-0, Yellow, 9MM
LW31	Signal, Distress, Personnel, Mk 138-0, Yellow, Caliber 38
LW32	Signal, Distress, Personnel, Mk 139-0, Green, Caliber 38
L118	Signal Kit, Personnel Distress, Mk 79-0
L190	Signal, Illumination, Marine, Green Comet, Mk 1 Mod 0
L191	Signal, Illumination, Marine, Red Comet, Mk 1 Mod 0
L192	Signal, Illumination, Marine, Yellow Comet, Mk 1 Mod 0
L193	Signal, Illumination, Marine, Mk 1 Mod 1, Red Star
L201	Signal, Smoke, Mk 2 Mods, Red, Rocket
L135	Cartridge, Photoflash, M112A1, 1-Second Delay
L136	Cartridge, Photoflash, M112A1, 2-Second Delay
L139	Cartridge, Photoflash, M123A1, 2-Second Delay
L140	Cartridge, Photoflash, M123A1, 4-Second Delay
L225	Signal, Illumination, A/C, M37A2
L226	Signal, Illumination, A/C, M38A2
L227	Signal, Illumination, A/C, M39A2
L258	Signal, Illumination, A/C, Mk 80 Mod 0, Red
L266	Signal, Smoke and Illumination, Marine, Mk 66-0, Red
L269	Signal, Smoke and Illumination, Marine, Mk 117-0, Green
L271	Signal, Smoke and Illumination, Marine, Mk 118-0, Yellow
L306	Signal, Illumination, Ground, M158, Red, Five-Star, Cluster
L307	Signal, Illumination, Ground, M159, White, Five-Star, Cluster
L311	Signal, Illumination, Ground, M126A1, Red, Five-Star, Parachute
L312	Signal, Illumination, Ground, M127A1, White, Five-Star, Parachute
L314	Signal, Illumination, Ground, M125A1, Green, Five-Star, Cluster
L323	Signal, Smoke, Ground, Red, Parachute, M129A1
L324	Signal, Smoke, Ground, Green, Parachute, M128A1
L366	Simulator, Projectile, Air Burst, M74, Series
L373	Simulator, Projectile, Air Burst
L414	Flare, Surface, Parachute, XM184, Battlefield Illum. Set
L450	Flare, Surface, High Altitude, Parachute, Mk 20-0
L541	Signal, Illumination, Marine, Mk 2-0, Very, Green
L542	Signal, Illumination, Marine, Mk 2-0, Very, Red
L543	Signal, Illumination, Marine, Mk 2-0, Very, White
LW53	Flare, Decoy, Mk 50 Mod 0
L337	Signal, Illumination, Personnel Distress, Mk 140 Mod 0
L426	Flare, A/C, Parachute, Mk 45 Mods
LW60	Flare, Decoy, Mk 46 Mod 1C
LW61	Flare, Decoy, MJU, 2/B
LW62	Flare, Decoy, MJU, 3/B
LW52	Flare, Decoy, Mk 48 Mod 0
LW53	Flare, Decoy, Mk 48 Mod 1
CW84	Rapid Bloom Off-Board Chaff
EW-76	Super Rapid Bloom Off-Board Chaff

List of Items for "Closed Cell" Testing

DODIC	NOMENCLATURE
L600	Simulator, Booby Trap, M119, Whistling
L601	Simulator, Hand Grenades, M116A1/M116E2
L591	Marker, Location, Marine, Mk 80-0, Yellow-Green Slick
L594	Simulator, Projectile, Ground Burst, M115A2/M115E2
L598	Simulator, Booby Trap, M117, Flash
L599	Simulator, Booby Trap, M118, Illumination
L525	Signal, Smoke and Illumination, A/C, Mk 6 Mods, Float Light
L535	Fuzee, Warning, Railroad, Blue, Mk 1-1
L536	Fuzee, Warning, Railroad, Red, Mk 1-0
L556	Marker, Location, Marine, Green, Uranine
L557	Marker, Location, Marine, Red, Rhodamine
L560	Marker, Location, Marine, Mk 1-2, DC, Day, Green
L561	Marker, Location, Marine, Mk 1-3, DC, Day, Yellow
L565	Marker, Location, Marine, Mk 2 Mods, DC, night
L495	Flare, Surface, Trip, M49 Series
L508	Fuzee, Warning Railroad, Red, 20 Minute, M72
L377	Detonation Simulator, Explosive, Mk 2-0
L378	Detonation Simulator, Explosive, M80
L275	Signal, Smoke and Illumination, Marine, Mk 13-0, Distress
L285	Signal, Smoke, Marine, Orange, Distress, Merchant
L210	Marker, Location, Submarine, Mk 24-0, Black
L211	Marker, Location, Submarine, Mk 23-0, Green
L212	Marker, Location, Submarine, Mk 22-0, Yellow
L213	Marker, Location, Submarine, Mk 21-0, Red
L169	Signal, Smoke, A/C, Mk 89-0, Green Smoke
L125	False Target, Submarine, Mk 2 Mods
LW41	Pigment, Chrome, Yellow, 1-lb can
LW42	Signal Kit, Flash, Mk 47-0, F/RIM-24 Series Missile
LW46	Flare, Decoy, Mk 48-0
K765	Riot Control Agent, CS, Capsule
K769	Riot Control Agent, CS2
K861	Smoke Pot, Ground Type, SGF2, Mk 6-0, W/Fz Mk 388-0
K864	Smoke Pot, Ground Type, SGF2, M6
K867	Smoke Pot, M4A2, Floating, HC
K869	Smoke Pot, M7, w/Oil, w/Fuze, SGF2
K870	Smoke Pot, M7, w/Oil, w/o Fuze
K873	Smoke Pot, M7, w/o Oil, w/o Fuze
K874	Smoke Pot, Ground Type, HC, Mk 3-0
K885	Fuze, Smoke Pot, M208, Mechanical Type
K886	Fuze, Smoke Pot, M209, Electrical Type
K764	Riot Control Agent, CS1
KW14	Charging Device, CN Spray Gun, Mk 1-0
K505	Riot Control Ag[illegible], CN, Capsule
K510	Riot Control Agent, CN, LBS
K515	Riot Control Agent, CN, Pellet
W10	Generator, Smoke, Mech., Mk 6-0, Less Tank
KW06	Fog Oil, SGF2, F/Smoke Pots, MIL-F012070A
KW07	Rack, Smoke Screen, Mk 1-0, F/Smoke Generator, Mk 3-0
KW08	Tank, Smoke Screen Generator, Mk 2 Mods, w/FM Smoke Mix

Enclosure (2)

List of Items for "Closed Cell" Testing

DODIC	NOMENCLATURE
G930	Grenade, Hand, Smoke, White, HC, AN-M8, w/Fz M200, M201 Series
G935	Grenade, Hand, Smoke, WP, M15, w/Fz M6A3, M6A4, M206 Series
G937	*Grenade, Hand or Rifle, Smoke, WP, M34, w/Fz M206A2
G940	Grenade, Hand, Smoke, Green, M18, w/Fz M200, M201 Series
G945	Grenade, Hand, Smoke, Yellow, M18, w/Fz M200, M201 Series
G950	Grenade, Hand, Smoke, Red, M18, w/Fz M200, M201 Series
G955	Grenade, Hand, Smoke, Violet, M18, w/Fz M200, M201 Series
G960	Grenade, Hand, Riot, CN, M7 or M7A1, w/Fz M200 or M201 Series
G963	Grenade, Hand, Riot, Capsuled CS, ABC-M7A2 or Pellet CS, M7A3
G965	Grenade, Hand Training, M1A1
G873	Fuze, Hand Grenade, Frag M204 Series
G874	Fuze, Hand Grenade, Burning Type, M201 Series
G880	*Grenade, Hand, Frag, XM61 w/F M204A2
G881	*Grenade, Hand, M67 w/F M213, T1011E2
G890	*Grenade, Hand, Frag, Mk 2, M26 and M26 A1 w/Fz M204 Series
G892	*Grenade, Hand, Frag Mk 2A1 w/Fz M10A3
G895	Grenade, Hand, Illuminating, Mk 1 Mods, w/Fz Mk 372-0
G900	Grenade, Hand, Incendiary, AN-M14 Series, w/Fz M201A1
G905	Grenade, Hand, Riot, CN-DM, M6 Series
G910	*Grenade, Hand, Offensive, Mk 3 Series, w/o Fuze
G911	*Grenade, Hand, Offensive, Mk 3 Series, w/Fz M206 Series
G916	Grenade, Hand, Practice, M21, w/Fz M10A3, M205A1, M205A2
G924	*Grenade, Hand, Riot, CSI, M25A2, Integral Fuze
G838	Cartridge, Grenade, Rifle, 30 Caliber
G839	Cartridge, Grenade, Rifle, 7-62MM, NATO
G841	Cartridge, Grenade, Rifle, 5.56MM
G850	Charge, Practice Hand Grenade
G851	Charge, Practice Hand Grenade
G870	Fuze, Hand Grenade, Practice, M10A3, M205A1, M205A2
G872	Fuze, Hand Grenade, Offensive, M6A3, M206 Series
L568	Marker, Location, Marine, Mk 28 Mods
L580	Marker, Location, Marine, Mk 58 Mods
L545	Marker, Location, Marine Mk 25-3
L212	Marker, Location, Submarine Mk 22-0, Yellow Smoke
L589	Marker, Location, Marine, Mk 78-0, Green Smoke, Submarine
L590	Marker, Location, Marine, Mk 79-0, Black Smoke, Submarine
F534	Cartridge, Signal, Practice Bomb, CXU-4/B
F562	Cartridge, Signal, Practice Bomb, Mk 4 Mod 3
F470	Cartridge, Signal, Practice Bomb, CSU-3A/B
L283	Signal, Smoke and Illunimation, Marine, Mk 124 Mod 0
L259	Signal, Smoke and Illumination, Mk 120 Mod 0
L260	Signal, Smoke and Illumination, Mk 121 Mod 0
L272	Signal, Smoke and Illumination, Mk 99
	*Mk 379-1, Auxiliary Detonating Fuze, Booster
	*Mk 395-1, Auxiliary Detonating Fuze, Booster
	*Mk 407-1, Point Detonating Fuze, Booster
	*Mk 118, Rockeye Bomblet
A020	Cartridge, Buckshot, 12 GA
A071	Cartridge, Ball, 5.56MM
A470	Cartridge, Ball, .45 Caliber
MW53	Mk 56 Explosive Sheet Charge

List of Items for "Closed Cell" Testing

DODIC	NOMENCLATURE
ML04	Cutter, Powder Actuated, Mk 23-0
ML05	Cutter, Powder Actuated, Mk 24-0
M792	Assembly, Demolition Charge, Mk 138-1
M029	ASC, 300 Gr.
	Torch, Cutting, Mk 2
	*Booster, Mk 30 Fuze
	*Booster, Mk 39 Fuze
	*Booster, Mk 53-1 Fuze
	*Booster, Mk 44-1 Fuze

*Protection for Fragmentation Required.

APPENDIX F

TOXIC HAZARDS ASSOCIATED WITH HAND-MANIPULATED SIGNALING DEVICES

Source: NAVSEA, 1985.

TABLE F-1 (Continued)

HAND-MANIPULATED SIGNALING DEVICES COMPOSITION COMPOUNDS AND TOXICITY RATINGS

Compound	Toxicity Level*
Benzanthrone	Low
Stearine (Stearic Acid)	Low
Amyl Acetate	Low
Xylene-azo-B-naphthol	Low
1-Methylaminoanthraquinone	Low
Silicon	Low
Vat Yellow 4	Low
Vinylidene Fluoride	Low
Zirconium Hydride	Low
1,4-di-p-toluidinoanthraquinone	Low
Titanium Powder	Low
Zirconium Powder	Low
Dechlorane	Low
Charcoal	None
Lactose, technical	None
Black Powder	Unknown
Anthracene, technical	Unknown
Ethyl Centralite (Carbamite)	Unknown
Red Dye	Unknown
Yellow Dye	Unknown
Shellac	Unknown
Ground Glass	Unknown
Arabic Gum	Unknown
Binder, cellulose Nitrate-Camphor	Unknown
Viton A	Unknown
Laminac	Unknown
Tetranitrocarbazole	Unknown
Polyvinyl Acetate	Unknown
Cornstarch	Unknown
Violet Dye	Unknown
Iron (III) Oxide	Unknown
Solvent Green Dye	Unknown

*Notes:

High = Severe toxicity.
This designation is for substances which produce permanent physical impairment, disfigurement, or threaten loss of life.

Moderate = Moderate toxicity.
This designation is for chemicals that can cause reversible or irreversible changes in the human body not necessarily severe enough to cause serious physical impairment to threaten life.

TABLE F-1

HAND-MANIPULATED SIGNALING DEVICES COMPOSITION COMPOUNDS AND TOXICITY RATINGS

Compound	Toxicity Level*
Potassium Perchlorate	High
Barium Nitrate	High
Barium Chlorate	High
Lead Peroxide	High
Sodium Oxalate	High
Copper Powder	High
Nitroglycerin	High
Dinitrotoluene	High
Diatomaceous Earth	High
Copper Chloride	High
Red Phosphorus	High
Lupersol DDM	High
Dichloromethane	High
Asbestos Powder	High
Potassium Nitrate	Moderate
Magnesium Powder	Moderate
Strontium Nitrate	Moderate
Asphaltum	Moderate
Antimony Sulfide	Moderate
Acetone	Moderate
Potassium Chlorate	Moderate
Yellow Dye (Auramine)	Moderate
Hexachloroethane, technical	Moderate
Hexachlorobenzene	Moderate
Castor Oil	Moderate
Diphenylamine	Moderate
Varnish	Moderate
Thinner (Petroleum Spirits)	Moderate
Red Lead	Moderate
Guanidine Nitrate	Moderate
Hexafluoropropylene	Moderate
Cobalt Naphthenate	Moderate
Antimony Trisulfide	Moderate
Sulfur	Low
Dextrin	Low
Polyvinyl Chloride	Low
Linseed Oil	Low
Calcium Carbonate	Low
Copper Oxide	Low
Silicon Powder	Low
1-Methylaminoanthraquinone Dye	Low
Aluminum	Low
Graphite, glazed	Low
Sodium Bicarbonate	Low

TABLE F-1 (Continued)

HAND-MANIPULATED SIGNALING DEVICES COMPOSITION COMPOUNDS AND TOXICITY RATINGS

Low = Slight toxicity.

This designation is for substances which produce changes in the human body which are readily reversible and which will disappear following termination of exposure, either with or without medical treatment.

None = No toxicity.

This designation is for chemicals which either produce no toxic effects under any conditions of normal usage or require overwhelming doses to produce any toxic effects in humans.

Unknown.

This rating covers chemicals for which insufficient data are available to enable a valid assessment of toxic hazard.

Source: NAVSEA, 1985.

RP/6EMRF/AB9

TABLE F-2

HAND-MANIPULATED SIGNALING DEVICES
PROBABLE PRODUCTS AND RESIDUES AND THEIR TOXICITY RATINGS

Compound	Toxicity Level*
Carbon Monoxide	High
Carbonyl Sulfide	High
Carbon Disulfide	High
Sulfur Dioxide	High
Sulfur Trioxide	High
Hydrogen Sulfide	High
Ammonia	High
Hydrogen Chloride	High
Nitric Oxide	High
Barium Oxide	High
Barium Sulfide	High
Barium Chloride	High
Barium Hydroxide	High
Potassium	High
Potassium Hydroxide	High
Antimony Trioxide	High
Antimony Pentoxide	High
Copper	High
1,1'-biphenyl	High
Chloromethylbenzene	High
Diethylphthalate[1]	High
Phenol[1]	High
Styrene	High
Thiophenol	High
Auramine	High
Chlorine	High
Hexachloroethane	High
Hydrogen Cyanide	High
Strontium Sulfide	High
Cyanogen	High
Potassium Cyanide	High
Cuprous Chloride	High
Phosphine	High
Sodium Cyanide	High
Sodium Hydride	High
Phosphorus Tetramer	High
Phosphorus Pentoxide Dimer	High
Phosphorus Trioxide Dimer	High
1,3-Dimethylbenzene	High
Amino-1,1'-biphenyls	High
Isoquinoline	High
Silicon Tetrafluoride	High
Sodium	High
Chlorine	High
Sulfuric Acid	High
Iron	High

TABLE F-2 (Continued)

HAND-MANIPULATED SIGNALING DEVICES
PROBABLE PRODUCTS AND RESIDUES AND THEIR TOXICITY RATINGS

Compound	Toxicity Level*
Potassium Carbonate	Moderate
Potassium Sulfate	Moderate
Strontium Oxide	Moderate
Lead	Moderate
1-Aminoanthraquinone	Moderate
2-Aminoanthraquinone	Moderate
Acenaphthalene	Moderate
Acetophenone	Moderate
Benzaldehyde	Moderate
Naphthalene	Moderate
Dichlorobenzene	Moderate
Magnesium Chloride	Moderate
Phenanthrene	Moderate
Tetrachloroethene	Moderate
Strontium	Moderate
Sodium Carbonate	Moderate
Sodium Hydroxide	Moderate
1,2-Propadienylbenzene	Moderate
4-Hydroxybenzonitrile	Moderate
Anisole	Moderate
Phenylhydrazine	Moderate
Lead Oxide, Red	Moderate
Lead Tetrafluoride	Moderate
Methylbenzoate	Moderate
Phthalic Anhydride	Moderate
Carbon Dioxide[1,2]	Low
Sulfur	Low
Carbon	Low
Potassium Chloride	Low
Magnesium Oxide	Low
Strontium Chloride	Low
Sulfur Dimer	Low
Lead Dimer	Low
Silicon	Low
Silicon Dioxide[3]	Low
1-Methylaminoanthraquinone	Low
1-Methylnaphthalene	Low
2-Methylnaphthalene	Low
Anthraqu[illegible]e	Low
Cyanobenzene	Low
Phenylacetylene	Low
Toluene[1]	Low
Trichloracetic Acid	Low

TABLE F-2 (Continued)

HAND-MANIPULATED SIGNALING DEVICES
PROBABLE PRODUCTS AND RESIDUES AND THEIR TOXICITY RATINGS

Compound	Toxicity Level*
9H-Fluorene	Unknown
C_{10}-Alkene	Unknown
C_{11}-Alkane	Unknown
C_3-Benzenes	Unknown
C_4-Alkynecyclohexane	Unknown
C_4-Benzene	Unknown
C_6-Benzene	Unknown
C_8-Alkyne	Unknown
Dibenzofuran	Unknown
Methylphenyldiazene-1-oxide	Unknown
1H-Indene	Unknown
Dibenzofuran-9-one	Unknown
Perchlorocyclopropane	Unknown
Barium Hydroxyl Radical	Unknown
Tetracarbon Dinitride	Unknown
Carbonyl Monochloride	Unknown
Potassium Hydroxide Dimer	Unknown
Barium	Unknown
Magnesium Aluminate	Unknown
Aluminum Nitride	Unknown
Aliphatic Amides	Unknown
Benzothiophene	Unknown
Cyanoanthraquinone	Unknown
Phthalate	Unknown
Methinophosphide	Unknown
Phosphorus Dimer	Unknown
Phosphorus Nitride	Unknown
Silicon Nitride	Unknown
1-(1,1-dimethylethyl)naphthalene	Unknown
1-aminonaphthalene	Unknown
1-cyanonaphthalene	Unknown
1-Hexylnylbenzene	Unknown
1-Isocyanonaphthalene	Unknown
1-Methylaminobiphenylene	Unknown
1-Phenyl-1-butyne	Unknown
1-Phenylnaphthalene	Unknown
IH-Indene, 1-methylene	Unknown
2-Amino-9H-fluorene	Unknown
2-Phenyloxazole	Unknown
3-Phenyl-2-propenal	Unknown
4-Methyl-1,1'-biphenyl	Unknown
Alpha-phenylaminobenzene-acetonitrile	Unknown
Amino-B-naphthol	Unknown

TABLE F-2 (Continued)

HAND-MANIPULATED SIGNALING DEVICES
PROBABLE PRODUCTS AND RESIDUES AND THEIR TOXICITY RATINGS

Compound	Toxicity Level*
Magnesium Chloride	Low
Cupric Oxide	Low
Sodium Chloride	Low
1,9-Benz-10-anthrone	Low
Dibenzo(b,def)chrysene-7,14-dione	Low
1,4-di-p-toluidinoanthraquinone	Low
1,4-Diamino-2,3-dihydroanthraquinone	Low
Silicon Carbide	Low
Xylene-azo-B-naphthol	Low
Vat Yellow 4	Low
Cyanobenzene	Low
Zirconium Dioxide	Low
Calcium Carbonate	Low
Zirconium Nitride	Low
1,4-Diaminoanthraquinone	Low
Titanium	Low
Titanium Dioxide	Low
Nitrogen[2]	None
Methane[2]	None
Hydrogen	None
Water	None
1,7,7-Trimethylbicyclo(2,2,1)heptane-2-one	None
Acetylene	None
Ethylene	None
Ethane	None
Oxygen	None
Disulfur Monoxide	Unknown
Sulfur Monohydride	Unknown
Sulfur Monoxide	Unknown
1-Fluoro-2-(2-methoxyethenyl)benzene-2-one	Unknown
1-p-toluidinoanthraquinone	Unknown
1-Phenyl-2,4-hexadiyn-1-one	Unknown
2,2-Dimethylcyclohexanone	Unknown
2-Butylbicyclo(2,2,1)heptane	Unknown
2-Methyl-1,1'-biphenyl	Unknown
2-Methylene-5-(1-methylethyl)cyclohexanone	Unknown
3,4,4-Trimethyl-2-cyclohexanone	Unknown
3,5,5-Trimethylbicyclo(4,1,0)heptane-2-one	Unknown
3-Methyl-3-cyclopentanone	Unknown
4,7,7-Trimethylbicyclo(2,2,1)heptane-2-one	Unknown
4-Methylnaphthalene	Unknown
6-methyl-3-(1-methylethyl)2-cyclohexon-1-one	Unknown

TABLE F-2 (Continued)

HAND-MANIPULATED SIGNALING DEVICES
PROBABLE PRODUCTS AND RESIDUES AND THEIR TOXICITY RATINGS

Compound	Toxicity Level*
Benzofuran	Unknown
Benzonitrile, N-oxide	Unknown
N,N-Diethylbenzeneamine	Unknown
Naphthol(2,1-b)furan	Unknown
Trifluorosilane	Unknown
1,1-Bicyclopentyl	Unknown
1,8-Dichloro- Vat Yellow 4	Unknown
1-Chloro- Vat Yellow 4	Unknown
1-Methylcyclopentanamine	Unknown
4-Undecane	Unknown
5-Cyclohexylmethyl-2-pyrrolidinone	Unknown
5-Hydroxybenzanthrone	Unknown
9-Hydroxyanthracene	Unknown
Dibenzo(a,h)Pyrene	Unknown
Dibenzo(a,h)Pyrene Peroxide	Unknown
2-Methylisocyanobenzene	Unknown
Difluorosilane	Unknown
Magnesium Hydride Radical	Unknown
Nitrogen Oxides	Unknown
C_{12}-Hexene	Unknown
C_2-Benzenes	Unknown
C_2-Thiophene	Unknown
Carbon Disulfoxide	Unknown
Hydrocarbon alkanes	Unknown
Phenyldiazobenzene	Unknown
C_1-Indane	Unknown
C_2-Indane	Unknown
C_2-Naphthalene	Unknown
C_3-Indane	Unknown
C_4-Indane	Unknown
C_5-Benzene	Unknown
C_7-Benzene	Unknown
Dihydronaphthalene	Unknown
Methylbenzothiophene	Unknown
Methylbiphenyl	Unknown
Methylnaphthalene	Unknown
Chlorine, Atomic	Unknown
Barium Chloride Radical	Unknown

TABLE F-2 (Continued)

HAND-MANIPULATED SIGNALING DEVICES
PROBABLE PRODUCTS AND RESIDUES AND THEIR TOXICITY RATINGS

*Notes:

1 - Only at concentrations greater than 200,000 ppm.
2 - A simple asphyxiant, but at 50% concentration it produces symptoms such as rapid respiration and diminishing mental awareness.
3 - Can cause pulmonary fibrosis (silicosis).

High = Severe toxicity.
This designation is for substances which produce permanent physical impairment, disfigurement, or threaten loss of life.

Moderate = Moderate toxicity.
This designation is for chemicals that can cause reversible or irreversible changes in the human body not necessarily severe enough to cause serious physical impairment or threaten life.

Low = Slight toxicity.
This designation is for substances which produce changes in the human body which are readily reversible and which will disappear following termination of exposure, either with or without medical treatment.

None = No toxicity.
This designation is for chemicals which either produce no toxic effects under any conditions of normal usage or require overwhelming doses to produce any toxic effects in humans.

Unknown.
This rating covers chemicals for which insufficient data are available to enable a valid assessment of toxic hazard.

Source: NAVSEA, 1985.

RP/6EMRF/AB9

APPENDIX G

NPDES OUTFALL 006 EXCEEDANCES

TABLE G-1

NPDES EXCEEDANCES OUTFALL 006
OCTOBER 1984 THROUGH OCTOBER 1989

Date	pH	Oil & Grease	Total Pb	Total Cr	Total Zn	Total Explosive	TNT	HMX	RDX
April 15, 1986		30	ND	ND	ND	ND	ND	ND	ND
January 7, 1987		ND	ND	0.09	ND	ND	ND	ND	ND
NPDES LIMIT*	6-9	10	0.05	0.08	0.8	0.2	0.2	0.2	0.2

NOTE: All parameters are in units of mg/l except pH which is expressed in Standard Units. A blank indicates that no exceedances were recorded.

* As specified in Permit No. IN 002 1539, effective October 7, 1984 through August 30, 1989.

ND = Not detected.

Source: NWSCC NPDES Monitoring Reports.

RP/6EMRF/AC6

TABLE G-2

OUTFALL 006 NPDES DISCHARGE EXCEEDANCES
OCTOBER 1979 THROUGH SEPTEMBER 1984

Effluent Parameter	pH	TSS	Cl	BOD	Oil	TOT Cn	TOT Cad	TOT Cr	TOT Cu	TOT Fe	TOT Pb	TOT Zn	TNT	RDX	HMX
NPDES Limit*	6.5-8.5	15	30	8	10	0.02	0.02	0.08	0.03	0.5	0.07	0.8	0.1	0.1	0.1
Exceedance Date															
Sept. 19, 1984			45							0.58					
Sept. 5, 1984			40							0.64					
Aug. 8, 1984										2.40					
July 19, 1984										1.0					
July 4, 1984		176.2								4.6					
June 20, 1984										0.60					
June 6, 1984										0.76					
April 4, 1984		198.4								6.2					
Mar. 21, 1984										1.5					
Mar. 7, 1984	5.9														
Feb. 15, 1984	5.6														
Feb. 1, 1984	6.2		36												
Dec. 7, 1983	6.4														
Nov. 3, 1983										0.66					
Oct. 5, 1983		21.6													
Sept. 21, 1983	6.4														
Sept. 7, 1983	6.3														
Aug. 17, 1983	6.2									0.52					
Aug. 3, 1983		29.8								2.7					
July 20, 1983										0.58					
July 6, 1983		39.2								1.2					

TABLE G-2 (Continued)

OUTFALL 006 NPDES DISCHARGE EXCEEDANCES
OCTOBER 1979 THROUGH SEPTEMBER 1984

Effluent Parameter	pH	TSS	Cl	BOD	Oil	TOT Cn	TOT Cad	TOT Cr	TOT Cu	TOT Fe	TOT Pb	TOT Zn	TNT	RDX	HMX
June 15, 1983										1.1					
June 1, 1983		20.4								0.76					
May 4, 1983										0.94					
April 20, 1983										0.51					
April 6, 1983										0.90					
Mar. 16, 1983										0.52					
Mar. 2, 1983	6.0									0.66					
Feb. 16, 1983	5.7														
Feb. 2, 1983	5.4	173.0													
Jan. 19, 1983	5.2														
Jan. 5, 1983	5.5									0.56					
Oct. 20, 1982										0.96					
Sept. 22, 1982										0.76					
Sept. 9, 1982	6.3									0.81					
Aug. 18, 1982										0.56					
Aug. 4, 1982	6.4									0.51					
July 21, 1982		21.6								0.62					
July 7, 1982		35.2								0.93					
June 16, 1982		31								1.4					
June 2, 1982		15.8								0.52					
May 19, 1982										0.75					
May 5, 1982										0.68					
April 21, 1982	6.0														
April 7, 1982	6.3														
March 17, 1982	6.3	17.2								0.73					

TABLE G-2 (Continued)

OUTFALL 006 NPDES DISCHARGE EXCEEDANCES
OCTOBER 1979 THROUGH SEPTEMBER 1984

Effluent Parameter	pH	TSS	Cl	BOD	Oil	TOT Cn	TOT Cad	TOT Cr	TOT Cu	TOT Fe	TOT Pb	TOT Zn	TNT	RDX	HMX
March 2, 1982										0.52					
February 17, 1982										0.77					
February 3, 1982										0.57					
January 20, 1982	6.4									0.51					
December 16, 1981										0.56					
December 2, 1981										0.96					
October 21, 1981			37.0												
September 16, 1981										0.54					
September 2, 1981		40.8								1.1					
August 19, 1981										0.60					
July 29, 1981										0.52					
July 1, 1981									0.04	0.52					
June 18, 1981										0.56					
June 10, 1981		201.5													
May 21, 1981										0.68	0.42				
May 14, 1981		44.0													
May 6, 1981										0.64					
April 30, 1981		32.1								2.9					
April 29, 1981		21.1													
April 23, 1981		40.0								1.5					
April 16, 1981		18.8													
April 1, 1981		18.7													
March 26, 1981										0.65					
March 25, 1981									0.06	0.57					
March 5, 1981										1.0					

TABLE G-2 (Continued)

OUTFALL 006 NPDES DISCHARGE EXCEEDANCES
OCTOBER 1979 THROUGH SEPTEMBER 1984

Effluent Parameter	pH	TSS	Cl	BOD	Oil	TOT Cn	TOT Cad	TOT Cr	TOT Cu	TOT Fe	TOT Pb	TOT Zn	TNT	RDX	HMX
February 12, 1981									0.12						
February 11, 1981		17.5							0.10	0.96					
February 5, 1981									0.15						
February 4, 1981									0.27						
January 22, 1981			31.7												
January 21, 1981			30.6												
January 15, 1981							0.033								
December 24, 1980										0.54					
November 20, 1980										0.615				0.117	
November 19, 1980										0.705					
November 13, 1980														0.120	
November 12, 1980														0.115	
November 7, 1980														0.110	
November 6, 1980														0.115	
October 30, 1980	6.1									0.508				0.142	
October 29, 1980	6.3													0.285	
October 23, 1980	6.4														
October 22, 1980	6.3														
October 16, 1980	6.3														
October 1, 1980	6.2								0.035						
September 25, 1980										0.663				0.83	
September 24, 1980										0.545					
September 18, 1980		18.9								0.975					
September 17, 1980		97.6								3.425					
September 11, 1980										0.58					

TABLE G-2 (Continued)

OUTFALL 006 NPDES DISCHARGE EXCEEDANCES
OCTOBER 1979 THROUGH SEPTEMBER 1984

Effluent Parameter	pH	TSS	Cl	BOD	Oil	TOT Cn	TOT Cad	TOT Cr	TOT Cu	TOT Fe	TOT Pb	TOT Zn	TNT	RDX	HMX
September 4, 1980		20.3								1.325					
September 3, 1980		65.5								3.375				0.201	
August 21, 1980										0.655					
August 20, 1980										0.675					
August 14, 1980										0.555					
August 13, 1980										0.518					
August 7, 1980										0.785					
August 6, 1980										0.825					
July 30, 1980										0.570					
July 24, 1980										0.525					
July 17, 1980										0.545					
July 16, 1980										0.513					
July 10, 1980										0.950					
July 9, 1980		15.1								1.013					
July 3, 1980		28.4								2.325					
July 2, 1980		19.7								0.523					
June 26, 1980										0.9					
June 25, 1980										1.375					
June 19, 1980		19.8								0.95					
June 18, 1980										0.95					
June 12, 1980	6.4									0.80					
June 11, 1980										0.725					
June 5, 1980										0.735					
June 4, 1980										0.688					
May 29, 1980										0.618					

TABLE G-2 (Continued)

OUTFALL 006 NPDES DISCHARGE EXCEEDANCES
OCTOBER 1979 THROUGH SEPTEMBER 1984

Effluent Parameter	pH	TSS	Cl	BOD	Oil	TOT Cn	TOT Cad	TOT Cr	TOT Cu	TOT Fe	TOT Pb	TOT Zn	TNT	RDX	HMX
May 28, 1980										0.658					
May 23, 1980										0.633					
May 22, 1980		16.8													
May 7, 1980		51.6													
April 17, 1980		23.8								0.605					
April 10, 1980										0.798					
April 9, 1980		16.6								0.739					
March 20, 1980										0.525					
March 19, 1980										0.530					
March 6, 1980										0.513				0.16	
March 5, 1980		62.9													
February 6, 1980										0.548					
December 27, 1979		20								0.580					
December 13, 1979		22								1.10				0.40	
December 5, 1979		55								0.510					
November 29, 1979										0.598					
November 21, 1979										0.523					
November 9, 1979										3.585					
November 8, 1979										0.535					
November 1, 1979										1.8					
October 25, 1979										0.585					
October 24, 1979										0.576					

NOTE:

All parameters in units of mg/l except pH which is expressed in Standard Units. A blank indicates that no exceedances were recorded.

*As specified in Permit No. IN 0021539, effective October 1979 through September 1984.

Source: NWSCC NPDES Monitoring Reports

RP/6EMRF/AC7

APPENDIX H

AEHA MINE FILL SURFACE WATER SAMPLE LOCATIONS

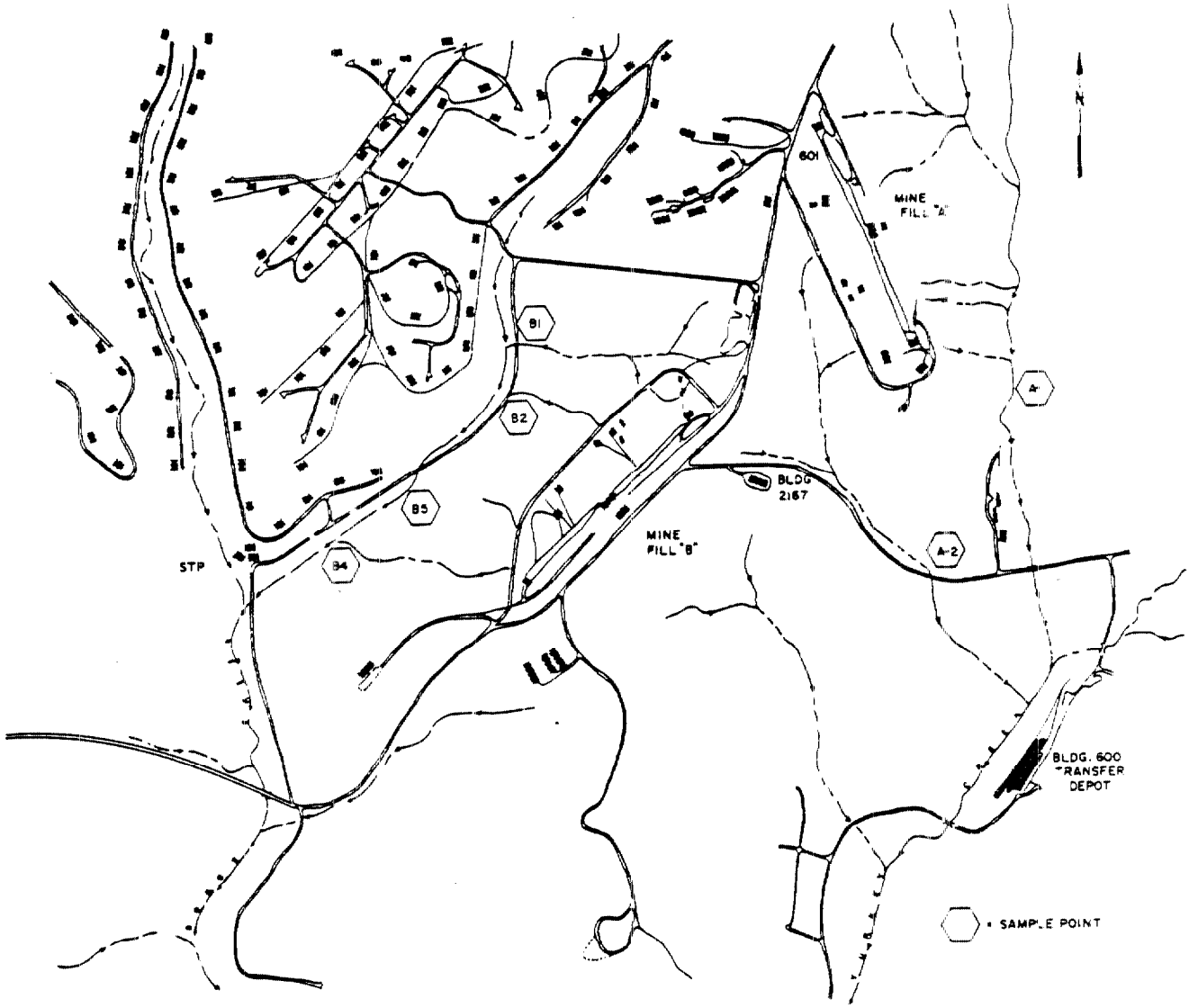
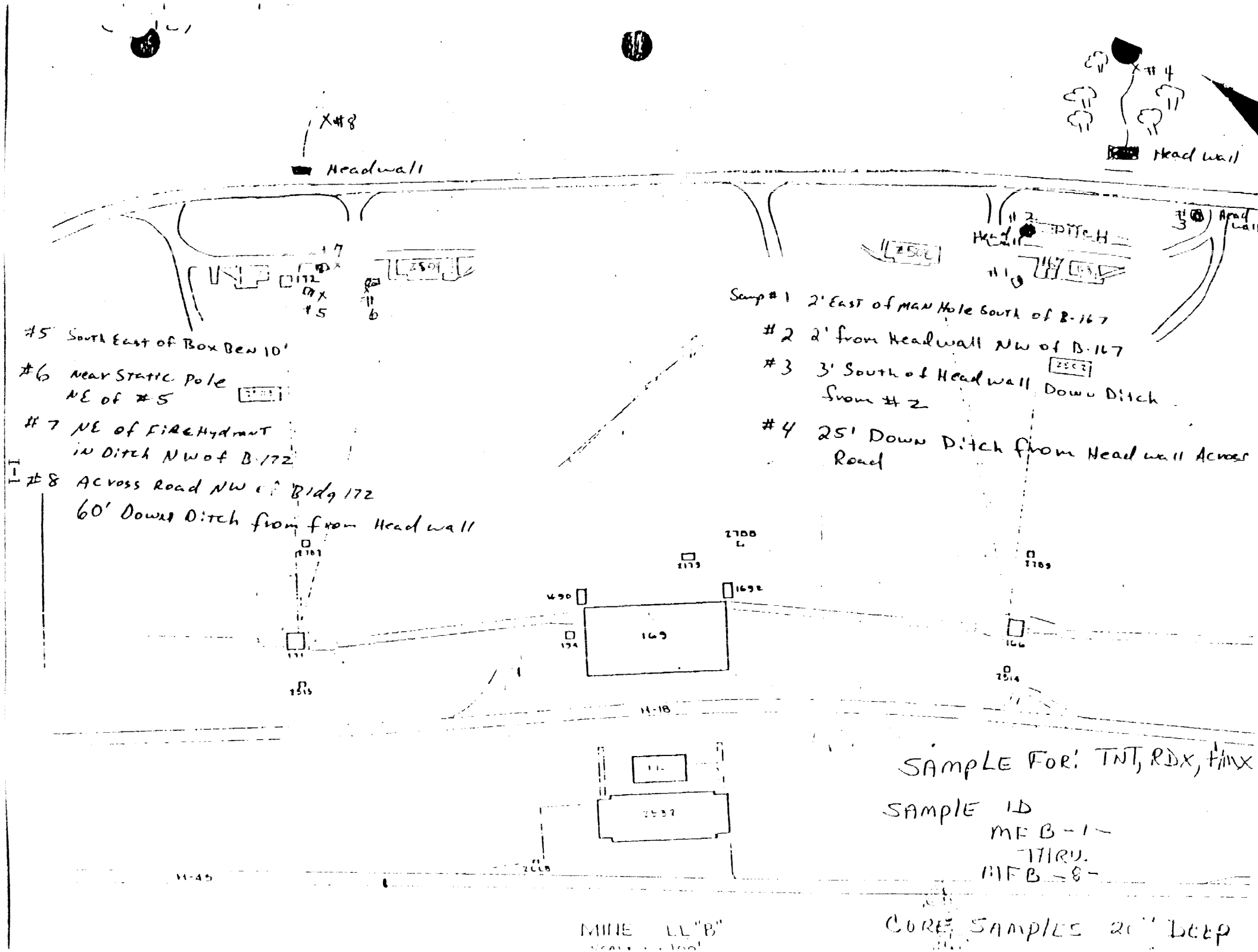
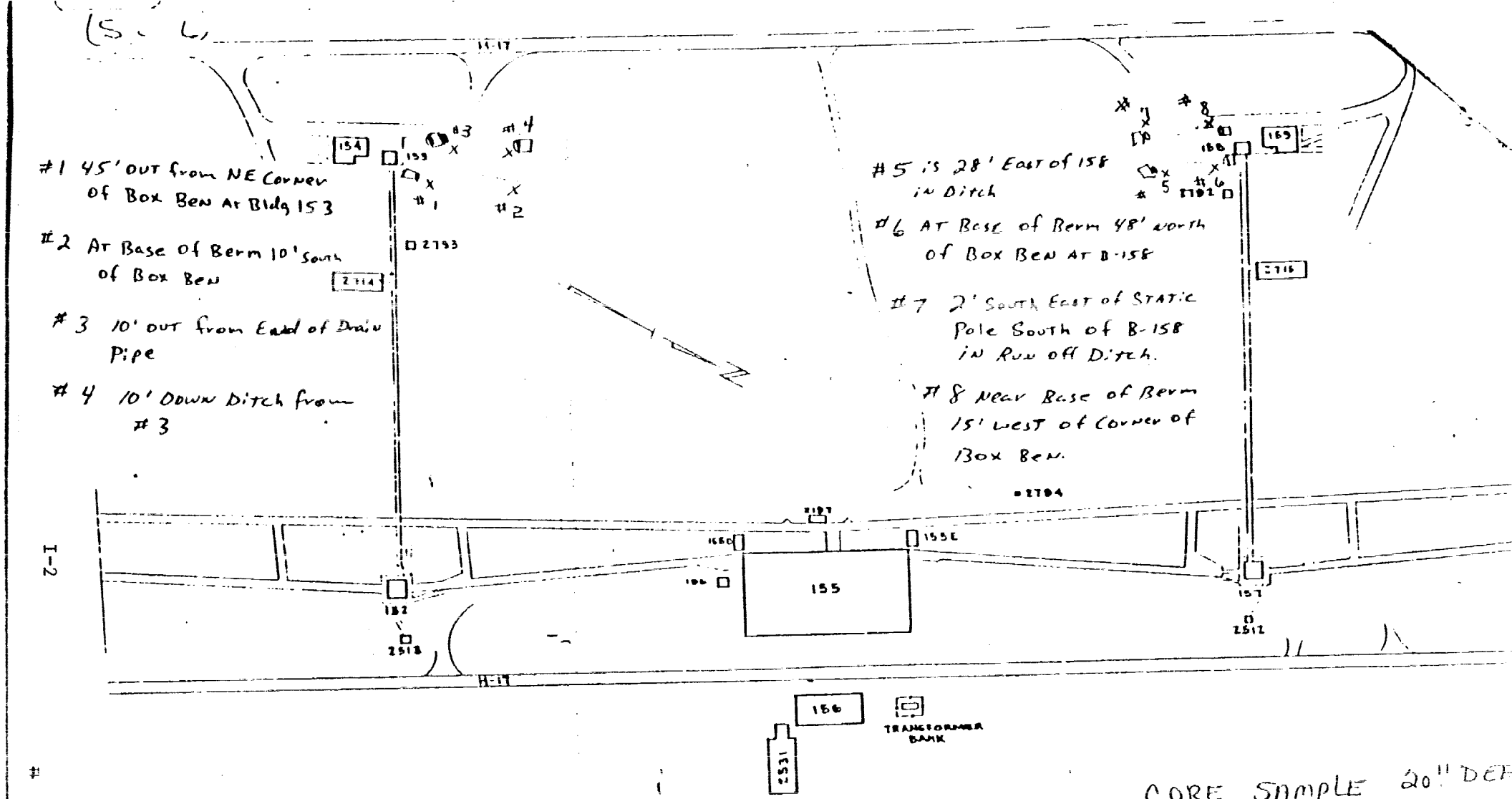


FIGURE A-4. MINE FILL "A" AND MINE FILL "B"

APPENDIX I

1985 MINE FILL SOIL SAMPLE LOCATION SKETCHES


X#8
Headwall
Head wall
#4
Head wall
#3
Head wall
DITCH
#1
#5
#6
#7
Samp #1 2' East of MAN Hole South of B-167
#2 2' from Headwall NW of B-167
#3 3' South of Headwall Down Ditch from #2
#4 25' Down Ditch from Head wall Across Road
#5 South East of Box Bew 10'
#6 Near Static Pole NE of #5
#7 NE of Fire Hydrant in Ditch NW of B-172
#8 Across Road NW of Bldg 172 60' Down Ditch from from Head wall
2700
2173
1692
490
169
174
171
2515
166
2514
11-18
11-45
SAMPLE FOR: TNT, RDX, HMX
SAMPLE ID
MFB-1-
THRU.
MFB-8-
MINE LL"B"
CORE SAMPLES 20" DEEP



MINE FILL "A"
SCALE 1"=100'

CORE SAMPLE 20" DEP

SAMPLE FOR: TNT, RDX,

SAMPLE ID
MFA-1-
T/IRU
MFA-8-

I-2

#8