SITE MANAGEMENT PLAN

PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

PART B

AREAS OF CONCERN

September 1995

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LIST OF ACRONYMS

AEC	Atomic Energy Commission
AOC	area of concern
ARARs	applicable or relevant and applicable (regulations)
AST	above-ground storage tank
BTEX	benzene, toluene, ethylbenzene, xylene
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
COC	contaminant of concern
COD	chemical oxygen demand
CLP	contract laboratory program
D&D	decontamination and decommission
D&M	Dames & Moore
DNT	2,4- or 2,6-dinitrotoluene
DOD	Department of Defense
EB	EBASCO Corporation
EPA	Environmental Protection Agency
GM	garage and maintenance facility
GSA	General Services Administration
HRS	hazard ranking system
HTF	Hypersonic Tunnel Facility
IT	IT Corporation
MCL	maximum contaminant level
MK	Morrison Knudsen
MSL	mean sea level
MW	monitoring well
NACA	National Advisory Committee for Aeronautics
NASA	National Aeronautics and Space Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
PA	preliminary assessment
PAH	polynuclear aromatic hydrocarbon
PBOW	Plum Brook Ordnance Works
PBRF	Plum Brook Reactor Facility
PBS	Plum Brook Station
PCB	polychlorinated biphenyls
PE	pentaerythrinol
PETN	pentaerythrinol tetranitrate
PMU	project management unit
ppb	parts per billion
ppm	parts per million
RA	risk assessment

LIST OF ACRONYMS
(Continued)

RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROD	record of decision
SAIC	Science Applications International Corporation
SB	soil boring
SD	sediment
SI	site inspection
SMP	site management plan
SS	surface soil
SVOC	semi-volatile organic compounds
SW	surface water
TCA	trichloroethane
TCE	trichloroethene
TCLP	toxicity characteristics leachate procedure
TNT	2,4,6-trinitrotoluene
TPH	total petroleum hydrocarbons
ug/ℓ	micrograms per litre
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compounds

PART B SUMMARY

Plum Brook Ordnance Works (PBOW) is located near Sandusky, Ohio, 50 miles west of Cleveland, Ohio, and four miles south of the Lake Erie Port of Sandusky. The site was acquired by the Department of Defense (DOD) in 1938 to manufacture 2,4,6-trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite. Production began on December 16, 1941 and continued through late 1945, yielding over 900 million pounds of these materials during this time. In December 1945, custody of PBOW was transferred to the U.S. Army Ordnance Department, and the U.S. Army Corps of Engineers (USACE) assumed responsibility for maintenance and custodial duties.

In 1956 the National Advisory Committee for Aeronautics (now known as the National Aeronautics and Space Administration, NASA) began leasing sections of PBOW from the Army. By 1963, approximately 6,400 acres of PBOW had been acquired by NASA for various aerospace research activities. Research and test activities were conducted by NASA at Plum Brook Station (PBS) throughout the 1960s and early 1970s.

Environmental remediation of the PBOW site is administered under the DOD Defense Environmental Restoration Program for Formerly-Used Defense Sites (DERP-FUDS) program. This Site Management Plan (SMP) provides a management tool for conducting environmental restoration at PBOW. The SMP is divided into three sections:

- Part A - Site Description and Management Approach
- Part B - Areas of Concern
- Part C - Project Management

This volume, Part B, describes the areas of potential contamination which are scattered over PBOW. These areas have been grouped by similarity of past activity into Areas of Concern (AOCs). The following is a brief description of the AOCs at PBOW identified as eligible for inclusion in the DERP-FUDS program.

S 1.0 TNT Areas

During World War II, the PBOW facility housed operations for the manufacture of TNT and DNT in three primary areas referred to as TNT Area A (approximately 113 acres on the east side of PBOW), TNT Area B (approximately 48 acres in the southern portion of PBOW), and TNT Area C (approximately 113 acres

on the west side of PBOW). Between 1941 and 1945, the TNT manufacturing process at PBOW involved approximately 925 million pounds of nitric acid, 63.5 million pounds of sulfuric acid, and over 425 million pounds of toluene for the manufacture of almost 900 million pounds of TNT and DNT. Based on past site activities, nitroexplosives and residue from the TNT manufacturing process are likely COCs at the TNT areas.

S 2.0 Red Water Ponds

During operation of the PBOW, process waste water, resulting from one of the final purification steps in the production of TNT, was discharged at the site. This waste water, referred to as "red water" because of its color, was transported to a waste water treatment and incineration area (Waste Water Disposal Plant #1) and discharged, via wooden flumes and elevated discharge pipes, to settling ponds located in two areas of the site:

- West Area Red Water Ponds, consisting of two irregular-shaped ponds referred to as West Pond and East Pond, located on the west side of PBOW. West and East Ponds together have a maximum capacity of 120,000 cubic yards of waste water and are separated by an earthen berm.

- Pentolite Road Red Water Ponds, located in the north central portion of PBOW, originally were approximately 200 ft × 400 ft with a maximum capacity of 182,000 cubic yards of waste water. The ponds have since been backfilled following a 1977 breach. Retention dikes and sump pits were constructed at the site and the surface ditch was diverted to prevent further runoff of the red water.

S 3.0 Underground Wastewater Flumes

The wastewater disposal systems at TNT Manufacturing Areas A, B, and C were comprised of above- and below-ground wooden flumes. The wooden flumes were used to carry liquid and solid wastes that accumulated in catch basins located at the wash houses at the three TNT areas. Wastes were transported from the catch basins by gravity flow to wooden settling tanks located in the northernmost portion of each TNT area, before being pumped to one of the red water ponds. The Underground Wastewater Flume lines are generally located:

- along the northern border of TNT Area A. The wastewater flumes and sewers from Area A carried liquid and solid waste to the Pentolite Road Red Water Ponds.

- in the northern portion of TNT Area B. The waste water from Area B was sent to the Pentolite Road Red Water Ponds.

- in the central and northern portions of TNT Area C, where waste water was piped to the West Area Red Water Ponds for disposal.

An estimate of the total piping associated with the flume lines is 20,825 feet of 4-inch pipe; 2,050 feet of 5-inch pipe; 11,250 feet of 6-inch pipe; and 8,875 feet of 10-inch pipe. The wooden flume lines often became clogged with TNT residue, and in some instances were completely plugged. The plugged lines were abandoned, and by-pass lines were constructed around the blocked areas to provide continual drainage of the waste water. Locations of by-pass lines were not documented. During decontamination and decommissioning (D&D) performed by both DOD and NASA, all known flumes were excavated and removed to the burning grounds for destruction. The locations of any remaining flumes at PBOW are unknown. Although a concerted D&D effort was aimed at removing and destroying all of the pipe and flumes, significant lengths of explosives-contaminated flumes may remain at the site. NASA has encountered previously unidentified flumes during construction activities at TNT Area A while installing water lines along Main Road.

S 4.0 Burn Grounds

During the operation of PBOW, burn grounds were used by the Army for the disposal of explosive manufacturing wastes and out-of-specification ordnance. Five burn grounds have been identified, but it is suspected that other areas at PBOW may also have been used as burn grounds. There has been some disagreement on the location of the five known burn grounds; the following is the most recent description of their locations:

- Reservoir #2 Burn Ground, located in the northwestern portion of PBOW south of Reservoir #2.

- G-8 Burn Ground, located in the southwestern portion of PBOW near the intersection of Campbell Street and Patrol Road.

- Taylor Road Burn Ground, located approximately 300 feet southeast of Taylor Road and 300 feet east of Ransom Road.

- Snake Road Burn Ground, located in the southern portion of PBOW approximately 800 feet north of the intersection of West Scheid and Snake Roads, occupies an area of approximately 20,000 square feet. The area east of Snake Road was used by the Army between 1941 and 1963 for the destruction of explosives during the D&D of PBOW.

- Fox Road Burn Ground, located in the northeastern portion of PBOW north of Fox Road, was used for the burning of contaminated flume lines and other TNT-contaminated pipes.

During the period of TNT manufacturing, the burn grounds were used for destruction of hazardous (off-specification TNT, explosives, acids, and solvents) and non hazardous (asbestos and waste oil) materials. The burn grounds were also used for the destruction of explosives-contaminated waste water flumes, intermediate settling tanks, and catch basins from the TNT areas. Contaminated putty, packing, asbestos insulation removed from buildings, and excavated contaminated soils from the TNT and pentolite areas were also burned. Additional explosives and materials contaminated with TNT, DNT, pentolite, and asbestos were burned in these areas during D&D operations. The quantity of waste destroyed at the burn grounds is unknown.

S 5.0 Waste Lagoons

Pentolite was manufactured at PBOW from March 1943 through August 1945. Wastewater generated from this process likely contained substantial concentrations of PE, PETN, TNT, and acetone. The wastewater was disposed in two waste water lagoons, or settling basins, located in the former pentolite dry storage area in what is now a grassy area north of Pentolite Road and south of the reactor facility, within the fenced area enclosing the reactor site. The lagoons were constructed of precast concrete blocks with asphalt-filled expansion joints placed on 4 to 6 inches of gravel or #4 stone; each lagoon basin measured approximately 100 feet by 140 feet. No information is available on the amount of waste water generated, the disposal of sludge, or the volume of waste water treated. Because the lagoons were removed and the pentolite area was graded for construction of the Plum Brook Reactor Facility (PBRF), the lagoons do not appear on current PBOW maps.

S 6.0 Ash Pits and Power Plants

During the operational period of PBOW, ash pits served as disposal areas for fly ash and ash generated from the burning of coal at on-site power plants. Fly ash generated from each of the boilers in the power house collected in pits. Water was added to the ash and the water-ash slurry flowed through a sluice trench to the ash sump located at the end of the building. From the ash sump, the ash traveled through a pipeline to a nearby surface impoundment (ash pit). The three ash pits and power plants include:

- Ash Pit #1, associated with Power Station #1 (Building 201), is located south of Maintenance Road and north of the railroad tracks and the power house building.

- Ash Pit #2, associated with Power Station #2 (Building 501), is located west of Campbell Street, across the street from the power station. It is rectangular in shape and covers approximately 8,000 square feet. Waste Water Disposal Plant #2, also associated with Power Station #2, is located west of Ash Pit #2 opposite Pipe Creek.

- Ash Pit #3, associated with Power Station #3, is located west of Ransom Road and south of Maintenance Road. Historical records indicate that the ash pit was a bermed square-shaped depression occupying an area of approximately 7,500 square feet. NASA's K Site Test Facility was constructed at the site of Power Station #3.

Other potential sources of contamination related to the former power stations include releases from the below-grade fly ash sumps located at each power house, the above ground fuel storage tanks, and the coal storage yards.

S 7.0 Toluene Tank Areas

During the active period of PBOW, six toluene storage tanks served as bulk storage for toluene used in the production of TNT. Each TNT production area had two above-ground toluene tanks of 200,000-gallon capacity each:

- Toluene Tanks 255 and 265, referred as the "Upper Toluene Tanks," supported TNT Area A during the operational period of PBOW and are located west of TNT Area A and Short Cut Road and south of Maintenance Road. The tanks are encircled by earthen dikes approximately 6 feet high. NASA renumbered these tanks as Tank 8951 (Tank 265) and Tank 8952 (Tank 255) and is currently using them for fuel oil storage.

- Tanks 425 and 435, also known as the "Middle Toluene Tanks," supported TNT Area B during ordnance production. They are located northwest of TNT Area B near Taylor Road, and are currently empty.

- Tanks 645 and 655, or the "Lower Toluene Tanks," supported TNT Area C during PBOW operations. They are located southeast of TNT Area C near the intersection of Patrol Road and Taylor Road. Tank 645 was moved by NASA to the Reactor Area for fuel oil storage.

The tanks were decommissioned in 1945 by pumping out their contents, draining the transfer lines, and opening top and bottom flanges for ventilation.

S 8.0 Rail Car Unloading Area/Sellite Area

The Rail Car Unloading Area, near the Garage and Maintenance Facility on the north side of Maintenance Road between Ransom Road and Taylor Road, may have been used principally for unloading of toluene and other chemicals from rail cars. It is estimated that more than 400 million pounds of toluene may have been unloaded at this site during the PBOW operational period. In addition, its proximity to the Garage and Maintenance Area may have led to its informal use for staging of equipment and supplies.

The Sellite Area, located west of the Rail Car Unloading Area, was used for the production and storage of sellite used for the TNT washing process. Extensive areas of bare soil and pieces of sulfur and slag were observed at the former Sellite Area during field reconnaissance by Dames & Moore. A shallow surface ditch which received runoff from the Sellite Area is located east of the Sellite Area.

S 9.0 Acid Areas

During the operation of PBOW, acid areas were used by the Army for the manufacturing of nitric and sulfuric acids used in various stages of the manufacture of TNT and pentolite. Three areas of acid manufacturing have been identified at PBOW, referred to as Acid Area #1, Acid Area #2, and Acid Area #3. Acid Area #1 is located in the central portion of PBOW, south of the Garage and Maintenance Area. Acid Area #2 is located in the westernmost portion of PBOW, south of Maintenance Road and just east of Patrol Road, northwest of Pipe Creek. Acid Area #3 is located in the northwestern portion of PBOW, along Ransom Road north of Maintenance Road. Each acid area is roughly rectangular in shape and cover an area of approximately ten acres.

S 10.0 Pentolite Area

During the operation of PBOW, the Pentolite Area was used by the Army for the manufacturing of pentolite. Pentolite was produced from March 1943 through August 1945 when PBOW ceased operation. The Pentolite Area was the only area at PBOW used for the production of pentolite. The area contained three pentolite lines with a designated capacity of 7,000 pounds per 24 hours. Two basins received wastewater generated during pentolite production. The volume of wastewater, specific treatment details, and sludge details are not known. The site is located in the north-central portion of PBOW, and lies within the boundaries of Ransom Road on the west, Pentolite Road on the south, and Patrol Road on the north and east. The exact size and shape of the site has not been determined.

The decommissioning of the Pentolite Area was begun in 1945 when ordnance manufacturing ceased. All buildings in the Pentolite Area were removed or burned in place. In 1956, the Pentolite Area was selected by NASA as the site for the construction of the PBRF. The entire pentolite area was graded to meet reactor site specifications, and potentially contaminated soil was removed to an unknown location or dispersed during construction. A Preliminary Assessment indicated that the wastewater generated during the manufacturing of pentolite probably contained significant concentrations of PE, PETN, acetone, and TNT.

S 11.0 Garage and Maintenance Area

During the operation of PBOW, the Garage and Maintenance Area was likely used by the Army for the general maintenance of equipment and vehicles. Underground storage tanks (USTs) were installed in this area for the storage of gasoline, solvents, and waste oil. These USTs have subsequently been removed. The Garage and Maintenance Area was operational between 1941 to 1945, becoming decommissioned when PBOW ceased operations. The site is located in the central portion of PBOW along Maintenance Road. The Garage and Maintenance Area is currently used in support of NASA activities. Additional USTs were installed at this site in 1964 and 1982 for the storage of solvents and diesel fuel. These USTs have also been removed.

S 12.0 TNT Rail Car Loading Areas

During the operation of PBOW, TNT was loaded onto rail cars for shipment from the site to storage areas on the site. The locations of these TNT Rail Car Loading Areas are unknown, and reference to them has not been found in site documents. However, it is suspected that there was a loading area at each of the TNT manufacturing areas, located along now-abandoned rail spurs. The presence of the remnants of blast-protection walls adjacent to abandoned rail tracks at the southern end of TNT Area B suggests this as a possible location of a TNT Rail Car Loading Area. Construction of facilities in support of NASA activities may have altered or removed the loading areas, particularly at TNT Area A.

S 13.0 Sitewide Ground Water

The potential for ground-water contamination exists at PBOW, although ground-water contamination has not been documented at the site. Ground-water contamination may have resulted from activities related to the operation of PBOW as well as later activities. The manufacturing and storage of acid and the storage and transport of process chemicals, including toluene and acetone, occurred at PBOW in support of the ordnance manufacturing. In addition, waste "red water" was transported via buried pipelines and flumes to treatment facilities, and from there to waste "red water" ponds for long-term storage. The possibility of spillage or leakage during storage, transport, and manufacturing of chemicals, wastes, and ordnance may have contributed to the contamination of ground water at the site. In addition, D&D activities may have contributed to ground-water contamination at the site.

1.0 INTRODUCTION

The Site Management Plan (SMP) provides a management tool for the remediation at the Plum Brook Ordnance Works (PBOW) (Figure 1-1). The SMP is divided into three sections:

- **Part A - Site Description and Management Approach** - contains a description of the regulatory framework, site setting, site investigations and results, management objectives, quality assurance requirements, sampling and analysis plans, site-specific safety and health plan, and document control and data management.

- **Part B - Areas of Concern** - presents detailed descriptions of each area of concern, including physical characteristics, site investigations and other studies, contaminants of concern, and the nature and extent of contamination, all based on existing information.

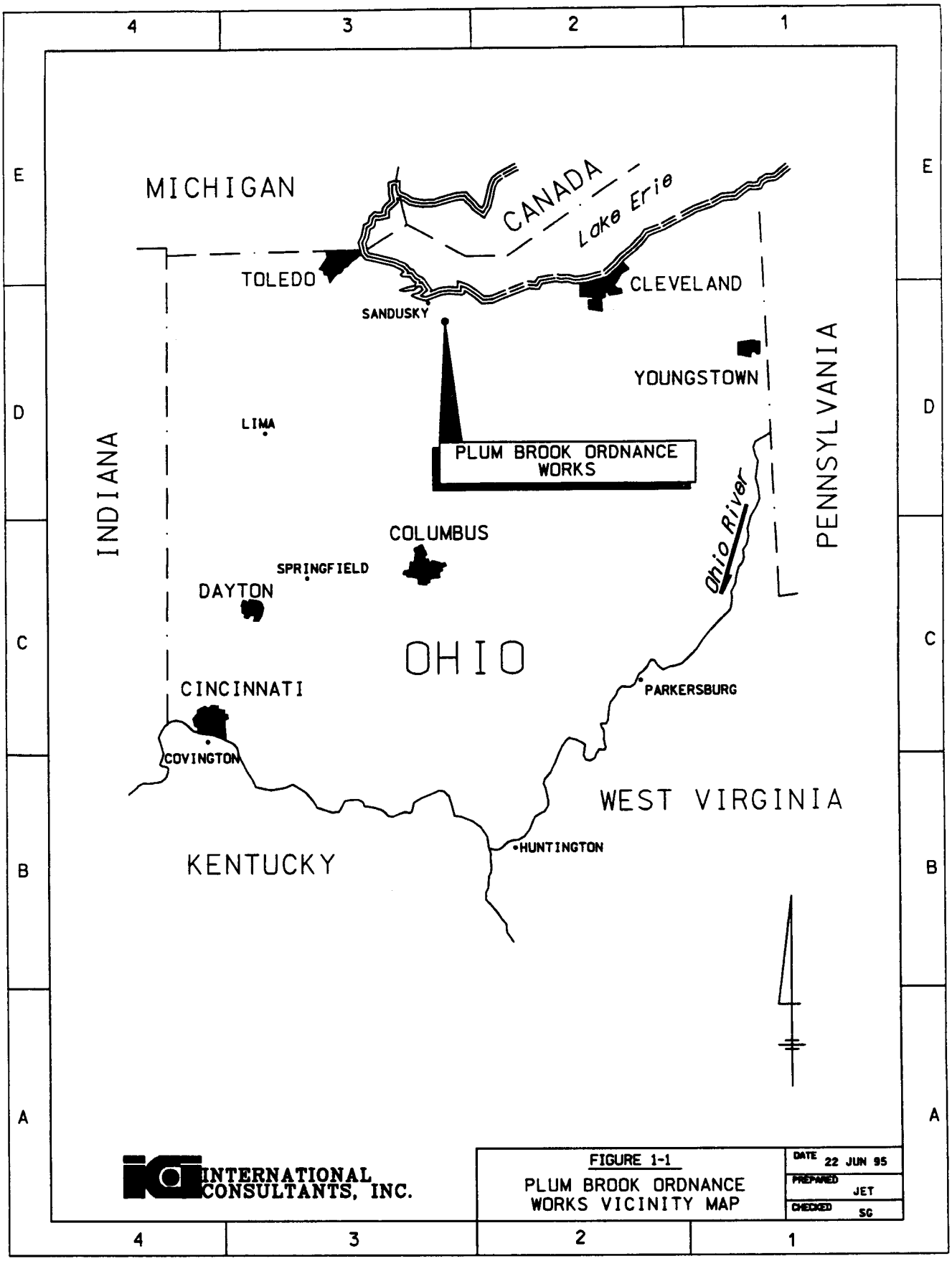
- **Part C - Project Management** - includes a road map for completing any remediation required at PBOW with descriptions of management responsibilities, community relations, the Administrative Record, area investigation prioritization and scheduling, funding requirements, and management resources, and a compilation of the results of all investigations previously performed at the site to provide a baseline for all future investigations. This document presents the management approach for future investigations.

This volume, Part B of the SMP, describes the Areas of Concern (AOCs) at PBOW. For each of the AOCs, discussed in Sections 2 through 14, the background and physical characteristics of the AOC are described; the contaminants of concern (COCs), nature and extent of contamination, and the current status of site characterization are discussed; and planned activities and recommendations for future activities are presented.

This introductory section provides a backdrop for the AOC-specific sections that follow by presenting the general site background, the site history, and the physical characteristics of PBOW as a whole. Also included here is a description of the remedial investigation process, and the criteria for making decisions in this process.

1.1 SITE BACKGROUND

The site background includes descriptive and historic information on PBOW and Plum Brook Station (PBS) that are relevant to developing an understanding of potential contamination that may have resulted from past site activities.


MICHIGAN
CANADA
Lake Erie
TOLEDO
SANDUSKY
CLEVELAND
YOUNGSTOWN
PENNSYLVANIA
LIMA
INDIANA
PLUM BROOK ORDNANCE WORKS
Ohio River
COLUMBUS
SPRINGFIELD
DAYTON
OHIO
CINCINNATI
PARKERSBURG
COVINGTON
WEST VIRGINIA
HUNTINGTON
KENTUCKY
INTERNATIONAL CONSULTANTS, INC.
FIGURE 1-1
PLUM BROOK ORDNANCE WORKS VICINITY MAP
DATE 22 JUN 95
PREPARED JET
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1.1.1 Location and General Description

Plum Brook Station is located near Sandusky, Ohio, 50 miles west of Cleveland, Ohio, and four miles south of the Lake Erie Port of Sandusky. The site lies principally in Perkins Township, with much of the southeastern portion in Oxford Township. The eastern edge of the site extends into Huron and Milan Townships. The site is bounded by U.S. Route 250 on the east, County Road 43 on the west, Bogart Road on the north, and Mason Road on the south. Most of PBOW is situated on undisturbed forested land, while the area surrounding the site is used for agriculture. The site has a total of 62.5 miles of internal paved roads and 15.7 miles of railroad line, most of which has been abandoned.

1.1.2 History of Past Operations

The original site was acquired by the Department of Defense (DOD) in 1938 and consisted of approximately 9,010 acres of land. Currently, PBS consists of approximately 6,400 acres, however, PBOW remediation addresses the entire 9,010 acres. In the early 1940s the U.S. Army contracted with the Trojan Powder Company to manufacture 2,4,6-trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite at PBOW. Production began on December 16, 1941 and continued through late 1945, ceasing two weeks after V-J Day (September 2, 1945). During this production period, over 900 million pounds of these materials were manufactured at PBOW. After the operation ceased, the area was turned over to the Army Ordnance Department and was renamed Plum Brook Depot and used for ammunition storage.

PBOW was placed in standby condition from 1945 to 1946. During this time, the Army conducted decontamination and decommissioning (D&D) of many of the buildings and structures associated with the manufacturing of ordnance (SAIC 1991). D&D included removal and relocation of all explosives to burn grounds for incineration. Where possible, remaining structures and buildings were burned in place. Drain lines and steam lines were flushed and dismantled; however, PBOW historical records do not indicate where they were flushed or where the water used for flushing was disposed.

In December 1945, custody of PBOW was transferred from the Trojan Powder Company to the U.S. Army Ordnance Department, and the U.S. Army Corps of Engineers (USACE) assumed responsibility for maintenance and custodial duties at PBOW from January 1 through June 30, 1946. In August 1946, PBOW was transferred to the War Assets Administration. Additional decontamination efforts were undertaken by Ravenna Arsenal from 1954 to 1958.

1.1.3 History of Current Operations

In 1956 the National Advisory Committee for Aeronautics (NACA) began leasing sections of PBOW from the Army. An agreement was made in 1956 for a lease of 500 acres of the north portion of the site to construct and operate the Plum Brook Reactor Facility (PBRF). In 1958 NACA became the National Aeronautics and Space Administration (NASA). By 1963, approximately 6,400 acres of PBOW had been acquired by NASA for various aerospace research activities, plus an additional 2,000 acres to serve as a buffer zone. Research and test activities were conducted by NASA at PBS throughout the 1960s and early 1970s.

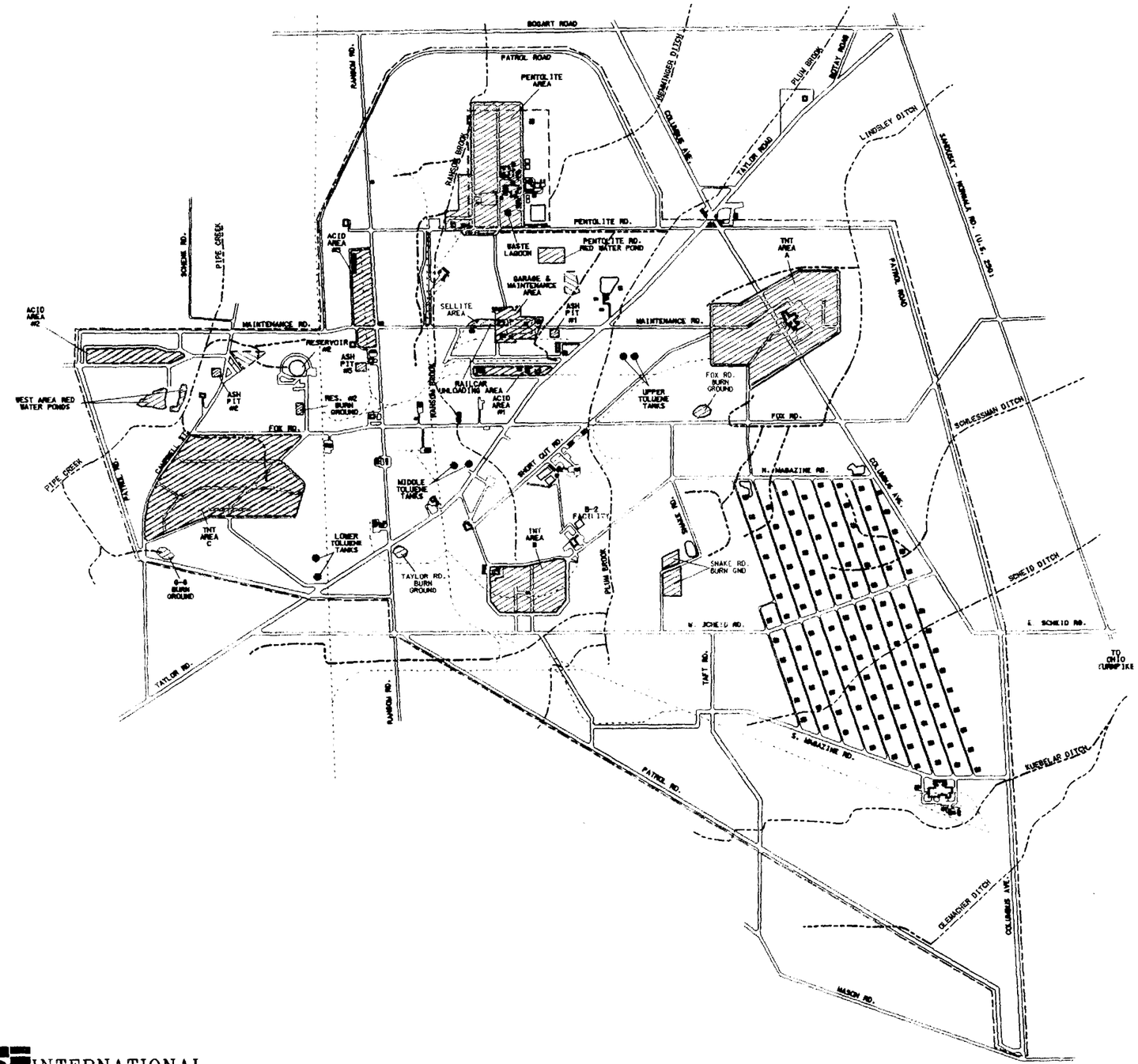
In 1978, NASA declared approximately 2,150 acres of land as excess. The Perkins Township Board of Education uses 46 of the excess acres as a bus transportation center. Much of the remaining excess property was reclaimed for farmland. NASA also excessed Parcel #59 to the General Services Administration (GSA) in 1978 for subsequent disposal. The efforts of the GSA to dispose of the property have been futile largely due to the presence of the waste water ponds resulting from PBOW activities. NASA controls the land associated with PBS through ownership of title, use of easements, leases, permits, and ownership of development rights. Detailed information on past operations at PBOW is available in *Plum Brook Ordnance Works Records Review Report* (Dames & Moore [D&M] 1995).

1.2 PHYSICAL CHARACTERISTICS

The physical characteristics of PBOW include topography, ecology, soil types, geology, and hydrology. A general description of these features is provided here for PBOW as a whole. The physical characteristics unique to each AOC are described in Sections 2 through 14. Figure 1-2 shows the location of the PBOW AOCs.

1.2.1 Topography

The PBOW site is located on relatively flat terrain resulting from glacial and lacustrine deposits from ancient glacial Lake Maumee, an extension of present-day Lake Erie. The site generally slopes gently northward toward Lake Erie, with an average slope of the ground surface of less than six percent. Elevations at the site range from 625 feet above mean sea level (MSL) in the northern portions near Bogart Road, to 675 feet above MSL at the southern and western edges of the site. The flat terrain has since been disrupted by construction of basins, berms, ditches, and levees in conjunction with PBOW and subsequent activities.



PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

0 500 1000 2000
SCALE IN FEET

LEGEND:
- STREAM
- RAILROAD
- PBS BOUNDARY FENCE
- AREA OF CONCERN
- MIS-LOCATED AOC (Sampled by M-K, 1994a)

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FIGURE 1-2
LOCATIONS of AREAS of CONCERN (AOCs) at PBOW

DATE	12 JUL 95
PREPARED	JET
CHECKED	DBJ

1.2.2 Ecology

There are six different vegetation habitats found at PBOW: grassland, brushland/oldfield, woodlands, structural, wetlands, and open water. The grassland habitat occupies the largest area at PBOW and contains native and introduced plants. Orchard grass, broomsedge, Kentucky bluegrass, switchgrass, and bluestream are typical grasses that occur in this habitat. Tree species found in this habitat include oak, hickory, maple or beech, and tulip-poplar. Controlled open burning of grassland is practiced in order to control nuisance weeds and enhance the growth of prairie grass species such as switchgrass, an excellent habitat for upland bird species.

Brushland/oldfield is the second most prevalent habitat at PBOW. Birds such as flycatchers, red-winged blackbird, sparrows, quail, and ruffled grouse are supported by this habitat. The cottontail rabbit and pheasant are also found in this area. The shrubs and thickets provide food and shelter to the wildlife.

Woodland habitats are located at several different locations around PBOW. Pine trees and secondary deciduous trees are the prominent plant types located here.

Structural habitats include areas of mostly weedy plants, ornamental trees, and shrubs. Rats, mice, pigeons and starlings frequent this habitat.

The most prevalent wildlife species is the white-tailed deer. During the winter of 1994/1995, 1,474 deer were counted within the fenced area of PBS. They inhabit the wooded areas, brushlands, grasslands, and even graze on the lawns of the site. There is managed, periodic thinning of the herd.

Potential wetlands make up approximately 1.5 percent of the total area at PBOW. Sixteen acres of these wetlands contain water on a year-round basis. Forty acres are seasonal, remaining wet over most of the year but having a dry period during the summer. Another 30 acres are wet long enough to maintain a good stand of sedges and rushes and yet dry enough to allow the growth of grasses and forbs. Cattails, spikerushes, rushes, and sedges form the dominant vegetation in the wetlands. Many species of birds make use of the dense vegetation of the wetlands for escape and nesting cover (Warner, et. al. 1990).

Open water habitats are also located within the boundaries of PBOW. The Red Water Ponds support sunfish, painted turtles, and snapping turtles. Wild ducks and geese swim, feed, and nest in and around the ponds.

A species survey was conducted on PBS in 1995 which was designed to identify plant species, breeding birds, reptiles and amphibians, fish and lepidoptera (butterflies and moths) (Bionetics 1995). The primary emphasis was on identification of any federal or state-listed species occurring on the facility. All species encountered during the survey were identified. The only federally-listed species observed during the survey was the bald eagle (*Haliaeetus leucocephalus*). An individual adult was observed on one occasion in early June near one of the reservoirs. As nesting sites are located near PBS but not observed on the site, it was assumed that this adult was a sporadic visitor to the site, rather than a nesting resident.

The state-listed species found at PBS include:

- **Endangered:**
  least St. John's-wort (*Hypericum gymnanthum*)
  sedge wren (*Cistothorus platensis*)
  thin-leaf sedge (*Carex cephaloidea*)

- **Threatened:**
  grove sandwort (*Arenaria laterifolia*)
  field sedge (*Carex conoidea*)
  ashy sunflower (*Helianthus mollis*)
  upland sandpiper (*Bartramia longicauda*)

- **Potentially Threatened:**
  prairie false indigo (*Baptisia lactea*)
  broad winged sedge (*Carex alata*)
  round-fruited hedge hyssop (*Gratiola virginiana*)
  tall St. John's wort (*Hypericum majus*)
  Virginia meadow beauty (*Rhexia virginiana*)
  lance-leaved violet (*Viola lanceolata*)

- **Special Concern:**
  Blanding's turtle (*Emydoidea blandingii*)
  Eastern fox snake (*Elaphe vulpina gloydi*)
  smooth green snake (*Opheodrys vernalis*).

The authors of the study indicated that this survey represents data collected for a single survey season only and does not present a comprehensive survey. A drought during the study period also affected the results.

1.2.3 Soils

Based on mapping by the Ohio Department of Natural Resources (ODNR) in cooperation with the U.S. Department of Agriculture (USDA), three soil associations are present at PBOW: The Arkport-Galen Association, the Prout Association, and the Del Rey-Lenawee Association.

The Arkport-Galen Association is characterized by deep, nearly level to moderately sloping, well-drained soils that have a subsoil of loamy fine sand and fine sand, and occur on hills and ridges. These soils are formed in very fine sand deposited by wind and water as beaches, sand bars, and sand dunes. Arkport soils are mostly gently-sloping to moderately sloping and well-drained; they occupy the nearby higher ridges in the county. Galen soils are nearly level, moderately well-drained light-colored soils that formed in water-laid sandy deposits. These soils are found on uplands in all parts of the county. The Arkport Galen Association is made up of about 40 percent Arkport Soils, 30 percent Galen Soils, and 30 percent other minor soils. The soils are productive, and the crops respond well to fertilization. Wind erosion is a hazard in cultivated areas. Low permeability, poor drainage, severe limitation for septic tank absorption fields, and moderate shrink-swell potential are some of the characteristics of the soil association.

The Prout Association is found mostly in the southern portion of PBOW. The Prout series consists of nearly level to gently sloping, dark colored, somewhat poorly drained soils that formed on glacial till or lakebed deposits. The series is made up of about 30 percent Prout soil, 30 percent Prout soil deep variant, and 30 percent Fries soils and other minor soils. Permeability is moderate and surface runoff in these soils are moderately slow. Because of the high acidity of the soil and a seasonal high water table, productivity of the soils is low to moderate.

The Del Rey-Lenawee association is found in the north-central and northwestern portions of the site. The Association consists of approximately 60 percent Del Rey soils, 30 percent Lenawee soils, and 10 percent other minor soils. Del Rey soils are somewhat poorly drained and light colored. Lenawee soils are nearly level to depressional, very poorly drained, and dark colored. Nearly all of this association is cropland. The soils are productive and crops respond well to fertilization. Poor drainage is the main limitation.

The Lewisburg Series is also seen in scattered parts of the Plum Brook Site. The Lewisburg Series consists of nearly level to gently sloping, light colored, medium-textured, moderately well drained soils that formed in high-lime glacial till. Runoff and permeability are moderately slow. Available moisture capacity is medium. Productivity is moderate if the soils are properly fertilized.

1.2.4 Geology

The site is situated on the glacial lacustrine plain of ancient Lake Maumee. The glacial deposits at PBOW are underlain by a gently eastward-dipping sequence of Paleozoic carbonate and clastic sedimentary rocks ranging in age from Cambrian to Devonian. The Silurian and Devonian formations that outcrop in Erie County are shown in the generalized geologic column provided in Figure 1-3.

Bedrock at PBOW consists of the Columbus Limestone, the Delaware Limestone, the Prout Limestone/Plum Brook Shale, and the Ohio Shale, listed in order of age from the oldest to youngest (SAIC 1991). Columbus and Delaware Limestones occur in the western and northern parts of the site, and the Prout Limestone/Plum Brook Shale and the Ohio Shale occur in the southern part. The depth to bedrock across PBOW varies from zero to more than 25 feet, based on data obtained from the few soil borings that penetrated bedrock (Morrison Knudsen [MK] 1994a).

The Columbus Limestone consists of dolomite and limestone, grading upward from dolomite having little calcium carbonate, to limestone containing 10 percent to 25 percent magnesium carbonate. The Delaware formation overlies the Columbus Limestone at the site. The Delaware is fine crystalline, hard, dense, and fossiliferous. The strata is generally uniformly bedded in layers less than one foot thick. Karst topography has selectively developed in some of the Silurian and Devonian carbonate bedrock in the northern and western portion of Erie County, resulting in cavernous porosity in some locations (SAIC 1991).

Overlying the Delaware Limestone is the Plum Brook Shale which in turn is overlain by Prout Limestone. The Prout Limestone is siliceous and hard, while the shale is soft and contains nodules of hard limestone. The shale is low in porosity, while the limestone is massive and moderately porous. Overlying the Prout Limestone is the Ohio Shale, which is black and thinly bedded. The Ohio Shale contains pyrite and abundant bituminous and carbonaceous matter, yielding natural gas in some locations.

1.2.5 Hydrology

This section summarizes the general surface water hydrology and the subsurface hydrogeology at PBOW. It has been interpreted from topographic maps, soil borings, and monitoring wells installed at the site. A conceptual model of the ground-water system at PBOW is provided in Section 14.6.

Age	Formation/Group	Depth to Top (ft)	Thickness (ft)a	Hydrologic Unith	Rock Description
DEVONIAN	Ohio Shale	*	300	Zone 3	Shale: *black, thin-bedded with bituminous and carbonaceous material*
	Prout Limestone/ Plum Brook Shale	Surface	210		Shale: *light gray, calcareous*
	Delaware Limestone	40	50	Zone 1 and Zone 2	Limestone: *buff, earthy, fossiliferous, interbedded w/brown crystalline dolomite*
	Columbus Limestone	90	110		Limestone: *brown to gray, fine crystalline, fossiliferous, w/tan to buff-gray, partly sandy dolomite at base*
	Lucas Dolomite	200	70		Dolomite: *brown, crystalline, porous, cherty*
SILURIAN	Amherstburg Dolomite	270	20		Dolomite: *tan to gray, microcrystalline, slightly argillaceous*
	Bass Island Dolomite	290	30		Dolomite: *light- to brownish-gray, microcrystalline, w/minor gray or black shale*
	Salina	320	590		Dolomite: *anhydrite and shale sequence. Interbedded and intercalated. Dolomite is tan to brown and mostly tight. Scattered shale laminae. Few scattered oil stains. Some dolomite is shaly. Few massive beds of dolomite and anhydrite*

Notes:

a - Depth to formation, formation thickness, and lithology based on single borehole.

b - Refer to Figure 1-4 for areal distribution of Zones 1, 2, and 3.

* - The Ohio Shale was not encountered in the single borehole; it outcrops in the southeastern portion of the PBOW site.

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FIGURE 1-3

GENERALIZED BEDROCK STRATIGRAPHIC AREA

DATE 15 MAY 95

PREPARED JET

CHECKED SG

1.2.5.1 Surface Water

Numerous ponds (man-made and natural) and streams lie within a 15-mile radius of PBOW. Lake Erie and Sandusky Bay, located 3.5 miles to the north, are the largest nearby surface water bodies. The PBOW lies within the Huron River drainage basin. The Huron River is located approximately 3.5 miles east of PBOW.

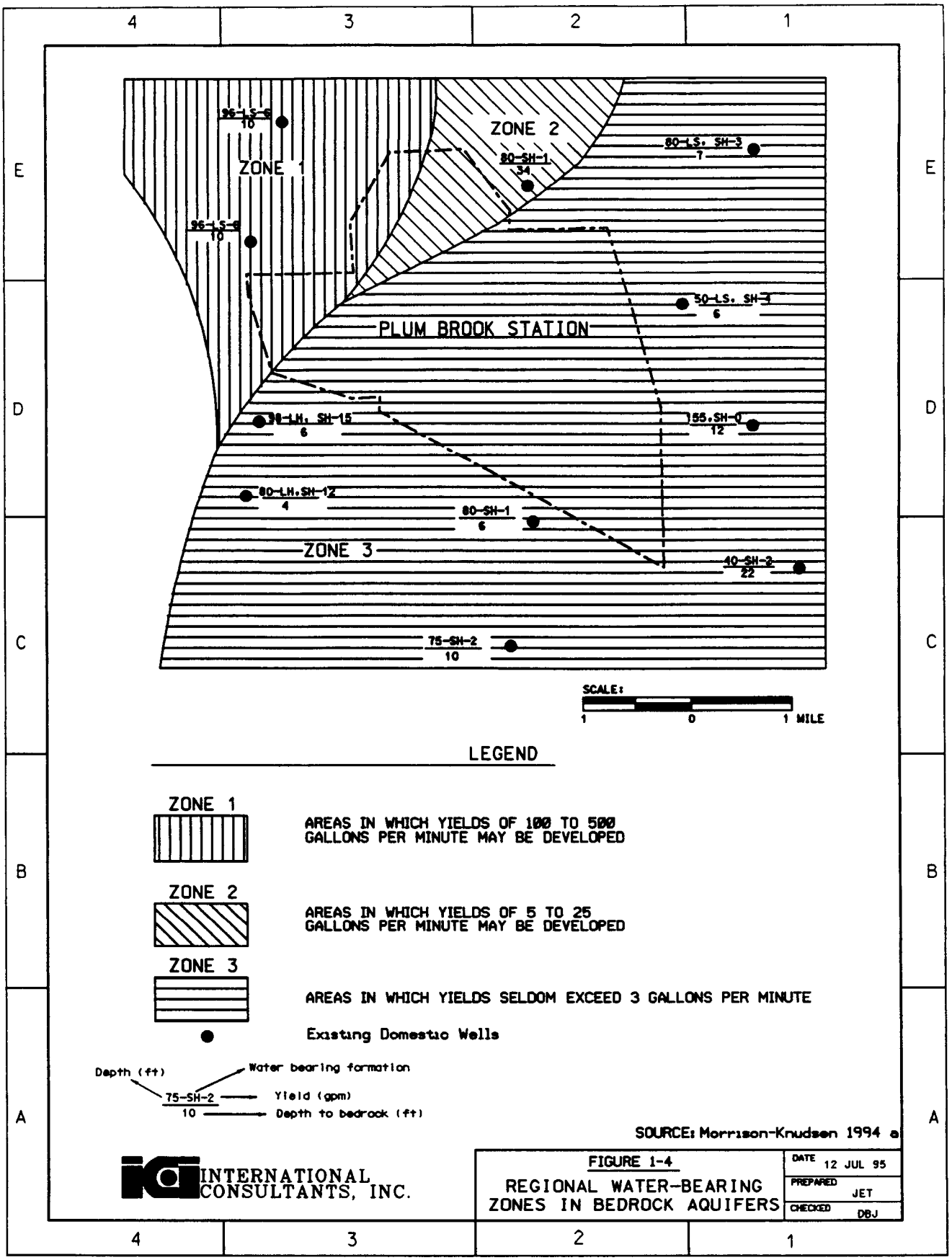
Eleven streams pass through or originate on PBS property. The streams flow northward and northeastward to converge into Ransom Brook, Storrs Ditch, Plum Brook, and Sawmill Creek, which all flow into Lake Erie. The drainage pattern is dendritic where streams are incised to bedrock; the drainage pattern on glacial deposits is erratic and poorly to moderately developed. Ditches within PBS total approximately 380,000 lineal feet (MK 1994a). The streams apparently receive part of their runoff from ground water. All streams may have zero flow in severe winter freezes and extended summer droughts. NASA currently monitors three streams for National Pollutant Discharge Elimination System (NPDES) discharge limits at PBOW: Ransom Brook, Kuebelar Ditch, and Plum Brook.

Seventeen isolated ponds and reservoirs, and three red water ponds are located on the site. The pond levels generally remain high even during dry months, suggesting that the ponds are fed by shallow surficial ground water.

1.2.5.2 Ground Water

Two principal bedrock aquifers occur in the PBOW area, both of which supply drinking water to portions of Erie County. A highly productive limestone (carbonate) aquifer is used in the western portion of the county, and a poorly productive shale (clastic) aquifer is used to the east. The transition between the western carbonate aquifer and the eastern clastic aquifer occurs beneath PBOW (Figure 1-4). The glacial deposits at PBOW overlie both aquifers (SAIC 1991). Wells surrounding PBS are used for agricultural purposes including irrigation, which could have an effect on drawdown near the site.

ODNR mapped three ground-water zones, informally referred to as Zones 1, 2, and 3, within the principal aquifers based on well yields (Figure 1-4). Zones 1 and 2 are developed in the carbonate aquifer, and Zone 3 is in either discontinuous sand and gravel deposits in the glacial till, or in the underlying bedrock shale (SAIC 1991).


ZONE 1
ZONE 2
ZONE 3
PLUM BROOK STATION
96-LS-6
10
96-LS-6
10
80-SH-1
34
80-LS. SH-3
7
50-LS. SH-4
6
80-LH. SH-15
6
55.SH-0
12
80-LH.SH-12
4
80-SH-1
6
40-SH-2
22
75-SH-2
10
SCALE:
1
0
1 MILE
LEGEND
ZONE 1
AREAS IN WHICH YIELDS OF 100 TO 500 GALLONS PER MINUTE MAY BE DEVELOPED
ZONE 2
AREAS IN WHICH YIELDS OF 5 TO 25 GALLONS PER MINUTE MAY BE DEVELOPED
ZONE 3
AREAS IN WHICH YIELDS SELDOM EXCEED 3 GALLONS PER MINUTE
Existing Domestic Wells
Depth (ft)
Water bearing formation
75-SH-2
Yield (gpm)
10
Depth to bedrock (ft)
SOURCE: Morrison-Knudsen 1994 a
INTERNATIONAL CONSULTANTS, INC.
FIGURE 1-4
REGIONAL WATER-BEARING ZONES IN BEDROCK AQUIFERS
DATE 12 JUL 95
PREPARED JET
CHECKED DBJ

Ground water within the carbonate aquifer occurs in a network of interconnected fractures, bedding plane joints, and solution channels. In some instances, dissolution has produced caverns in the limestone at depths of less than 100 feet, providing zones of cavernous porosity with very high ground-water yields (100 to 500 gallons per minute). Yields in the carbonate aquifer are highest to the west and decrease to the east as the transition to the clastic aquifer is approached. The direction of ground-water flow in the carbonate aquifer is to the north to points of discharge in Lake Erie. The clastic aquifer that occurs in the eastern portion of PBOW has low yields because of the fine-grained nature of the shale. Locally, shales outcropping at the surface may be highly fractured from weathering, providing the shale with some capacity to store and transmit water (SAIC 1991).

The thin layer of glacial and lacustrine deposits overlying bedrock is not considered to be a major aquifer, although it does contain discontinuous layers of sand and gravel which may be water-bearing (SAIC 1991). Numerous water-bearing sand lenses have been encountered in the glacial deposits at PBOW at depths of less than 10 feet. Glacial till generally has a low hydraulic conductivity because of the high clay and silt content, making it a poor source of ground water. However, the till has an interconnected network of fractures in places that may enhance its capability for vertical ground-water flow. The sand and gravel lenses in the till may be a source of recharge for bedrock aquifers.

Water level depths encountered in boreholes at the site ranged from less than three feet to greater than 15 feet, with most water levels occurring between five and ten feet below the surface. A number of boreholes drilled at the site did not encounter ground water either because of shallow bedrock or extensive low-permeability layers in the glacial till. The surficial ground water generally flows in a northerly or northeasterly direction (MK 1994a), but local variations are common, especially near surface bodies of water (H^{+}GCL 1992).

1.3 REMEDIAL INVESTIGATION PROCESS

The environmental site inspection and remedial investigation processes contain a number of decision points at which a determination is made whether to proceed to further site restoration, or that no further action is required. The following figures (Figures 1-5 and 1-6) present decision diagrams for environmental site inspections and remedial investigations, respectively. Each AOC at PBOW will likely undergo different levels of restoration, with some possibly requiring no remediation.

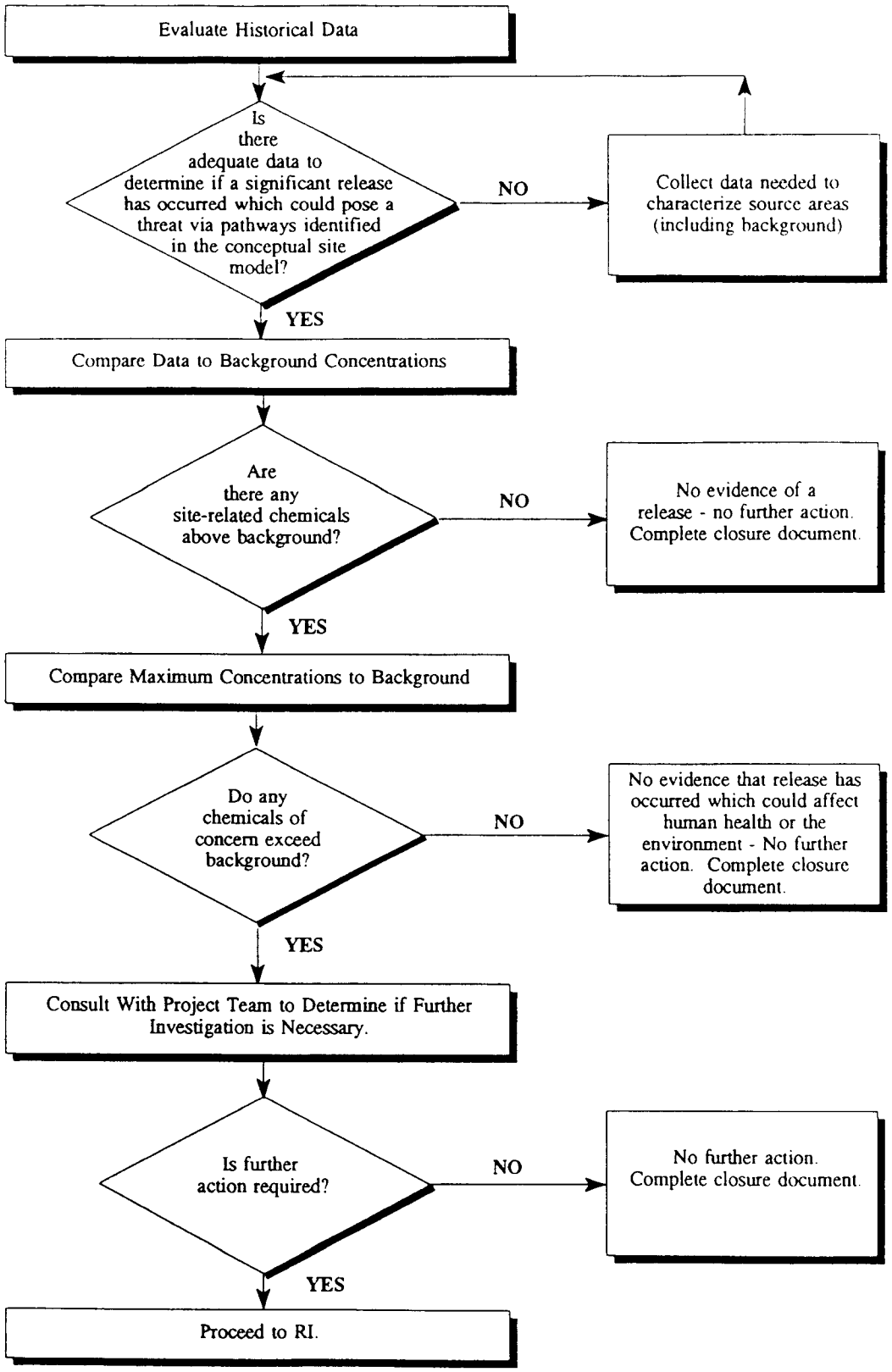


FIGURE 1-5. ENVIRONMENTAL SITE INSPECTION DECISION DIAGRAM

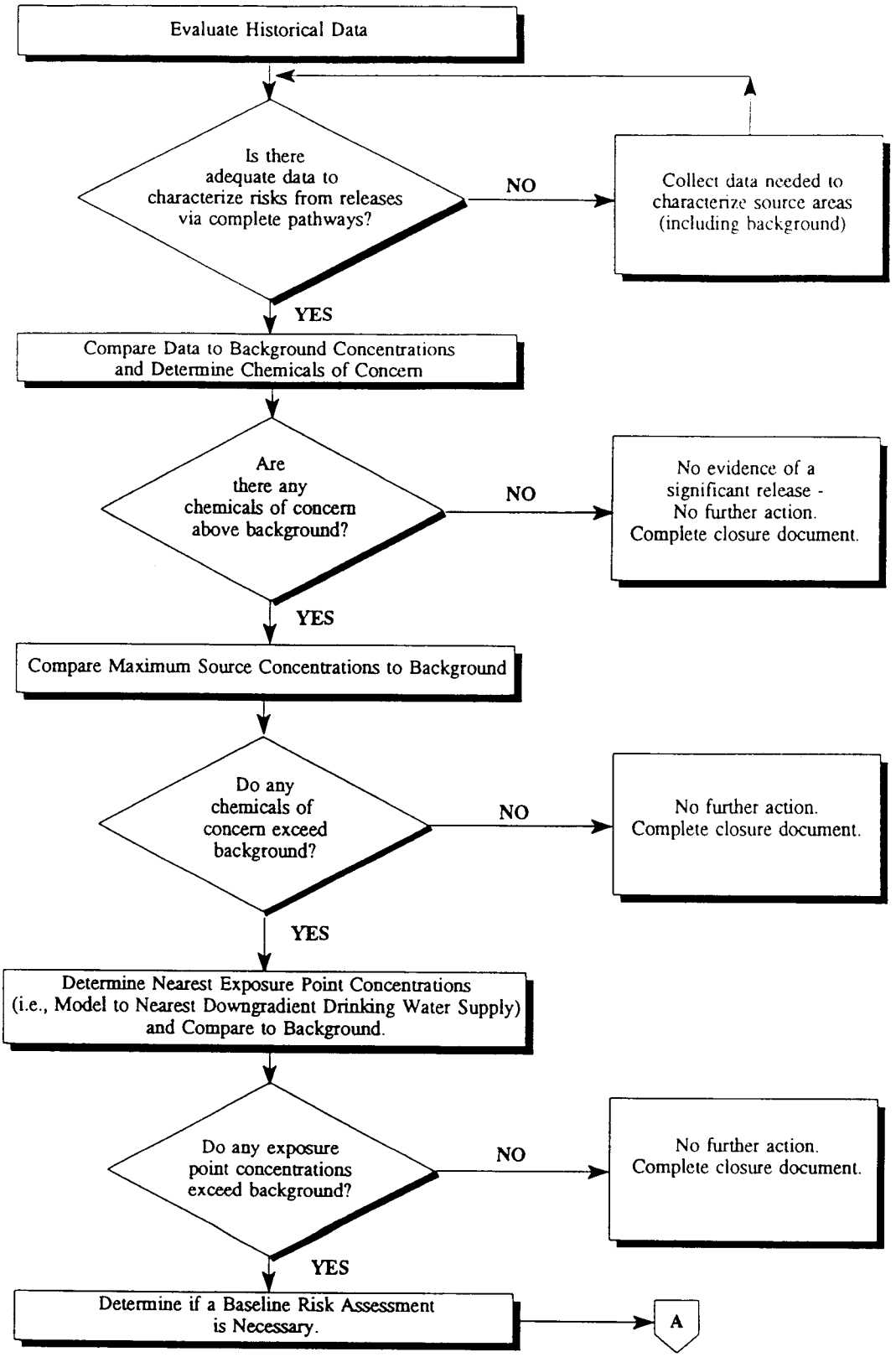


FIGURE 1-6. REMEDIAL INVESTIGATION DECISION DIAGRAM

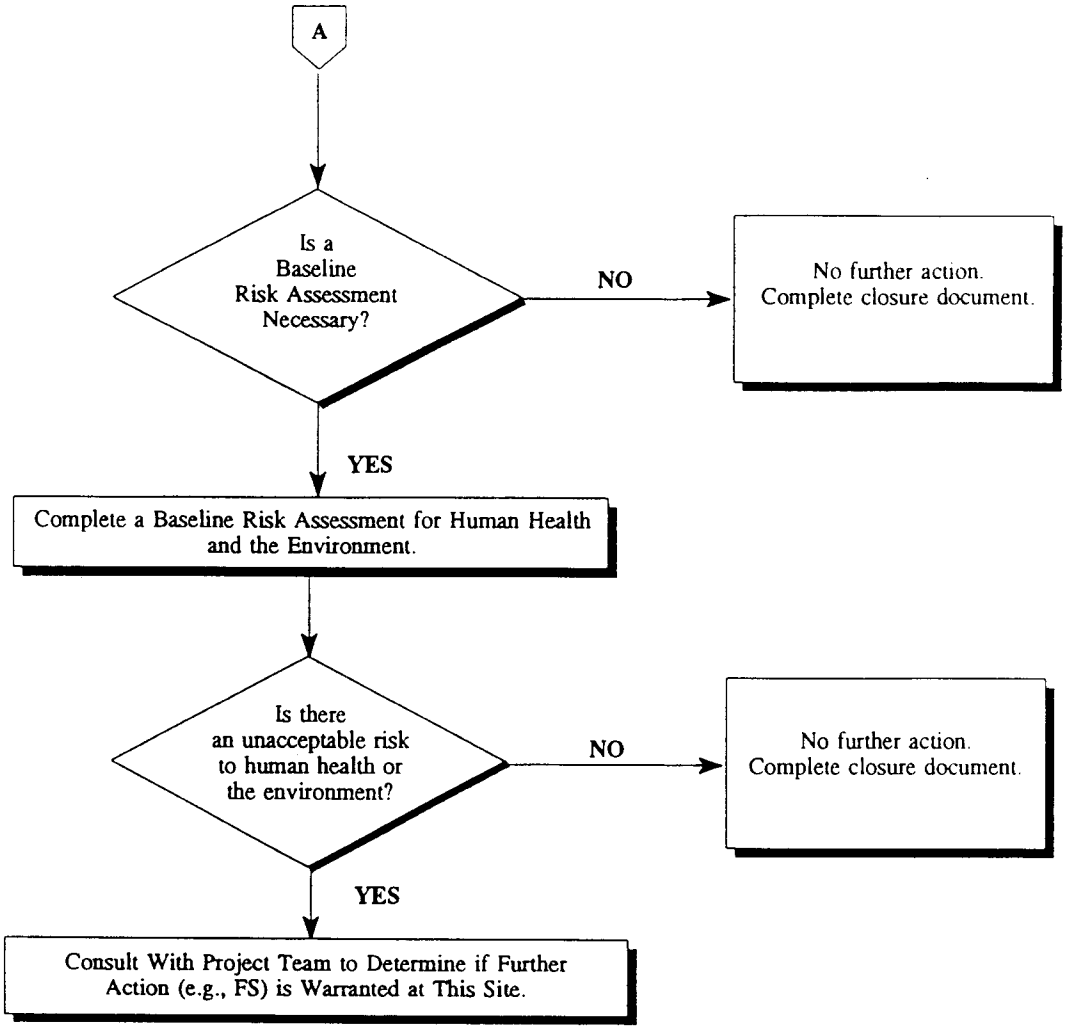


FIGURE 1-6. CONTINUED

2.0 TNT AREAS

2.1 BACKGROUND

The three areas used for the manufacture of 2,4,6-trinitrotoluene (TNT) at PBOW were identified in a Preliminary Assessment as having potential for contamination from PBOW activities, especially contamination of surface soil, surface water, and ground water (SAIC 1991). This section provides descriptive and historic background information on the TNT areas that may be related to potential contamination at the sites.

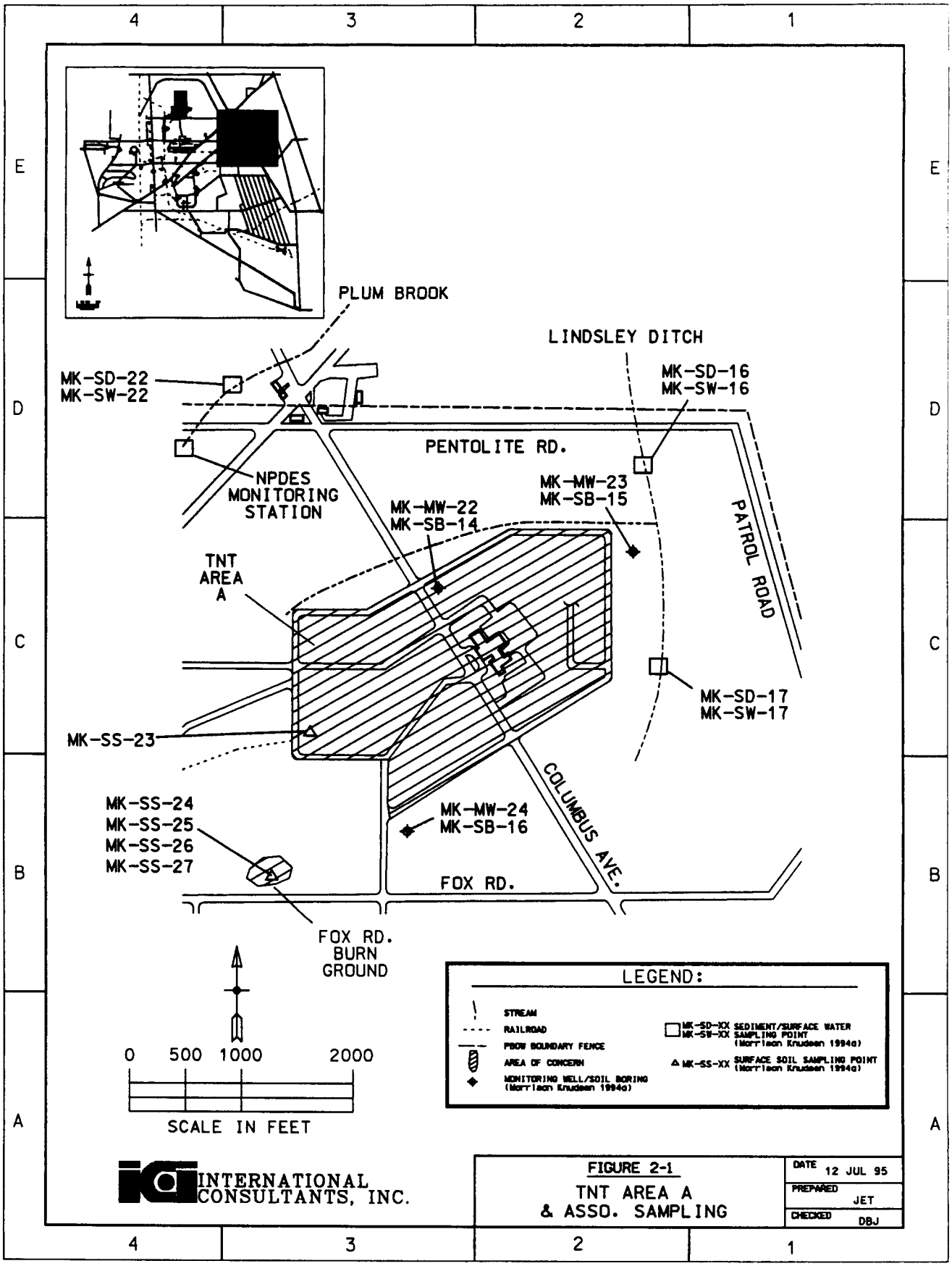
2.1.1 Description

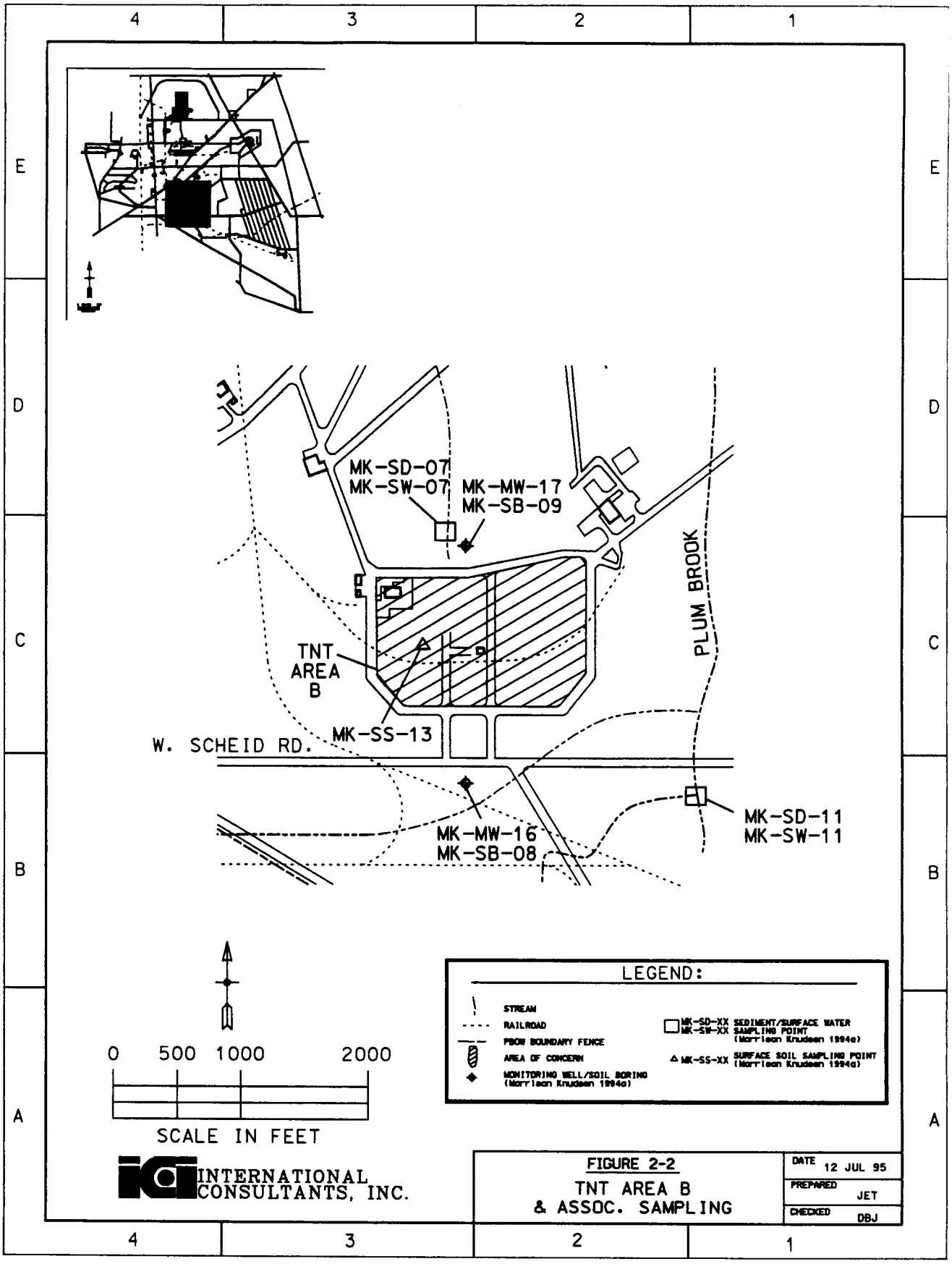
During World War II, the PBOW facility housed operations for the manufacture of TNT, dinitrotoluene (DNT), and pentolite. TNT was manufactured in three primary areas referred to as TNT Areas A, B, and C. The TNT manufacturing arcas consisted of temporary, irregularly placed buildings which were primarily constructed of wood frame, asbestos siding, and sheet metal.

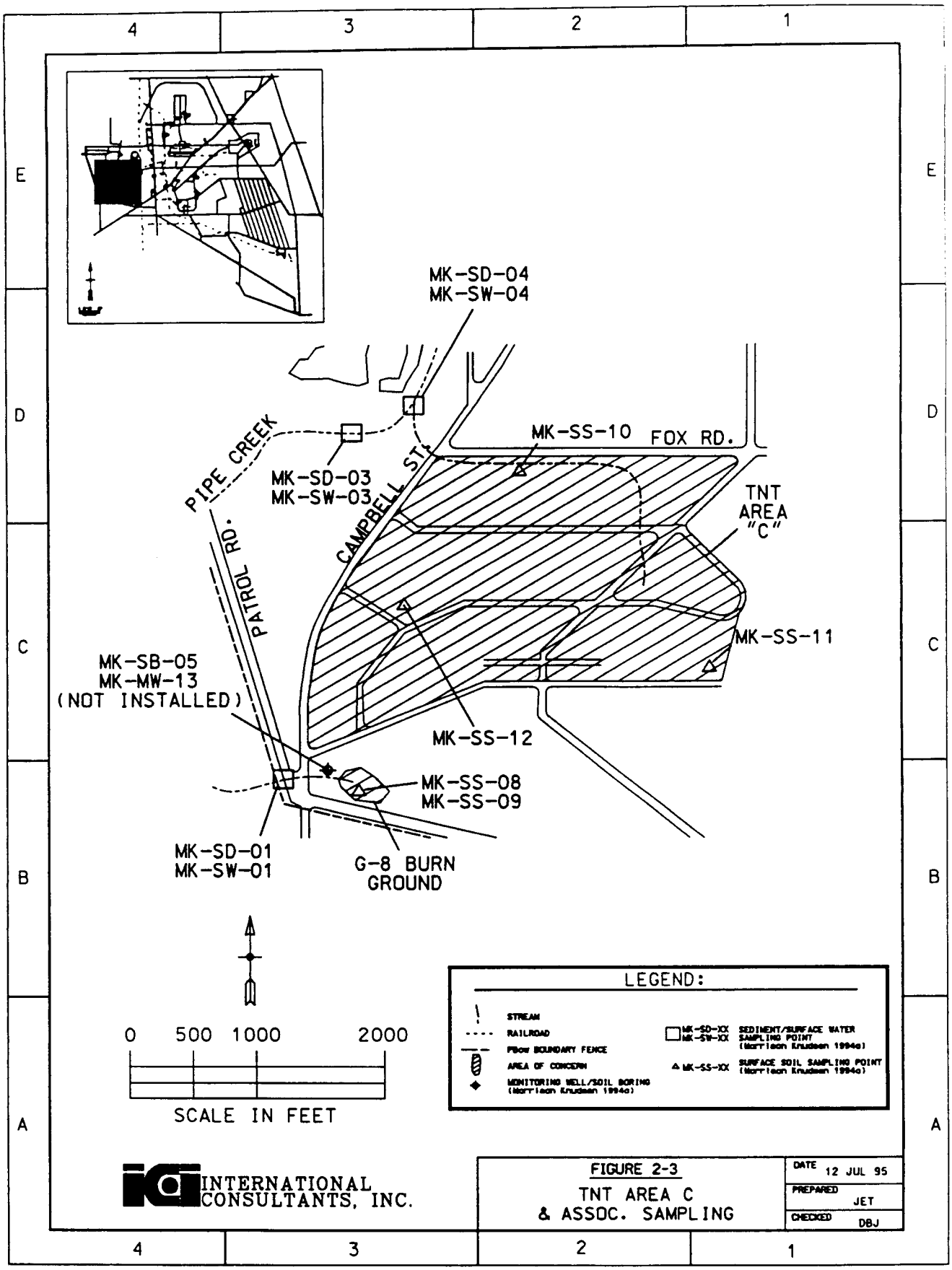
TNT Area A comprises approximately 113 acres of land on the east side of PBOW (Figure 2-1). Engineering Building 7141, presently owned and operated by NASA, is located on the site. During the operation of PBOW, TNT Area A contained four TNT lines of six buildings each, and two DNT lines of one building each (SAIC 1991). The Pentolite Road Red Water Ponds, located northwest of this area, received waste water from TNT Area A.

TNT Area B occupies approximately 48 acres of land in the southern portion of PBOW (Figure 2-2). The NASA Hypersonic Tunnel Facility (HTF) is located on the northwest side of the area, and the B2 facility is located immediately northeast of Area B. During PBOW operations, the area contained three TNT lines of six buildings each, and one DNT line of one building. Waste water from this area was sent to the Pentolite Road Red Water Ponds.

TNT Area C, located on the west side of PBOW, covers approximately 113 acres (Figure 2-3). This TNT area does not contain any NASA buildings or facilities. During the operation of PBOW, the area contained five TNT lines of six buildings each and no DNT lines. The West Area Red Water Ponds received waste from TNT Area C.


PLUM BROOK
LINDSLEY DITCH
MK-SD-22
MK-SW-22
MK-SD-16
MK-SW-16
PENTOLITE RD.
NPDES
MONITORING
STATION
MK-MW-23
MK-SB-15
MK-MW-22
MK-SB-14
PATROL ROAD
TNT
AREA
A
MK-SD-17
MK-SW-17
MK-SS-23
COLUMBUS AVE.
MK-SS-24
MK-SS-25
MK-SS-26
MK-SS-27
MK-MW-24
MK-SB-16
FOX RD.
FOX RD.
BURN
GROUND
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
MK-SD-XX MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
0 500 1000 2000
SCALE IN FEET
INTERNATIONAL CONSULTANTS, INC.
FIGURE 2-1
TNT AREA A
& ASSO. SAMPLING
DATE 12 JUL 95
PREPARED JET
CHECKED DBJ


MK-SD-07
MK-SW-07
MK-MW-17
MK-SB-09
PLUM BROOK
TNT
AREA
B
MK-SS-13
W. SCHEID RD.
MK-MW-16
MK-SB-08
MK-SD-11
MK-SW-11
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
MK-SD-XX MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
0 500 1000 2000
SCALE IN FEET
INTERNATIONAL CONSULTANTS, INC.
FIGURE 2-2
TNT AREA B
& ASSOC. SAMPLING
DATE 12 JUL 95
PREPARED JET
CHECKED DBJ


MK-SD-04
MK-SW-04
MK-SS-10
FOX RD.
PIPE CREEK
MK-SD-03
MK-SW-03
CAMPBELL ST.
TNT
AREA
"C"
PATROL RD.
MK-SS-11
MK-SB-05
MK-MW-13
(NOT INSTALLED)
MK-SS-12
MK-SS-08
MK-SS-09
MK-SD-01
MK-SW-01
G-8 BURN
GROUND
0 500 1000 2000
SCALE IN FEET
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
MK-SD-XX MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
INTERNATIONAL CONSULTANTS, INC.
FIGURE 2-3
TNT AREA C
& ASSOC. SAMPLING
DATE 12 JUL 95
PREPARED JET
CHECKED DBJ

1962 photographs of TNT Areas A and B are shown in Figures 2-4 and 2-5, which were taken prior to D&D of these areas. Figure 2-6 is a 1984 panoramic photograph of PBOW with the TNT Areas indicated. This photograph shows that the PBOW buildings had been removed and vegetation was recovering in these areas. Figures 2-7, 2-8, and 2-9 are recent photographs of TNT Areas A, B, and C, respectively.

2.1.2 History

The history of activities at the TNT areas is divided into two periods: the operational period of PBOW and the post-operational period, including post-World War II decommissioning activities.

2.1.2.1 Operational Period (1941 - 1945)

Construction of PBOW began December 21, 1940, when the federal government entered into a contractual agreement with E. B. Badger and Sons construction company. A subsequent contract was signed with the Trojan Powder Company on December 28, 1940 for the purpose of manufacturing TNT, DNT, pentolite, and nitric and sulfuric acids. The first TNT and DNT lines were ready for operation in December, 1941.

TNT manufacturing operations began on December 16, 1941. TNT was manufactured in a three-stage process involving the nitration of toluene by the addition of nitric and sulfuric acid. A flow chart depicting the TNT manufacturing process is shown in Figure 2-10. The acids were combined with toluene in a nitrator in successive steps forming nitrotoluene, dinitrotoluene, and finally the raw liquid 2,4,6-trinitrotoluene, or crude TNT. The crude TNT was purified with warm water and soda ash water, which dissolved and neutralized the free acid present. This was then washed with sellite, a mixture of sodium sulfite and sodium hydrogen sulfite. The sellite process removed unwanted isomers of TNT and various oxidation products resulting from the nitration process, generating waste "red water" as a by-product. The purified TNT was then sent to the finishing process where it was dried and packed for shipment, or stored in concrete magazine bunkers. Approximately 925 million pounds of nitric acid, 63.5 million pounds of sulfuric acid, and over 425 million pounds of toluene were used to manufacture explosives at PBOW between 1941 and 1945 (SAIC 1991).

Some spillage or pipe leakages may have occurred during the TNT manufacturing process at PBOW. It is documented that in 1942 and 1945, when TNT manufacturing was in progress, contaminated water flowed to surface streams which in turn flowed into Sandusky Bay resulting in sizable fish kills, contamination of the Wyandotte marsh, and discoloration and pollution of Sandusky Bay. Reports indicated that TNT-contaminated water continued to flow into Sandusky Bay even after 1945, when the TNT manufacturing operations had ceased (D&M 1995).

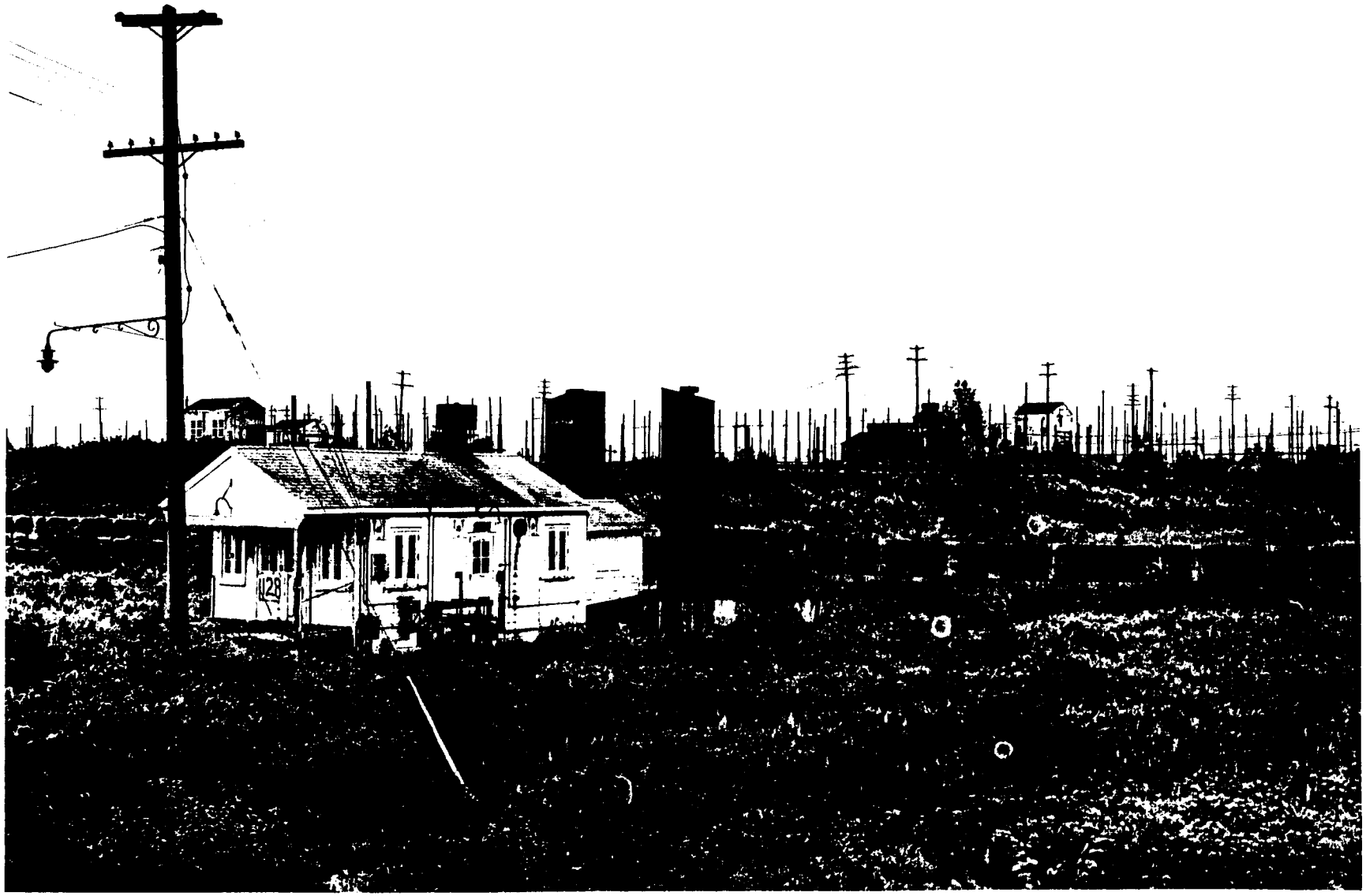


Figure 2-4. TNT Area A, 1962

NASA
P-62-1672

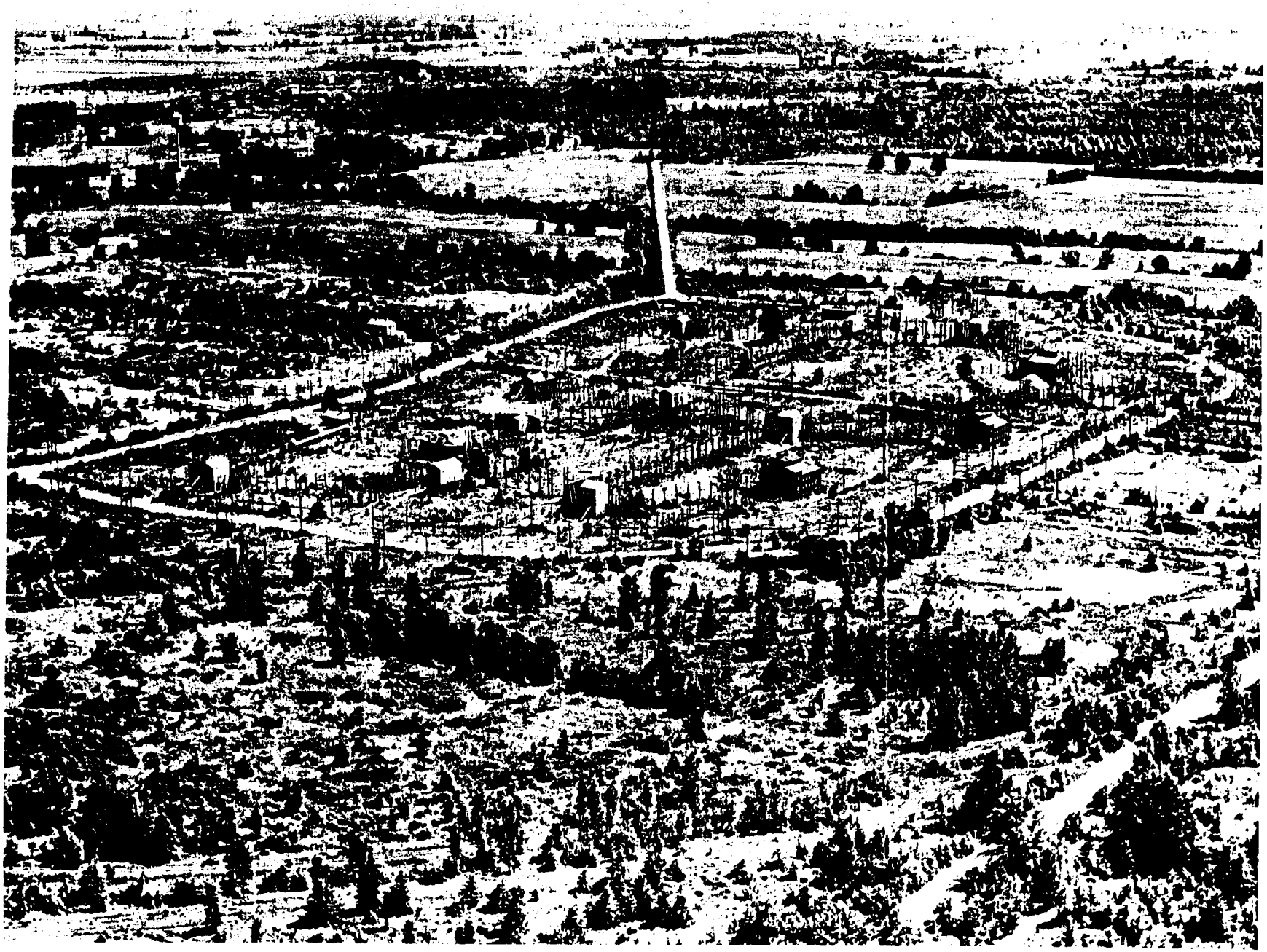


Figure 2-5. TNT Area B, 1962

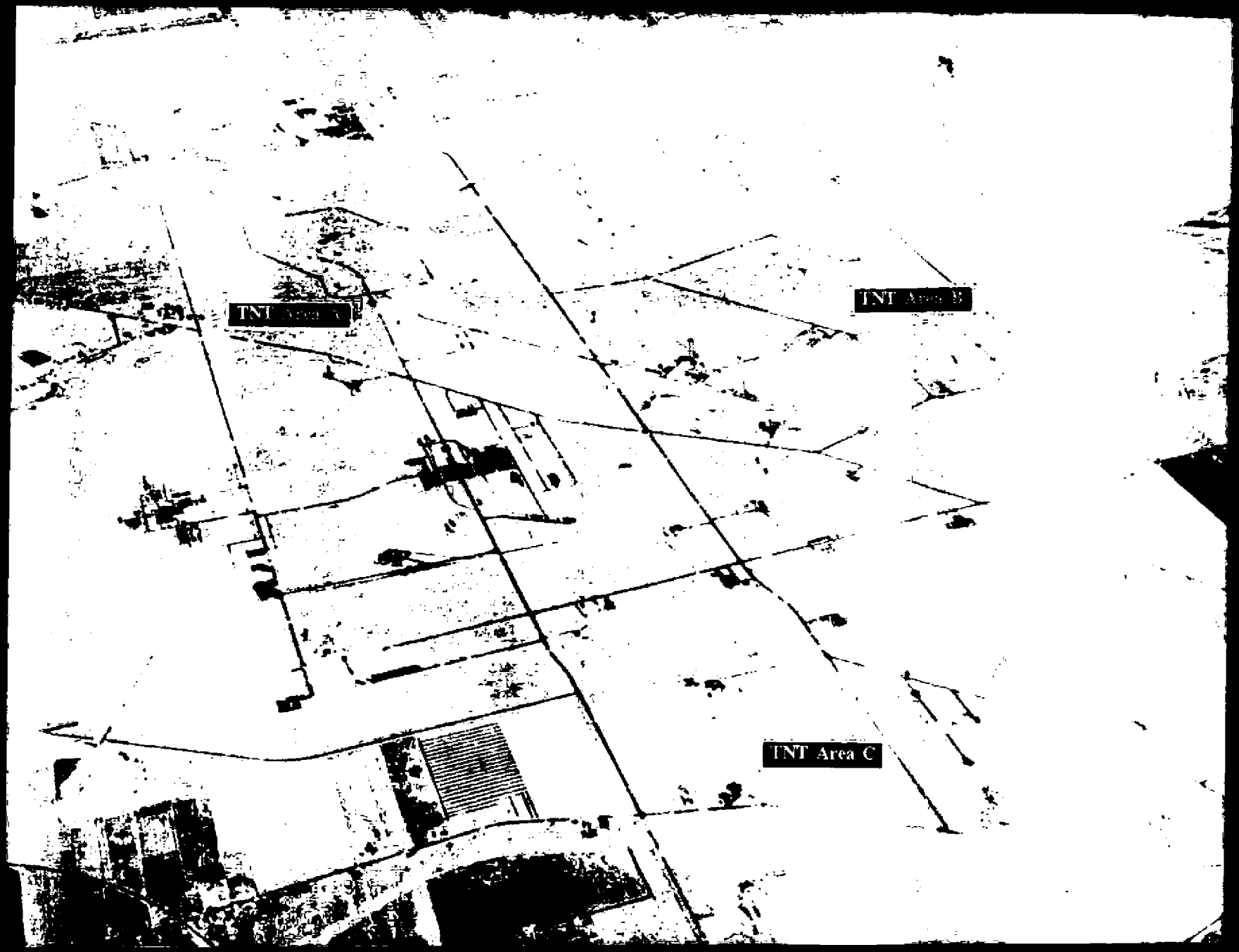
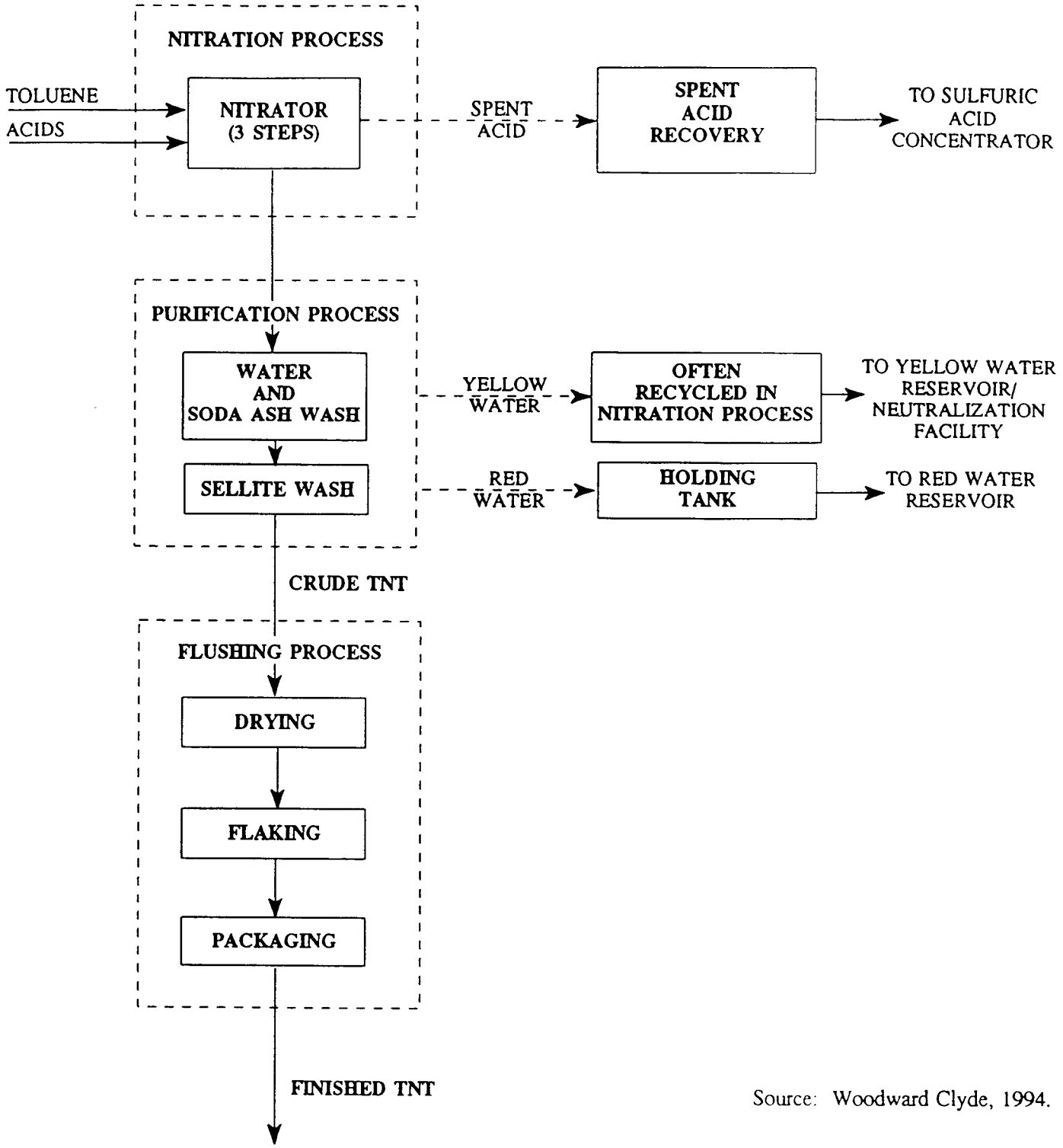


Figure 2.6 – TNT Areas A, B and C – 1984

Figure 2-7. INT Area A, 1995

Figure 2-8. INT Area B, 1995

Figure 2-9. INT Area C, 1995



Source: Woodward Clyde, 1994.

Figure 2-10. TNT Batch Production Schematic

2.1.2.2 Post-Operational Period

After TNT production ceased at the end of World War II, the site was maintained in an "as is" condition until the mid-1950s (SAIC 1991). In 1955, preliminary decontamination and decommissioning (D&D) of the TNT areas was initiated. TNT Area A was first to be decontaminated, followed by TNT Areas B and C. Typical D&D methods involved removing soil around building catch basins and digging up flume lines and wooden and ceramic waste disposal sewers and relocating them to a burning ground where they were burned. All known steam lines, flume lines, drain lines, and waste lines were flushed and dismantled but there are no records to indicate where the lines were flushed or where the flush water was disposed. In 1966, additional decontamination was performed in five stages: ground inspection and removal of contaminants, digging up ground at regular intervals and removing visible contamination, burning of buildings and rough grading the area, decontamination of sump basins and removal of concrete, and further decontamination of already decontaminated equipment for selling to outside buyers. Records indicate that substantial decontamination was performed at TNT Area A, but TNT Areas B and C were not decontaminated as thoroughly. Overall, more than 16,000 lbs of TNT were removed from Area A (D&M 1995).

The majority of the PBOW site was transferred to NASA in 1963 to conduct research as a satellite operation of NASA's Lewis Research Center in Cleveland, Ohio. Several buildings and facilities have been constructed at the site by NASA, including the Engineering Building constructed in TNT Area A and the Hypersonic Tunnel Facility in TNT Area B.

2.2 PHYSICAL CHARACTERISTICS

The physical characteristics of the TNT areas include surface features, geology, and hydrology. The general physical characteristics of PBOW are described in Section 1.0.

2.2.1 Surface Features

The TNT Areas are located on relatively flat terrain. Ranges in elevation at the three areas are:

- TNT Area A - 645 feet above MSL in the north and northeast to 665 feet above MSL in the south and southeast.
- TNT Area B - about 670 feet above MSL in the north to 675 feet above MSL in the south.
- TNT Area C - 635 feet above MSL in the north, to approximately 650 feet on the east and south.

Vegetation at the TNT areas consists primarily of grassland, brushland, and woodlands. Where NASA construction activities have occurred, the vegetation is mostly maintained grasses and ornamental plants.

Buildings and facilities constructed in support of NASA activities include the Engineering Building, number 7141, located in the center of TNT Area A, and the HTF in the northwest corner of TNT Area B. Remnants from PBOW operations, such as building foundations, railroad lines, and small structures, can also be seen at the TNT areas. In addition, underground flumes and sewer lines used for the PBOW are suspected at the TNT areas, but their exact locations have not been determined (Figure 4-1). Site records do not indicate that other waste disposal activities occurred at the TNT areas either during PBOW operations or following World War II. However, D&D operations and accidental spills may have occurred at these sites.

2.2.2 Geology

The glacial deposits underlying the TNT areas are described on borehole lithologic logs for monitoring wells installed in and near the sites (Figures 2-1, 2-2, 2-3). In each area, the boreholes penetrated a sequence of unconsolidated sands, silts, and clays in varying proportions. The borehole logs at TNT Area A (MK-MW-22, MK-MW-23, and MK-MW-24) indicate an upper silty sand layer from the surface to a depth of five to nine feet underlain by silty clay changing from brown to gray with depth. Boreholes MK-MW-22 and MK-MW-24 terminated at 9.5 feet in the gray silty clay; borehole MK-MW-23 penetrated gray silty clay to a depth of 16 feet before the drilling was terminated because of auger refusal (MK 1994).

Two monitoring wells, MK-MW-16 and MK-MW-17, were installed south and north, respectively, of TNT Area B. Both boreholes encountered weathered shale bedrock at shallow depths (4 and 5 feet), and MK-MW-17 hit ground water at a depth of three feet. The silt and silty clay encountered in the upper four to five feet contained weathered shale fragments in both borings.

No monitoring wells were installed at TNT Area C, however MK-MW-12 was installed west of the site, west of Pipe Creek, and the borehole for MK-MW-13 was drilled and logged at a location south of the TNT area. MK-MW-12 penetrated one foot of silty clay at the surface, underlain by silty sand to its total depth of 13 feet where limestone bedrock was encountered. MK-MW-13 was drilled through two feet of "topsoil" before encountering limestone bedrock; the well was not installed.

2.2.3 Hydrology

The hydrology of the TNT areas has been interpreted from topographic maps, soil borings, and monitoring wells installed at and near the sites (Figures 2-1, 2-2, 2-3). Aquifer tests have not been conducted in the wells at the TNT Areas, and therefore hydrogeologic parameters are not defined.

2.2.3.1 Surface Water

Surface runoff in the area of the TNT sites generally flows to the north and east to drainage ditches or streams. TNT Area A is flanked by Lindsley Ditch, which flows northeastward off the site, joining Plum Brook at its intersection with State Route 2. Surface runoff from TNT Area B generally flows northeastward to drainage ditches which empty into Plum Brook, or northward to Ransom Brook. At TNT Area C, surface runoff is northward into an unnamed tributary of Pipe Creek.

2.2.3.2 Ground Water

During the construction of monitoring wells at the TNT areas, ground water was reported as shallow as three feet in MK-MW-17 at TNT Area B, six feet in MK-MW-24 at TNT Area A, and 12.5 feet deep in MK-MW-12 west of Pipe Creek. The occurrence of ground water was not reported on the logs of the other boreholes at and near the TNT areas, either because of shallow bedrock, low permeability clay, or oversight.

2.2.3.3 Monitoring Wells

Five monitoring wells have been installed by Morrison Knudsen (1995) to monitor ground water in the vicinity of the TNT areas. Three monitoring wells were installed at TNT Area A: MK-MW-22 is located along the northwestern edge of the site, adjacent to Columbus Road; MK-MW-23 is northeast of the site between the boundary of the site and Lindsley Ditch; and MK-MW-24 is located south (upgradient) of the TNT area to monitor background conditions. Two monitoring wells were installed at TNT Area B: MK-MW-16 is south (upgradient) of the site, south of West Scheid Road, a location chosen to monitor background conditions; and MK-MW-17 is located north of the TNT area to detect contaminants migrating off the site. Aquifer tests have not been conducted in these wells. Detailed information on monitoring wells is included in Section 14.0.

2.3 CONTAMINANTS OF CONCERN (COCs)

COCs for the TNT areas were determined on the basis of past PBOW operations, including later D&D activities and on the results of environmental investigations conducted at the sites, if any.

2.3.1 Contaminants Resulting from PBOW Activities

Based on past site activities, nitroexplosives and residue from the TNT manufacturing process are likely COCs at the TNT areas. Previous investigations at the three TNT areas have shown that nitroexplosives and toluene may be present in the sediments, soils, surface water, and ground water of the TNT areas (SAIC 1991). D&D activities at the TNT areas, especially the burning of buildings in place, may also have released contaminants into the soil such as nitroaromatic compounds, heavy metals, and semi-volatile organic compounds (SVOC) such as polynuclear aromatic hydrocarbons (PAH).

In addition to the COCs listed above, there is a possibility of accidental contaminant releases related to other activities, including potential asbestos contamination resulting from D&D activities. Also, VOCs and pesticides have been detected in TNT Area A, and SVOCs have been found in soil samples from TNT Area B (MK 1994). No contaminants were detected in the surface soil samples analyzed from TNT Area C.

Because TNT Area A is located downgradient from Fox Road Burn Ground, there may be contaminated ground water under the area. Potential contaminants from the burn ground are nitroaromatic compounds, heavy metals, and SVOCs such as PAH.

2.3.2 Transport Mechanisms

Possible transport mechanisms in the TNT areas include:

- Surface transport of liquid phase or particulate-borne contaminants in precipitation runoff to Pipe Creek, Ransom Brook, and Plum Brook.
- Migration of contaminants from soils and surface water to shallow ground water.
- Migration of contaminants in shallow ground water to off-site locations and to the deeper limestone aquifers in bedrock.
- Transport of air-borne particulates.
- Contaminant transport via the food chain.

2.3.3 Action Levels

Action levels apply to clean-up goals established by PBOW Records of Decision (RODs), U.S. Environmental Protection Agency (USEPA) regulations, applicable and relevant or appropriate regulations (ARARs) (i.e., maximum contaminant levels [MCLs] and National Pollutant Discharge Elimination System [NPDES]), or determined from risk-based calculations. Action levels have not been established for the TNT areas.

2.4 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination at the TNT areas has been investigated to a limited extent in the Site Inspection conducted by Morrison Knudsen (1994). The results of this investigation are summarized here. Locations of samples are shown in Figures 2-1 (Area A), 2-2 (Area B), and 2-3 (Area C).

2.4.1 TNT Area A

2.4.1.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined. Monitoring well MK-MW-24 is located south (upgradient) of TNT Area A (MK 1994) and may serve as a background location for this site.

2.4.1.2 Sediment and Surface Water Investigations

Sediment and surface water samples from ditches and streams at PBOW were analyzed during the Site Inspection conducted by Morrison Knudsen (1994). Two sediment and two surface water samples were collected in Lindsley Ditch adjacent to TNT Area A. Sediment sample MK-SD-17 and surface water sample MK-SW-17 were collected from the ditch east of the TNT area, and samples MK-SD-16 and MK-SW-16 were collected northeast of the TNT area just downstream from the confluence of a small tributary and Lindsley Ditch. Organic compounds were not detected in the surface water samples, but low levels of VOCs and pesticides were found in the sediments (Table 2-1). Both MK-SD-16 and MK-SD-17 contained minor acetone and SVOCs (particularly PAH), and low levels of DDT and dieldrin were detected in both sediment samples. Also, MK-SD-16 contained minor methoxychlor, a pesticide.

Table 2-1. Sediment Sampling Analytical Results, TNT Areas[a]

Compound	TNT Area A	TNT Area A	TNT Area B	TNT Area C
	MK-SD-16	MK-SD-17	MK-SD-07	MK-SD-04
1,1-Dichloroethane	U	U	2J	U
2-Butanone	U	U	10J	U
2-Methylnaphthalene	U	U	60J	U
2,4-Dinitrotoluene	170J	U	200J	U
2,4,6-Trinitrotoluene	U	U	25,000	U
4,4'-DDT	9.8J	NA	U	U
Acetone	25	21	53	U
Benzo(a)pyrene	70J	76J	100J	U
Benzo(b)fluoranthene	190J	200J	260J	U
Benzo(ghi)perylene	U	U	87J	U
Bis(2-ethylhexyl)phthalate	U	U	3800B	U
Chrysene	120J	91J	150J	U
Dieldrin	2.7J	NA	U	U
Fluoranthene	220J	180J	240J	180J
Methoxychlor	29	NA	U	U
Methylene chloride	0.9J	U	1J	U
Phenanthrene	82J	52J	140J	160J
Pyrene	160J	140J	200J	120J
Toluene	U	1J	U	U

[a]Units in µg/kg.
B Analyte is found in the associated blank as well as the sample.
J Estimated value.
U Compound was analyzed for but not detected.
NA Not analyzed.

Source: Morrison Knudsen, 1994 (Chapter 4).

2.4.1.3 Surface Soil Investigations

A single surface soil sample, MK-SS-23, was collected in the southwestern corner of TNT Area A near a railroad spur. Chemical analysis did not reveal the presence of COCs in this sample. Surface soil analytical results for samples with detected compounds are provided in Table 2-2.

2.4.1.4 Subsurface Soil Investigations

Subsurface soil samples were collected from soil borings MK-SB-14, 15, and 16 (corresponding to monitoring wells MK-MW-22, 23, and 24, respectively) at TNT Area A. The soil samples were collected from the upper two feet of the boring in each case. Only minor SVOCs (primarily PAH) were detected in MK-SB-14 and MK-SB-16. Subsurface soil analytical results for samples with detected compounds are provided in Table 2-3.

Table 2-2. Surface Soil Sampling Analytical Results, TNT Areas[a]

Compound	TNT Area B	TNT Area C	TNT Area C	TNT Area C
	MK-SS-13	MK-SS-10	MK-SS-11	MK-SS-12
Benzo(a)anthracene	U	140J	U	U
Benzo(b)fluoranthene	U	190J	U	U
Benzo(k)fluoranthene	U	79J	U	U
Bis(2-ethylhexyl)phthalate	44J	U	U	U
Chloroform	1J	U	U	U
Fluoranthene	U	340J	U	U
Phenanthrene	U	160J	U	U
Pyrene	U	350J	U	U
Toluene	33	4J	4J	2J

[a]Units in µg/kg.
J Estimated value.
U Compound was analyzed for but not detected.
Source: Morrison Knudsen, 1994 (Chapter 4).

Table 2-3. Subsurface Soil Sampling Analytical Results, TNT Areas[a]

Compound	TNT Area A	TNT Area A	TNT Area A	TNT Area B
	MK-SB-14	MK-SB-15	MK-SB-16	MK-SB-09
2,4,6-Trinitrotoluene	U	U	U	12,000
2,6-Dinitrotoluene	U	U	U	60
Acenaphthylene	33J	U	U	U
Acetone	U	U	U	J
Benzo(a)anthracene	220J	U	55J	U
Benzo(a)pyrene	160J	U	U	U
Benzo(b)fluoranthene	230J	U	78J	U
Benzo(ghi)perylene	74J	U	U	U
Benzo(k)fluoranthene	110J	U	36J	U
Chrysene	160J	U	73J	U
Fluoranthene	300J	U	110J	U
Indeno(1,2,3-cd)pyrene	96J	U	U	U
Methylene chloride	U	U	U	8
Phenanthrene	91J	U	41J	U
Pyrene	250J	U	U	U
Toluene	11J	3J	4J	U

[a]Units in µg/kg.
J Estimated value.
U Compound was analyzed for but not detected.

Source: Morrison Knudsen, 1994 (Chapter 4).

2.4.1.5 Ground-Water Investigations

Morrison Knudsen installed three wells in TNT Area A. Well MK-MW-22 is located to the north of the Engineering Building along Columbus Avenue. MK-MW-23, near Loop Road in the northeast corner TNT Area A, was installed to 16 feet below ground surface where bedrock was encountered. MK-MW-24, in the southwest corner of TNT Area A, was installed to a depth of 9.5 feet below the

ground surface. Analyses performed on ground-water samples from these wells detected only 22 µg/ℓ of bis(2-ethylhexyl)phthalate, in MK-MW-24.

2.4.2 TNT Area B

2.4.2.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined. Monitoring well MK-MW-16 was installed south (upgradient) of TNT Area B, and may serve as a background location for ground water (MK 1994). Other background sampling sites have not been identified.

2.4.2.2 Sediment and Surface Water Investigations

MK-SD-07 and MK-SW-07 were collected near the origin of Ransom Brook immediately north of TNT Area B (MK 1994). This sampling point is near a former location of TNT storage tanks and is considered to be a possible point of entry for surface water contaminants. Organic compounds were not detected in the surface water (MK-SW-07). However, the sediment sample, MK-SD-07, contained acetone, SVOCs, and 2,4,6-TNT (25,000 ppb) (Table 2-1).

2.4.2.3 Surface Soil Investigations

In TNT Area B, a surface soil sample, MK-SS-13, was collected near the location of a trough used to carry TNT product to the storage areas. Minor amounts of toluene (33 ppb) were detected in this sample (Table 2-2).

2.4.2.4 Subsurface Soil Investigations

Samples from the upper two feet of soil were collected for analysis in soil borings MK-SB-08 and MK-SB-09 (corresponding to monitoring wells MK-MW-16 and MK-MW-17, respectively) at TNT Area B. Morrison Knudsen (1994a, Figure 4-2) indicated both 2,4,6-TNT (12,000 ppb) and 2,6-DNT (60 ppb) detected in MK-SB-09 (Table 2-3).

2.4.2.5 Ground-Water Investigations

Two monitoring wells, MK-MW-16 and MK-MW-17, were installed adjacent to TNT Area B. Morrison Knudsen (1994, Figure 4-2) reported the presence of bis(2-ethylhexyl)phthalate at a concentration of 12 ppb in MK-MW-17. Well MK-MW-17 is located north (downgradient) of the area and corresponds to soil boring MK-SB-9 in which nitroaromatic compounds were detected.

2.4.3 TNT Area C

2.4.3.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined. Background sampling sites have not been identified for TNT Area C.

2.4.3.2 Sediment and Surface Water Investigations

Sediment and surface water samples from ditches and streams at PBOW were analyzed during the Site Inspection conducted by Morrison Knudsen (1994). Samples MK-SD-04 and MK-SW-04 were collected just downstream of the confluence of Pipe Creek and a small tributary just north of TNT Area C. The sampling point was considered the most likely point of entry of contaminants to the stream from this area. Organic compounds were not detected in the surface water sample, and only minor SVOCs (PAH) were detected in the sediment sample from this location (Table 2-1).

2.4.3.3 Surface Soil Investigations

Surface soil samples MK-SS-10, MK-SS-11, and MK-SS-12 were collected in and around TNT Area C. Sample MK-SS-10 was collected adjacent to Fox Road near the location of storage tanks used in the production of TNT; MK-SS-11 was collected southeast of the TNT area near the remains of a building; and MK-SS-12 was collected in a clearing near the suspected location of a TNT flume. The analyses of these samples detected very low quantities of toluene ("J"-flagged, or "estimated"), and sample MK-SS-10 contained minor concentrations of SVOCs, primarily PAH (Table 2-2).

2.4.3.4 Subsurface Soil Investigations

There have been no subsurface soil investigations located at or near TNT Area C.

2.4.3.5 Ground-Water Investigations

There are no ground water monitoring wells located at or near TNT Area C.

2.5 CURRENT STATUS OF SITE CHARACTERIZATION

This section describes the current status of site characterization at the TNT Areas, including additional investigations that may be necessary to define source areas of contamination, characterize potential migration pathways, or identify potential receptors and exposure pathways. Any further investigations suggested here are not intended to be requirements for future work at this AOC. They are suggested for consideration for future work, to be implemented only if determined necessary through the site scoping process.

2.5.1 Physical Characteristics

The geologic characteristics of the glacial sediments underlying TNT Areas A and B were determined from boreholes drilled for the installation of monitoring wells (MK 1994). Suggestions for additional characterization at the TNT Areas include:

- Boreholes should be drilled and sampled at TNT Area C to determine geologic and hydrogeologic properties of the glacial sediments;
- Boreholes should be drilled to bedrock at TNT Areas A and C to completely characterize the glacial stratigraphy and determine depths to bedrock.

2.5.2 Nature and Extent of Contamination

The presence of contamination has been examined at the TNT Areas through the Site Inspection conducted by Morrison Knudsen (1994). Suggestions for additional investigations to establish the nature and extent of contamination at the TNT Areas include the following:

- Surface soil samples were collected at each of the TNT Areas to determine the presence of contamination. A systematic examination of surface soils should be considered for each TNT Area to delineate the full extent of soil contamination.
- Subsurface soil sampling has been conducted at TNT Areas A and B. Borehole sampling is suggested at TNT Area C to evaluate subsurface soil contamination at this site.

- Sediment and surface water contamination has been characterized for the major streams at and near the TNT Areas. Sediment and surface water sampling in drainage ditches adjacent to and within the TNT Areas is also suggested for further work. Surface water and sediment locations in Ransom Brook north of TNT Area B should be considered for sampling to confirm the high value of 2,4,6-TNT found in MK-SD-07 (MK 1994), and to trace contaminant migration in the brook.

2.5.3 Background Data

A statistical evaluation of existing site-wide background data should be considered to evaluate their usefulness to support a risk assessment for the TNT Areas. Additional background sampling also should be considered for this AOC.

2.6 POTENTIAL HAZARDS TO HUMAN HEALTH AND THE ENVIRONMENT

No formal risk assessment, either human health or environmental, has been conducted for the TNT areas. Information on the nature and magnitude of soil, sediment, and surface-water contamination sufficient to conduct a risk assessment with respect to these media does not exist. A hazard ranking was conducted on the TNT areas (SAIC 1991) in which scores for the various transport pathways ranged from 2.16 to 5.45, well below the USEPA-designated hazard ranking score of 28.5, at which a site becomes eligible for inclusion on the National Priorities List (NPL). An updated scoring was performed by Morrison Knudsen in 1994 on TNT Area B which received a site score of 3.71.

2.7 FEASIBILITY STUDIES

A feasibility study has not been conducted for the TNT areas.

2.8 REMEDIAL ACTIONS

Remedial actions have not been conducted at the TNT areas, other than the D&D efforts following PBOW closure.

2.9 WETLANDS ASSESSMENTS

A wetlands survey has not been conducted at the TNT areas, although the potential exists for wetlands identification, especially in TNT Areas B and C (Warner, et. al. 1990). A site-wide wetlands delineation is planned (Bower 1994).

2.10 PLANNED ACTIVITIES

An environmental investigation is planned for the TNT Areas (D&M 1994) to determine where contamination is present at these sites. Sample locations have been chosen in areas where there is a high probability of contamination, based on historical information on the locations of buildings and process lines. Twenty-six shallow subsurface sampling locations are planned for each TNT area. The soil samples will be analyzed for metals and nitroexplosive compounds. Shallow monitoring wells will also be installed at the TNT areas: two at TNT Area A, one at TNT Area B, and four at TNT Area C. Ground water will be tested for nitroaromatics, total metals, and dissolved metals. Eight new bedrock wells are also planned for various locations at PBOW. The bedrock ground-water samples will be tested for VOCs and SVOCs in addition to the parameters listed for the shallow wells. Sediment sampling in ditches in TNT Area C is also planned.

2.11 RECOMMENDATIONS

The investigations planned for the TNT Areas should be sufficient to determine the presence of contamination in soil and ground water at these sites and to conduct a limited risk assessment. If soil contamination is found, additional soil sampling may be needed to determine the extent of soil contamination at these sites.

3.0 RED WATER PONDS

3.1 BACKGROUND

The red water ponds at PBOW were identified in a Preliminary Assessment as having potential for contamination from PBOW activities, especially contamination of surface water and ground water (SAIC 1991). This section provides descriptive and historic background information that may be related to potential contamination at the site.

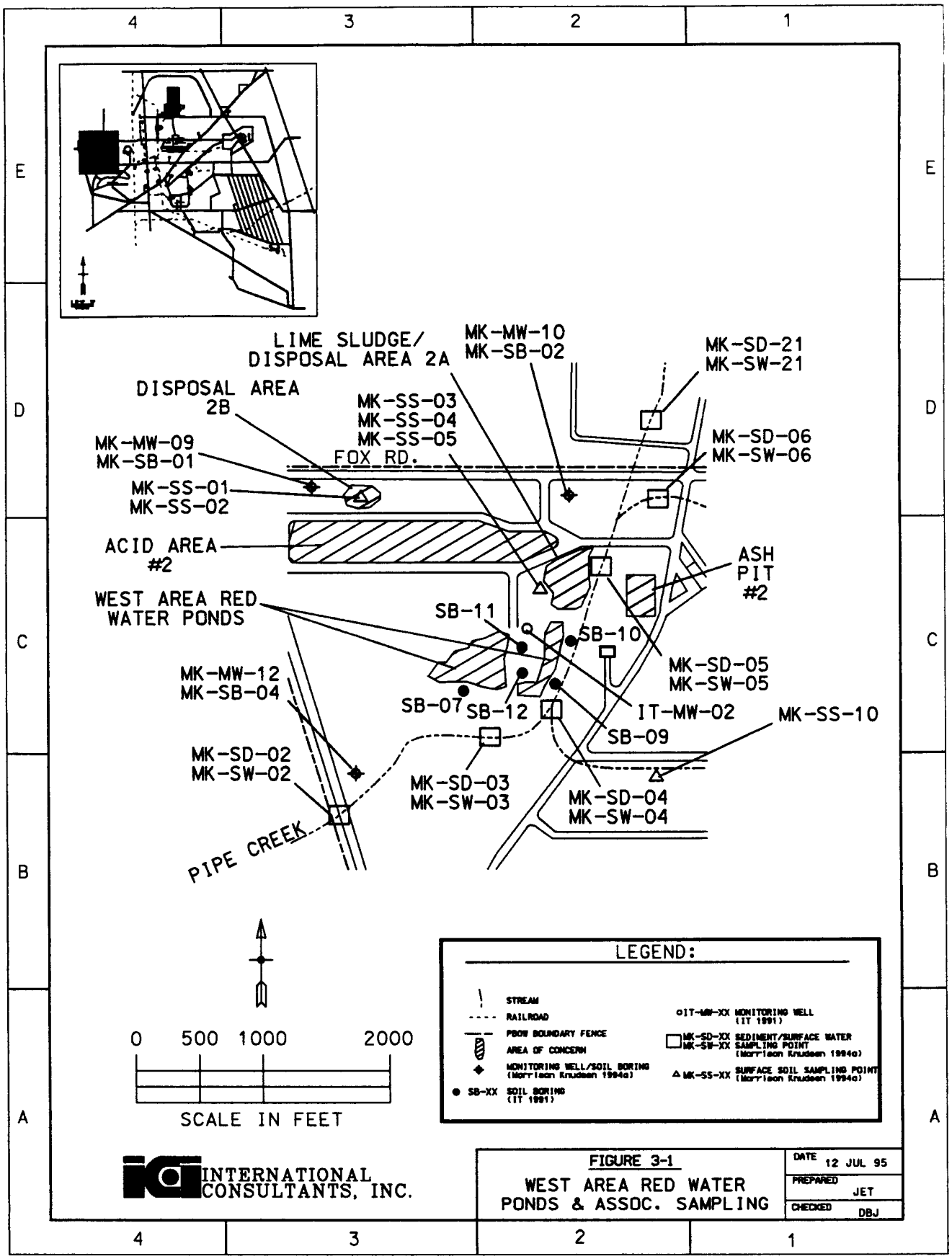
3.1.1 Description

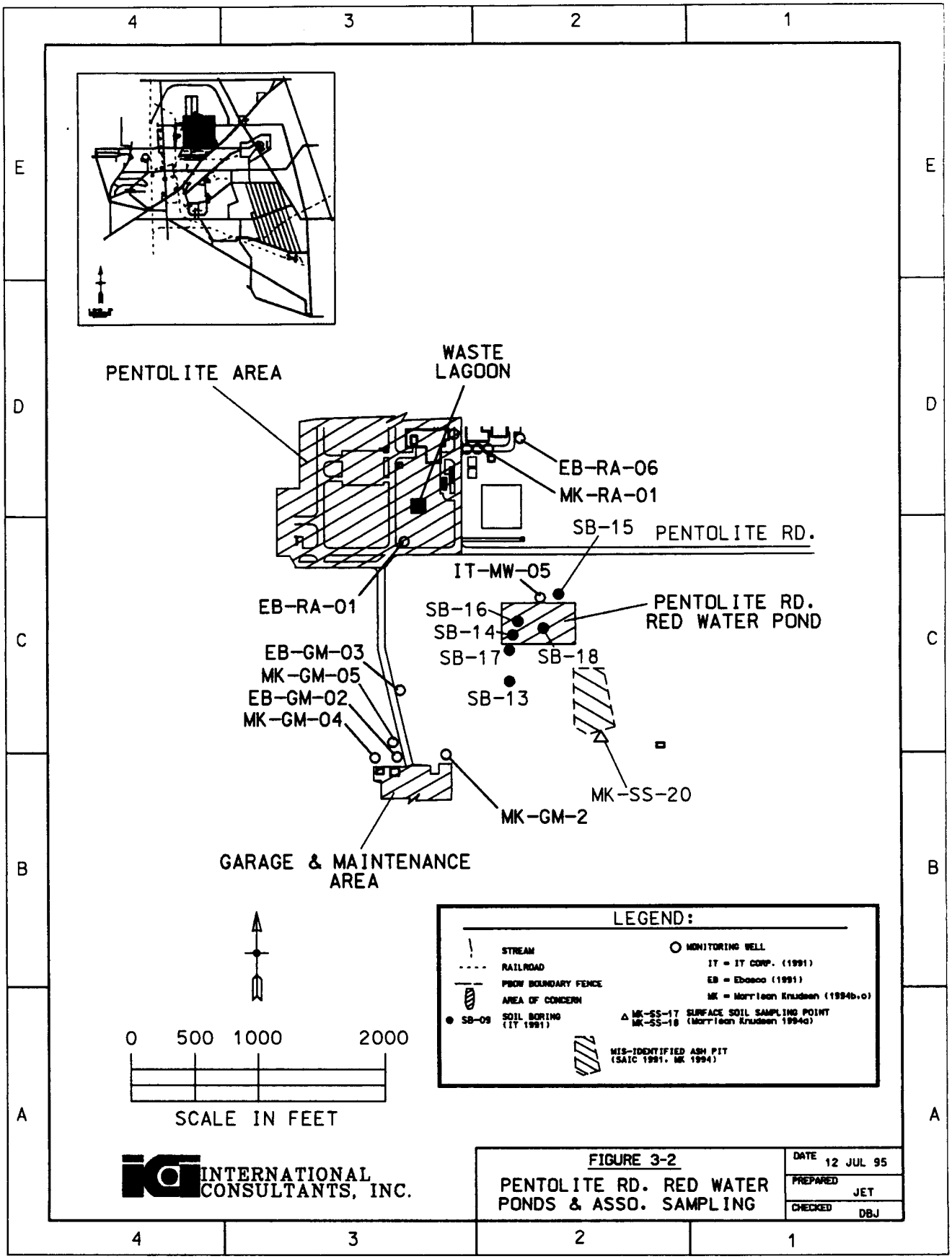
During operation of the PBOW, process wastewater was disposed in settling ponds located in two areas of the site. This wastewater, referred to as "red water" because of its color, contains byproducts of the TNT manufacturing process, including nitroaromatic compounds. The two areas of red water ponds are referred to as the West Area Red Water Ponds and the Pentolite Road Red Water Ponds.

The West Area Red Water Ponds consist of two irregular-shaped ponds, referred to as West Pond and East Pond, located on the west side of PBOW (Figure 3-1). West and East Ponds together have a maximum capacity of 120,000 cubic yards of wastewater (approximately 24.3 million gallons). The East Pond has been observed as both dry and wet during site visits, depending on the time of year.

The Pentolite Road Red Water Ponds are located in the north central portion of PBOW (Figure 3-2). A 1941 construction plan for the ponds indicated dimensions of 200 ft × 400 ft × 3 ft, with a one-foot high levee surrounding the ponds (D&M 1995). A pre-construction drawing indicates that dynamite was used to loosen the subsoil during the construction of these ponds, although this could not be verified from post-construction documents (D&M 1995). The Pentolite Road Red Water Ponds had a maximum capacity of 182,000 cubic yards of wastewater (approximately 36.9 million gallons). The ponds have been subsequently backfilled, but standing water still occurs in topographic depressions.

Figures 3-3 and 3-4 are photographs taken by NASA of the red water pond areas, Figure 3-3 shows the West Area Red Water Pond before East Pond was partially backfilled. Figure 3-4 is a 1989 photograph of the Pentolite Road Ponds Area illustrating the extent of backfilling at this site. Recent photographs of these areas are shown in Figures 3-5 and 3-6.


LIME SLUDGE/
DISPOSAL AREA 2A
MK-MW-10
MK-SB-02
MK-SD-21
MK-SW-21
DISPOSAL AREA
2B
MK-SS-03
MK-SS-04
MK-SS-05
MK-SD-06
MK-SW-06
MK-MW-09
MK-SB-01
FOX RD.
MK-SS-01
MK-SS-02
ACID AREA
#2
ASH
PIT
#2
WEST AREA RED
WATER PONDS
SB-11
SB-10
MK-SD-05
MK-SW-05
MK-MW-12
MK-SB-04
SB-07
SB-12
IT-MW-02
MK-SS-10
SB-09
MK-SD-02
MK-SW-02
MK-SD-03
MK-SW-03
MK-SD-04
MK-SW-04
PIPE CREEK
0 500 1000 2000
SCALE IN FEET
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
SB-XX SOIL BORING (IT 1991)
IT-MW-XX MONITORING WELL (IT 1991)
MK-SD-XX MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
INTERNATIONAL CONSULTANTS, INC.
FIGURE 3-1
WEST AREA RED WATER PONDS & ASSOC. SAMPLING
DATE 12 JUL 95
PREPARED JET
CHECKED DBJ


PENTOLITE AREA
WASTE LAGOON
EB-RA-06
MK-RA-01
SB-15
PENTOLITE RD.
IT-MW-05
EB-RA-01
SB-16
SB-14
SB-17
SB-18
PENTOLITE RD. RED WATER POND
EB-GM-03
MK-GM-05
EB-GM-02
MK-GM-04
SB-13
MK-SS-20
MK-GM-2
GARAGE & MAINTENANCE AREA
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
SB-09 SOIL BORING (IT 1991)
MONITORING WELL
IT = IT CORP. (1991)
EB = Ebasco (1991)
MK = Morrison Knudsen (1994b,c)
MK-SS-17 MK-SS-18 SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994c)
MIS-IDENTIFIED ASH PIT (SAIC 1991, MK 1994)
0 500 1000 2000
SCALE IN FEET
INTERNATIONAL CONSULTANTS, INC.
FIGURE 3-2
PENTOLITE RD. RED WATER PONDS & ASSO. SAMPLING
DATE 12 JUL 95
PREPARED JET
CHECKED DBJ

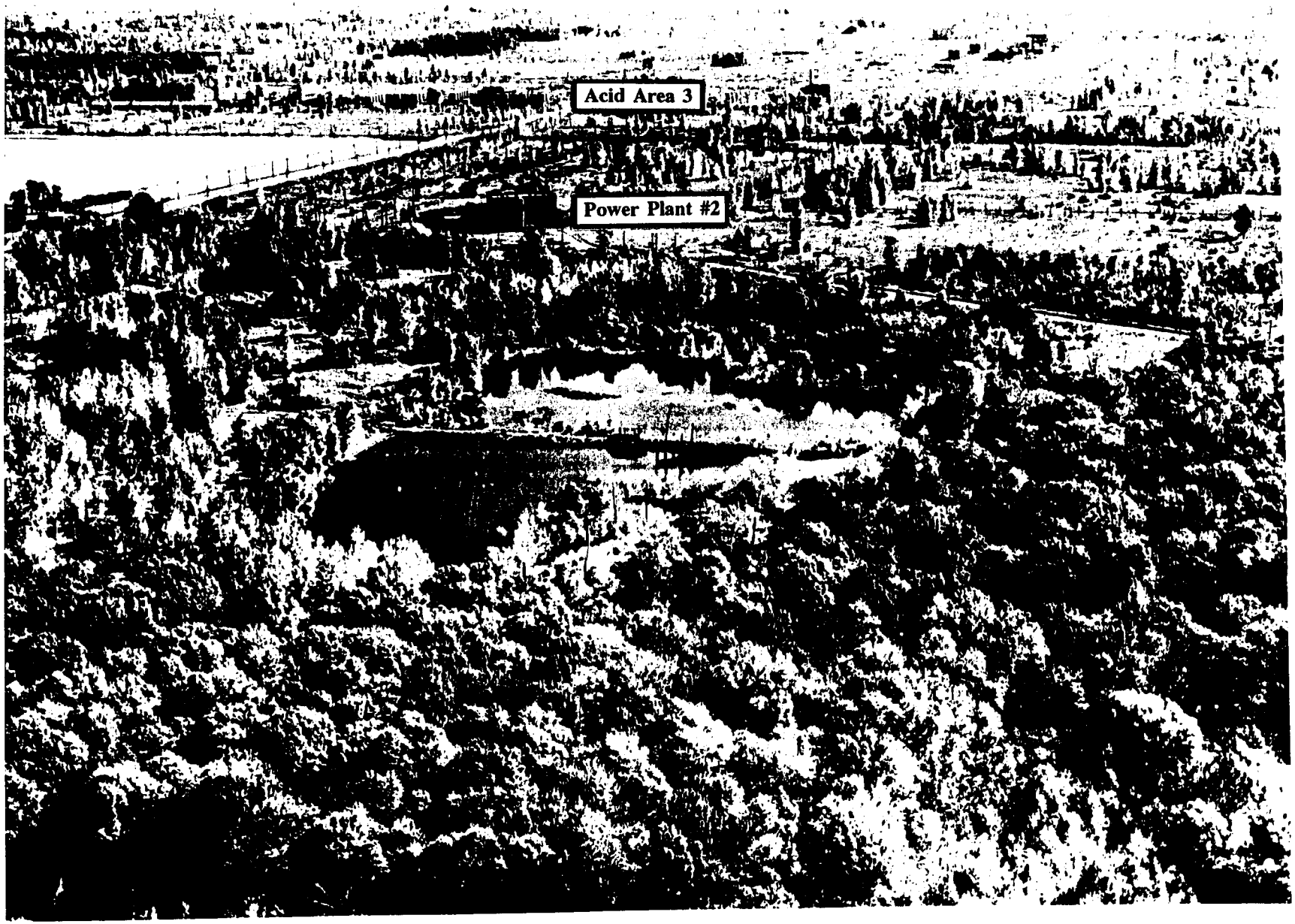


Figure 3-3. Early Photograph of the West Area Red Water Ponds

Figure 3-4. Pentolite Road Area Red Water Ponds, 1989

Figure 3-5. East Pond of the West Area Red Water Ponds, 1995

Figure 3-6. Pentolite Road Red Water Ponds, 1995

3.1.2 History

The history of activities at the red water pond areas is divided into two periods: the operational period of PBOW and the post-operational period, including post-World War II decommissioning activities.

3.1.2.1 Operational Period (1941-1945)

The wastewater ponds were constructed in 1941 and were in use until the end of World War II when the PBOW was decommissioned. The red water waste stream resulted from one of the final purification steps in the production of TNT (Figure 2-4). To remove the small amount of DNT from the TNT, aqueous sodium sulfite ("sellite") was used to wash the TNT. DNT was thus sulfonated and solubilized in water. The red water was transported to a wastewater treatment and incineration area and discharged to the settling ponds, via wooden flumes and elevated discharge pipes, for evaporation (D&M 1995).

3.1.2.2 Post-War Period

Following World War II, PBOW was in standby condition from 1945 to 1946. During this time, the Army began D&D of many of the buildings and structures associated with the manufacturing of ordnance. Removal and decontamination of TNT and DNT lines were conducted in 1945.

During the years that NASA operated the site, leakage and seepage has been observed on occasion from the red water ponds. In April of 1977, a small surface ditch adjacent to the Pentolite Road Red Water Ponds was observed to contain pockets of reddish-brown water. It was discovered that a drain tile on the southeast corner of the spoils area, associated with the red water pond, had broken. Retention dikes and sump pits were immediately constructed to prevent leakage of the red water to surface streams and the surface ditch was diverted. Approximately 60,000 gallons of red water were removed from the pond and hauled off-site for disposal. The pond was backfilled, and measures were taken to eliminate ponding and improve surface drainage (MK 1994a).

In 1989, PBS personnel observed reddish-brown water emanating from a drainage tile into Pentolite Ditch. Water samples were collected and analyzed for chemical oxygen demand (COD), pH, chromium, copper, lead, iron, and zinc. The iron and COD concentrations were approximately 6 to 10 times higher at the discharge pipe than at NPDES station located downstream (D&M 1995).

In April 1990, and again in February 1991, reddish-brown water was observed discharging into Pentolite Ditch from an underground pipe. In both instances, the Ohio Environmental Protection Agency (OEPA)

and the National Response Center were contacted. Water samples were taken upstream of the discharge, at the discharge point, and downstream of the discharge at the Plum Brook weir. None of the NPDES limits for outfall 003 (Plum Brook weir) were exceeded as a result of the discharge, but levels of iron, nickel, nitrate, sulfate, and zinc at the weir were significantly higher than upstream levels. Concentrations of explosives were below the detection limit of the analytical method. The amount of red water released to the Pentolite Ditch is unknown, but the estimated flow rate during the 1990 release was five gallons per minute (MK 1994a).

The red water ponds are not inspected on a routine basis for overflow or discharge into streams or ditches. However, in the case of a heavy rainfall, it is likely that these areas will be inspected for leakage, particularly at the discharge pipe into Pentolite Ditch.

A breach between East and West Ponds occurred at an unknown date which resulted in a discharge to Pipe Creek (USACE 1995).

3.2 PHYSICAL CHARACTERISTICS

The physical characteristics of the red water pond areas include surface features, geology, and hydrology. The general physical characteristics of PBOW are described in Section 1.0.

3.2.1 Surface Features

The Red Water Ponds are located on a relatively flat terrain, with man-made berms and levees. Elevations at the West Area Red Water Ponds range between 640 and 644 feet above MSL, and at the Pentolite Road Red Water Pond between 625 and 629 feet above MSL.

East Pond and West Pond at the West Area Red Water Ponds are separated by an earthen berm. The original shapes of the ponds were changed during their use; however, based on aerial photographs, their shapes do not appear to have changed significantly since the early 1950s. Although East Pond appears to have been partially filled in, red-tinted water can still be seen in the East Pond area adjacent to the berm (IT 1991a). West Pond contains water with a depth of approximately three feet.

Pentolite Road Red Water Ponds were backfilled following the 1977 breach and red water leakage described in Section 3.1.2.2. Retention dikes and sump pits were constructed at the site and the surface ditch was diverted to prevent further runoff of the red water.

As with most of the Plum Brook site, vegetation at the red water pond areas consists primarily of grassland, brushland, and woodlands. The West Area Red Water Ponds includes an open water area. Some potential wetland areas exist at both pond sites. Agricultural land is found west of the West Area Red Water Ponds, west of the PBOW site boundary.

No buildings or structures are known to exist at either of the red water pond areas. Red water sewer lines formerly emptied into the ponds, but their exact locations have not been determined. Site records do not indicate that other waste disposal activities occurred at the red water ponds either during PBOW activity or following World War II. However, a lime sludge disposal site was created north of East Pond at the West Area Red Water Ponds.

3.2.2 Geology

The glacial deposits underlying the area of the red water ponds are described on borehole lithologic logs for monitoring well IT-MW-02 installed north of the West Area Ponds, and monitoring well IT-MW-05 north of the Pentolite Road Ponds (IT 1991a). The boreholes were drilled to depths of 18 and 21 feet, respectively, without encountering bedrock. At the West Area Red Water Ponds, borehole IT-MW-02 encountered clayey, sandy silt and very fine sand to a depth of about four feet, and increasing amounts of silty clay and clay at depth. At the Pentolite Road Red Water Pond, borehole IT-MW-05 penetrated very fine sand in the first three feet, clay and silty clay from three feet to about seven feet, and plastic clay from seven feet to the bottom of the borehole.

3.2.3 Hydrology

The hydrology of the Red Water Pond areas has been interpreted from topographic maps, soil borings, and monitoring wells installed at and near the sites. The general hydrology of PBOW is provided in Part B Section 1.0 of this document.

3.2.3.1 Surface Water

Both West Area Red Water Ponds contain standing water, although East Pond appears to have been partially filled in at its northern end, and is sometimes dry. Precipitation runoff in the area flows either to the ponds or toward Pipe Creek. A seep from the West Area Ponds into Pipe Creek was observed in 1994.

The Pentolite Road Red Water Ponds have been backfilled and surface drainage patterns were altered following the discovery of seepage into Plum Brook. Standing water still occurs in the area of the ponds, particularly after heavy rains, and red water in deer tracks has been observed. The standing water in the Pentolite Road Red Water Ponds appears to be affected by seasonal precipitation. Surface runoff in the area of the ponds generally flows to the north and east to drainage ditches which flow into Plum Brook.

3.2.3.2 Ground Water

During the construction of monitoring wells at the red water pond areas, ground water was encountered at a depth of about 10 feet at the West Area Ponds (IT-MW-02) and about 15 feet at the Pentolite Road Ponds (IT-MW-05) (IT 1991a). Correlations between surface water and ground-water levels have not been systematically observed, nor have vertical ground-water gradients been established. However, communication between the surface water in the West Area Ponds and the shallow ground water is suggested by the presence of red water observed in a trench constructed downgradient of the ponds in a search for old sewer lines (Bower 1995).

3.2.3.3 Monitoring Wells

Four monitoring wells have been installed in the vicinity of the West Area Red Water Ponds (Figures 3-1 and 3-2):

- IT-MW-02, between East Pond and West Pond.
- MK-MW-10, north (downgradient) of the ponds near Maintenance Road.
- MK-MW-09, northwest of the area near the intersection of Maintenance and Patrol Roads.
- MK-MW-12, southwest (upgradient) of the ponds near the intersection of Patrol Road and Pipe Creek.

In the Pentolite Road area, monitoring well IT-MW-05 was installed adjacent to the north edge of the pond site (downgradient). Additional wells near the site were installed to monitor other AOCs, including former underground storage tank (UST) areas, all of which are south (upgradient) of the Pentolite Pond area (Figure 3-2). A rising head slug test was performed at monitoring well IT-MW-02 in October 1990, providing a value for hydraulic conductivity of K = 0.25 feet per day (IT 1991a). There are no paired wells in the area to evaluate vertical gradients. Detailed information on monitoring wells is included in Section 14.0

3.3 CONTAMINANTS OF CONCERN (COCs)

COCs for the red water ponds were determined on the basis of past operational activities (Section 3.1.2), and on the results of environmental investigations conducted at the sites.

3.3.1 Contaminants Resulting from PBOW Activities

Previous investigations and field observations at the two red water pond areas indicate the presence of explosives residues (SAIC 1991; MK 1994a). Nitro explosives, nitroaromatics, and heavy metals are the major COCs at the red water ponds.

With the exception of the lime sludge disposal site north (downgradient) of the West Area Ponds, other waste disposal did not occur at or near the red water ponds either during PBOW activity or following World War II. The downgradient location of the lime sludge disposal site precludes potential contamination from this site affecting the red water ponds area.

The Pentolite Road Red Water Ponds Area is located downgradient from a former UST site, which could potentially have resulted in ground-water contamination. Possible COCs from USTs include petroleum by-products and heavy metals in the ground water.

3.3.2 Transport Mechanisms

Possible transport mechanisms in the red water pond areas include:

- Surface transport of liquid phase or particulate-borne contaminants in precipitation runoff to Pipe Creek and Plum Brook, particularly in times of flooding or accidental breaches.
- Migration of contaminants from surface water to shallow ground water.
- Migration of contaminants in shallow ground water to off-site locations and to the deeper limestone aquifers in bedrock.
- Contaminant transport via the food chain.

3.3.3 Action Levels

Action levels apply to clean-up goals established by PBOW RODs, USEPA regulations, or ARARs (i.e., MCLs and NPDES), or are determined from risk-based calculations. Action levels have not been established for the red water pond areas.

3.4 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination at the red water ponds has been investigated in a contamination investigation by IT Corporation (1991a) and in a Site Inspection conducted by Morrison Knudsen (1994a). The results of these investigations are summarized here.

3.4.1 West Area Red Water Ponds

3.4.1.1 Background Data

Background chemical analytical values for COCs in various media for the PBOW in general have not yet been determined. Monitoring well MK-MW-12 was installed upgradient from the West Area Red Water Ponds and can serve as a background well for that site. Monitoring well IT-MW-01 in the south-central part of PBOW may be suitable for background for the PBOW site as a whole.

3.4.1.2 Sediment and Surface Water Investigations

A number of studies have been conducted on the surface water and sediments of the red water pond areas. In the West Area Ponds, 34 bottom sediment samples were collected in a grid pattern from West Pond by Ohio National Guard environmental health personnel, and screened for TNT and DNT derivatives (Burgess and Niple, Ltd. 1985). The average values of TNT and DNT found in the sediments were 0.0374 ppm and 0.0018 ppm, respectively; the highest values found for TNT and DNT were 0.32 ppm and 0.01, respectively. Because new techniques and methods for nitroaromatics analyses have been in place since 1991, these data may not be comparable to more recent information. Lead was also detected in these sediments at a slightly elevated concentration. The presence of lead can be linked to the coating of flume lines of the ordnance plant. Acid used in the manufacturing process likely etched lead from the lines, which ended up in the red wash water.

Morrison-Knudsen (1994a) analyzed surface water and sediment samples from Pipe Creek near the West Area Red Water Ponds. In Pipe Creek, sediment and surface water samples were collected upgradient and

Table 3-1. Sediment Sampling Analytical Results, Red Water Ponds

Compound	Units	West Area	West Area
		MK-SD-04	MK-SD-14
2-Butanone	µg/kg	U	2J
Acetone	µg/kg	U	17
Bis(2-ethylhexyl)phthalate	µg/kg	U	570
DNT	mg/kg	U	U
Fluoranthene	µg/kg	180J	U
Phenanthrene	µg/kg	160J	U
Pyrene	µg/kg	120J	U
TNT	mg/kg	U	U
Toluene	µg/kg	U	2J

< Compound was analyzed for but not detected above the applicable method detection limit.
NA Not analyzed.
J Estimated value.
U Compound was analyzed for but not detected.

Source: Morrison Knudsen, 1994a (Chapter 4).

downgradient of the site and adjacent to the site (Figure 3-1). Samples were analyzed for VOCs, SVOCs, and nitroaromatics. Table 3-1 shows the analytical results for samples with detectable contaminants.

3.4.1.3 Surface Soil Investigations

Surface soil samples were collected at various locations at PBOW for the Site Inspection conducted by Morrison-Knudsen (1994a), however, no soil samples were collected at the red water pond sites.

Three surface soil samples were collected north of the West Area Ponds at a lime sludge disposal area. No VOCs were detected in the surface soil samples, however several SVOCs were found, primarily coal tar derivatives and PCB's, including Aroclor-1260 at a level of 630 ppb.

In 1984, a surface soil sample from the spoils area at West Pond was analyzed by Battelle Laboratories in Columbus, Ohio. Concentrations of 0.2 ppm of 2,4-DNT and 13.6 ppm of 2,6-DNT were detected (Battelle 1984). Because new techniques and methods for nitroaromatics analyses have been in place since 1991, these data may not be compatible with more recent information.

3.4.1.4 Subsurface Soil Investigations

Subsurface soil samples were collected for analysis in the vicinity of the West Area Red Water Ponds from soil borings IT-SB-07, IT-MW-02, and IT-SB-09 through IT-SB-12 (Figure 3-1). At soil boring locations with visible potential soil contamination (e.g., standing red water or crystalline solids at the surface), the soil was collected from the upper two feet of the borehole. At IT-SB-19 (background sample located along Patrol Road in the southern portion of the site) bedrock was encountered at 3 feet, and only the 0- to 2-foot interval was collected. The soil samples were analyzed for VOCs, SVOCs, total metals, total sulphate, nitrates, pH, and nitroaromatic explosive compounds. The following is a summary of the results of the subsurface soils analyses shown in Table 3-2:

- Acetone was detected in sample IT-SB-07 at a concentration greater than 2,000 ppb, attributed to field decontamination procedures.
- Nitroaromatic compounds were detected in only minor quantities in samples collected from soil borings near the West Area Red Water Ponds.
- Soil samples from IT-MW-02 showed a manganese concentration (2,600 ppm) significantly higher than the background sample, attributed to contamination resulting from activities associated with red water disposal.
- Sodium concentrations in IT-SB-07 and IT-SB-12 (0 to 2 feet) were significantly above the measured background levels. These results probably represent residual breakdown products from waste materials disposed in these areas.
- Elevated sulfate and nitrate values were detected in soil samples collected near the West Area Red Water Ponds, which probably represent residual breakdown products from acid waste materials disposed in these areas.

3.4.1.5 Ground-Water Investigations

One ground-water monitoring well, IT-MW-02, was installed at the West Area Red Water Ponds (Figure 3-1) (IT 1991a). One background well, IT-MW-01, was installed near the southern boundary of PBOW to provide ground-water background data. Ground-water samples were analyzed for VOCs, SVOCs, total metals, total sulfate, nitrates, pH, and nitroaromatic explosive compounds.

Table 3-2. Subsurface Soil Sampling Analytical Results, Red Water Ponds

Compound	Units	West Area	West Area	West Area	West Area	West Area	West Area	Pentolite	Pentolite
		IT-SB-07 (0-2')	IT-MW-02[a] (0-2')	IT-SB-09 (0-2')	IT-SB-10 (0-2')	IT-SB-11 (0-2')	IT-SB-12 (0-2')	IT-SB-13 (0-2')	IT-SB-14 (0-2')
1,3-Dinitrobenzene	mg/kg	U	U	U	U	U	0.59	0.62	3.7
1,3,5-Trinitrobenzene	mg/kg	0.41	U	U	U	U	3.4	0.73	14
2,4-Dinitrotoluene[b]	mg/kg	0.23	U	U	U	U	0.91	U	20
2,4-Dinitrotoluene[c]	µg/kg	170J	NR	U	U	U	620J	1600	11000
2,4,6-Trinitrotoluene	mg/kg	U	U	U	U	U	0.68	U	U
2,6-Trinitrotoluene[b]	mg/kg	U	U	U	U	U	U	U	U
2,6-Dinitrotoluene[c]	µg/kg	U	NR	U	U	U	U	180J	1700
Acetone	µg/kg	2,300E	12J	5J	3J	3J	56	170	80
Bis(2-ethylhexyl)phthalate	µg/kg	180J	NR	230J	280J	170J	340J	230J	180J
Carbon tetrachloride	µg/kg	U	1J	U	U	U	U	U	U
Manganese	mg/kg	530	2,600	104	271	211	262	263	146
Methylene chloride	µg/kg	5J	6J	8	6J	10	8	6	9
Nitrobenzene	mg/kg	U	U	U	U	U	U	U	U
Nitrotoluene	mg/kg	U	U	U	U	U	U	U	U
Toluene	µg/kg	U	U	U	U	4J	U	U	U

Table 3-2 (Continued)

Compound	Units	Pentolite IT-SB-15 (2-4')	Pentolite IT-SB-15 (4-6')	Pentolite IT-SB-16 (0-2')	Pentolite IT-SB-16 (4-6')	Pentolite IT-SB-17 (0-2')	Pentolite IT-SB-18 (0-2')	Backg'nd IT-SB-19 (0-2')	Backg'nd IT-SB-19D (0-2')
1,3-Dinitrobenzene	mg/kg	U	U	0.55	6.4	U	5.0	U	U
1,3,5-Trinitrobenzene	mg/kg	U	U	1.2	15	0.67	10	U	U
2,4-Dinitrotoluene[b]	mg/kg	U	U	3.2	16	1.1	19	U	U
2,4-Dinitrotoluene[c]	µg/kg	U	U	1900	7300	740	5900	U	U
2,4,6-Trinitrotoluene	mg/kg	U	U	U	U	U	U	U	U
2,6-Dinitrotoluene[b]	mg/kg	U	U	0.53	U	U	2.7	U	U
2,6-Dinitrotoluene[c]	µg/kg	U	U	320J	1,500	82J	1000	U	U
Acetone	µg/kg	U	U	160	54	150	U	3000E	11000
Bis(2-ethylhexyl)phthalate	µg/kg	320J	450	340J	500J	280J	250J	410J	270J
Carbon tetrachloride	µg/kg	U	U	U	U	U	U	U	U
Manganese	mg/kg	181	244	78.2	435	141	97.6	18.0	15.5
Methylene chloride	µg/kg	7	7	5J	8	5J	U	7	6J
Nitrobenzene	mg/kg	U	U	0.48	U	U	U	U	U
Nitrotoluene	mg/kg	U	U	0.48	U	U	U	U	U
Toluene	µg/kg	1J	U	U	U	25J	1J	9	U

[a]Soil boring (SB-08) was not installed, instead a soil sample was collected from monitoring well (MW-02) and analyzed.
[b]Reported as a nitro-aromatic explosive compound.
[c]Reported as SVOC.
D Duplicate sample.
J Estimated value.
U Compound was analyzed for but not detected.
E Compound exceeded CLP calibration range but was within instrument linear range.
NR Not reported.
Source: IT 1991a.

Monitoring well IT-MW-02 was also sampled during the Site Inspection conducted by Morrison-Knudsen (1994a). The following is a summary of the results of the ground-water analyses shown in Table 3-3:

- Acetone was detected in small amounts in well IT-MW-02 during both the IT study and the Morrison-Knudsen study.
- Significant concentrations of 2,6-DNT were detected in the ground water sample collected from IT-MW-02 in both the IT and Morrison-Knudsen studies.
- Metal analyses of ground water samples indicated elevated chromium concentrations from IT-MW-02.
- The elevated sulfate concentration in IT-MW-02 exceeds the MCL for sulfate.

3.4.2 Pentolite Road Red Water Ponds

3.4.2.1 Background Data

Background chemical analytical values for COCs in various media for the PBOW in general have not yet been determined. Monitoring well IT-MW-01 in the south-central part of PBOW may be suitable for background for PBOW site as a whole. Background locations specific to the Pentolite Road Red Water Ponds have not been established.

3.4.2.2 Sediment and Surface Water Investigations

Morrison-Knudsen (1994a) analyzed surface water and sediment samples from a drainage ditch along Pentolite Road north of the Pentolite Road Pond area (Figure 3-2). Samples were analyzed for VOCs, SVOCs, and nitroaromatics. No samples from the Pentolite Road ditch showed detectable levels of contaminants.

3.4.2.3 Surface Soil Investigations

Surface soil samples were collected at various locations at PBOW for the Site Inspection conducted by Morrison-Knudsen (1994a), however, no soil samples were collected at the red water pond sites.

In 1977, a thin layer of salt-like crystalline material on the soil at the Pentolite Road Ponds Area was collected by NASA laboratory personnel. Analysis indicated high levels of sulfate concentrations, interpreted as sodium sulfate from the neutralization of waste acid (D&M 1995).

Table 3-3. Ground-Water Sampling Analytical Results, Red Water Ponds[a]

Compound	West Area IT-MW-02	West Area IT-MW-02D	Pentolite IT-MW-05
2-Nitroaniline	2J	2J	U
2,4-Dinitrotoluene	160	140	U
2,6-Dinitrotoluene	27	25	U
3-Nitroaniline	13J	12J	U
4-Nitrophenol	3J	U	U
Acetone	12	U	7J
Bis(2-ethylhexyl)phthalate	2J	U	2J
Carbon disulfide	U	U	4J
Chromium	U	0.12	U
Manganese	2.8	3.0	0.053
Sodium	401	441	17
Sulfate	950	950	U

[a]Units in µg/l.
D Duplicate sample.
J Estimated value.
U Compound was analyzed for but not detected.

Source: IT, 1991a.

3.4.2.4 Subsurface Soil Investigations

Subsurface soil samples were collected for analysis in the vicinity of the Pentolite Road Red Water Ponds from soil borings IT-SB-13 through IT-SB-18 (IT 1991a) (Figure 3-2). At soil boring locations with visible soil contamination (e.g., standing red water or crystalline solids at the surface), the soil was collected from the upper two feet of the borehole. Because the surface soil at locations IT-SB-14 and IT-SB-15 showed no visible evidence of surface contamination, the soil samples were collected from the four- to six-foot interval. Two additional soil samples were collected immediately above a 6-foot deep clay layer in boreholes IT-SB-15 and IT-SB-16. At IT-SB-19 (background sample) bedrock was encountered

at 3 feet, and only the 0- to 2-foot interval was collected. The soil samples were analyzed for VOCs, SVOCs, total metals, total sulfate, nitrates, pH, and nitroaromatic explosive compounds (Table 3-2). The analyses revealed the following:

- Concentrations greater than or equal to 740 ppb of 2,6-DNT and 2,4-DNT were detected in samples collected from the Pentolite Road Red Water Ponds area.
- Sodium concentrations in IT-SB-13, IT-SB-14, IT-SB-16 (0 to 2 feet), IT-SB-16 (4 to 6 feet), IT-SB-17 (0 to 2 feet), and IT-SB-18 (0 to 2 feet) also were significantly above the measured background levels. These results probably represent residual breakdown products from waste materials disposed in these areas.

3.4.2.5 Ground-Water Investigations

Monitoring well IT-MW-05 was installed at the Pentolite Red Water Pond Area (IT 1991a). Ground-water samples were analyzed for VOCs, SVOCs, total metals, total sulfate, nitrates, pH, and nitroaromatic explosive compounds. The well was also sampled during the Site Inspection conducted by Morrison-Knudsen (1994a) (Table 3-3).

3.5 CURRENT STATUS OF SITE CHARACTERIZATION

This section describes the current status of site characterization at the TNT Areas, including additional investigations that may be necessary to define source areas of contamination, characterize potential migration pathways, or identify potential receptors and exposure pathways. Any further investigations suggested here are not intended to be requirements for future work at this AOC. They are suggested for consideration for future work, to be implemented only if determined necessary through the site scoping process.

3.5.1 Physical Characteristics

Suggestions for additional characterization at the red water ponds include:

- Two monitoring wells were installed at the red water ponds by IT (1991a): IT-MW-02 at the West Area Ponds and IT-MW-05 at the Pentolite Road Pond. The geology of the ponds areas has been characterized from these wells and from shallow borings. Deep borings should be considered for future work to characterize the glacial geology and depth to bedrock.
- Qualitative hydrogeologic characteristics have been moderately well-defined from wells and borings and a slug test was conducted in IT-MW-02. Additional characterization, particularly

vertical hydraulic gradients and the relationship between the bedrock aquifer and the shallow unconfined aquifer, should be considered for future work.

- The relationship between surface water at the ponds and the shallow ground-water system has not been well defined. This should also be considered for future work.

3.5.2 Nature and Extent of Contamination

Suggestions for additional investigations to establish the nature and extent of contamination at the red water ponds include the following:

- Shallow subsurface soil contamination has been characterized from five soil borings at the West Area Ponds and six soil borings at the Pentolite Road Ponds (IT 1991a). However, a systematic examination of surface and subsurface soils to delineate the extent of soil contamination should be considered for future work.

- Sediment and surface water contamination have been characterized with the analysis of samples from West Pond, Pipe Creek, and a drainage ditch north of the Pentolite Road Pond. Additional sampling and analysis may be desirable to evaluate seasonal variations in sediment and surface water contamination, and to verify previous results.

- Monitoring wells IT-MW-02 and IT-MW-05 were sampled, analyzed, and found to contain concentrations of nitroaromatic compounds, VOCs, and SVOCs (IT 1991a). Additional shallow and deep wells should be considered for future studies.

3.5.3 Background Data

Background samples have been collected in all sampling media at PBOW, but only at a few locations. Suggestions for further background sampling in connection with the red water ponds areas include the following:

- A statistical evaluation of the available background data should be conducted to evaluate their usefulness for future risk assessments at the site.

- Additional background sampling sites for all media of interest may be needed to establish site-wide background conditions at PBOW.

3.6 POTENTIAL HAZARDS TO HUMAN HEALTH AND THE ENVIRONMENT

No formal risk assessment, either human health or environmental, has been conducted for the red water pond areas. Sufficient information may exist on the nature and magnitude of soil, sediment, and surface-water contamination to conduct a risk assessment with respect to these media, but the ground water has not been characterized sufficiently to establish risks to potential human consumers. A hazard ranking was conducted on the red water ponds areas (SAIC 1991) in which scores for the various transport pathways ranged from 2.16 to 5.45, well below the USEPA-designated hazard ranking score of 28.5, at which a site becomes eligible for inclusion on the NPL. An updated scoring was performed by Morrison Knudsen in 1994 in which the West Red Water Ponds Area received a site score of 4.08 and the Pentolite Road Ponds Area received a score of 7.10.

3.7 FEASIBILITY STUDIES

A feasibility study has not been conducted for the red water pond areas.

3.8 REMEDIAL ACTIONS

Although some emergency measures were undertaken to control the seepage of red water into surface streams and ditches, no remedial actions have been conducted at the red water ponds.

3.9 WETLANDS ASSESSMENTS

Potential wetlands make up about 1.5 percent of the total habitat at PBOW. The red water pond areas, by virtue of their vegetation and standing water, are likely candidates for wetlands classification (Warner, et. al. 1990).

3.10 PLANNED ACTIVITIES

A focused Remedial Investigation (RI) is planned for the red water pond sites (D&M 1994) to determine the nature and extent of contamination in these areas. Extensive sampling of soils and sediments, and their analyses for explosives residues and metals, is proposed for both pond areas. Surface water samples will also be collected and analyzed for explosives residues, total suspended solids, total metals, dissolved metals, and biological activity. Two additional shallow monitoring wells and one bedrock well are planned for the West Area Ponds and three new shallow wells are planned for the Pentolite Road Ponds. Ground water will be tested for nitroaromatics, total metals, and dissolved metals. The bedrock ground-

water samples will also be tested for VOCs and SVOCs. Following the RI, human health and environmental risk assessments may be conducted.

3.11 RECOMMENDATIONS

The focused RI planned for the red water pond areas is believed to be sufficient to determine the nature and extent of contamination at these sites and to conduct a risk assessment. If contamination is detected in the bedrock well near the West Area Ponds, it is recommended that additional monitoring wells be installed in bedrock downgradient of both pond areas, and the bedrock aquifer monitored regularly for contaminants of concern.

4.0 UNDERGROUND WASTEWATER FLUMES

4.1 BACKGROUND

The Underground Wastewater Flumes at PBOW were identified in a Preliminary Assessment as having potential for contamination from PBOW activities, particularly contamination of subsurface soil and ground water (SAIC 1991). This section provides descriptive and historic background information on the Underground Wastewater Flumes that may be related to potential contamination at the site.

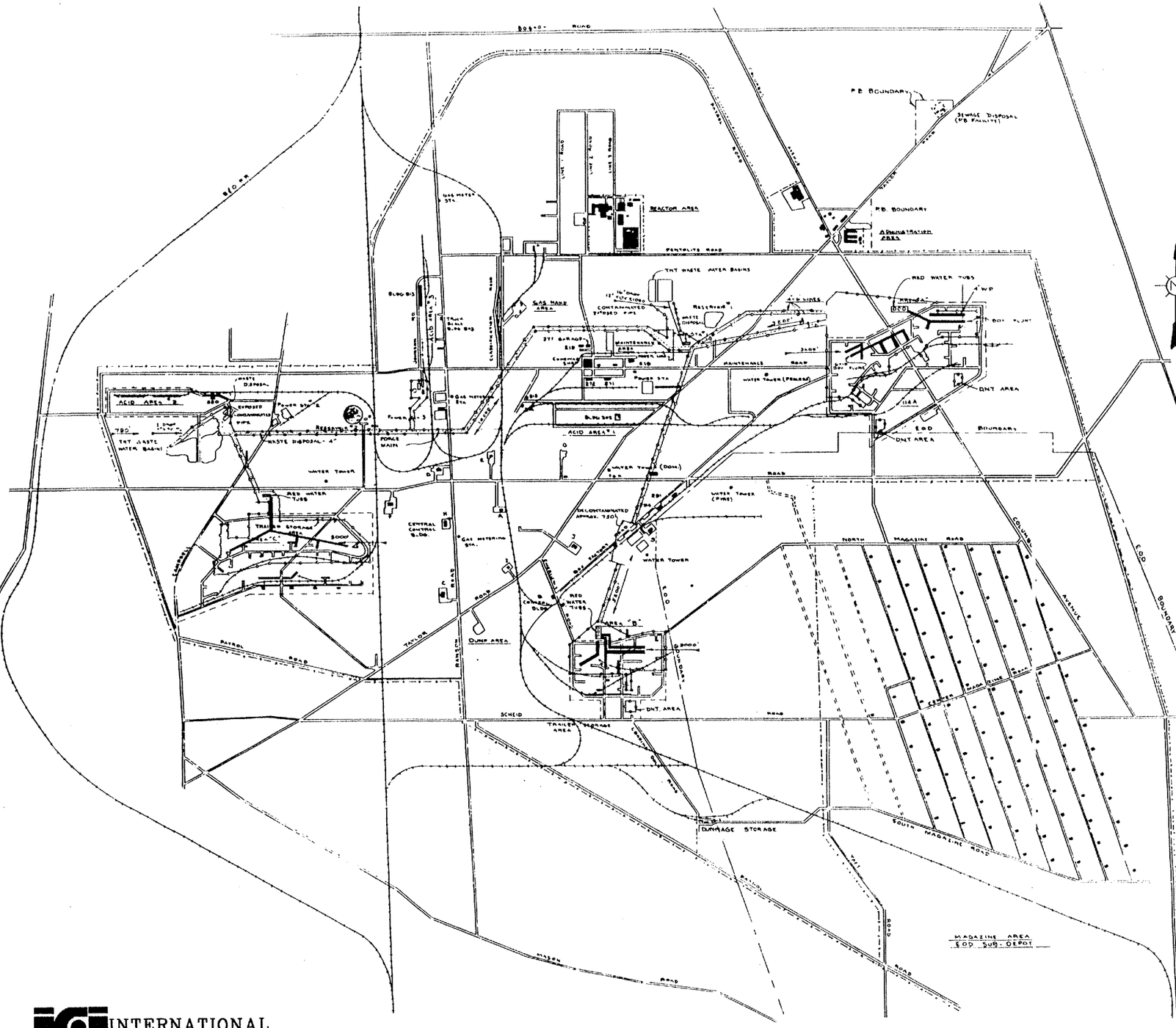
4.1.1 Description

During World War II, the PBOW facility housed operations for the manufacture of TNT, DNT, and pentolite. The wastewater disposal systems at the TNT Manufacturing Areas A, B, and C (described in Section 2.0) were comprised of above- and below-ground wooden flumes. The wooden flumes were used to carry liquid and solid wastes that accumulated in catch basins located at the wash houses at the three TNT areas. The locations of the original flumes are shown on a 1945 site map of PBOW, reproduced here as Figure 4-1. Wastes were transported from the catch basins by gravity flow to wooden settling tanks located in the northernmost portion of each TNT area, before being pumped to one of the red water ponds. The wooden settling tanks were 40 feet in diameter and 4 feet deep (SAIC 1991).

Underground Wastewater Flumes at TNT Area A are along the northern border of the TNT area, near Engineering Building 7141 which currently houses NASA administrative offices. During PBOW operation, the wastewater flumes and sewers from Area A carried liquid and solid waste to the Pentolite Road Red Water Ponds.

In TNT Area B, Underground Wastewater Flumes are located at the northern end of the area. The Hypersonic Tunnel Facility (HTF) is located on the northwest side of TNT Area B, and the B2 Test Facility is located to the northeast. The wastewater from Area B was sent to the Pentolite Road Red Water Ponds.

Underground Wastewater Flumes at TNT Area C are in the central and northern portions of the area. This TNT Area does not currently house NASA buildings or facilities. During the operation of PBOW, wastewater was piped to the West Area Red Water Ponds for disposal (SAIC 1991).



CONTAMINATED BLDGS.

	AREA "A"	AREA "B"	AREA "C"
MONO HOUSE	111-121-131-141	451-461-471	681-691-601-611-621
BI-FORTIFIER HOUSE	113-123-133-143	453-463-473	683-693-603-613-623
TRI HOUSE	112-122-132-142	452-462-472	682-692-602-612-622
WASH HOUSE	1-126-136-146	456-466-476	686-696-606-616-626
NAIL HOUSE	126-146	456-466	696-616-626
RECOVERY HOUSE	9-129-139-149	459-469-479	689-699-609-619-629
DNT NITRATOR HOUSE	185-195	415	
DNT SWEATING AND GRAINING HOUSE	182-192	412	

ROUTE & AREA MARKING

AREA OUTLINE

UNDERGROUND FLUME LINE

NOTES

50' STRIP STRADDLING ROUTES OF UNDERGROUND STEEL OR WOODEN PIPE LINES SPREAD AS FOUND NECESSARY IN FIELD TO COVER AREAS CONTAMINATED DUE TO SPILLAGE FROM PIPES. STAKES PLACED AT 100' INTERVALS STAGGERED ON EACH SIDE OF ROUTE. SPACE STAKES AT 50' INTERVALS WHERE ARE NECESSARY.

MANUFACTURING AREAS A-B-C ARE TO BE STAKED AT 50' INTERVALS AND ARE NOT TO BE STAGGERED.

STAKES ARE TO BE 3 TO 4 FEET IN LENGTH AND PAINTED RED & DRIVEN 1 FT. INTO THE GROUND.

STAKES MARKING THE MANUFACTURING AREAS ARE TO BE LOCATED 5 FEET OFF THE BRIM, INSIDE THE ROAD.

THE CONTAMINATED AREAS INDICATED ARE THOSE SHOWN TO BE CONTAMINATED BY PBOW DWGS OTHER AREAS MAY BE CONTAMINATED THAT ARE NOT SO MARKED AND ANY ORDNANCE FACILITIES MUST BE CHECKED FOR TNT BEFORE BEING USED BY NASA PERSONNEL.

NOTES:
DATA COPIED FROM DRAWING OF TROJAN POWDER COMPANY, PLUM BROOK ORDNANCE WORKS SANDUSKY OHIO. NO. 1670-T-505-B DATE 11-21-45
PENTOLITE AREA AND SECTION OF FLUME LINES AT BOX FACTORY ROAD DECONTAMINATED SINCE 11-21-45

DRAWING NUMBER CHANGED AS SHOWN TO CONFORM TO PLUM BROOK STATION NUMBERING SYSTEM. DRAWING PREVIOUSLY NUMBERED CF 147120 M

SCALE 1" = 800'	REFERENCES		INITIAL	DATE	CHANGE	NO	REVISION	DATE	CK. APP.
UNLESS OTHERWISE SPECIFIED		DR					NASA Plum BROOK FACILITIES PLOT PLAN		
		CK							
		D ENG					MARKING OF AREA CONTAINING CONTAMINATED SOIL		
		E ENG							
		F ENG							
		D S HD					NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LEWIS RESEARCH CENTER CLEVELAND, OHIO	DWG NO PF22598	
	SAFETY APPROVAL	E S HD							
	BY DATE	D D CH							
	AREA SAFETY COMM.	S D HD							

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FIGURE 4-1

LOCATION OF WASTE WATER FLUMES (HISTORICAL MAP)

DATE 20 JAN 95
PREPARED JET
CHECKED DBJ

4.1.2 History

The history of activities at the Underground Wastewater Flumes is divided into two periods: the operational period of PBOW, and the post-operational period, including post-World War II decommissioning activities.

4.1.2.1 Operational Period (1941-1945)

Between 1941 and 1945 wooden flumes were used to dispose of liquid and solid wastes that accumulated in catch basins located at the wash houses in each of the three TNT manufacturing areas. The 4-inch diameter wooden flumes drained waste from the DNT nitrator buildings and wash house catch basins to the settling tanks. After the waste had segregated in the settling tanks, the waste slurry was pumped through either four- or six-inch pipe to the raw waste storage tanks prior to disposal in the Red Water Ponds. The wooden flume lines often became clogged with TNT residue, and in some instances were completely plugged. The plugged lines were abandoned, and by-pass lines were constructed around the blocked areas to provide continual drainage of the wastewater. A summary of linear footage of wooden pipe and box flumes documented on PBOW engineering drawings and maps is provided in Table 4-1.

4.1.2.2 Post-Operational Period

Following World War II, PBOW was in standby condition from 1945 to 1946. During this time, the Army conducted D&D work on many of the buildings and structures associated with the manufacturing of ordnance, including the Underground Wastewater Flumes. The TNT manufacturing areas underwent further decontamination by NASA from 1963 to 1965. All known flumes were excavated and removed to the burning grounds for destruction (Figures 4-2 and 4-3). NASA has encountered previously unidentified flumes during subsequent construction activities. The locations of any remaining flumes at PBOW are unknown. Although a concerted D&D effort was aimed at removing and destroying all of the pipe and flumes, it is suspected that lengths of explosives-contaminated flumes remain buried at the site (SAIC 1991).

4.2 PHYSICAL CHARACTERISTICS

The physical characteristics of the Underground Wastewater Flume areas include surface features, geology, and hydrology and are closely associated with the characteristics of the TNT areas, discussed in Section 2.0. The physical characteristics of PBOW as a whole are described in Section 1.0.

Figure 4-2. Excavated Contaminated Flume Lines, 10 July 1963

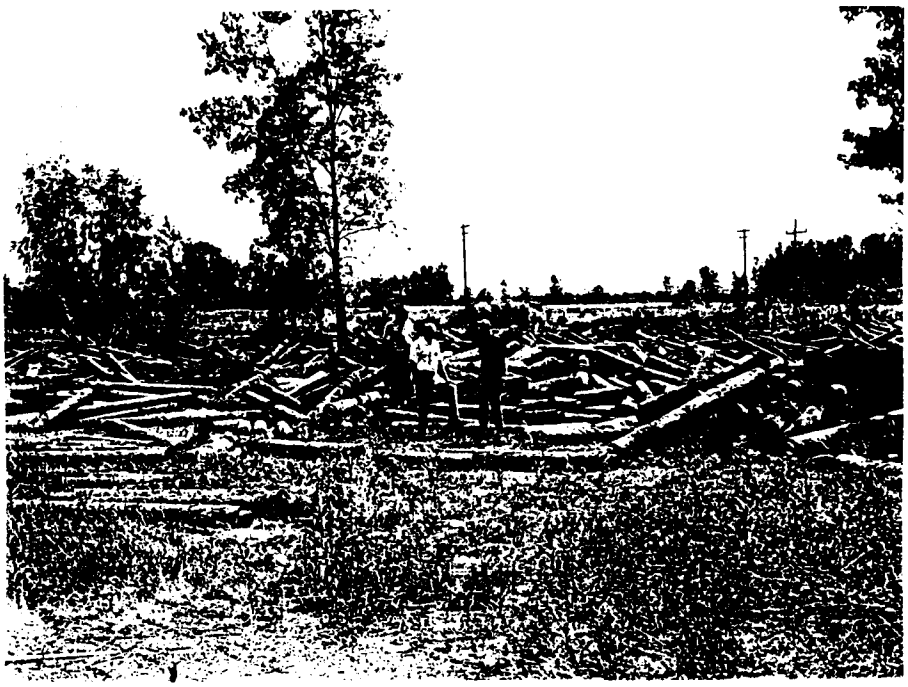


Figure 4-3. Flume Piping Being Burned, 8 June 1962

Table 4-1. Summary of Wooden Pipe and Flume Linear Footage at TNT Manufacturing Areas

TNT Area	4-Inch Pipe	5-Inch Pipe	6-Inch Pipe	6x10-In. Flume
A	4,900	1,550	0	3,425
B	2,150	500	100	1,325
C	2,500	0	0	2,575
Other Areas	11,275	0	11,150	1,550
TOTAL	20,825	2,050	11,250	8,875

Source: SAIC 1991.

4.2.1 Surface Features

The Underground Wastewater Flumes are presumed to be located in and near the TNT Areas, and between the TNT Areas and the red water ponds. Elevations in these areas range from approximately 635 feet to 675 feet above MSL, with lower elevations generally occurring in the northern parts of PBOW. The depth of burial of the flumes is not consistent, having been uncovered at depths of three to seven feet.

Buildings and facilities constructed in support of NASA activities are presumed to be located in close proximity to the Underground Wastewater Flumes in TNT Areas A and B, including Engineering Building 7141 in the center of TNT Area A, and the HTF in the northwest corner of Area B. Remnants of PBOW structures, such as building foundations and railroad lines, are also located close to the presumed areas of Underground Wastewater Flumes.

Site records do not indicate that waste disposal activities, other than contamination due to production activities, occurred in Underground Wastewater Flume areas either during PBOW activity or following World War II.

4.2.2 Geology

The glacial deposits underlying the Underground Wastewater Flume areas are described from lithologic information obtained from borehole logs drilled to install monitoring wells in and near the site. The

discussion of geology related to TNT Areas A, B, and C in Section 2.2.2 also relates to the Underground Wastewater Flumes.

4.2.3 Hydrology

The hydrology and hydrogeology of the Underground Wastewater Flume areas have been interpreted from topographic maps, soil borings, and monitoring wells installed at and near the TNT areas, as discussed in Section 2.0. The general description of the hydrology and hydrogeology of PBOW is provided in Section 1.0.

4.2.3.1 Surface Water

Surface runoff in the area of the Underground Wastewater Flumes generally flows to the north and east to drainage ditches or streams. The specific surface drainage patterns for the flumes located in the TNT Areas are assumed to be the same as the respective TNT Areas (Section 2.2.3.1).

4.2.3.2 Ground Water

Ground water in the surficial aquifer generally flows north beneath the PBOW site. The specific ground-water features for the flumes located in the TNT Areas are assumed to be the same as the respective TNT Areas (Section 2.2.3.2).

4.2.3.3 Monitoring Wells

Monitoring wells located in the vicinity of the Underground Wastewater Flume areas are discussed in Section 2.2.3.3.

4.3 CONTAMINANTS OF CONCERN (COCs)

COCs for the Underground Wastewater Flume areas were determined on the basis of past operational activities (Section 4.1.2), and on the results of environmental investigations conducted at the sites.

4.3.1 Contaminants Resulting from PBOW Activities

Based on past site activities, nitroexplosives and residue from the TNT manufacturing process are likely COCs at the sites of the flumes. Previous investigations at the three TNT areas where the flumes were

located have shown that nitroexplosives, toluene, and acetone may be present in the sediments, soils, surface water, and ground water in these areas (SAIC 1991), some of which may be related to releases from the underground flumes. Later decommissioning activities to remove the flume lines may have resulted in additional releases of these chemicals.

Other waste disposal activities did not occur at or near the Underground Wastewater Flume areas either during PBOW operations or following World War II, although there is a possibility of accidental contaminant releases related to later activities. The presence of VOCs and pesticides has been noted in TNT Area A, and SVOCs have been detected in soil samples from TNT Area B (MK 1994a). No contaminants were detected in surface soil samples analyzed from TNT Area C.

Because the wastewater flumes at TNT Area A are located approximately 1,200 feet downgradient from Fox Road Burn Ground, ground water from the burn ground may affect the ground water in the wastewater flume area. Potential contaminants from the burn ground are nitroaromatic compounds, heavy metals, and SVOCs such as PAH.

4.3.2 Transport Mechanisms

The flumes were buried wooden wastewater conduits, with no engineered barriers to migration. Possible transport mechanisms from leaking flumes include:

- Migration of contaminants from soils to shallow ground water.
- Migration of contaminants in shallow ground water to surface water.
- Migration of contaminants in shallow ground water to off-site locations and to the deeper limestone aquifers in bedrock.
- Contaminant transport via the food chain.

4.3.3 Action Levels

Action levels apply to clean-up goals established by PBOW RODs, USEPA regulations, ARARs (e.g., MCL and NPDES levels), or are determined from risk-based calculations. Action levels have not been established for the Underground Wastewater Flume areas.

4.4 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination at the Underground Wastewater Flume areas have not been independently investigated. However, the Site Inspection of the TNT Areas conducted by Morrison Knudsen (1994a) provides some information about the Underground Wastewater Flume areas. The results of the site investigation conducted at the TNT Areas are summarized in section 2.4. All contaminant data in the following discussion are included in the following tables in Section 2.0 *TNT Areas*: Table 2-1, sediment sampling; Table 2-2, surface soils sampling; and Table 2-3, subsurface soils sampling.

4.4.1 Underground Wastewater Flumes in TNT Area A

4.4.1.1 Background Data

Monitoring well MK-MW-24 is located south (upgradient) of TNT Area A (MK 1994a) and may serve as a background location for this TNT area and its associated wastewater flumes. Additional background sampling sites for the flume areas have not been identified.

4.4.1.2 Sediment and Surface Water Investigations

Sediment and surface water samples from ditches and streams at PBOW were analyzed during the Site Inspection conducted by Morrison Knudsen (1994a). The two sediment and two surface water samples collected in Lindsley Ditch adjacent to TNT Area A, may reflect potential contamination from the wastewater flumes there. Sediment sample MK-SD-17 and surface water sample MK-SW-17 were collected from the ditch east of the TNT area, and samples MK-SD-16 and MK-SW-16 were collected northeast of the TNT area just downstream from the confluence of a small tributary and Lindsley Ditch. Organic compounds were not detected in the surface water samples, but low levels of VOCs and pesticides were found in the sediments. Both MK-SD-16 and MK-SD-17 contained minor acetone and SVOCs, particularly PAH; analysis of MK-SD-16 revealed low levels of the pesticide methoxychlor; and low levels of DDT and dieldrin were detected in both sediment samples.

4.4.1.3 Surface Soil Investigations

A single surface soil sample, MK-SS-23, was collected in the southwestern corner of TNT Area A near a railroad spur. Chemical analysis did not reveal the presence of COCs in this sample.

4.4.1.4 Subsurface Soil Investigations

Subsurface soil samples were collected from soil borings at TNT Area A and associated wastewater flumes: MK-SB-14, -15, and -16 (corresponding to monitoring wells MK-MW-22, -23, and -24, respectively). The soil samples were collected from the upper two feet of the boring in each case. Only minor SVOCs (primarily PAH) were detected in MK-SB-14 and MK-SB-16 (MK 1994a).

4.4.1.5 Ground-Water Investigations

Morrison Knudsen installed three wells in TNT Area A, none of which were specifically targeted for the wastewater flumes:

- MK-MW-22, located on the north side of the Engineering Building along Columbus Avenue.
- MK-MW-23, located on the Loop Road surrounding the Engineering Building in the northeast corner of the area.
- MK-MW-24 in the southwest corner of TNT Area A.

Analyses performed on ground-water samples from these wells detected no significant contamination.

4.4.2 Underground Wastewater Flumes in TNT Area B

4.4.2.1 Background Data

Monitoring well MK-MW-16, installed south (upgradient) of TNT Area B (MK 1994a), may serve as a background location for this TNT area and its associated wastewater flumes. Additional background sampling sites for the flume areas have not been identified.

4.4.2.2 Sediment and Surface Water Investigations

Sediment and surface water samples from ditches and streams at PBOW were analyzed for the Site Inspection conducted by Morrison Knudsen (1994a). MK-SD-07 and MK-SW-07 were collected near the origin of Ransom Brook immediately north of TNT Area B. This sampling point is near a former location of TNT storage tanks and is considered to be a possible point of entry for surface water contaminants from wastewater flumes as well as the TNT area. Sediment sample MK-SD-07 contained acetone, SVOCs (PAH) and bis(2-ethylhexyl)phthalate at 3,800 ppb, and 2,4,6-TNT (25,000 ppb).

4.4.2.3 Surface Soil Investigations

In TNT Area B, a surface soil sample, MK-SS-13, was collected near the location of a trough used to carry TNT product to the storage areas. Minor amounts of toluene (33 ppb) were detected in this sample.

4.4.2.4 Subsurface Soil Investigations

Samples from the upper two feet of soil borings were collected for analysis in MK-SB-08 and MK-SB-09 (corresponding to MK-MW-16 and MK-MW-17, respectively) at TNT Area B. Only very minor quantities of SVOCs were reported for these samples in the text of the report, however, Figure 4-2 of the report indicates both 2,4,6-TNT (12,000 ppb) and 2,6-DNT (60 ppb) in MK-SB-09 (MK 1994a).

4.4.2.5 Ground-Water Investigations

Two monitoring wells, MK-MW-16 and MK-MW-17, were installed adjacent to TNT Area B. Well MK-MW-17, located north (downgradient) of the area of the wastewater flumes, corresponds with soil boring MK-SB-9 in which nitroaromatic compounds have been detected. Figure 4-2 of the Morrison Knudsen report (1994a) indicates the presence of bis(2-ethylhexyl)phthalate at a concentration of 12 ppb in ground water from MK-MW-17.

4.4.3 Underground Wastewater Flumes in TNT Area C

4.4.3.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined. Additional background sampling sites for the flume areas have not been identified.

4.4.3.2 Sediment and Surface Water Investigations

Sediment and surface water samples from ditches and streams at PBOW were analyzed for the Site Inspection conducted by Morrison Knudsen (1994a). Samples MK-SD-04 and MK-SW-04 were collected just downstream of the confluence of Pipe Creek and a small tributary stream just north of TNT Area C. The sampling point was considered the most likely point of entry from Area C and its wastewater flumes to the stream. Organic compounds were not detected in the surface water sample, and only minor SVOCs (PAH) were detected in the sediment sample.

4.4.3.3 Surface Soil Investigations

Surface soil samples MK-SS-10, MK-SS-11, and MK-SS-12 were collected in and around TNT Area C and the likely locations of flume lines. Sample MK-SS-10 was collected adjacent to Fox Road near the location of the storage tanks used in the production of TNT; MK-SS-11 was collected southeast of the TNT area near the remains of a building; and MK-SS-12 was collected in a clearing near the suspected location of a TNT flume. The analyses of these samples detected very low quantities of toluene, and sample MK-SS-10 contained minor concentrations of SVOCs, particularly PAH.

4.4.3.4 Subsurface Soil Investigations

No subsurface soil samples have been collected from TNT Area C.

4.4.3.5 Ground-Water Investigations

There are no ground water monitoring wells located on or near TNT Area C.

4.5 CURRENT STATUS OF SITE CHARACTERIZATION

This section describes the current status of site characterization at the TNT Areas, including additional investigations that may be necessary to define source areas of contamination, characterize potential migration pathways, or identify potential receptors and exposure pathways. Any further investigations suggested here are not intended to be requirements for future work at this AOC. They are suggested for consideration for future work, to be implemented only if determined necessary through the site scoping process.

4.5.1 Physical Characteristics

The geologic characteristics of the glacial sediments underlying the wastewater flumes underlying TNT Areas A and B were determined from boreholes drilled for the installation of monitoring wells (MK 1994a). Suggestions for additional characterization at the wastewater flume areas include:

- No wells or boreholes have been installed at TNT Area C, and geologic properties have not been determined. Wells or boreholes suggested for this area to characterize the geology in the area of the underground flumes.
- The locations of remaining wastewater flumes and pipelines have not been identified, and it is suggested that this be considered in future scoping.

4.5.2 Nature and Extent of Contamination

The presence of contamination has been examined at the wastewater flumes at the TNT Areas through the Site Inspection conducted by Morrison Knudsen (1994a). Suggestions for additional investigations to establish the nature and extent of contamination at the flume lines include the following:

- Surface and subsurface soil samples have been collected from each of the TNT areas, but not necessarily to examine contamination from flume lines. An examination of soils to delineate the extent of soil contamination is suggested, particularly in areas where flumes have been excavated or are suspected.

- Sediment and surface water contamination has been characterized for the major streams at and near the TNT Areas. Sediment and surface water in drainage ditches adjacent to and within the TNT Areas should also be sampled and analyzed for COCs. Surface water and sediment locations in Ransom Brook north of TNT Area B near the flume lines should be sampled to confirm the high value of 2,4,6-TNT found in MK-SD-07 (MK 1994a), and to trace contaminant migration in the brook.

4.5.3 Background Data

Background samples have been collected in all sampling media at limited locations at PBOW. Additional background sampling in connection with the wastewater flumes is suggested.

4.6 POTENTIAL HAZARDS TO HUMAN HEALTH AND THE ENVIRONMENT

No formal risk assessment, either to human health or the environment, has been conducted for the Underground Wastewater Flume areas. There is insufficient information on the nature and magnitude of soil, sediment, surface water and ground water contamination to conduct a risk assessment with respect to these media. A hazard ranking was conducted on the Underground Wastewater Flume areas (SAIC 1991) in which scores for the various transport pathways ranged from 2.16 to 5.45, well below the USEPA-designated hazard ranking score of 28.5 at which point a site becomes eligible for inclusion in the NPL.

4.7 FEASIBILITY STUDIES

A feasibility study has not been conducted at the Underground Wastewater Flume areas.

4.8 REMEDIAL ACTIONS

With the exception of the removals during the decommissioning of PBOW, no remedial actions have been performed at the Underground Wastewater Flume areas.

4.9 WETLANDS ASSESSMENTS

Potential wetlands make up to about 1.5 percent of the total habitats at PBOW. Some wastewater flume areas could potentially be located in wetlands (Warner, et. al. 1990). A site-wide wetlands delineation is planned (Bower 1995).

4.10 PLANNED ACTIVITIES

A focused Remedial Investigation (RI) is planned for the TNT areas (D&M 1994) to determine whether contamination is present in these areas. Sample locations have been chosen in areas where there is a high probability of contamination, based on historical information on the locations of buildings and process lines, including wastewater flumes in some instances. Twenty-six shallow subsurface sampling locations are planned for each TNT area. The soil samples will be analyzed for metals and nitroexplosive compounds. Shallow monitoring wells will also be installed at the TNT areas: two at TNT Area A, one at TNT Area B, and four at TNT Area C. Ground water will be tested for explosives residues, total metals, and dissolved metals. Eight new bedrock wells are also planned for various locations at PBOW. The bedrock ground-water samples will be tested for VOCs and SVOCs in addition to the parameters listed for the shallow wells. Sediment sampling in ditches at TNT Area C is also planned. Following the RI, human health and environmental risk assessments may be conducted for the TNT areas and their associated wastewater flumes.

4.11 RECOMMENDATIONS

The focused RI planned for the TNT areas should be sufficient to determine the presence of contamination at these sites and to conduct a limited risk assessment. However, the Underground Wastewater Flumes are not specifically targeted in this study, and additional subsurface soil sampling may be required to characterize the flume areas, especially because the location of remaining flumes is unknown. A systematic search for the buried wastewater flumes and sewer lines may need to be undertaken, perhaps using a geophysical technique such as ground-penetrating radar. Surface water and sediment sampling and analysis in Ransom Brook north of TNT Area B may be needed to confirm the high value of 2,4,6-TNT found in MK-SD-07, and to trace contaminant migration in the brook.

5.0 BURN GROUNDS

5.1 BACKGROUND

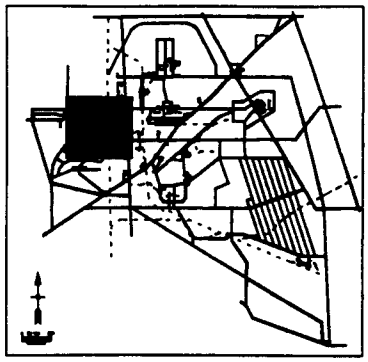
The burn grounds at PBOW have been used by the Army and NASA for destruction of both hazardous and nonhazardous material. They were identified in a Preliminary Assessment as having potential for contamination from PBOW and other activities, particularly contamination of surface soils, surface water, and ground water, because of their use as disposal sites for contaminated wastes (SAIC 1991). This section provides descriptive and historic background information on the burn grounds that may be related to potential contamination at the sites.

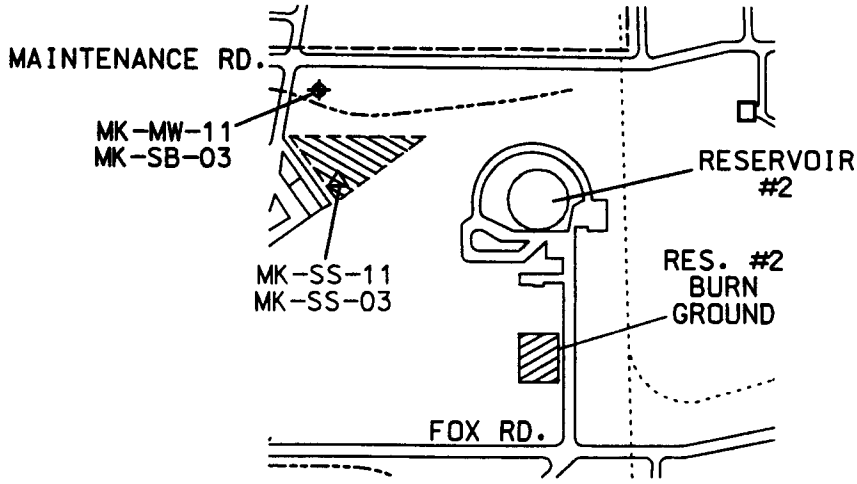
5.1.1 Description

During the operation of PBOW, burn grounds were used by the Army for the disposal of explosive manufacturing wastes and out-of-specification ordnance. Five burn grounds have been identified, but it is suspected that other areas at PBOW may also have been used as burn grounds. The five known burn grounds are referred to as Reservoir #2 Burn Ground, G-8 Burn Ground, Taylor Road Burn Ground, Snake Road Burn Ground, and Fox Road Burn Ground.

Reservoir #2 Burn Ground is located in the northwestern portion of PBOW south of Reservoir #2 (Figure 5-1). It was originally identified in the Preliminary Assessment (SAIC 1991) at a location near Power Station #2, west of Reservoir #2. In the Site Inspection Report (MK 1994a) the burn ground (referred to as "Burn Ground 1") is shown behind Power Station #2 on Campbell Road. However, the records review conducted by Dames & Moore (1995) indicated that this area had not been used as a burn ground, and instead, based on aerial photos and site records, placed the location south of the reservoir at the current site of a ball field.

The G-8 Burn Ground is located in the southwestern portion of PBOW near the intersection of Campbell Street and Patrol Road (Figure 5-2). It was originally identified in the Preliminary Assessment (SAIC 1991) at a location east of former Guard House G-8, hence its name. Morrison Knudsen (1994a) described the burn ground (referred to as "Burn Ground 2") as a clear area east of the intersection of Campbell Street and Patrol Road. The records search conducted by Dames & Moore (1995) revealed only a single reference to this area as a burn ground, and a site walkover indicated no apparent surface





0 500 1000 2000

SCALE IN FEET

LEGEND:

- STREAM
- RAILROAD
- PBOW BOUNDARY FENCE
- AREA OF CONCERN
- MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
- MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
- MIS-IDENTIFIED BURN GROUND (SAIC 1991; MK 1994a)

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FIGURE 5-1

RESERVOIR #2 BURN GROUND & ASSO. SAMPLING

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PREPARED JET
CHECKED DBJ

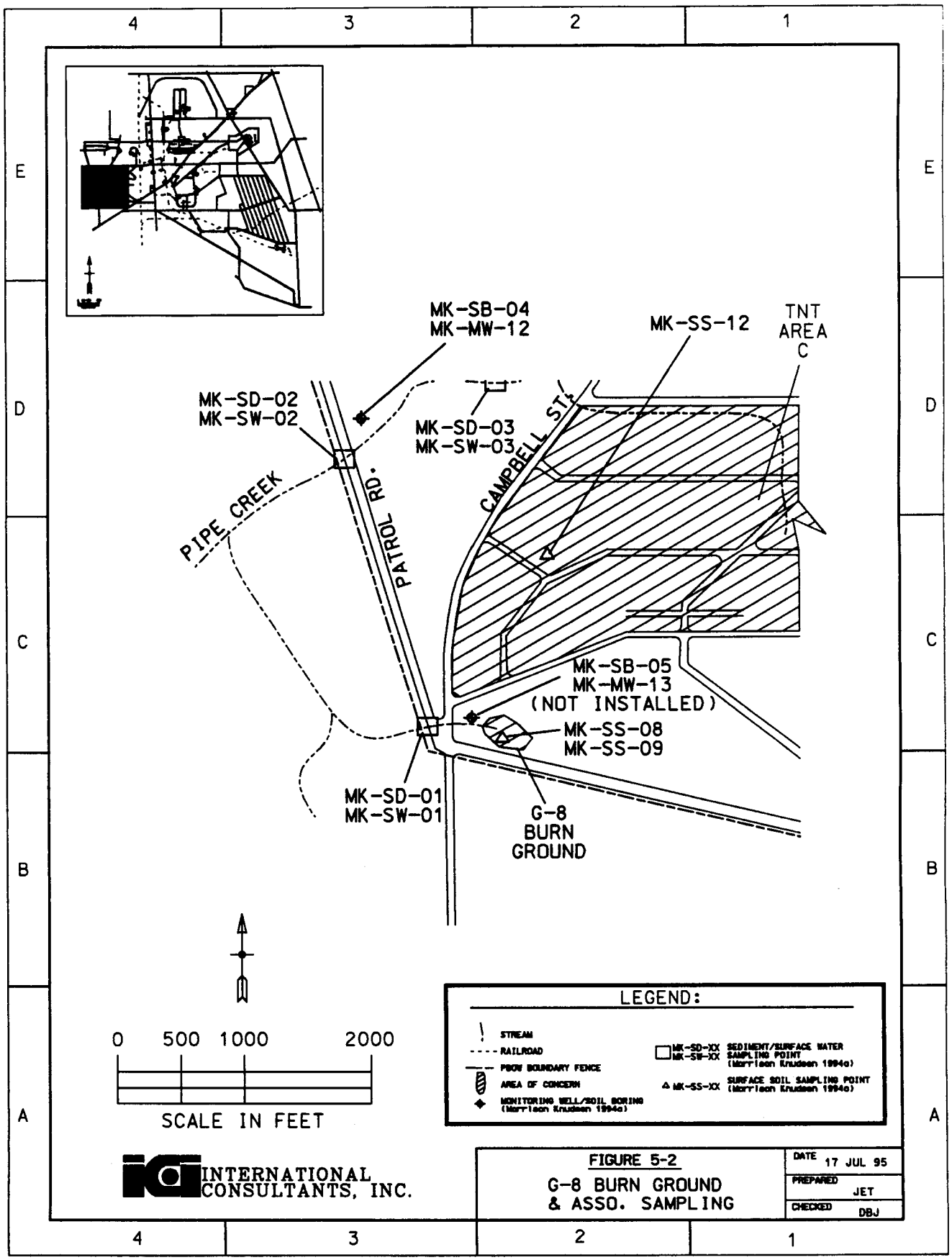
MK-SB-04
MK-MW-12
MK-SS-12
TNT AREA C
MK-SD-02
MK-SW-02
MK-SD-03
MK-SW-03
CAMPBELL ST.
PIPE CREEK
PATROL RD.
MK-SB-05
MK-MW-13
(NOT INSTALLED)
MK-SS-08
MK-SS-09
MK-SD-01
MK-SW-01
G-8 BURN GROUND
0 500 1000 2000
SCALE IN FEET
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
MK-SD-XX MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
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FIGURE 5-2
G-8 BURN GROUND & ASSO. SAMPLING
DATE 17 JUL 95
PREPARED JET
CHECKED DBJ

disturbance, other than the vegetative clearing, that would suggest the presence of a burn ground at this location.

The Taylor Road Burn Ground is located southeast of the intersection of Taylor and Ransom Roads (Figure 5-3). It was identified in the Preliminary Assessment (SAIC 1991) as roughly circular in shape, covering an area of approximately 14,000 square feet. In the Site Inspection (MK 1994a), the burn ground is referred as "Taylor and Ransom Roads Burn Ground." Dames & Moore (1995) placed the burn ground approximately 300 feet southeast of Taylor Road and 300 feet east of Ransom Road.

The Snake Road Burn Ground is located in the central portion of PBOW (Figure 5-4). Its location was described in the Preliminary Assessment (SAIC 1991) as east of Snake Road and north of West Scheid Road, occupying an area of approximately 20,000 square feet. Morrison Knudsen (1994a) placed the burn ground (referred to as "Snake Road Burn Pit") east and west of Snake Road. IT (1991a) referred to the burn ground as "Scheid Road Burning Grounds." Dames & Moore (1995) placed the burn ground approximately 800 feet north of the intersection of West Scheid and Snake Roads. In their Phase 1 Site Characterization, H+GCL (1992) located the burn ground (referred to as "Disposal Area Three") on both the east and west sides of Snake Road.

The Fox Road Burn Ground is located in the northeastern portion of PBOW north of Fox Road (Figure 5-5). The records review conducted by Dames & Moore revealed documentation and photos that suggest that this site was used for the burning of contaminated flume lines and other TNT-contaminated pipes.

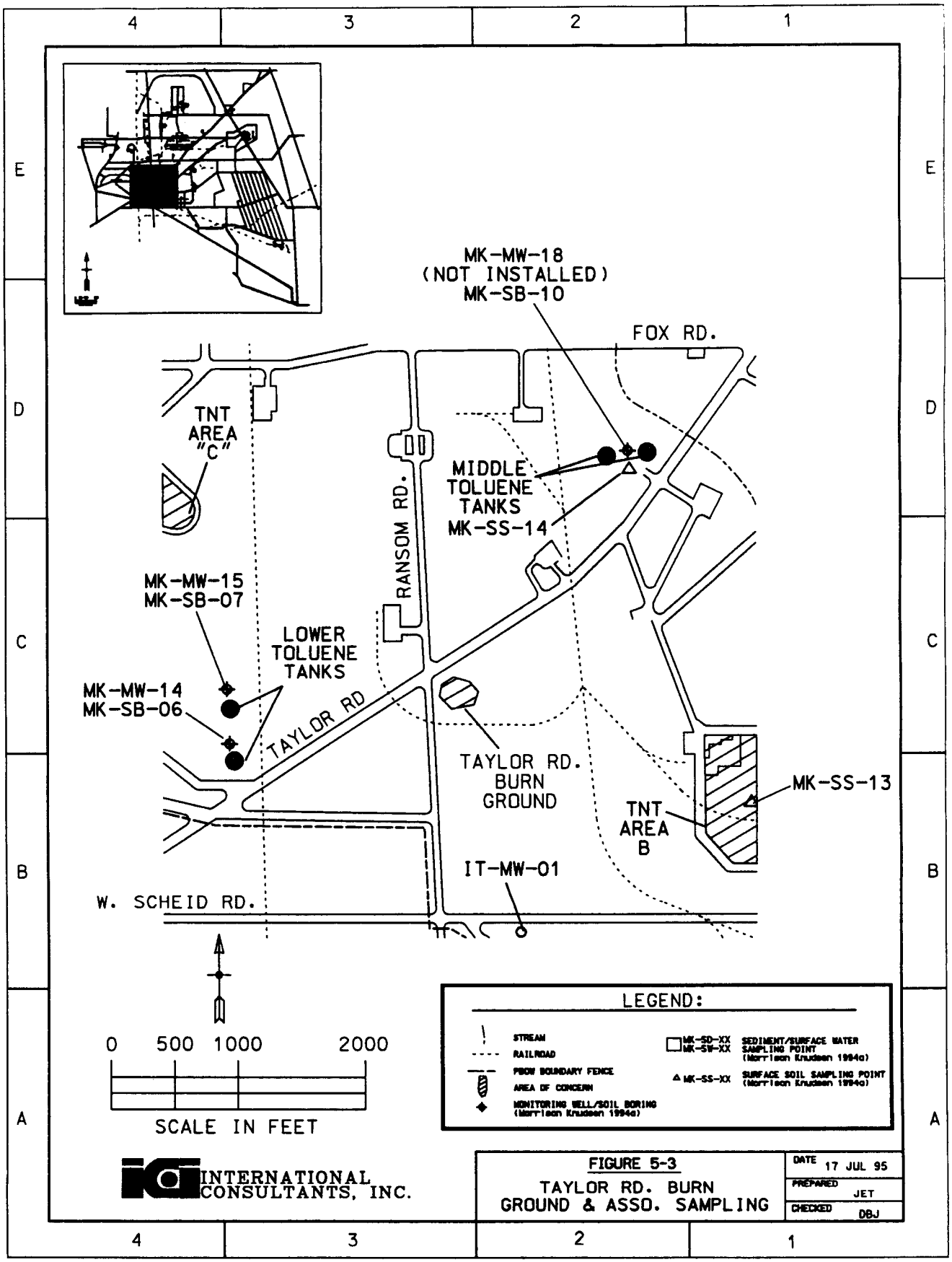
Current photographs of the burn grounds are shown in Figures 5-6 through 5-10.

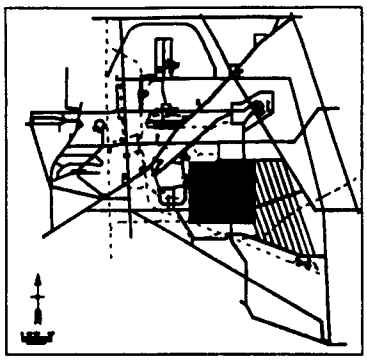
5.1.2 History

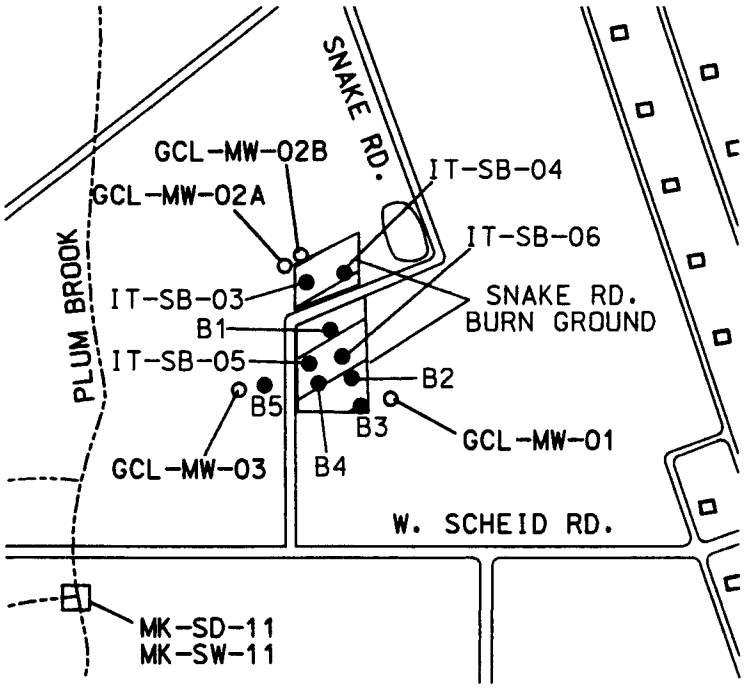
The history of activities at the burn grounds is divided into two periods: the operational period of PBOW, and the post-operational period, including decommissioning activities.

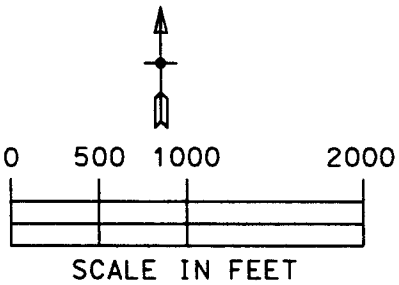
5.1.2.1 Operational Period (1941 - 1945)

The TNT manufacturing facilities were constructed in 1941 and operated until 1945. During this time, some burn grounds, referred to as rubbish burn grounds, were used for destruction of hazardous (off-specification TNT, explosives, acids, and solvents) and non hazardous (asbestos and waste oil) materials. The burn grounds were also used for the destruction of explosives-contaminated wastewater flumes, intermediate settling tanks, and catch basins from the TNT areas. Contaminated putty, packing, asbestos


MK-MW-18
(NOT INSTALLED)
MK-SB-10
FOX RD.
TNT
AREA
"C"
MIDDLE
TOLUENE
TANKS
MK-SS-14
RANSOM RD.
MK-MW-15
MK-SB-07
LOWER
TOLUENE
TANKS
MK-MW-14
MK-SB-06
TAYLOR RD
TAYLOR RD.
BURN
GROUND
MK-SS-13
TNT
AREA
B
IT-MW-01
W. SCHEID RD.
0 500 1000 2000
SCALE IN FEET
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
MK-SD-XX MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
INTERNATIONAL CONSULTANTS, INC.
FIGURE 5-3
TAYLOR RD. BURN GROUND & ASSO. SAMPLING
DATE 17 JUL 95
PREPARED JET
CHECKED DBJ







LEGEND:

- STREAM
- RAILROAD
- PBOW BOUNDARY FENCE
- AREA OF CONCERN
- MONITORING WELL/SOIL BORING (Morrison Knudsen 1994)
- MK-GM-XX MONITORING WELL (Morrison Knudsen 1994a)
- IT-SB-XX SOIL BORING (IT 1991)
- BX SOIL BORING (H+GCL 1992)
- GCL-MW-XX MONITORING WELL (H+GCL 1992)
- MK-SD-XX / MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
- MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)

INTERNATIONAL CONSULTANTS, INC.

FIGURE 5-4

SNAKE RD. BURN GROUND & ASSO. SAMPLING

DATE 20 JUL 95
PREPARED JET
CHECKED DBJ

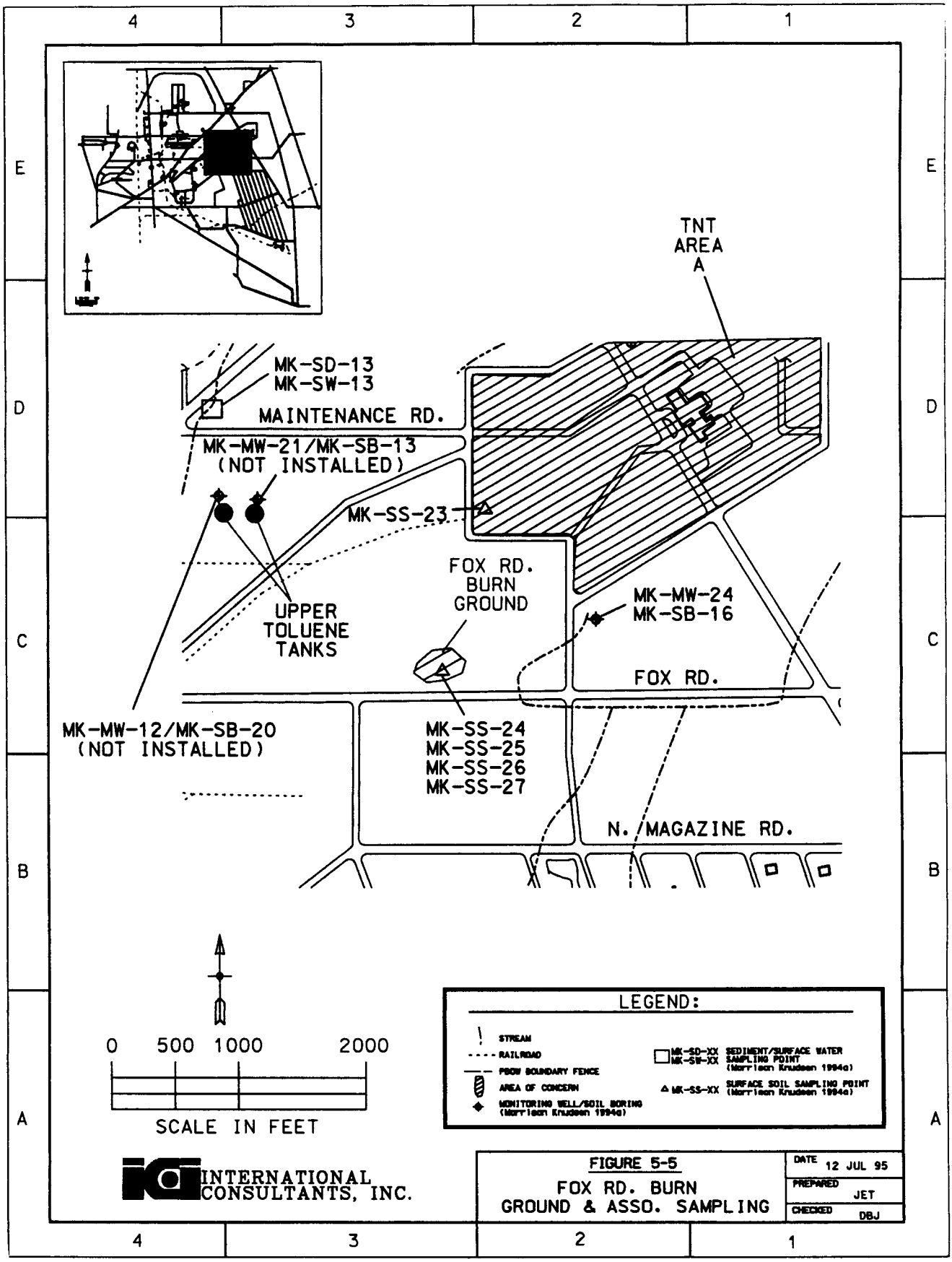

TNT AREA A
MK-SD-13
MK-SW-13
MAINTENANCE RD.
MK-MW-21/MK-SB-13
(NOT INSTALLED)
MK-SS-23
FOX RD. BURN GROUND
UPPER TOLUENE TANKS
MK-MW-24
MK-SB-16
FOX RD.
MK-MW-12/MK-SB-20
(NOT INSTALLED)
MK-SS-24
MK-SS-25
MK-SS-26
MK-SS-27
N. MAGAZINE RD.
0 500 1000 2000
SCALE IN FEET
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
MK-SD-XX MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
INTERNATIONAL CONSULTANTS, INC.
FIGURE 5-5
FOX RD. BURN GROUND & ASSO. SAMPLING
DATE 12 JUL 95
PREPARED JET
CHECKED DBJ

Figure 5-6. Reservoir #2 Burn Ground, 1995

Figure 5-7. G-8 Burn Ground, 1995

Figure 5-8. Taylor Road Burn Ground, 1995

Figure 5-9. Snake Road Burn Ground, 1995

Figure 5-10. Fox Road Burn Ground, 1995

insulation removed from buildings, and excavated contaminated soils from the TNT and pentolite areas were also burned. The quantity of waste destroyed at the burn grounds is unknown.

5.1.2.2 Post-Operational Period

In 1955, preliminary decontamination and decommissioning (D&D) of the TNT areas was initiated. D&D included removal and relocation of all explosives and materials contaminated with TNT, DNT, pentolite, and asbestos to a burn ground where they were burned.

Before the transfer of property to NASA in 1963, Reservoir #2 Burn Ground and G-8 Burn Ground were decontaminated. Areas to be decontaminated at these burn grounds were identified by a visual inspection of the surface and sampling to a depth of about 12 inches. Controlled burning was conducted in areas where explosives were encountered. After the burn, the ground was plowed to a depth of six inches and tested again for explosive material. If explosives were detected, the process was repeated (SAIC 1991).

The burn grounds located at Taylor Road, Fox Road, and Snake Road have been used in the past by NASA for waste disposal (SAIC 1991). The NASA disposal areas at Snake Road overlapped, but did not

coincide with, the Army burn site. A fire training area was at one time located on the southwest side of the burn ground (H+GCL 1992). Hazardous materials disposed in these burn grounds by NASA may have included waste oils, solvents, and other chemicals. A fire at the Snake Road Burn Ground in 1973 may have been caused by the spontaneous combustion of chemicals and oils dumped together (SAIC 1991).

5.2 PHYSICAL CHARACTERISTICS

The physical characteristics of the burn grounds include surface features, geology and hydrology. The general physical characteristics of PBOW are described in Section 1.0.

5.2.1 Surface Features

The burn grounds are located on relatively flat land, with the following approximate average elevations:

- Reservoir #2 Burn Ground, 640 feet
- G-8 Burn Ground, 671 feet
- Fox Road Burn Ground, 650 feet
- Taylor Road Burn Ground, 675 feet
- Snake Road Burn Ground, 670 feet.

The Taylor, Snake, and Fox Road burn grounds are located in depressions and have soil revetments surrounding them. Aside from the revetments, there are no other engineered barriers to migration of contaminants (SAIC 1991). The vegetation at the burn grounds is typical of the diverse vegetation found at PBOW (Warner, et. al. 1990):

- Taylor Road Burn Ground is located in potential wetlands.
- G-8 Burn Ground is located in a woodland area.
- Snake Road Burn Ground and Reservoir #2 Burn Ground are located in grassland areas.
- Fox Road Burn Ground is located in brushland.

An abandoned single-track rail spur passes Reservoir #2 Burn Ground to the south and another to the north. There is also a pumping station reservoir to the north of this burn ground. An abandoned single-track rail spur runs just north of G-8 Burn Ground, and another runs west and south of Taylor Road Burn Ground. There are no other structures located at the burn grounds. As discussed in Section 5.1.2.2, the burn grounds located at Taylor Road, Fox Road, and Snake Road have been used by NASA for waste disposal (SAIC 1991), and a fire training area was at one time located at the Snake Road Burn Ground (H+GCL 1992). Site records do not indicate that Reservoir #2 Burn Ground and G-8 Burn Ground were used for other waste disposal activities.

5.2.2 Geology

The glacial deposits underlying PBOW are described on borehole lithologic logs for monitoring wells installed at the site. With the exception of Snake Road Burn Ground, wells were not installed to specifically monitor the burn grounds, however some wells were installed close enough to some burn grounds to be able to infer the local geology at these sites. At the Snake Road Burn Ground, four wells were installed by H+GCL (1992) for their Phase 1 Site Investigation.

The glacial deposits underlying Reservoir #2 Burn Ground can be inferred from the borehole log for monitoring well MK-MW-11 located approximately 2,000 feet northwest of the burn area (MK 1994a). The borehole was drilled to a depth of 13 feet, and encountered a sandy silt in the top foot, underlain by brown silty clay to the bottom of the boring. Ground water was encountered at a depth of three feet in this borehole.

The borehole for well MK-MW-13 was drilled near the northwest edge of the G-8 Burn Ground. Because limestone bedrock was encountered at a depth of two feet at this location, the well was not installed.

Monitoring wells GCL-MW-01, 02A, 02B, and 03 were installed adjacent to Snake Road Burn Ground to monitor potential contamination from this site (H+GCL 1992). An additional five boreholes were drilled at the site to collect subsurface soil samples. The lithologic logs for these boreholes indicate up to ten feet of glacial sediments composed of mixtures of fine sand, silt, and clay in varying proportions, underlain by brownish-yellow bedrock shale. Auger refusal occurred in the shale at depths between six and ten feet. Most of the borings also penetrated a zone of weathered shale and shale fragments 2 to 3 feet thick between the glacial sediments and the shale.

Monitoring well MK-MW-24 was installed northeast of Fox Road Burn Ground, near TNT Area A. The borehole was drilled to a depth of 9.5 feet, penetrating brown silty sand for most of its length, and encountering gray silty clay at a depth of 9 feet. Ground water was found at a depth of 6 feet.

5.2.3 Hydrology

The hydrology of the Burn Grounds has been interpreted from topographic maps, soil borings, and monitoring wells installed at and near the sites. Aquifer tests have not been conducted in wells near these areas, and therefore hydrogeologic parameters are not defined.

5.2.3.1 Surface Water

Surface runoff for the burn grounds is as follows:

- Reservoir #2 Burn Ground runoff flows either east or north toward a tributary of Pipe Creek.
- G-8 Burn Ground runoff flows westward in a tributary of Pipe Creek.
- Fox Road Burn Ground runoff flows to a tributary of Lindsley Ditch which flows northward to merge with Plum Brook.
- Taylor Road Burn Ground runoff flows east into Ransom Brook.
- Snake Road Burn Ground runoff flows west toward Plum Brook, or east toward a tributary of Lindsley Ditch which flows into Plum Brook.

5.2.3.2 Ground Water

During installation of monitoring wells near the burn grounds, ground water was encountered at a depth of three feet in MK-MW-11 north of Reservoir #2 Burn Ground (MK 1994a), six feet in MK-MW-24 northeast of Fox Road Burn Ground (MK 1994a), and at an average depth of between one and two feet in the monitoring wells surrounding Snake Road Burn Ground (H$^+$GCL 1992). At Snake Road Burn Ground, shale bedrock was encountered at depths between six and ten feet. At G-8 Burn Ground, limestone bedrock was encountered at a depth of two feet, and no ground water was found in the borehole for well MK-MW-13, which was not installed.

At Snake Road Burn Ground, measurements of static ground-water levels indicate a westward direction of ground-water flow toward Plum Brook, with a horizontal gradient of about 0.005. The difference in ground-water levels in adjacent wells GCL-MW-2A (deep) and GCL-MW-2B (shallow) suggest a downward flow gradient (about 0.03) in this area (H$^+$GCL 1992). Correlations between surface water and ground-water levels have not been systematically observed in the areas of burn grounds.

5.2.3.3 Monitoring Wells

Except for the monitoring wells at Snake Road Burn Ground (H$^+$GCL 1992) (Figure 5-4), no wells have been installed specifically to monitor ground water at the burn grounds at PBOW. Well MK-MW-11 was installed approximately 600 feet north of Reservoir #2 Burn Ground, and well MK-MW-24 is located

approximately 1,100 feet northeast of Fox Road Burn Ground (MK 1994a). Detailed information on monitoring wells is provided in Section 14.0.

5.3 CONTAMINANTS OF CONCERN (COCs)

COCs for the burn grounds were determined on the basis of past activities and the results of environmental investigations conducted at the sites.

5.3.1 Contaminants Resulting from PBOW Activities

Based on past site activities, residue from the burning of explosives and other wastes are likely COCs at the burn grounds. Previous investigations have shown that nitroaromatic compounds, acetone, SVOCs (bis(2-ethylhexyl)phthalate), and metals (arsenic, barium, chromium, iron, lead, manganese, silver, and sodium) may be present in elevated quantities in surface soils (IT 1991a; SAIC 1991; H$^+$GCL 1992). By inference, these contaminants can be expected also in ground water, surface water, and sediment at these sites. In addition, the burning of asbestos siding in these areas may have contributed asbestos to the soils.

The burn grounds located at Taylor Road, Fox Road, and Snake Road have been used periodically by NASA and/or DOD for waste disposal (SAIC 1991). Hazardous materials disposed in these burn grounds may have included waste oils, solvents, and other chemicals. Relatively high levels of acetone were detected at Taylor Road and Snake Road Burn Grounds (IT 1991a).

5.3.2 Transport Mechanisms

Possible transport mechanisms in the burn ground areas include:

- Surface transport of liquid phase or particulate-borne contaminants in precipitation runoff to nearby ditches and streams.
- Migration of contaminants from soils and surface water to shallow ground water.
- Migration of contaminants in shallow ground water to off-site locations and to the deeper limestone aquifers in bedrock.
- Transport of particulate contaminants (including asbestos) by wind.
- Contaminant transport via the food chain.

5.3.3 Action Levels

Action levels apply to clean-up goals established by PBOW RODs, USEPA regulations, ARARs (i.e., MCLs and NPDES), or are determined from risk-based calculations. Action levels used in the Phase I site characterization conducted at Snake Road Burn Ground (H^+GCL 1992) for soils include:

- TCLP toxicity characteristics thresholds set forth in 40 CFR Part 261.
- Proposed RCRA soil action levels as set forth in 55 FR 30798.
- PCB clean-up standards in 40 CFR Part 761.

Ground-water analyses were compared to drinking water standards set forth in Ohio Administrative Code 3745-54-94 and Federal MCLs listed in 40 CFR 141.

5.4 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination at the burn grounds has been investigated to a limited extent in the contamination evaluation conducted by IT Corporation (1991a), the Site Inspection conducted by Morrison Knudsen (1994a), and the Phase I site characterization conducted by H^+GCL (1992). The results of these investigations are summarized here. Sample locations are shown on Figures 5-1 through 5-5.

5.4.1 Reservoir #2 Burn Ground

5.4.1.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined.

5.4.1.2 Sediment and Surface Water Investigations

Sediment and surface water samples from ditches and streams at PBOW were analyzed for the Site Inspection conducted by Morrison Knudsen (1994a). Samples MK-SD-06 and MK-SW-06 were collected in a tributary of Pipe Creek downstream from the location believed to be "Burn Ground 1" (MK 1994a). However, this location for Reservoir #2 Burn Ground is believed to be incorrect (Figure 5-1). Small quantities of SVOCs, particularly PAH, were detected in the sediment sample from this location. No samples were taken at the Reservoir #2 Burn Ground.

5.4.1.3 Surface Soil Investigations

Surface soil samples were collected for analysis during the Site Inspection conducted by Morrison Knudsen (1994a). Samples MK-SS-06 and 07 were collected from the site of Power Station #2 near Campbell Road, believed to be site of "Burn Ground 1" (Figure 5-1). Toluene was detected in sample MK-SS-07 at a concentration of 19 ppb and SVOCs were detected in MK-SS-06 at Power Station #2. No samples were taken at the Reservoir #2 Burn Ground.

5.4.1.4 Subsurface Soil Investigations

One soil boring (MK-SB-03) was collected downgradient of "Burn Ground 1" (MK 1994a). No samples were taken at the Reservoir #2 Burn Ground.

5.4.1.5 Ground-Water Investigations

No monitoring wells have been installed at the Reservoir #2 Burn Ground.

5.4.2 G-8 Burn Ground

5.4.2.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined.

5.4.2.2 Sediment and Surface Water Investigations

Sediment and surface water samples from ditches and streams at PBOW were analyzed for the Site Inspection conducted by Morrison Knudsen (1994a). Sediment sample MK-SD-01 and surface water sample MK-SW-01 were collected at the head of a small stream which feeds Pipe Creek in the southwest corner of G-8 Burn Ground (Figure 5-2). Quantities of SVOCs (PAH), were detected in the sediment sample but not in the surface water at this location. Sediment analytical results are shown in Table 5-1.

5.4.2.3 Surface Soil Investigations

Surface soil samples were collected for analysis during the Site Inspection conducted by Morrison Knudsen (1994a). Samples MK-SS-08 and 09 were collected in G-8 Burn Ground (Figure 5-2). Soil

Table 5-1. Sediment Sampling Analytical Results, Burn Grounds[a]

Compound	G-8 Burn Ground	"Burn Ground #1"	Snake Road	Fox Road	Fox Road
	MK-SD-01	MK-SD-06	MK-SD-12	MK-SD-16	MK-SD-17
2-Methylnaphthalene	U	U	39J	U	U
2-Methylphenol	U	54J	U	U	U
2,4-Dinitrotoluene	U	U	U	170J	U
Acenaphthene	U	U	26J	U	U
Acenaphthylene	U	U	140J	U	U
Acetone	U	U	U	25	21
Anthracene	U	U	270J	U	U
Benzo(a)anthracene	450J	U	960	U	U
Benzo(a)pyrene	710J	U	660	70J	76J
Benzo(b)fluoranthene	730J	82J	1100	190J	200J
Benzo(ghi)perylene	490J	U	160J	U	U
Benzo(k)fluoranthene	780J	U	420J	U	U
Bis(2-ethylhexyl)phthalate	U	U	130J	U	U
Carbon disulfide	U	U	2J	U	U
Chrysene	730J	51J	730	120J	180J
Dibenzo(a,h)anthracene	U	U	46J	U	U
Fluoranthene	1000J	40J	1900	220J	180J
Fluorene	U	U	110J	U	U
Indeno(1,2,3-cd)pyrene	610J	U	210J	U	U
Phenanthrene	380J	U	850	82J	52J
Pyrene	1100J	U	1500	160J	140J
Toluene	U	U	9	U	1J

[a]Units in µg/kg.
J Estimated value.
U Compound was analyzed for but not detected.

Source: Morrison Knudsen, 1994a (Chapter 4).

samples were analyzed for VOCs, SVOCs, total metals, total sulfate, nitrate, pH, and nitroaromatic explosive compounds (Table 5-2). Minor SVOCs ("J"-qualified) were detected in sample MK-SS-09.

5.4.2.4 Subsurface Soil Investigations

No subsurface soil samples have been collected at the G-8 Burn Ground.

5.4.2.5 Ground-Water Investigations

No monitoring wells have been installed at the G-8 Burn Ground.

5.4.3 Taylor Road Burn Ground

5.4.3.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined. Monitoring well IT-MW-01 (IT 1991a) is upgradient of Taylor Road Burn Ground and can serve as a background well for this site.

5.4.3.2 Sediment and Surface Water Investigations

No sediment or surface water samples have been taken from the Taylor Road Burn Ground.

5.4.3.3 Surface Soil Investigations

No surface soil samples have been collected for analysis at the Taylor Road Burn Ground.

5.4.3.4 Subsurface Soil Investigations

Subsurface soil samples were collected at a depth of four to six feet from soil borings IT-SB-01 and IT-SB-02 at the Taylor Road Burn Ground (Figure 5-3) (IT 1991a). The samples were analyzed for VOCs, SVOCs, total metals, total sulfate, nitrates, pH, and nitroaromatic compounds. Table 5-3 summarizes the results of the sample analyses, briefly described below:

- Methylene chloride was detected in sample IT-SB-01 ranging from 8 ppb to 10 ppb.
- Bis(2-ethylhexyl)phthalate was detected at 380 ppb in IT-SB-01.

Table 5-2. Surface Soil Sampling Analytical Results, Burn Grounds[a]

Compound	Res. #2	Res. #2	G-8	G-8	Fox Road	Fox Road	Fox Road	Fox Road
	MK-SS-06	MK-SS-07	MK-SS-08	MK-SS-09	MK-SS-24	MK-SS-25	MK-SS-26	MK-SS-27
2-Methyl napthalene	320J	U	U	U	U	U	U	U
Acetone	U	10J	U	U	U	U	U	U
Benzo(a)anthracene	U	U	U	140J	U	U	U	U
Benzo(b)fluoranthene	46J	U	U	92J	U	32J	31J	U
Benzo(k)fluoranthene	U	U	U	41J	U	U	U	U
Bis(2-ethylhexyl)phthalate	U	U	U	99J	U	U	U	U
Fluoranthene	U	U	U	140J	U	U	U	U
Napthalene	240J	U	U	U	U	U	U	U
Phenanthrene	130J	U	U	U	U	U	U	U
Pyrene	U	U	U	U	U	U	U	U
Toluene	U	19	1J	U	5J	23	14	8
Total xylenes	U	1J	U	U	U	U	U	U

[a]Units in µg/kg.
< Compound was analyzed for but not detected above the applicable metod detection limit.
NA Not analyzed.
B Analyte is found in the associated blank as well as the sample.
J Estimated value.
D Duplicate sample.
U Compound was analyzed for but not detected.

Source: Morrison Knudsen, 1994a (Chapter 4).

Table 5-3. Subsurface Soil Sampling Analytical Results, Burn Grounds[a]

Compound	Units	Snake Road	Snake Road	Snake Road	Snake Road	Snake Road	Snake Road	Snake Road
		GCL-MW-01	GCL-MW-2A	GCL-MW-2B	CGL-MW-03	GCL-MW-03D	GCL-SB-B1 (2-4')	GCL-SB-B2 (4-6')
1,1,1-Trichloroethane	µg/kg	<6	<6	<6	<6	<6	<7	42
1,3,5-Trinitrobenzene	µg/kg	U	U	U	U	U	U	U
2-Butanone	µg/kg	<12	<12	4J	6BJ	<12	<14	<12
2-Hexanone	µg/kg	U	U	U	U	U	U	U
2-Methyl napthalene	µg/kg	300J	450J	99J	450J	NA	<760	220J
Acetone	µg/kg	12	26B	15B	15B	10BJ	9BJ	<12
Arsenic	mgkg	U	U	U	U	U	U	U
Barium	mg/kg	U	U	U	U	U	U	U
Benzo(a)anthracene	µg/kg	U	U	U	U	NA	U	U
Benzo(b)fluoranthene	µg/kg	<810	<850	<760	<800	NA	<760	43J
Benzo(k)fluoranthene	µg/kg	U	U	U	U	NA	U	U
Bis(2-ethylhexyl)phthalate	µg/kg	<810	<850	<760	<800	NA	220J	<760
Bromodichloromethane	µg/kg	<6	<6	<6	<6	<6	<6	<6
Carbon tetrachloride	µg/kg	U	U	U	U	U	U	U
Chloroform	µg/kg	<6	<6	<6	<6	<6	<7	<6
Chromium	mg/kg	U	U	U	U	U	U	U
Chrysene	µg/kg	<810	<850	<760	<800	NA	<760	55J
Di-n-butyl phthalate	µg/kg	72J	<850	<760	<800	NA	48J	<760
Fluoranthene	µg/kg	U	U	U	U	NA	U	U
Iron	mg/kg	U	U	U	U	U	U	U
Lead	mg/kg	U	U	U	U	U	U	U
Manganese	mg/kg	U	U	U	U	U	U	U
Methylene chloride	µg/kg	9B	23B	18B	18B	15B	19B	7B
Napthalene	µg/kg	82J	100J	<760	160J	NA	<760	70J
Phenanthrene	µg/kg	U	U	U	U	NA	<760	70J
Pyrene	µg/kg	<810	<850	<760	<800	NA	<760	43J
Silver	mg/kg	U	U	U	U	U	U	U
Sodium	mg/kg	U	U	U	U	U	U	U
Toluene	µg/kg	U	U	U	U	U	U	U

Table 5-3 (Continued)

Compound	Units	Snake Road	Snake Road	Snake Road	Snake Road	Snake Road	Taylor Road	Taylor Road
		IT-SB-03	IT-SB-04	IT-SB-04D	IT-SB-05	IT-SB-06	IT-SB-01	IT-SB-02
1,1,1-Trichloroethane	mg/kg	U	U	U	U	U	U	U
1,3,5-Trinitrobenzene	µg/kg	0.093	U	U	U	U	U	U
2-Butanone	mg/kg	U	U	U	U	U	U	U
2-Hexanone	µg/kg	3J	U	U	U	U	2J	2J
2-Methyl napthalene	mg/kg	U	U	U	U	U	U	U
Acetone	µg/kg	990	65	U	4,300	2,300	U	U
Arsenic	mg/kg	U	U	1.3	2.0	U	7.0	2.8
Barium	mg/kg	31.6	41.0	29.8	21.1	58.9	51.0	51.3
Benzo(a)anthracene	mg/kg	U	U	U	U	U	U	U
Benzo(b)fluoranthene	mg/kg	U	U	U	U	U	U	U
Benzo(k)fluoranthene	mg/kg	U	U	U	U	U	U	U
Bis(2-ethylhexyl)phthalate	µg/kg	380	1,200	350J	420	470	400	370J
Bromodichloromethane	mg/kg	U	U	U	U	U	U	U
Carbon tetrachloride	µg/kg	U	3J	4J	U	U	3J	3J
Chloroform	mg/kg	U	U	U	U	U	U	U
Chromium	mg/kg	10	7	4	4	6	7.0	11
Chrysene	mg/kg	U	U	U	U	U	U	U
Di-n-butyl phthalate	mg/kg	U	U	U	U	U	U	U
Fluoranthene	mg/kg	U	U	U	U	U	U	U
Iron	mg/kg	15,600	11,000	4,090	4,940	6,420	10,200	15,400
Lead	mg/kg	50	16	10	9.0	16	10	10
Manganese	mg/kg	71.3	14.5	9.8	35.0	129	300	180
Methylene chloride	µg/kg	10	8	9	5J	5J	10	48J
Napthalene	mg/kg	U	U	U	U	U	U	U
Phenanthrene	mg/kg	U	U	U	U	U	U	U
Pyrene	mg/kg	U	U	U	U	U	U	U
Silver	mg/kg	U	0.5	U	U	U	U	U
Sodium	mg/kg	76	45	34	32	80	65	110
Toluene	µg/kg	U	4J	4J	U	U	4J	3J

Table 5-3 (Continued)

Compound	Units	Snake Road GCL-SB-B2D (6-8')	Snake Road GCL-SB-B3 (6-8')	Snake Road GCL-SB-B3D (6-8')	Snake Road GCL-SB-B4 (6-8')	Snake Road GCL-SB-B4D (6-8')	Snake Road GCL-SB-B5 (2-4')	Snake Road GCL-SB-B5D (2-4')
1,1,1-Trichloroethane	mg/k	64	<6	<6	<6	<6	<6	<6
1,3,5-Trinitrobenzene	µg/ℓ	U	U	U	U	U	U	U
2-Butanone	mg/k	<12	<12	<12	<12	<12	<12	<12
2-Hexanone	µg/ℓ	U	U	U	U	U	U	U
2-Methyl napthalene	mg/k	NA	170J	NA	95J	NA	100J	NA
Acetone	µg/ℓ	18	26	32	31	39	16	46
Arsenic	mg/k	U	U	U	U	U	U	U
Barium	mg/k	U	U	U	U	U	U	U
Benzo(a)anthracene	mg/k	U	U	U	U	U	U	U
Benzo(b)fluoranthene	mg/k	NA	<800	NA	44J	NA	<800	NA
Benzo(k)fluoranthene	mg/k	U	U	U	U	U	U	U
Bis(2-ethylhexyl)phthalate	µg/ℓ	NA	<800	NA	43J	NA	<800	NA
Bromodichloromethane	mg/k	<6	<6	<6	<6	<6	<6	<6
Carbon tetrachloride	µg/ℓ	U	U	U	U	U	U	U
Chloroform	mg/k	<6	<6	<6	<6	<6	<6	<6
Chromium	mg/k	U	U	U	U	U	U	U
Chrysene	mg/k	NA	<800	NA	52J	NA	<800	NA
Di-n-butyl phthalate	mg/k	NA	<800	NA	82J	NA	<800	NA
Fluoranthene	mg/k	U	U	U	U	U	U	U
Iron	mg/k	U	U	U	U	U	U	U
Lead	mg/k	U	U	U	U	U	U	U
Manganese	mg/k	U	U	U	U	U	U	U
Methylene chloride	µg/ℓ	11B	10B	13B	11B	12B	8B	10B
Napthalene	mg/k	NA	56J	NA	<800	NA	<800	NA
Phenanthrene	mg/k	NA	48J	NA	56J	NA	69J	NA
Pyrene	mg/k	NA	,800	NA	47J	NA	<800	NA
Silver	mg/k	U	U	U	U	U	U	U
Sodium	mg/k	U	U	U	U	U	U	U
Toluene	µg/ℓ	U	U	U	U	U	U	NA

Table 5-3 (Continued)

<	Compound was analyzed for but not detected above the applicable metod detection limit.
NA	Not analyzed.
B	Analyte is found in the associated blank as well as the sample.
J	Estimated value.
D	Duplicate sample.
U	Compound was analyzed for but not detected .

MK	Morrison Knudsen, 1994a (Chapter 4).
GCL	H'GCL, 1992.
IT	IT Corp, 1991a.

- The metals arsenic, barium, chromium, iron, lead, manganese, and sodium were detected above background levels in the soil samples from Taylor Road Burn Ground.

5.4.3.5 Ground-Water Investigations

No monitoring wells have been installed at the Taylor Road Burn Ground.

5.4.4 Snake Road Burn Ground

5.4.4.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined. Based on the water table map of Snake Road Burn Ground (H^+GCL 1992), monitoring well GCL-MW-01 is located upgradient of this site and can be used for local soil and ground-water background data. Well IT-MW-01 may also serve as a background well for PBOW in general.

5.4.4.2 Sediment and Surface Water Investigations

Sediment sample MK-SD-12, collected from Plum Brook at its intersection with Fox Road, contained quantities of SVOCs, primarily PAH (Figure 5-4 and Table 5-1). This location is downgradient (approximately 4,000 feet north) of Snake Road Burn Ground, and may reflect contamination from this source. This sample site is also downgradient of TNT Area B, which may have contributed to possible contamination.

5.4.4.3 Surface Soil Investigations

No surface soil samples have been collected at the Snake Road Burn Ground.

5.4.4.4 Subsurface Soil Investigations

Subsurface soil samples were collected at a depth of four to six feet from soil borings IT-SB-03 through IT-SB-06 at the Snake Road Burn Ground (Figure 5-4) (IT 1991a). The samples were analyzed for VOCs, SVOCs, total metals, total sulfate, nitrates, pH, and nitroaromatic compounds. Table 5-3 summarizes the results of the sample analyses, briefly described below:

- Acetone was detected in samples IT-SB-05 and IT-SB-06 at more than 2,000 ppb. Although attributed to field decontamination processes, they may reflect soil contamination.

- Methylene chloride was detected in sample IT-SB-03 and IT-SB-04 ranging from 8 ppb to 10 ppb.

- Bis(2-ethylhexyl)phthalate ranged between 380 and 1200 ppb in samples IT-SB-03, IT-SB-04, IT-SB-05, and IT-SB-06.

- A concentration of 0.093 ppm of 1,3,5-trinitrobenzene was detected in soil boring IT-SB-04.

- The metals arsenic, barium, chromium, iron, lead, manganese, and sodium were detected above background levels in the soil samples.

Subsurface soil samples were also collected at Snake Road Burn Ground for the Phase I site characterization conducted by H+GCL (1992). A total of nine soil borings were drilled for this investigation, four of which were completed as monitoring wells (Figure 5-4). Soil samples were collected from nine boreholes (GCL-SB-01, GCL-SB-2A, GCL-SB-2B, GCL-SB-03, GCL-SB-B1, GCL-SB-B2, GCL-SB-B3, GCL-SB-B4, and GCL-SB-B5) and analyzed for VOCs, SVOCs, PCBs, pesticides, herbicides, TPH (gasoline and diesel), TCLP metals, and explosives and explosive residues. The analytical results are provided in Table 5-3 and are summarized below:

- Low levels of acetone, 1,1-dichloroethane, 1,1,1-trichloroethane, and 2-butanone were detected in soil borings GCL-SB-2, GCL-MW-2B, and GCL-MW-5.

- Eight SVOCs were detected in the soil samples, however they were present at levels below the quantitation limit and are therefore estimated values. Of these eight compounds, three (2-methylnaphthalene, phenanthrene, and naphthalene) were detected in more than half the samples. Soil samples from GCL-SB-2 and SB-4 contained the greatest number of SVOCs. In addition, bis(2-ethylhexyl)phthalate was detected in boring GCL-SB-1 at 220 µg/kg, well below the proposed RCRA action level (50,000 µg/kg).

- The analytical results for TCLP metals in soil were below the RCRA TCLP thresholds for characterizing hazardous waste. The highest total lead and mercury levels in the soil (272 mg/kg and 0.25 mg/kg, respectively) were within background ranges reported by the U.S. Geological Survey (Professional Paper 1270).

- The TPH (gasoline) results ranged from 0.6 to 14 mg/kg, and TPH (diesel) concentrations were below detection limits except for sample GCL-MW-2B (86 mg/kg). The recommended action level for petroleum-based contamination in soils in Ohio is 1 mg/kg or background.

- PCBs were detected in soil samples from GCL-SB-2 (980 µg/kg) and SB-4 (100 µg/kg). These values are below USEPA's recommended cleanup guideline of 10,000 µg/kg, but exceed the RCRA proposed action level of 90 µg/kg.

- Explosives, pesticides, and herbicides were not detected in the soil samples.

5.4.4.5 Ground-Water Investigations

Ground water was sampled from monitoring wells GCL-MW-1, GCL-MW-2A, GCL-MW-2B, and GCL-MW-3 installed around Snake Road Burn Ground (Figure 5-4). Table 5-4 presents the results of sampling. Acetone was found in ground water in all wells except GCL-MW-1, but at levels below the proposed RCRA action level of 4,000 µg/kg. Benzene was detected in GCL-MW-2A at a concentration of 1 µg/kg, below the MCL for benzene (5 µg/kg). Arsenic, chromium, lead, and silver were also detected in the ground water below the MCL for these metals.

5.4.5 Fox Road Burn Ground

5.4.5.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined. Well IT-MW-01 may serve as a background well for PBOW in general.

5.4.5.2 Sediment and Surface Water Investigations

Sediment samples MK-SD-16 and MK-SD-17, collected from Lindsley Ditch downstream from the Fox Road Burn Ground, contained minor quantities of VOCs (acetone, methylene chloride, and toluene) and SVOCs (primarily PAH) (Table 5-1). These sample sites are adjacent TNT Area A, and may reflect contamination from this source.

5.4.5.3 Surface Soil Investigations

Surface soil samples were collected for analysis during the Site Inspection conducted by Morrison Knudsen (1994a). Samples MK-SS-24, -25, -26, and -27 were collected at Fox Road Burn Ground (Figure 5-5). Soil samples were analyzed for VOCs, SVOCs, total metals, total sulfate, nitrate, pH, and nitroaromatic explosive compounds (Table 5-2). Toluene was detected in surface soil samples MK-SS-24 through 27 ranging from 23 ppb (in MK-SS-25) to 5 ppb (in MK-SS-23).

5.4.5.4 Subsurface Soil Investigations

No subsurface soil samples have been taken from the Fox Road Burn Ground.

Table 5-4. Ground-Water Sampling Analytical Results, Burn Grounds

Compound	Units	Snake Road GCL-MW-01	Snake Road GCL-MW-2A	Snake Road GCL-MW-2B	Snake Road CGL-MW-03	Snake Road GCL-MW-03D
Acetone	µg/ℓ	<10	46	24	27	9J
Benzene	µg/ℓ	<5	1J	<5	<5	<5
Methylene chloride	µg/ℓ	2BJ	2BJ	5BJ	5BJ	4BJ
Total Arsenic	mg/ℓ	0.0068	<0.005	<0.005	<0.005	<0.005
Total Chromium	mg/ℓ	0.022	0.018	0.015	0.017	0.011
Total Lead	mg/ℓ	0.0091	0.0048	0.0037	<0.003	0.003
Total Silver	mg/ℓ	<0.005	<0.003	0.006	<0.005	<0.005

< Compound was analyzed for but not detected above the applicable metod detection limit.
B Analyte is found in the associated blank as well as the sample.
J Estimated value.
D Duplicate sample.

Source: H^{+}GCL, 1992.

5.4.5.5 Ground-Water Investigations

No monitoring wells have been installed at the Fox Road Burn Ground.

5.5 CURRENT STATUS OF SITE CHARACTERIZATION

This section describes the current status of site characterization at the burn grounds, including additional investigations that may be necessary to define source areas of contamination, characterize potential migration pathways, or identify potential receptors and exposure pathways. Any further investigations suggested here are not intended to be requirements for future work at this AOC. They are suggested for consideration for future work, to be implemented only if determined necessary through the site scoping process.

5.5.1 Physical Characteristics

Suggestions for additional characterization at the burn grounds include:

- The location of Reservoir #2 Burn Ground should be verified from field reconnaissance and site records.
- Soil borings have been completed only at Snake Road and Taylor Road Burn Grounds. The geology of the glacial sediments and depth to bedrock has not been described for the other burn grounds. This should be considered in future scoping.

5.5.2 Nature and Extent of Contamination

Suggestions for additional investigations to establish the nature and extent of contamination at the burn grounds include the following:

- Investigations have not been conducted at the newly-identified Reservoir #2 Burn Ground. Sampling and analysis at this site should be considered in future site planning
- Surface soil contamination has been characterized from surface soil samples at only two of the five burn grounds (G-8 and Fox Road) (MK 1994a). A systematic examination of surface soils to determine the extent of contamination should be considered for each of the burn grounds.
- Surface water and sediment sampling has been conducted to test for contamination from G-8 Burn Ground. Additional sediment sampling in drainage ditches in or adjacent to the other burn grounds is suggested to characterize surface transport from these areas.

- Subsurface soil contamination has been examined in ten soil borings, two from Taylor Road Burn Ground (IT 1991a) and eight from Snake Road Burn Ground (IT 1991a; H+GCL 1992). Subsurface soil analyses have not been conducted at the other three burn grounds and should be considered for future studies.

- With the exception of the shallow wells at Snake Road Burn Ground (H+GCL 1992), no monitoring wells are present in or adjacent to the burn grounds. The extent of shallow and deep ground-water contamination has not been determined at these sites, and should be considered for future studies.

5.5.3 Background Data

Suggestions for further background sampling in connection with the burn grounds include establishing soil and sediment background values for the PBOW site and for the individual burn grounds.

5.6 POTENTIAL HAZARDS TO HUMAN HEALTH AND THE ENVIRONMENT

No formal risk assessment, either human health or environmental, has been conducted for the burn grounds in general. However, a qualitative risk assessment was conducted on Snake Road Burn Ground (H+GCL 1992), which determined that an exposure hazard did not exist at this site. A hazard ranking was conducted on the burn grounds (SAIC 1991) in which scores for the various transport pathways ranged from 2.16 to 5.45, well below the USEPA-designated hazard ranking score of 28.5, at which point a site becomes eligible for inclusion on the NPL.

5.7 FEASIBILITY STUDIES

A feasibility study has not been conducted for the burn ground areas.

5.8 REMEDIAL ACTIONS

No remedial actions have been performed at the burn ground areas.

5.9 WETLANDS ASSESSMENTS

A wetlands survey has not been conducted at the burn grounds, although the potential exists for wetlands identification, particularly at Taylor Road Burn Ground (Warner, et. al. 1990). A site-wide wetlands delineation is planned (Bower 1995).

5.10 PLANNED ACTIVITIES

A focused Remedial Investigation (RI) is planned for portions of PBOW (D&M 1994) to determine whether contamination is present in the areas to be investigated. Although the burn grounds are not specifically targeted for this study, a site-wide ground-water investigation is planned to evaluate the presence and nature of contamination in the bedrock aquifer underlying the site. Also, a background soil quality assessment will be done to establish background levels of COCs in site soils, particularly levels of metals.

5.11 RECOMMENDATIONS

Additional investigations in the remaining burn grounds are recommended to determine the nature and extent of contamination at these sites. Further surface soil sampling should be considered to delineate the extent of contamination and to locate possible hot spots. Sediment samples should be selected from drainage in and adjacent to the burn grounds to determine the potential for contaminant transport from surface runoff. Shallow and bedrock monitoring wells may be installed at or near the burn grounds during the planned site-wide ground-water investigation (D&M 1994) to monitor for contaminants in the shallow and deep aquifers. Also, a background chemical study is recommended for PBOW to support a risk assessment in the burn grounds and other AOCs.

6.0 WASTE LAGOONS

6.1 BACKGROUND

The Waste Lagoons in the Pentolite Area at PBOW were identified in a Preliminary Assessment as having potential for contamination from PBOW activities, particularly contamination of surface soil, surface water, and ground water (SAIC 1991). This section provides descriptive and historic background information on the Waste Lagoons that may be related to potential contamination at the sites.

6.1.1 Description

Pentolite was manufactured at PBOW from March 1943 through August 1945. Wastewater generated from this process was disposed in two wastewater lagoons, or settling basins, located in the former pentolite dry storage area in what is now a grassy area north of Pentolite Road and south of the reactor facility, within the fenced area enclosing the reactor site (SAIC 1991) (Figure 6-1). Because the lagoons were removed and the pentolite area was graded for construction of the Plum Brook Reactor Facility (PBRF), the lagoons do not appear on current PBOW maps. A 1989 photograph of the lagoons is shown in Figure 3-4.

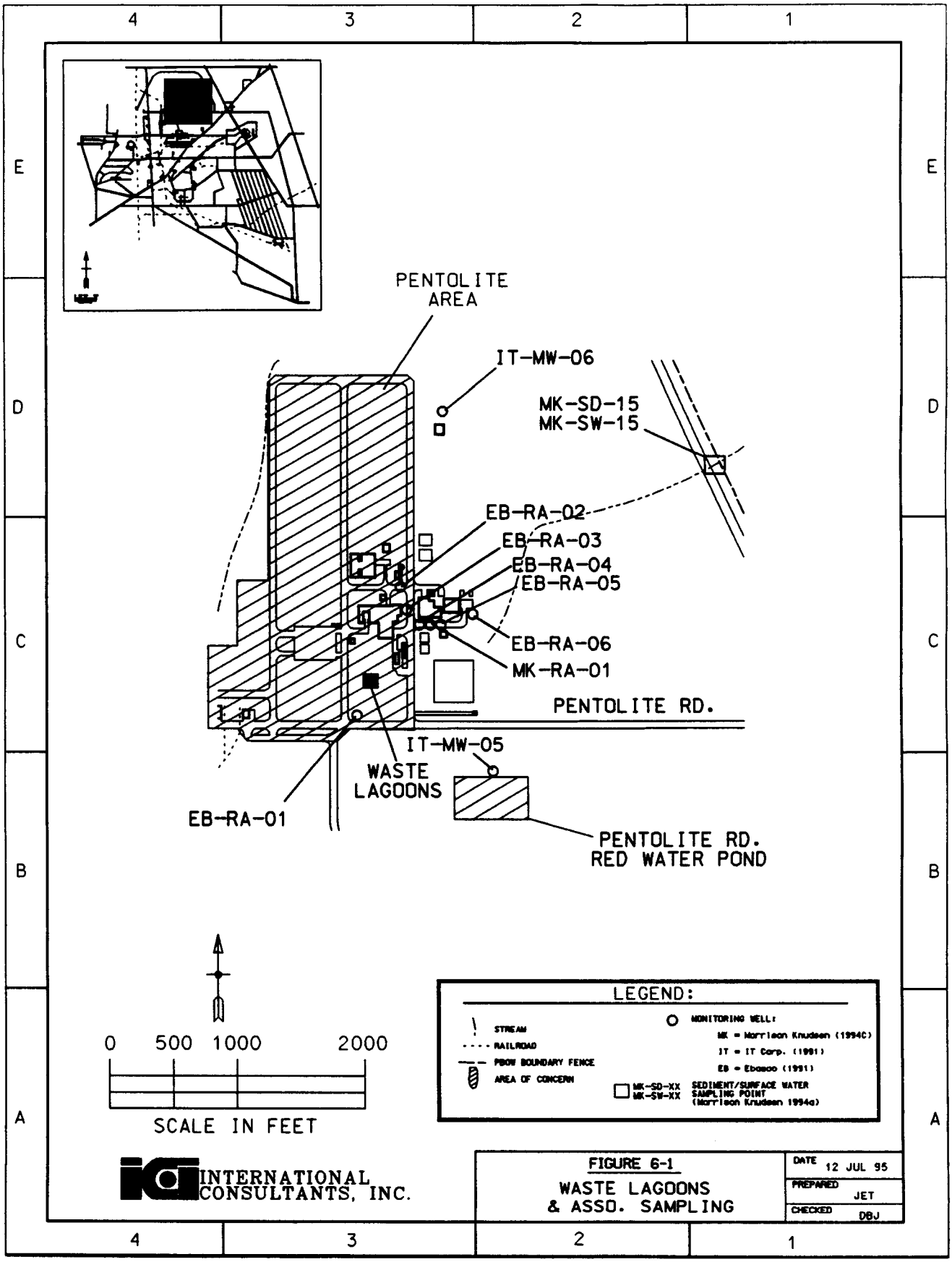
6.1.2 History

The history of activities at the Waste Lagoons is divided into two periods: the operational period of PBOW, and the post-operational period, including post-World War II decommissioning activities.

6.1.2.1 Operational Period (1941-1945)

The Waste Lagoons were constructed in 1941 and were in use until the end of World War II when PBOW was decommissioned. The lagoons were constructed of precast concrete blocks, measuring 15 feet by 9.75 feet, with asphalt-filled expansion joints. The blocks were placed on 4 to 6 inches of gravel or #4 stone (SAIC 1991). Each lagoon basin measured approximately 100 feet by 140 feet (D&M 1995).

The manufacturing of pentolite involved nitration of pentaerythritol (PE) by addition of nitric acid and water. Pentaerythritol tetranitrate (PETN) was generated by this process, along with wastewater containing 5% nitric acid. The PETN was treated with water, acetone, and ammonium bicarbonate to dissolve and


PENTOLITE AREA
IT-MW-06
MK-SD-15
MK-SW-15
EB-RA-02
EB-RA-03
EB-RA-04
EB-RA-05
EB-RA-06
MK-RA-01
PENTOLITE RD.
IT-MW-05
WASTE LAGOONS
EB-RA-01
PENTOLITE RD. RED WATER POND
0 500 1000 2000
SCALE IN FEET
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL:
MK = Morrison Knudsen (1994C)
IT = IT Corp. (1991)
EB = Ebasco (1991)
MK-SD-XX
MK-SW-XX
SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
INTERNATIONAL CONSULTANTS, INC.
FIGURE 6-1
WASTE LAGOONS & ASSO. SAMPLING
DATE 12 JUL 95
PREPARED JET
CHECKED DBJ

neutralize the free acid present. Pentolite was produced by mixing PETN and TNT, a process which involved the addition of acetone and water. The wastewater from this process likely contained substantial concentrations of PE, PETN, TNT, and acetone (SAIC 1991). No information is available on the amount of wastewater generated, the disposal of sludge, or the volume of wastewater treated.

In March 1944, decontamination of the Waste Lagoons was begun. Decontamination was performed by draining the impoundments and flushing the limestone bed and basin with water under high pressure. The wet limestone was removed to an unknown location and the basin was flushed again and inspected for accumulated explosives (D&M 1995).

6.1.2.2 Post-Operational Period

After pentolite production ceased at the end of World War II, the site was maintained in an "as is" condition until the mid-1950s (SAIC 1991), at which time the Waste Lagoons were decommissioned along with the rest of PBOW.

In 1956, the Pentolite Area, including the area of the Waste Lagoons, was selected by NASA as the site for the construction of the PBRF. The entire Pentolite Area was graded to meet reactor site specifications, and lagoon-contaminated soil was likely removed or dispersed to an unknown location during construction. Between 1963 and 1973, NASA operated the PBRF under an agreement with the Atomic Energy Commission. NASA currently holds a license with the Nuclear Regulatory Commission for safe, protective storage of the reactor.

6.2 PHYSICAL CHARACTERISTICS

The physical characteristics of the Waste Lagoons include surface features, geology, and hydrology. The physical characteristics of PBOW in general are described in Section 1.0.

6.2.1 Surface Features

The Waste Lagoons lie in relatively flat terrain with a gentle northward slope. The elevation at the Waste Lagoons ranges from 632 feet above MSL in the south to 630 feet above MSL in the north. The lagoons were originally located in brushlands (Warner, et.al. 1990), though the current vegetation is mostly maintained grasses and ornamental plants.

The PBRF is located north of the Waste Lagoons. There is a water reservoir to the east, a water tower on the northeast, and a water tank on the north side of the Waste Lagoons. Some UST were located northeast of this site. Site records do not indicate that other waste disposal activities occurred at the Waste Lagoons either during PBOW activity or following World War II. However, D&D operations and accidental spills may have occurred here.

6.2.2 Geology

The glacial deposits underlying the Waste Lagoons can be inferred from borehole lithologic logs for monitoring wells installed near the site. Monitoring well EB-RA-01 was installed south of the Waste Lagoons as a background well for an UST investigation (EBASCO 1991). The borehole log indicates an upper fine sand layer with trace silt, clay, and cobbles from the surface to a depth of approximately seven feet. This is underlain by grayish sandy clayey silt to a depth of 15 feet, grading to clayey silt to the bottom of the borehole at 16 feet. Bedrock was not encountered.

6.2.3 Hydrology

The hydrology of the Waste Lagoons area has been interpreted from topographic maps, soil borings, and monitoring wells installed at and near the site. Aquifer tests have not been conducted in the wells near the site, and hydrogeologic parameters are not defined.

6.2.3.1 Surface Water

Surface runoff in the Waste Lagoons area generally flows northeast toward Hemminger Ditch which eventually empties into Lake Erie. A cooling pond is located east of the site.

6.2.3.2 Ground Water

Water levels in monitoring well EB-RA-01 south of the Waste Lagoons were measured at approximately three to four feet beneath the surface (EBASCO 1991). Water level measurements in wells installed for the investigation of a former UST area north of the Waste Lagoons, indicate a local ground-water gradient to the north-northeast, similar to the regional gradient (EBASCO 1991).

6.2.3.3 Monitoring Wells

Seven monitoring wells were installed to investigate USTs associated with PBRF, six by EBASCO (1991) and one by Morrison Knudsen (1994c). One monitoring well, EB-RA-01, was installed south of the Waste Lagoons to monitor background for the UST investigation, which can also serve as background for the Waste Lagoons. Monitoring well IT-MW-06 (IT 1991a) was installed north of the PBRF and may serve as a downgradient well for the Waste Lagoons. Detailed information on monitoring wells at PBOW is provided in Section 10.0.

6.3 CONTAMINANTS OF CONCERN (COCs)

COCs for the Waste Lagoons were determined on the basis of past operational activities (Section 6.1.2), and on the results of environmental investigations conducted at the sites.

6.3.1 COCs Resulting from PBOW Activities

Based on past site activities, acetone, TNT, PE, and PETN are the most likely COCs at the Waste Lagoons. With the exception of former UST sites adjacent the lagoons site, environmental investigations have not been conducted in this area. The investigations associated with former UST sites involved sampling and analysis only for petroleum products that may have been released to the soil and ground water.

Other waste disposal activities did not occur at or near the Waste Lagoons either during PBOW operations or following World War II. During the construction of PBRF, soil from the Waste Lagoons area was tilled and moved, possibly causing shallow soil and surface water contamination.

An accidental fuel oil spill at PBRF was reported in 1976, when approximately 50 to 75 gallons of No. 2 fuel oil leaked from an above-ground storage tank (AST) which fed fuel to a boiler in a service building. In addition, leakage from USTs at the PBRF may have contributed petroleum products to the soil and ground water at the site, although these USTs were downgradient from the Waste Lagoons.

6.3.2 Transport Mechanisms

Possible transport mechanisms in the Waste Lagoons area include:

- Surface transport of liquid phase in precipitation runoff to Hemminger Ditch.

- Migration of contaminants from soils and surface water to shallow ground water.
- Migration of contaminants in shallow ground water to off-site locations and to the deeper bedrock aquifers.
- Contaminant transport via the food chain.

6.3.3 Action Levels

Action levels apply to clean-up goals established by PBOW RODs, USEPA regulations, ARARs (i.e., MCLs and NPDES), or have been determined from risk-based calculations. Action levels have not been established for the Waste Lagoons.

6.4 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination at the Waste Lagoons have not been investigated. However, the Site Inspection conducted by Morrison Knudsen (1994a) included areas near the Waste Lagoons which may have been affected by contaminants from this site.

6.4.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined. Monitoring well EB-RA-01 was installed south (upgradient) of the Waste Lagoons and may serve as a background reference for ground water at this location.

6.4.2 Sediment and Surface Water Investigations

One sediment sample (MK-SD-15) and one surface water sample (MK-SW-15) were collected in Hemminger Ditch downgradient from the Waste Lagoons (MK 1994a). The sampling point is thought to be a possible point of entry to surface waters for contaminants from the USTs that were near the PBRF, and may also be a point of entry for contaminants from the Waste Lagoons. Acetone was detected in the sediment sample (66 ppb) along with minor amounts of chloroform. Other COCs were not detected in sediment or surface water samples.

6.4.3 Surface Soil Investigations

No surface soil samples have been collected in the vicinity of the Waste Lagoons.

6.4.4 Subsurface Soil Investigations

No surface soil samples have been collected in the vicinity of the Waste Lagoons.

6.4.5 Ground-Water Investigations

A single monitoring well, EB-RA-01, is located upgradient of the Waste Lagoons, an additional six monitoring wells are located in the former UST areas, downgradient of the Waste Lagoons (EBASCO 1991; MK 1994c). Ground-water samples from these wells were analyzed for petroleum products only.

6.5 CURRENT STATUS OF SITE CHARACTERIZATION

This section describes the current status of site characterization at the Waste Lagoon Areas, including additional investigations that may be necessary to define source areas of contamination, characterize potential migration pathways, or identify potential receptors and exposure pathways. Any further investigations suggested here are not intended to be requirements for future work at this AOC. They are suggested for consideration for future work, to be implemented only if determined necessary through the site scoping process.

6.5.1 Physical Characteristics

The geology near the Waste Lagoons has been partially characterized by analysis of a nearby borehole drilled and logged for a UST investigation. An additional boring at the site would be needed to fully characterize the geology of the site and determine depth to bedrock.

6.5.2 Nature and Extent of Contamination

The nature and extent of contamination at the Waste Lagoons has not been investigated in previous studies. Suggestions for additional investigations include the following:

- One sediment and one surface water sample (MK-SD-15 and MK-SW-15, respectively) were collected for analysis from Hemminger Ditch, downstream from the Waste Lagoons, the PBRF, and a former UST area). Collection of additional sediment data from nearby drainage is suggested, particularly with the presence of acetone indicated in MK-SD-15.

- Surface and subsurface soils have not been collected at or near the Waste Lagoons. A systematic examination of the soils to delineate the extent of soil contamination should be considered in future scoping.

- Although there are monitoring wells immediately downgradient of the Waste Lagoons in former UST areas, ground water samples from these wells were analyzed only for petroleum products, not for Waste Lagoon COCs. No monitoring wells exist specifically to characterize the ground water at the Waste Lagoons. It is suggested that the UST monitoring wells be sampled for Waste Lagoon COCs.

6.5.3 Background Data

Soil and sediment background values have not been established for the PBOW site nor for the Waste Lagoons. Background sampling should be considered in future scoping at these locations.

6.6 POTENTIAL HAZARDS TO HUMAN HEALTH AND THE ENVIRONMENT

No formal risk assessment, either to human health or the environment, has been conducted for the Waste Lagoons. Sufficient information does not exist for this site to conduct a risk assessment. A hazard ranking was conducted on the Waste Lagoons (SAIC 1991) in which scores for the various transport pathways ranged from 3.84 to 9.7, well below the USEPA-designated hazard ranking score of 28.5, at which point a site becomes eligible for inclusion in the NPL.

6.7 FEASIBILITY STUDIES

A feasibility study has not been conducted for the Waste Lagoons.

6.8 REMEDIAL ACTIONS

The Waste Lagoons were drained and flushed following closure of PBOW. No additional remedial actions have been conducted at this site.

6.9 WETLANDS ASSESSMENTS

There are no potential wetlands identified in the vicinity of the Waste Lagoons (Warner, et. al. 1990).

6.10 PLANNED ACTIVITIES

A focused Remedial Investigation (RI) is planned for portions of PBOW (D&M 1994) to determine whether contamination is present in the areas to be investigated. Although the Waste Lagoons are not specifically targeted for this study, a site-wide ground-water investigation is planned to evaluate the

presence and nature of contamination in the surficial and bedrock aquifers underlying the site. Also, a background soil quality assessment will be done to establish background levels of constituents of concern in site soils, particularly levels of metals. Following the RI, human health and environmental risk assessments may be conducted.

6.11 RECOMMENDATIONS

Additional investigations for the Waste Lagoons may be needed to determine the nature and extent of residual contamination, if any, at this site. Surface soils in these areas should be sampled to delineate the extent of contamination and sediment samples should be analyzed for COCs. A single monitoring well should also be considered in the Waste Lagoons Area to test for COCs in the ground water.

7.0 ASH PITS AND POWER PLANTS

7.1 BACKGROUND

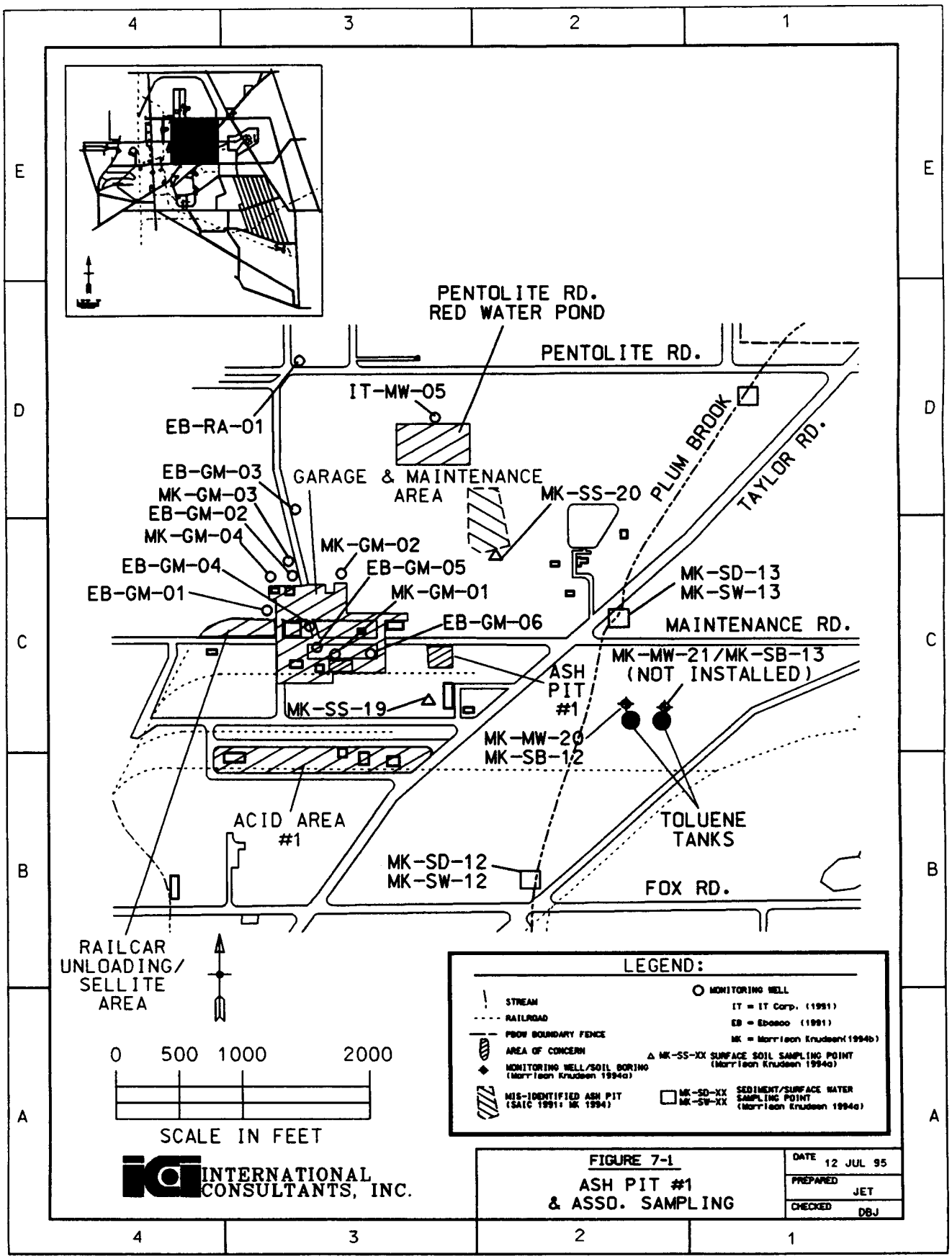
The ash pits at PBOW were identified in a Preliminary Assessment as having potential for contamination from PBOW activities, particularly contamination of surface and subsurface soils (SAIC 1991). This section provides descriptive and historic background information on the ash pits and power plants that may be related to potential contamination at the sites. Also included in this AOC are the former locations of PBOW power plants associated with, and responsible for, the ash pits.

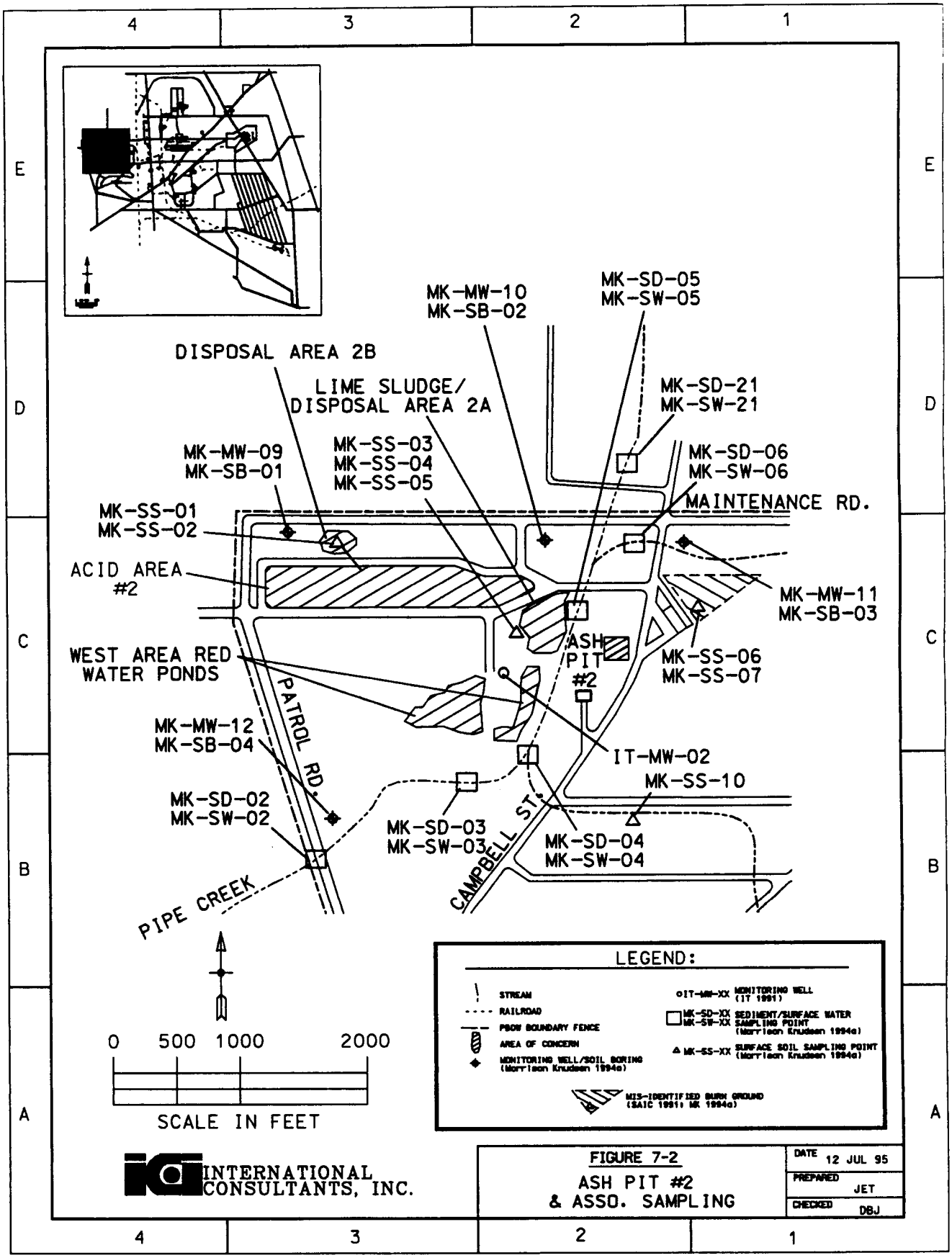
7.1.1 Description

Three large ash pits, also known as Power Station #1 Ash Pit, Power Station #2 Ash Pit, and Power Station #3 Ash Pit, were used to dispose of coal ash wastes generated at the three power stations at PBOW. Their locations with respect to PBOW are shown in Figure 1-2.

Ash Pit #1, associated with Power Station #1 (Building 201), is located south of Maintenance Road and west of Taylor Road (Figure 7-1). In the Preliminary Assessment conducted by SAIC (1991), this ash pit, also referred to as the "Ash Settling Pit," is shown located north of Maintenance Road (Figure 7-1). Based on a records search of historical drawings and aerial photos, however, Dames and Moore (1995) identified the location of Ash Pit #1 as south of Maintenance Road and north of the railroad tracks and the power house building. Wastewater Disposal Plant #1, associated with Power Station #1, is located north of Maintenance Road and may have been mis-identified as an ash disposal area.

Ash Pit #2, associated with Power Station #2 (Building 501), is located west of Campbell Street, across the street from the power station (Figure 7-2). In their Preliminary Assessment, SAIC (1991) did not identify an ash pit associated with Power Station #2, and stated that ash from Power Station #2 was probably disposed of in the ash pit at Power Station #3, or Power Station #2 used an unmapped informal disposal yard for the disposal of ash. However, Dames & Moore (1995) located the ash pit west of Campbell Street based on site records and a walkover of the area. This ash disposal area is rectangular in shape and covers approximately 8,000 square feet. Wastewater Disposal Plant #2, also associated with Power Station #2, is located west of Ash Pit #2 opposite Pipe Creek.


PENTOLITE RD.
RED WATER POND
PENTOLITE RD.
IT-MW-05
EB-RA-01
EB-GM-03
MK-GM-03
EB-GM-02
MK-GM-04
EB-GM-04
EB-GM-01
GARAGE & MAINTENANCE AREA
MK-GM-02
EB-GM-05
MK-GM-01
EB-GM-06
MK-SS-20
PLUM BROOK
TAYLOR RD.
MK-SD-13
MK-SW-13
MAINTENANCE RD.
MK-MW-21/MK-SB-13
(NOT INSTALLED)
ASH PIT #1
MK-SS-19
MK-MW-20
MK-SB-12
ACID AREA #1
TOLUENE TANKS
MK-SD-12
MK-SW-12
FOX RD.
RAILCAR UNLOADING/ SELLITE AREA
0 500 1000 2000
SCALE IN FEET
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
MIS-IDENTIFIED ASH PIT (SAIC 1991; MK 1994)
MONITORING WELL
IT = IT Corp. (1991)
EB = Ebasco (1991)
MK = Morrison Knudsen(1994b)
MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
MK-SD-XX MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
INTERNATIONAL CONSULTANTS, INC.
FIGURE 7-1
ASH PIT #1 & ASSO. SAMPLING
DATE 12 JUL 95
PREPARED JET
CHECKED DBJ


MK-MW-10
MK-SB-02
MK-SD-05
MK-SW-05
DISPOSAL AREA 2B
LIME SLUDGE/
DISPOSAL AREA 2A
MK-SD-21
MK-SW-21
MK-MW-09
MK-SB-01
MK-SS-03
MK-SS-04
MK-SS-05
MK-SD-06
MK-SW-06
MAINTENANCE RD.
MK-SS-01
MK-SS-02
ACID AREA
#2
MK-MW-11
MK-SB-03
ASH
PIT
#2
MK-SS-06
MK-SS-07
WEST AREA RED
WATER PONDS
PATROL RD.
MK-MW-12
MK-SB-04
IT-MW-02
MK-SS-10
MK-SD-02
MK-SW-02
MK-SD-03
MK-SW-03
MK-SD-04
MK-SW-04
CAMPBELL ST.
PIPE CREEK
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
IT-MW-XX MONITORING WELL (IT 1991)
MK-SD-XX MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
MIS-IDENTIFIED BURN GROUND (SAIC 1991; MK 1994a)
0 500 1000 2000
SCALE IN FEET
INTERNATIONAL CONSULTANTS, INC.
FIGURE 7-2
ASH PIT #2
& ASSO. SAMPLING
DATE 12 JUL 95
PREPARED JET
CHECKED DBJ

Ash Pit #3, associated with Power Station #3, is located west of Ransom Road and south of Maintenance Road, near Building 2811, the K Site Test Facility (Figure 7-3). Historical records indicate that the ash pit was a bermed square-shaped depression occupying an area of approximately 7,500 square feet (D&M 1995). NASA's K Site Test Facility was constructed inside the remodelled Power Station. Current photographs of the power plants and ash pits are included in Figures 7-4 (Ash Pit #1), 7-5 (Ash Pit #2), 7-6, and 7-7 (Ash Pit #3).

7.1.2 History

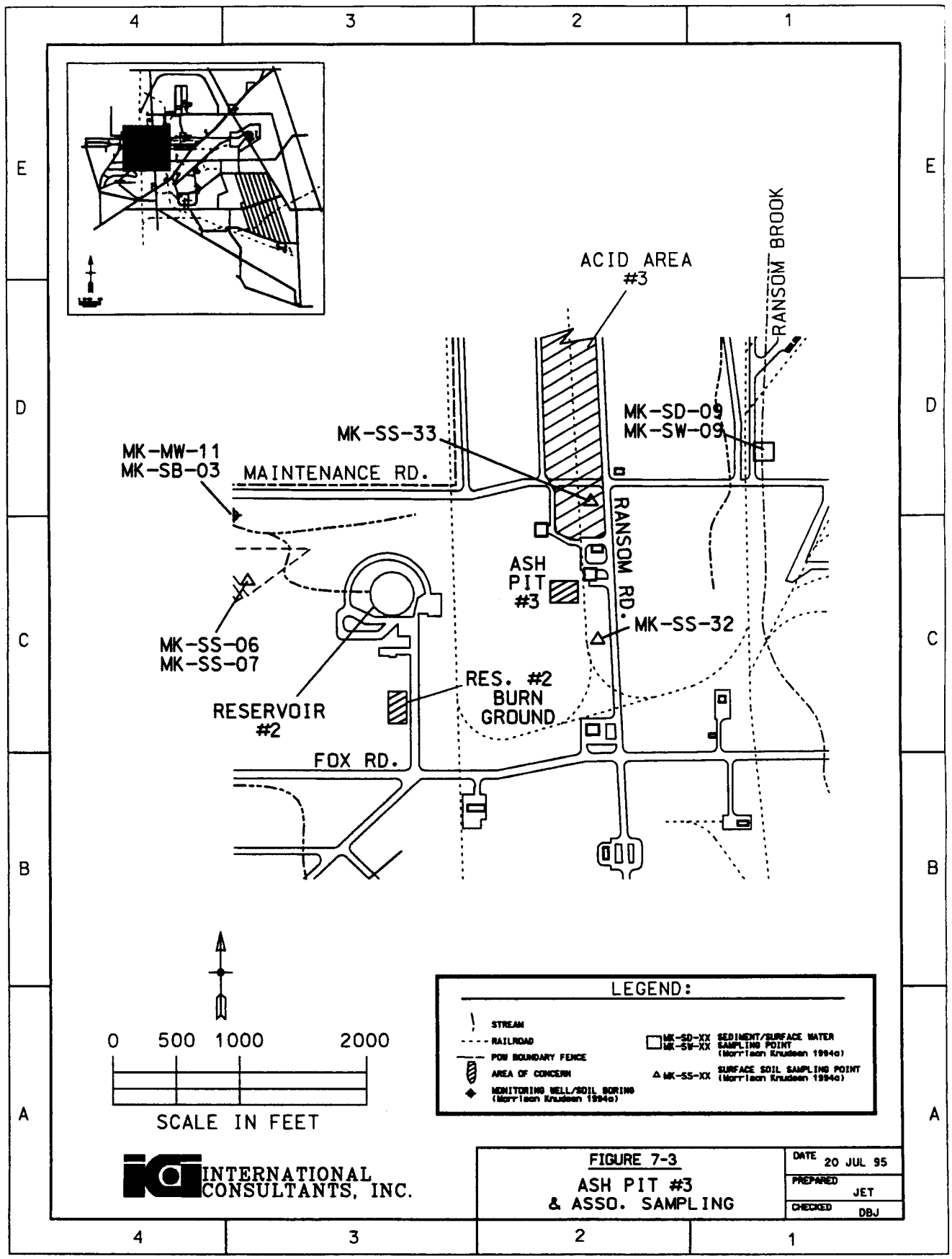
The history of activities at the ash pits and power plants is divided into two periods: the operational period of PBOW, and the post-operational period, including post-World War II decommissioning activities.

7.1.2.1 Operational Period (1941-1945)

During the operational period of PBOW, the ash pits served as disposal areas for fly ash and ash generated at on-site power plants. There were three power stations at PBOW corresponding to Power and Maintenance Areas 1, 2, and 3. Each power station consisted of a main power house, a coal storage area, and a diked area containing fuel oil storage tanks (11,500-gallon ASTs). Each power house building consisted of a boiler house, compressor room, electrical room, filter room, and locker room. The buildings also contained two to four large coal-burning boilers, a turboelectric generator, a feedwater treatment system, and several steam-driven or electric air compressors. The generated steam was used for space heating, driving compressors, and generating electric power. Fly ash generated from each of the boilers in the power house collected in pits. Water was added to the ash and the water-ash slurry flowed through a sluice trench to the ash sump located at the end of the building. From the ash sump, the ash traveled through a pipeline to a nearby surface impoundment (ash spoils pile, or ash pit) (D&M 1995).

7.1.2.2 Post-Operational Period

Information concerning the status or use of the ash pits following the war is limited. During the 1960's, the power plant facility at Power and Maintenance Area 3 was remodelled to become the K Site Test Facility. The area of fly ash disposal was graded and fly ash may have been removed to an unknown location (MK 1994a).


ACID AREA
#3
RANSOM BROOK
MK-SD-09
MK-SW-09
MK-SS-33
MK-MW-11
MK-SB-03
MAINTENANCE RD.
RANSOM RD.
ASH
PIT
#3
MK-SS-32
MK-SS-06
MK-SS-07
RESERVOIR
#2
RES. #2
BURN
GROUND
FOX RD.
0 500 1000 2000
SCALE IN FEET
LEGEND:
STREAM
RAILROAD
POW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
MK-SD-XX MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
INTERNATIONAL CONSULTANTS, INC.
FIGURE 7-3
ASH PIT #3
& ASSO. SAMPLING
DATE 20 JUL 95
PREPARED JET
CHECKED DBJ

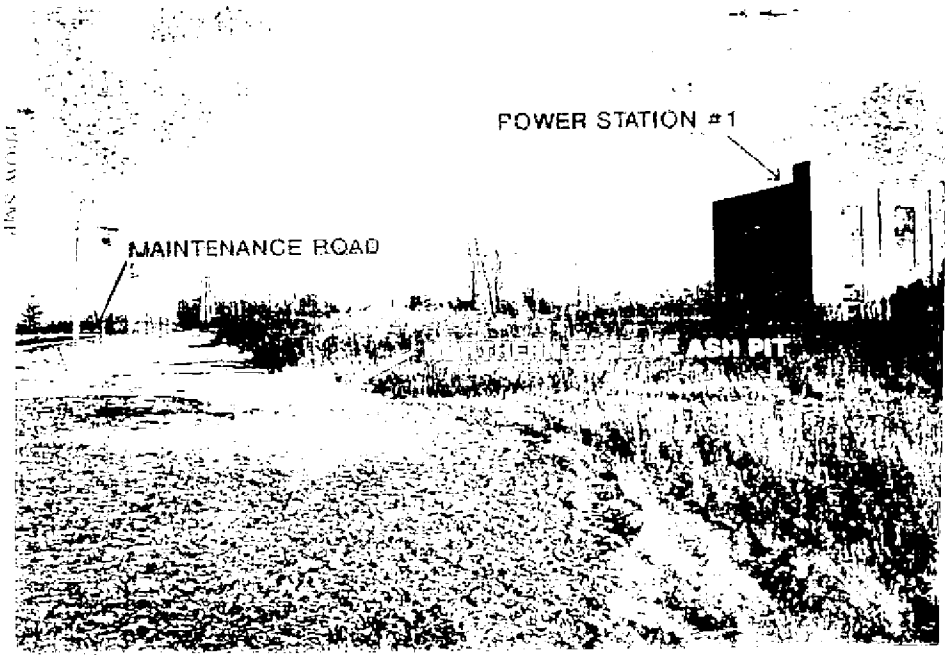


Figure 7-4. Ash Pit and Power Plant #1

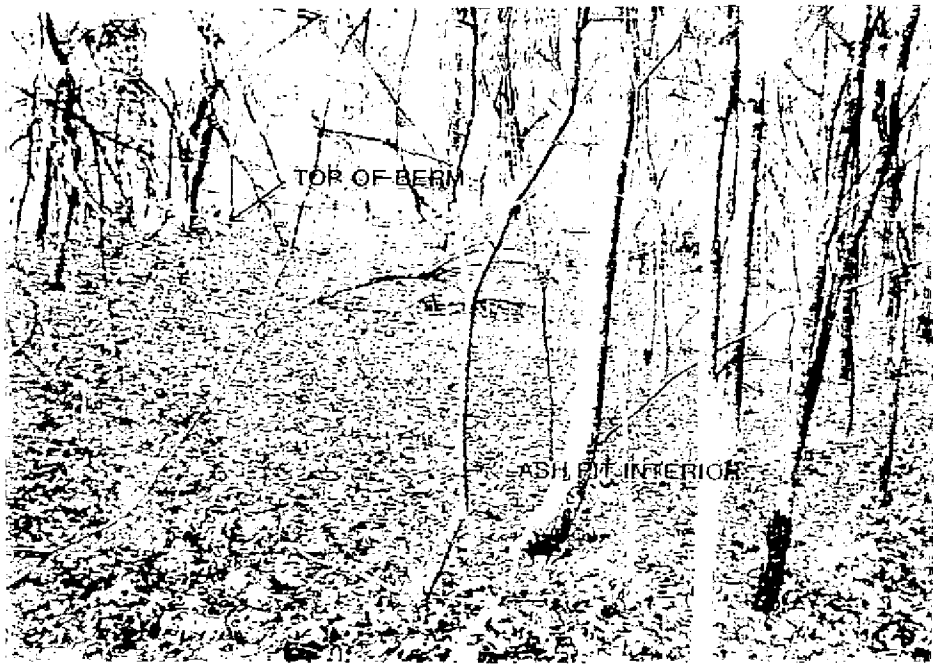


Figure 7-5. Ash Pit and Power Plant #2

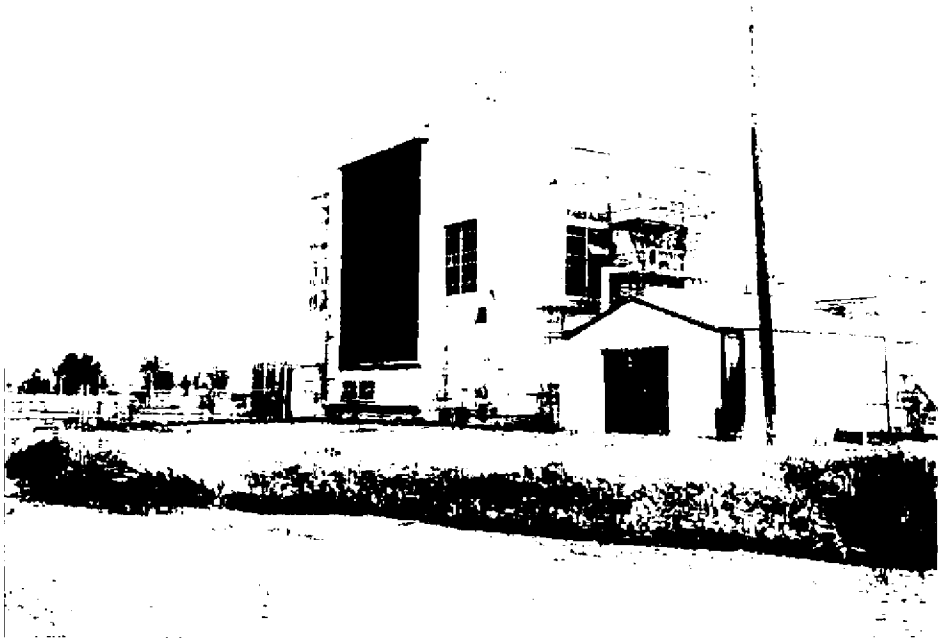


Figure 7-6. Power Plant #3

Figure 7-7. Ash Pit #3

7.2 PHYSICAL CHARACTERISTICS

The physical characteristics of the ash pits include surface features, geology, and hydrology. The general physical characteristics of PBOW are described in Section 1.0.

7.2.1 Surface Features

The ash pits and power plants are located primarily in grassland areas on relatively flat terrain at PBOW (Warner, et. al. 1990). The elevations of the ash pits range between 630 and 640 feet above MSL.

Buildings and facilities constructed at the K Site Test Facility in support of NASA activities occupy portions of Ash Pit #3. Single track railroad tracks are located north and south of Ash Pit #1, north of Ash Pit #2, and east of Ash Pit #3. Site records do not indicate that waste disposal activities other than the disposal of ash occurred in the ash pits either during the operational period of PBOW or following World War II.

7.2.2 Geology

Ash Pit #1 is adjacent a former UST area in which five monitoring wells have been installed (EBASCO 1991; MK 1994b). The well logs for the EBASCO wells (EB-PS-1 through 4) recorded an upper 3 to 5 feet of fine sand and sandy silt, with grayish brown clayey silt or clay with some gravel to depths of 18 feet, the deepest borehole in the former UST area. Bedrock was not encountered in these borings. The boring log for monitoring well MK-MW-10 (MK 1994a), installed north of Ash Pit #2, indicated dark brown to brown silty clay to its total depth of 14 feet. No boreholes were drilled in the vicinity of Ash Pit #3.

7.2.3 Hydrology

The hydrology of the ash pits and power plants has been interpreted from topographic maps, soil borings, and monitoring wells installed at and near the sites.

7.2.3.1 <u>Surface Water</u>

Precipitation runoff from Ash Pit #1 flows eastward toward Plum Brook. Surface runoff from Ash Pit #2 flows west toward Pipe Creek, and surface runoff from Ash Pit #3 flows northward to a tributary of Pipe Creek. Ash Pit #3 contains standing water.

7.2.3.2 Ground Water

Ground water was encountered at a depth of two to three feet below the land surface during installation of monitoring wells at a former UST area near Ash Pit #1 (EBASCO 1991). Based on ground-water elevations in these wells, ground-water flow in the surficial aquifer beneath Ash Pit #1 is toward the north or northeast (EBASCO 1991). Near Ash Pit #2, ground water was encountered in well MK-MW-10 at a depth of six feet. Monitoring wells have not been installed in the vicinity of Ash Pit #3.

7.2.3.3 Monitoring Wells

No monitoring wells have been drilled specifically for the ash pits and power plants. Monitoring wells MK-PS-01, EB-PS-01, EB-PS-02, EB-PS-03, and EB-PS-04 were installed to investigate a former UST area located approximately 500 feet west of Ash Pit #1 (EBASCO 1991; MK 1994b). Detailed information on monitoring wells at PBOW is included in Section 14.0.

7.3 CONTAMINANTS OF CONCERN (COCs)

COCs for the ash pits and power plants were determined on the basis of past operational activities and the results of environmental investigations conducted at the sites.

7.3.1 Contaminants Resulting from PBOW Activities

Fly ash at PBOW is expected to be hazardous with respect to pH, heavy metals, and possibly organic compounds (SAIC 1991). The ash was disposed and concentrated in the ash pits associated with each power station and in the open ditches associated with each wastewater disposal plant. Therefore, the ash pits and open ditches would most likely have the highest probability for contamination at these sites. Although the surface soils are the most likely medium to be contaminated, leachate from the soils may have contaminated surface water and ground water as well.

Other potential sources of contamination related to the former power stations include releases from the below-grade fly ash sumps located at each power house, the above ground fuel storage tanks, and the coal storage yards (D&M 1995).

The K Site Test Facility, near Ash Pit #3, is the only known activity conducted near the ash pits and power plants. Therefore, no contaminants from outside sources are suspected in these areas.

7.3.2 Transport Mechanisms

Possible mechanisms for the transport of contaminants from the ash pits and power plants include:

- Surface transport of dissolved or particulate-borne contaminants in runoff to nearby bodies of water.
- Transport of particulate contaminants by wind.
- Migration of contaminants from soils and surface water to shallow ground water.
- Migration of contaminants in shallow ground water to off-site locations and to the deeper limestone aquifers in bedrock.
- Contaminant transport via the food chain.

7.3.3 Action Levels

Action levels apply to clean-up goals established by PBOW RODs, USEPA regulations, ARARs (e.g., MCL and NPDES), or are determined from risk-based calculations. Action levels have not yet been proposed for the ash pits and power plants.

7.4 NATURE AND EXTENT OF CONTAMINATION

The nature of contamination at the ash pits and power plants has not been investigated specifically, however, inferences can be made from the Site Inspection conducted by Morrison Knudsen (1994a). The results of this investigation relative to the ash pits are summarized in this section.

7.4.1 Ash Pit and Power Plant #1

7.4.1.1 <u>Background Data</u>

Background chemical analytical values for COCs in various media for the PBOW have not yet been established. Samples have not been collected that were intended to provide background values for Ash Pit and Power Plant #1.

7.4.1.2 Sediment and Surface Water Investigations

Sediment and surface water samples have not been collected at or near Ash Pit and Power Plant #1.

7.4.1.3 Surface Soil Investigations

Surface soil samples were collected at various locations at PBOW for the Site Inspection conducted by Morrison Knudsen (1994a), but none specifically at Ash Pit #1. Surface soil sample MK-SS-19 was collected west of former Power Station #1 near Ash Pit #1 and MK-SS-20 was collected north of Maintenance Road near the ash pit location mis-identified by SAIC (1991).

7.4.1.4 Subsurface Soil Investigations

No subsurface soil samples have been collected at or near Ash Pit and Power Plant #1.

7.4.1.5 Ground-Water Investigations

No ground-water monitoring wells are located at Ash Pit and Power Plant #1. Monitoring wells MK-MW-07, EB-PS-01, EB-PS-02, EB-PS-03, and EB-PS-04, located near Ash Pit #1, were installed to investigate contamination from a former UST area.

7.4.2 Ash Pit and Power Plant #2

7.4.2.1 Background Data

Samples have not been collected that were intended to provide background values for Ash Pit and Power Plant #2.

7.4.2.2 Sediment and Surface Water Investigations

Sediment samples (MK-SD-05 and MK-SD-06) and surface water samples (SW-SW-05 and MK-SW-06) were collected from Pipe Creek to investigate contamination from the red water ponds (Section 3.0). The samples are also near Ash Pit #2 (Figure 7-2) and may reflect contamination from Ash Pit and Power Plant #2. Sediment sample MK-SD-06 contained minor VOCs and SVOCs.

7.4.2.3 Surface Soil Investigations

Surface soil samples were collected at various locations at PBOW for the Site Inspection conducted by Morrison Knudsen (1994a). MK-SS-06 and MK-SS-07 were collected east of Ash Pit #2 behind the power station to investigate the site identified by SAIC (1991) as a burn ground (Section 5.0) (Figure 7-2). Toluene was detected in MK-SS-07 at a concentration of 19 ppb, along with minor concentrations of other contaminants.

7.4.2.4 Subsurface Soil Investigations

No subsurface soil samples have been collected at Ash Pit and Power Plant #2.

7.4.2.5 Ground-Water Investigations

No ground water monitoring wells are located at Ash Pit and Power Plant #2.

7.4.3 Ash Pit and Power Plant #3

7.4.3.1 Background Data

Samples have not been collected that were intended to provide background values for Ash Pit and Power Plant #3.

7.4.3.2 Sediment and Surface Water Investigations

Surface water and sediment samples MK-SW-05 and MK-SD-06 were collected from a tributary of Pipe Creek northwest and downstream of Ash Pit #3, and may reflect potential contamination from the ash pit or power plant. Sediment sample MK-SD-06 had minor ("J" qualified) quantities of SVOCs (PAH).

7.4.3.3 Surface Soil Investigations

Surface soil samples were collected at various locations at PBOW for the Site Inspection conducted by Morrison Knudsen (1994a). MK-SS-33 and MK-SS-32 were collected on the north and south of K Site Test Facility near Ash Pit #3 (Figure 7-3). Heavy metals were not detected above regional background levels in either of these surface soil samples.

7.4.3.4 Subsurface Soil Investigations

No subsurface soil samples have been collected at Ash Pit and Power Plant #3.

7.4.3.5 Ground-Water Investigations

No ground water monitoring wells are located in the vicinity of Ash Pit and Power Plant #3.

7.5 CURRENT STATUS OF SITE CHARACTERIZATION

This section describes the current status of site characterization at the Ash Pits and Power Plants, including additional investigations that may be necessary to define source areas of contamination, characterize potential migration pathways, or identify potential receptors and exposure pathways. Any further investigations suggested here are not intended to be requirements for future work at this AOC. They are suggested for consideration for future work, to be implemented only if determined necessary through the site scoping process.

7.5.1 Physical Characteristics

The ash pits and power plants have not been investigated and their physical characteristics are not known. Future investigations should consider the following activities:

- The locations of Ash Pits #1 and #2 should be verified by field sampling and/or observation.
- Boreholes are suggested to characterize geology at the ash pit and power plant areas.

7.5.2 Nature and Extent of Contamination

The ash pits and power plant areas have not been investigated. Suggestions for future investigations to establish the nature and extent of contamination at these areas should include an examination of sediment, surface water, ground water, and surface and subsurface soil contamination in future scoping.

7.5.3 Background Data

Soil, sediment, and ground water background values have not been established for PBOW nor for the ash pits and power plant sites. It is suggested that background conditions be established to support risk assessment calculations at the site.

7.6 POTENTIAL HAZARDS TO HUMAN HEALTH AND THE ENVIRONMENT

No formal risk assessment, either human health or environmental, has been conducted for any of the Ash Pits and Power Plants. There is insufficient data on the nature and extent of contamination in these areas to support a quantitative risk assessment. A hazard ranking was conducted on the Ash Pits (SAIC 1991) in which scores for the various transport pathways ranged from 2.16 to 7.45, well below the USEPA-designated hazard ranking score of 28.7, the point at which a site becomes eligible for inclusion in the NPL.

7.7 FEASIBILITY STUDIES

A feasibility study has not been conducted at the ash pits and power plants.

7.8 REMEDIAL ACTIONS

No remedial actions have been performed at the ash pits and power plants.

7.9 WETLANDS ASSESSMENTS

Potential wetlands make up to about 1.5 percent of the total habitats at PBOW. Neither of the ash pits and power plants are located in potential wetland areas. A site-wide wetlands delineation is planned (Bower 1995).

7.10 PLANNED ACTIVITIES

A focused Remedial Investigation (RI) is planned for portions of PBOW (D&M 1994) to determine whether contamination is present in the areas to be investigated. Although the ash pits and power plants are not specifically targeted for this study, a site-wide ground-water investigation is planned to evaluate the presence and nature of contamination in the bedrock aquifer underlying the site. Also, a background soil quality assessment will be done to establish background levels of constituents of concern in site soils, particularly levels of metals. Following the RI, human health and environmental risk assessments may be conducted on the PBOW in general, or on specific sites or groups of sites.

7.11 RECOMMENDATIONS

Further investigation of the ash pit and power plant areas is recommended to determine the nature and extent of contamination in these areas. In particular, surface and subsurface soil investigations at the ash pits are needed to delineate the areas of the ash pits and the nature and extent of heavy metals contamination in these areas. A soil background evaluation is also recommended to determine background levels of metals in the soils. The planned site-wide ground-water investigation (D&M 1994) may be sufficient to detect ground-water contamination from the spoils areas, provided that the ground water is analyzed for heavy metals.

8.0 TOLUENE STORAGE TANKS

8.1 BACKGROUND

The toluene storage tank areas at PBOW were identified in a Preliminary Assessment as having potential for contamination from PBOW activities, particularly contamination of surface soil, surface water, and ground water (SAIC 1991). This section provides descriptive and historic background information on the toluene storage tank areas that may be related to potential contamination at the sites.

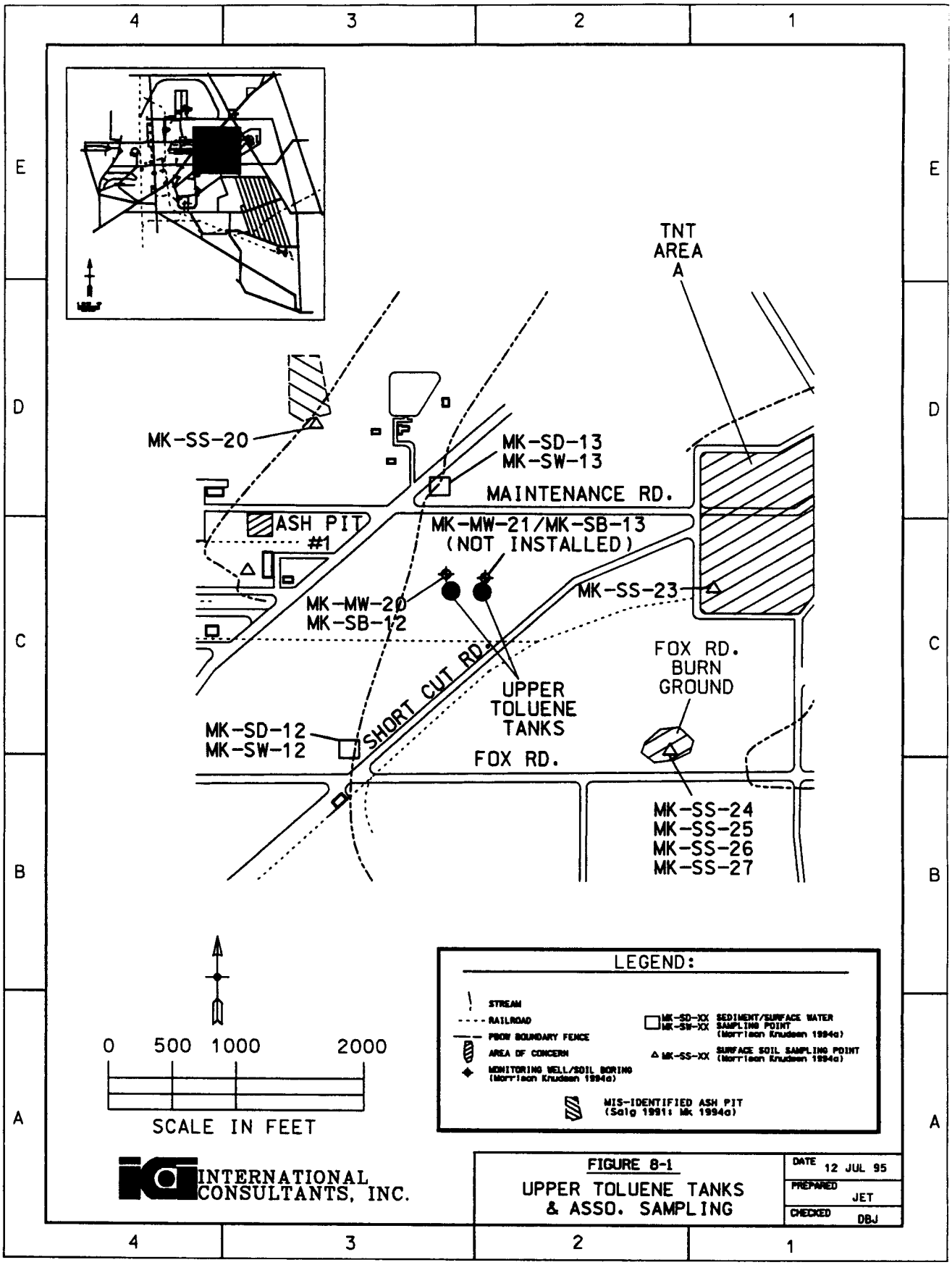
8.1.1 Description

During the active period of PBOW, six toluene storage tanks served as bulk storage for toluene used in the production of TNT. Each TNT production area had two above-ground toluene tanks of 200,000-gallon capacity each. These tanks, approximately 30 feet in diameter and 41 feet in height, were constructed of steel. Each tank rested on a concrete foundation surrounded by a 1-foot wide by 1-foot high concrete containment berm. The berm emptied into a 3-square foot drain valve pit near which the pump for each toluene tank was located (D&M 1995). The tank sites occupy approximately three to five acres each. The locations of the tanks in relation to other PBOW features are shown in Figure 1-2.

Toluene Tanks 255 and 265, known as the "Upper Toluene Tanks," supported TNT Area A during the operational period of PBOW. They are located west of TNT Area A and south of Maintenance Road (Figure 8-1). The tanks are encircled by earthen dikes approximately 6 feet high. NASA renumbered these tanks as Tank 8951 (Tank 265) and 8952 (Tank 255) and used them for fuel oil storage.

Tanks 425 and 435, known as the "Middle Toluene Tanks," supported TNT Area B during ordnance production. They are located northwest of TNT Area B near Taylor Road (Figure 8-2). These tanks are currently empty.

Tanks 645 and 655, the "Lower Toluene Tanks," supported TNT Area C during PBOW operations. They are located southeast of TNT Area C near the intersection of Patrol Road and Taylor Road (Figure 8-3). Tank 645 was moved by NASA to the Reactor Area for fuel oil storage (MK 1994a).


TNT AREA A
MK-SS-20
MK-SD-13
MK-SW-13
MAINTENANCE RD.
ASH PIT #1
MK-MW-21/MK-SB-13
(NOT INSTALLED)
MK-MW-20
MK-SB-12
MK-SS-23
SHORT CUT RD.
UPPER TOLUENE TANKS
FOX RD. BURN GROUND
MK-SD-12
MK-SW-12
FOX RD.
MK-SS-24
MK-SS-25
MK-SS-26
MK-SS-27
0 500 1000 2000
SCALE IN FEET
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
MK-SD-XX MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
MIS-IDENTIFIED ASH PIT (Salg 1991; MK 1994a)
INTERNATIONAL CONSULTANTS, INC.
FIGURE 8-1
UPPER TOLUENE TANKS & ASSO. SAMPLING
DATE 12 JUL 95
PREPARED JET
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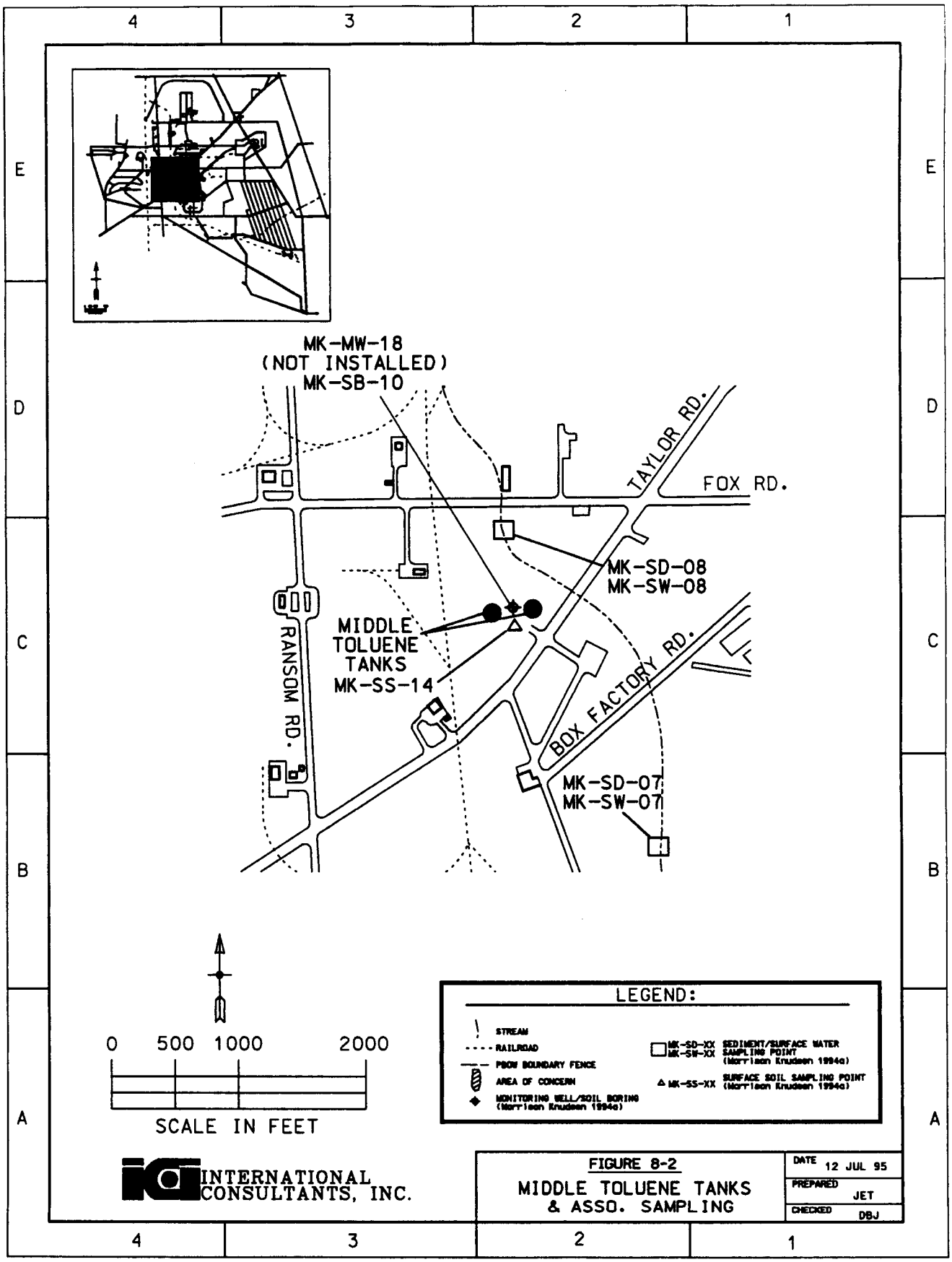

MK-MW-18
(NOT INSTALLED)
MK-SB-10
TAYLOR RD.
FOX RD.
MK-SD-08
MK-SW-08
MIDDLE
TOLUENE
TANKS
MK-SS-14
RANSOM RD.
BOX FACTORY RD.
MK-SD-07
MK-SW-07
0 500 1000 2000
SCALE IN FEET
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
MK-SD-XX MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
INTERNATIONAL CONSULTANTS, INC.
FIGURE 8-2
MIDDLE TOLUENE TANKS & ASSO. SAMPLING
DATE 12 JUL 95
PREPARED JET
CHECKED DBJ

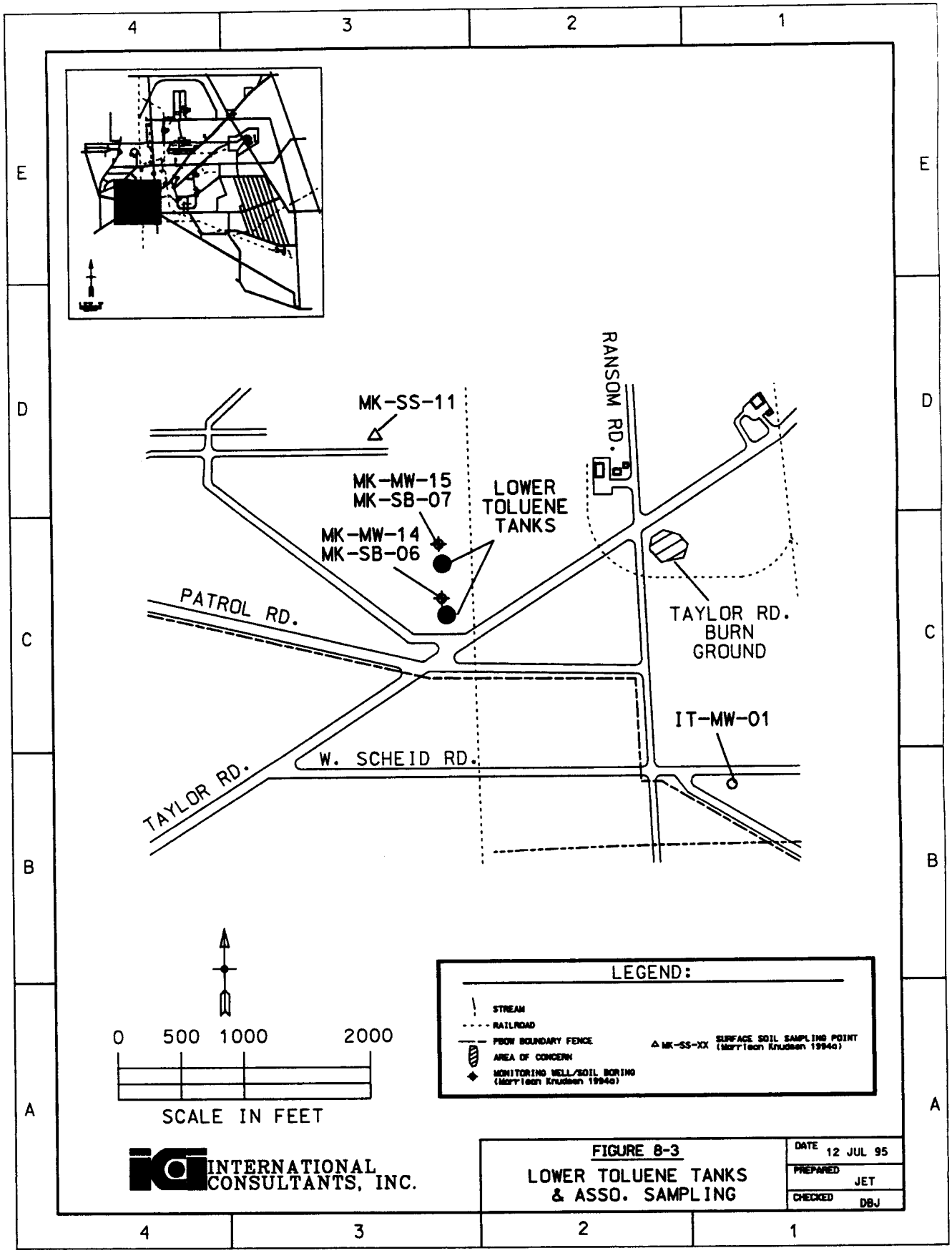

MK-SS-11
MK-MW-15
MK-SB-07
MK-MW-14
MK-SB-06
LOWER TOLUENE TANKS
RANSOM RD.
PATROL RD.
TAYLOR RD. BURN GROUND
IT-MW-01
W. SCHEID RD.
TAYLOR RD.
0 500 1000 2000
SCALE IN FEET
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
INTERNATIONAL CONSULTANTS, INC.
FIGURE 8-3
LOWER TOLUENE TANKS & ASSO. SAMPLING
DATE 12 JUL 95
PREPARED JET
CHECKED DBJ

Figure 8-4 is an early NASA photograph (1960s) of the Middle Toluene Tanks. Earthen berms are clearly visible in the photograph. Figure 8-5 is a recent (1995) photograph of the Lower Toluene Tanks illustrating the pervasive growth of vegetation at the site and the continued erosion of the berms. Tank 645, which was moved to the reactor area, was located in the left foreground of this photograph. Photographs of the Middle and Upper Tank Areas are in figures 8-6 and 8-7 on Page 8-8.

8.1.2 History

The history of activities at the toluene tank areas is divided into two periods: the operational period of PBOW, and the post-operational period, including post-World War II decommissioning activities.

8.1.2.1 Operational Period (1941-1945)

The toluene tanks were installed in 1941 and were used to store bulk toluene for the manufacture of TNT during World War II. Toluene was brought on site by railroad, and transported from the tanks to the TNT Areas through underground pipelines. These tanks were in service at PBOW from 1942 to 1945, and were decommissioned when the war ended.

8.1.2.2 Post-Operational Period

Following World War II, PBOW was in standby condition from 1945 to 1946. During this time, the Army conducted D&D work on many of the buildings and structures associated with the manufacturing of ordnance, including the toluene tanks. The tanks were decommissioned in 1945 by pumping out their contents, draining the transfer lines, and opening top and bottom flanges for ventilation.

NASA renumbered the two tanks in the Upper Toluene Tank Area, Tanks 265 and 255, to 8951 and 8952, respectively, to be used for fuel oil storage. In addition, NASA moved Tank 645 from the Lower Toluene Tank Area to the reactor facility for fuel storage (MK 1994a).

In January 1989, there was a leak reported from Tank 8951 (formerly 265) which originally (in 1976) contained approximately 185,000 gallons of heating oil. The area around the tank was discolored, a fuel oil odor was noticed, and fuel oil seepage was observed on the eastern side of the tank. An area of approximately 456 square feet was contaminated with fuel oil to a depth of approximately 4 to 5 inches. About 6 to 8 inches of affected soil and vegetation were removed from the contaminated area and taken to a burn ground for incineration. Approximately 230 gallons of fuel oil and sludge were removed from the drain valve pit and absorbent matting was used to soak up oil which seeped from underneath the tank. It is believed that the seepage was contained within the berm (D&M 1995).

3A
1074
B-435-25

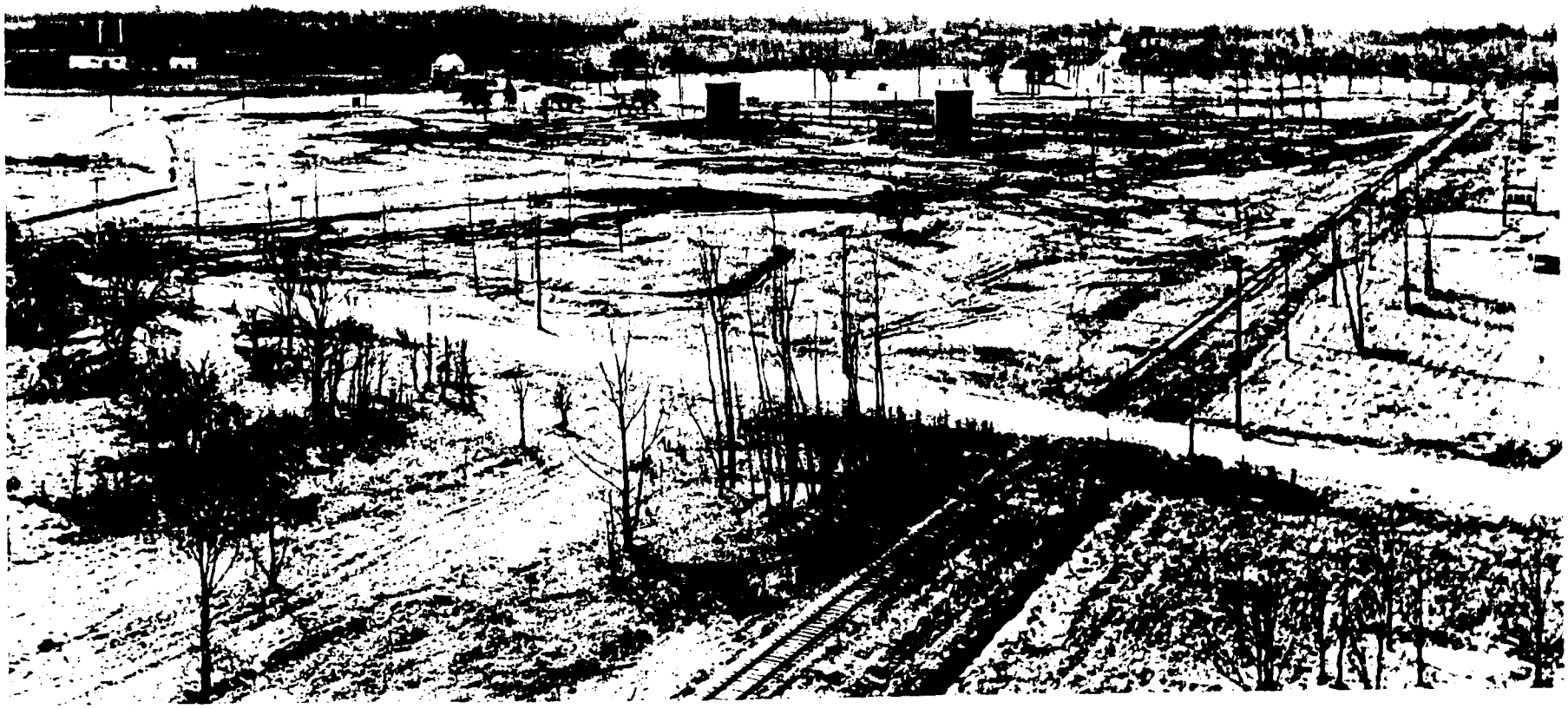


Figure 8-4. Middle Toluene Tanks, 1960s

Figure 8-5. Lower Toluene Tanks, 1995

8.2 PHYSICAL CHARACTERISTICS

The physical characteristics of the toluene tank areas include surface features, geology, and hydrology. The general physical characteristics of PBOW as a whole are described in Section 1.0.

8.2.1 Surface Features

The toluene tanks are located on relatively flat terrain with an average northerly slope of less than six percent. The approximate elevations and habitat of the tank areas are:

Figure 8-6. Upper Toluene Tanks, 1995

Figure 8-7. Middle Toluene Tanks, 1995

- Lower Toluene Tank Area (Tanks 645 and 655) is 675 feet above MSL and located in grasslands.
- Middle Toluene Tank Area (Tanks 425 and 435) is 650 feet above MSL and located in woodlands.
- Upper Toluene Tank Area (Tanks 255 and 265) is 640 feet above MSL and located in grasslands.

Unlined earthen berms up to six feet high were constructed around the tanks as well, however, these may have been reduced by erosion or have been removed (Warner, et. al. 1990).

Some buildings and facilities constructed in support of NASA activities are located in the vicinity of the toluene tanks. The I Site Test Facility and the A Site Test Facility are located southwest and northwest of the Middle Toluene Tank Area, respectively. Also, a domestic water tower is located northeast of Tank 255. Some abandoned single track railroad lines are located south of the Upper Toluene Tank Area, west of the Middle Toluene Tank Area, and east of the Lower Toluene Tank Area. All of the toluene tanks are located on concrete foundations of the same circumference as the base of the tank, and earthen berms were constructed around each of the tanks. The berms have apparently been removed around Tanks 425, 435, and 645 (D&M 1995). Site records do not indicate that waste disposal activities, other than unexpected releases, occurred in the toluene tank areas either during PBOW activity or following World War II.

8.2.2 Geology

The glacial deposits underlying the Lower Toluene Tank Area are described on borehole logs for monitoring wells MK-MW-14 (installed north of Tank 645) and MK-MW-15 (installed north of Tank 655). The boreholes were drilled to depths of 11.5 feet and 9 feet, respectively, before encountering bedrock. Each borehole penetrated brown silty sand from the surface to total depth (MK 1994a).

In the Middle Toluene Tank Area, a single borehole was drilled and logged for well MK-MW-18 located between Tanks 425 and 435. The borehole penetrated brown silty sand before encountering weathered shale at a depth of six feet, and auger refusal at nine feet. Because the borehole was dry, the well was not installed (MK 1994a).

The sediments underlying the Upper Toluene Tank Area are described on borehole logs for monitoring wells MK-MW-20 (north of Tank 265) and MK-MW-21 (north of Tank 255). The boreholes were drilled to depths of 23 feet and 15 feet, respectively, penetrating brown silty clay to total depth. The boring for

MK-MW-21 was begun on the earthen dike and drilled through six feet of fill before reaching the silty clay; the borehole was terminated with auger refusal at 15 feet, and the well was not installed (MK 1994a).

8.2.3 Hydrology

The hydrology of the toluene tank areas has been interpreted from topographic maps, soil borings, and monitoring wells installed at and near the sites. Aquifer tests have not been conducted in the wells in the toluene tank areas, and therefore hydrogeologic parameters are not defined.

8.2.3.1 Surface Water

Surface runoff at the Upper Toluene Tank Area (255 and 265) flows west toward Plum Brook, which in turn flows in a northeasterly direction off the site. Surface runoff at the Middle Toluene Tank Area (425 and 435) flows northeastward to Ransom Brook which flows northward off the site. At the Lower Toluene Tank Area (645 and 655) runoff accumulates in a nearby surface depression or pond adjacent to the site, or flows northward to a tributary of Pipe Creek.

8.2.3.2 Ground Water

During the construction of monitoring wells in the Upper Toluene Tank Area, ground water was encountered at a depth of 17 feet below ground surface in monitoring well MK-MW-20, and no water was reported on the borehole log for monitoring well MK-MW-21 (drilled to 15 feet). At the Middle Toluene Tank Area, bedrock was encountered at nine feet with no water. At the Lower Toluene Tank Area, water was reported on the borehole logs at a depth of about six feet in monitoring well MK-MW-14 and at a depth of approximately four feet in monitoring well MK-MW-15 (MK 1994a).

8.2.3.3 Monitoring Wells

Monitoring well MK-MW-20 was installed in the vicinity of the Upper Toluene Tank Area downgradient from Tank 265. Monitoring well MK-MW-21 was to be installed in the earthen dike area on the north edge of Tank 255. This boring was drilled to a depth of 15 feet below the ground surface before encountering bedrock. Because the boring did not produce water, a monitoring well was not installed.

Monitoring well MK-MW-18 was to be installed between the two tanks at the Middle Toluene Tank Area located along Taylor Road but was not installed due to shallow bedrock.

Two monitoring wells were installed in the vicinity of the Lower Toluene Tank Area. MK-MW-15 is located north (downgradient) of Tank 656 and MK-MW-14 is located north (downgradient) of Tank 645 (MK 1994a). Detailed information on monitoring wells at PBOW is included in Section 14.0.

8.3 CONTAMINANTS OF CONCERN (COCs)

COCs for the toluene tank areas were determined on the basis of past operational activities (Section 8.1.2), and on the results of environmental investigations conducted at the sites.

8.3.1 Contaminants Resulting from PBOW Activities

Based on past activities at PBOW, toluene is a suspected contaminant at the toluene tank areas. The points of entry to soil and ground water are at transfer stations, transfer line valves, and the base of tanks. Morrison Knudsen (1994a) detected significant toluene contamination in ground water at the Upper Toluene Tank Area.

NASA's use of the Upper Toluene Tanks for fuel oil storage may have resulted in contamination of soil and ground water in this area. In January 1989, a leak from Tank 8951 (formerly Tank 265) contaminated soil in an area of approximately 465 square feet (SAIC, 1991).

8.3.2 Transport Mechanisms

Possible transport mechanisms in the toluene tank areas include:

- Migration of contaminants from soils and surface water to shallow ground water.
- Migration of contaminants in shallow ground water to off-site locations and to the deeper limestone aquifers in bedrock.
- Contaminant transport via the food chain.

8.3.3 Action Levels

Action levels apply to clean-up goals established by PBOW RODs, USEPA regulations, ARARs (i.e., MCL and NPDES), or are determined from risk-based calculations. Action levels have not been established for the toluene tank areas.

8.4 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination at the toluene tank areas has been investigated to a limited extent in the Site Inspection conducted by Morrison Knudsen (1994a). The results of this investigation are summarized in this section.

8.4.1 Upper Toluene Tank Area

8.4.1.1 Background Data

Background chemical analytical values for COCs in various media for the Plum Brook Site or the toluene tank areas have not been determined.

8.4.1.2 Sediment and Surface Water Investigations

Surface water and sediment samples MK-SW-13 and MK-SD-13 were collected from Plum Brook near the Upper Toluene Tank Area (Figure 8-1). A number of SVOCs (primarily PAH) were found in the sediment sample, along with minor amounts of toluene. No contamination was detected in any of the surface water samples. Sediment sample analytical results are shown in Table 8-1.

8.4.1.3 Surface Soil Investigations

No surface soil samples have been obtained from the Upper Toluene Tank Area.

8.4.1.4 Subsurface Soil Investigations

Subsurface soil samples were collected for analysis from soil borings MK-SB-12 (well MK-MW-20) and MK-SB-13 from the Upper Toluene Tank Area (MK 1994a). Samples were collected from the upper two feet of the borehole soils. The samples were analyzed for VOCs, SVOCs, total metals, sulfate, nitrates, pH, and nitroaromatic explosive compounds. The subsurface soil sample from MK-SB-13 contained acetone, toluene, and SVOCs (primarily PAH) in minor quantities (estimated values). Table 8-2 summarizes the results of these analyses.

Table 8-1. Sediment Sampling Analytical Results, Toluene Tank Areas[a]

Compound	Middle Tank Area	Upper Tank Area
	MK-SD-08	MK-SD-13
2,4-Dinitrotoluene	U	140J
Acetone	21	U
Acenaphthylene	U	110J
Anthracene	U	110J
Benzo(a)anthracene	U	730
Benzo(a)pyrene	U	560
Benzo(b)fluoranthene	U	880
Benzo(ghi)perylene	U	130J
Benzo(k)fluoranthene	U	370J
Chrysene	U	530
Dibenzo(a,h)anthracene	U	44J
Fluoranthene	U	970
Indeno(1,2,3-cd)pyrene	U	180J
Phenanthrene	U	200J
Pyrene	U	1,100
Toluene	1J	2J

[a]Units in µg/kg.
J Estimated value.
U Compound was analyzed for but not detected .

Source: Morrison Knudsen, 1994a (Chapter 4).

8.4.1.5 Ground-Water Investigations

Monitoring well MK-MW-20 is located within the earthen dike surrounding Tank 265 in the Upper Toluene Tank Area (MK 1994a). Ground water samples were analyzed for VOCs, SVOCs, total metals, total sulfate, nitrate, pH, and nitroaromatic explosive compounds. Analysis of the MK-MW-20 sample indicated the presence of volatile and semi-volatile compounds in the ground water (Table 8-3).

Table 8-2. Subsurface Soil Sampling Analytical Results, Toluene Tank Areas[a]

Compound	Lower Tank Area	Lower Tank Area	Upper Tank Area
	MK-SB-06	MK-SB-07	MK-SB-13
Acetone	U	U	36J
Anthracene	U	U	24J
Benzo(a)anthracene	U	U	92J
Benzo(a)pyrene	U	U	60J
Benzo(b)fluoranthene	U	U	86J
Benzo(ghi)perylene	U	U	32J
Benzo(k)fluoranthene	U	U	39J
Bis(2-ethylhexyl)phthalate	130J	970	83J
Chrysene	U	U	76J
Fluoranthene	U	U	210J
Indeno(1,2,3-cd)pyrene	U	U	39J
Phenanthrene	U	U	120J
Pyrene	U	U	150J
Toluene	U	U	4J

[a]Units in µg/kg.
J Estimated value.
U Compound was analyzed for but not detected.

Source: Morrison Knudsen, 1994a (Chapter 4).

Table 8-3. Ground-Water Sampling Analytical Results, Toluene Tank Areas[a]

Compound	Upper Tank Area	Upper Tank Area
	MK-MW-20	MK-MW-20D
2-Butanone	33J	U
2-Methylphenol	590E	520S
4-Methylphenol	200E	190S
Acetone	110J	U
Benzene	10J	U
Benzoic acid	13J	13SJ
Benzyl alcohol	13	U
Toluene	3,700EJ	36,000S
Total xylenes	8J	U

[a]Units in µg/ℓ.
J Estimated value.
D Duplicate sample.
U Compound was analyzed for but not detected.
E Compound exceeded CLP calibration range but was within instrument linear range.
S Analysis at a secondary dilution factor.

Source: Morrison Knudsen, 1994a (Chapter 4).

8.4.2 Middle Toluene Tank Area

8.4.2.1 Background Data

Background chemical analytical values for COCs in various media for PBOW or the toluene tank areas have not been determined.

8.4.2.2 Sediment and Surface Water Investigations

One surface water sample (MK-SW-08) and one sediment sample (MK-SD-08) were collected from Ransom Brook near the Middle Toluene Tank Area (Figure 8-2). Acetone was detected in the

sediment sample at a value of 21 ppb. Minor SVOCs and inorganic compounds were also detected in the sediment sample. Sediment sample analytical results are shown in Table 8-1.

8.4.2.3 Surface Soil Investigations

One surface soil sample (MK-SS-14) was obtained from the Middle Toluene Tank Area, collected from the low diked area between the two tanks (Figure 8-2). Neither VOCs, SVOCs, nor nitroexplosive compounds were detected in this sample.

8.4.2.4 Subsurface Soil Investigations

Subsurface soil samples were collected for analysis from soil boring MK-SB-10 from the Middle Toluene Tank Area (MK 1994a). Samples were collected from the upper two feet of the borehole

soils. The samples were analyzed for VOCs, SVOCs, total metals, sulfate, nitrates, pH, and nitroaromatic explosive compounds. No VOCs, SVOCs, or nitroexplosive compounds were detected.

8.4.2.5 Ground-Water Investigations

No monitoring wells have been installed at the Middle Toluene Tank Area.

8.4.3 Lower Toluene Tank Area

8.4.3.1 Background Data

Background chemical analytical values for COCs in various media for PBOW or the toluene tank areas have not been determined.

8.4.3.2 Sediment and Surface Water Investigations

No surface water or sediment samples have been collected from the Lower Toluene Tank Area.

8.4.3.3 Surface Soil Investigations

No surface soil samples have been collected from the Lower Toluene Tank Area.

8.4.3.4 Subsurface Soil Investigations

Subsurface soil samples were collected for analysis from soil borings MK-SB-06 and MK-SB-07 (wells MK-MW-14 and MK-MW-15) from the Lower Toluene Tank Area (MK 1994a). Samples were collected from the upper two feet of the borehole soils. The samples were analyzed for VOCs, SVOCs, total metals, sulfate, nitrates, pH, and nitroaromatic explosive compounds. No VOCs or nitroexplosive compounds were detected in samples MK-SB-06 and MK-SB-07. However, bis(2-ethylhexyl)phthalate (an SVOC) was detected in minor quantities (estimated values) in both boreholes (Table 8-2).

8.4.3.5 Ground-Water Investigations

Monitoring wells MK-MW-14 and MK-MW-15 were installed at the Lower Toluene Tank Area (MK 1994a). Ground water samples were analyzed for VOCs, SVOCs, total metals, total sulfate, nitrate, pH, and nitroaromatic explosive compounds. Contaminants were not detected in either monitoring well.

8.5 CURRENT STATUS OF SITE CHARACTERIZATION

This section describes the current status of site characterization at the toluene tank areas, including additional investigations that may be necessary to define source areas of contamination, characterize potential migration pathways, or identify potential receptors and exposure pathways. Any additional investigations suggested here are not intended to be requirements for future work at this AOC. They are suggested for consideration for future work, to be implemented only if determined necessary through the site scoping process.

8.5.1 Physical Characteristics

Physical characteristics at the toluene tank areas have been determined from soil borings and monitoring wells installed at each of the sites.

8.5.2 Nature and Extent of Contamination

Suggestions for additional investigations to establish the nature and extent of contamination at the toluene tank areas include the following:

- Shallow surface soil contamination has been evaluated from only one surface soil sample at the Middle Toluene Tank Area and a systematic examination of surface soils to delineate the extent of soil contamination should be considered at each of the areas.

- Surface water and sediment sampling in the vicinity of the Lower Toluene Tank Area is suggested for consideration in future scoping.

- Due to the presence of shallow bedrock, no monitoring wells have been installed at the Middle Toluene Tank Area. A bedrock well is suggested at this location to sample shallow ground water.

8.5.3 Background Data

Additional background sampling in connection with the toluene tank areas is suggested for all media of concern.

8.6 POTENTIAL HAZARDS TO HUMAN HEALTH AND THE ENVIRONMENT

No formal risk assessment, either to human health or the environment, has been conducted for the toluene tank areas. A hazard ranking was conducted on the toluene tank areas (SAIC 1991) in which scores for the various transport pathways ranged from 3.84 to 9.7, well below the USEPA-designated hazard score of 28.5, at which point a site becomes eligible for inclusion in the NPL.

8.7 FEASIBILITY STUDIES

A feasibility study has not been conducted at the toluene tank areas.

8.8 REMEDIAL ACTIONS

No remedial actions have been performed at the toluene tank areas.

8.9 WETLANDS ASSESSMENTS

Potential wetlands make up to about 1.5 percent of the total habitats at PBOW. None of the toluene tanks are located in known or potential wetland areas. A site-wide wetlands delineation is planned (Bower 1995).

8.10 PLANNED ACTIVITIES

A focused Remedial Investigation (RI) is planned for portions of PBOW (D&M 1994) to determine whether contamination is present in the areas to be investigated. Although the toluene tank areas are not specifically targeted for this study, a site-wide ground-water investigation is planned to evaluate the presence and nature of contamination in the surficial and bedrock aquifers underlying the site. Also, a background soil quality assessment will be done to establish background levels of constituents of concern in site soils, particularly levels of metals. Following the RI, human health and environmental risk assessments may be conducted.

8.11 RECOMMENDATIONS

Additional sediment, soil, surface water, and ground-water investigations are recommended to determine the nature and extent of contamination in the toluene tank areas. The planned site-wide ground-water investigation (D&M 1994) should provide sufficient coverage to monitor potential ground-water contamination from the toluene tank areas. However, it is recommended that:

- Sediment and surface water be sampled and analyzed at the Lower Toluene Tank Area.
- Surface soils be systematically sampled at the toluene tank areas to determine the extent of contamination at these sites.
- Ground-water contamination detected at the Upper Toluene Tanks be further examined with monitoring wells to determine the presence and extent of any contaminant plume.

9.0 RAIL CAR UNLOADING AREA/SELLITE AREA

9.1 BACKGROUND

The Rail Car Unloading Area at PBOW was identified in the Preliminary Assessment as having potential for contamination from PBOW activities, particularly contamination of surface soil, surface water, and ground water (SAIC 1991). A Sellite Area, located adjacent the west side of the Rail Car Unloading Area, may have contributed contamination to the site and is therefore included in this AOC. This section provides descriptive and historic background information that may be related to potential contamination at the site.

9.1.1 Description

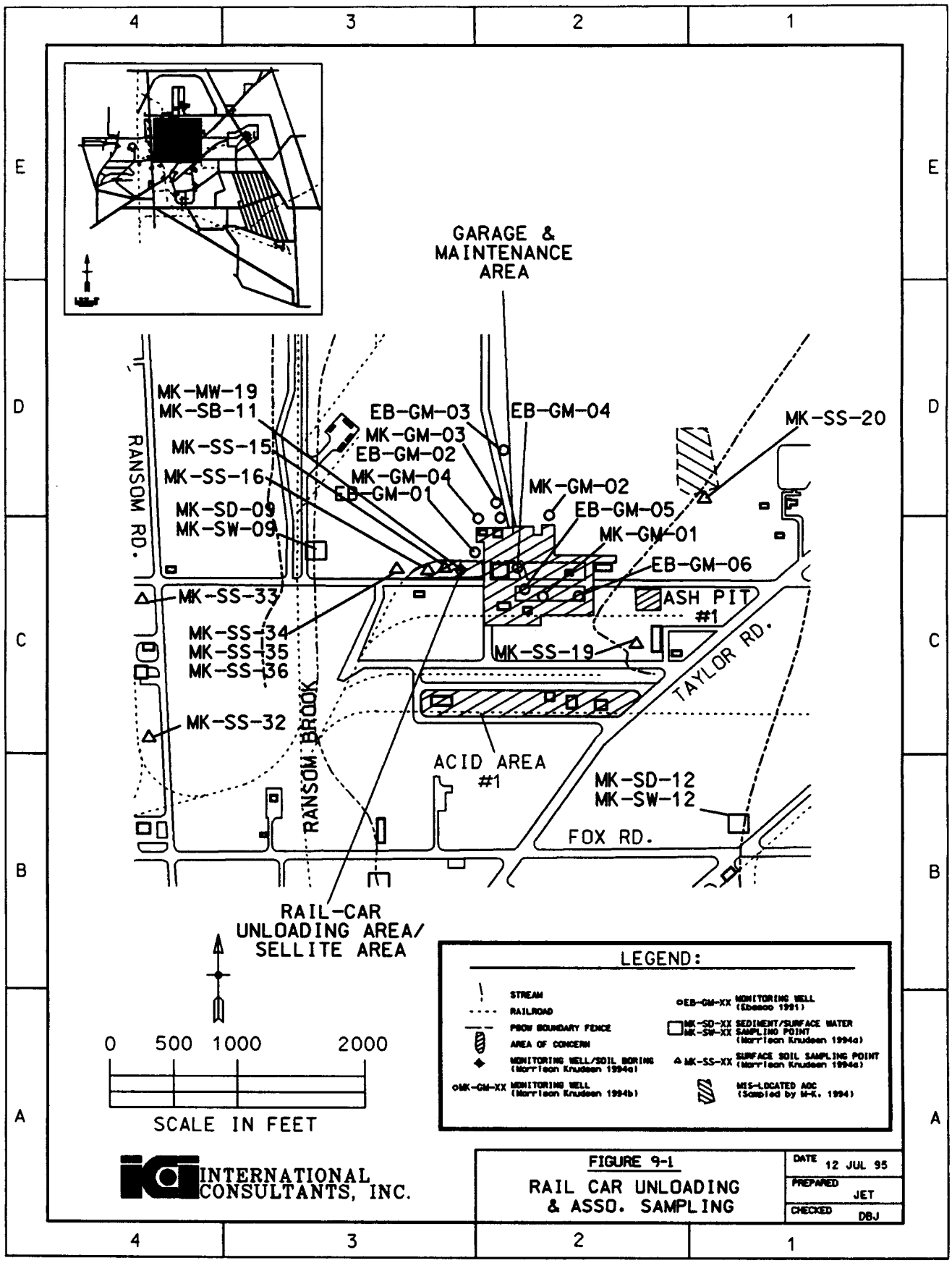
The Rail Car Unloading Area is near the Garage and Maintenance Area located on the north side of Maintenance Road between Ransom Road and Taylor Road, as shown in Figure 9-1. The site has been variously described as covering 1 acre (SAIC 1991) and 5 acres (MK 1994a).

The Sellite Area, located west of the Rail Car Unloading Area, was used for the production and storage of sellite used for the TNT washing process. A shallow surface water ditch which received runoff from the Sellite Area, is located to the east. Extensive areas of bare soil and pieces of sulfur and slag were observed at the former Sellite Area during field reconnaissance by Dames & Moore (1995).

Figure 9-2 is a 1958 NACA photograph which shows a portion of the Rail Car Unloading Area/Sellite Area. The building has since been removed, but remnants of the site remain, including cinders and sulfur, as shown in Figure 9-3.

9.1.2 History

The history of activities at the Rail Car Unloading Area is divided into two periods: the operational period of PBOW, and the post-operational period, including post-World War II decommissioning activities.


GARAGE & MAINTENANCE AREA
MK-MW-19
MK-SB-11
MK-SS-15
MK-SS-16
MK-SD-09
MK-SW-09
EB-GM-03
MK-GM-03
EB-GM-02
MK-GM-04
EB-GM-01
EB-GM-04
MK-GM-02
EB-GM-05
MK-GM-01
EB-GM-06
MK-SS-20
RANSOM RD.
MK-SS-33
MK-SS-34
MK-SS-35
MK-SS-36
MK-SS-32
ASH PIT #1
MK-SS-19
TAYLOR RD.
RANSOM BROOK
ACID AREA #1
MK-SD-12
MK-SW-12
FOX RD.
RAIL-CAR UNLOADING AREA/ SELLITE AREA
0 500 1000 2000
SCALE IN FEET
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
MK-GM-XX MONITORING WELL (Morrison Knudsen 1994b)
EB-GM-XX MONITORING WELL (Ebasco 1991)
MK-SD-XX MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
MIS-LOCATED AOC (Sampled by M-K, 1994)
INTERNATIONAL CONSULTANTS, INC.
FIGURE 9-1
RAIL CAR UNLOADING & ASSO. SAMPLING
DATE 12 JUL 95
PREPARED JET
CHECKED DBJ

NACA
APRA
C-7-L
8-15-58

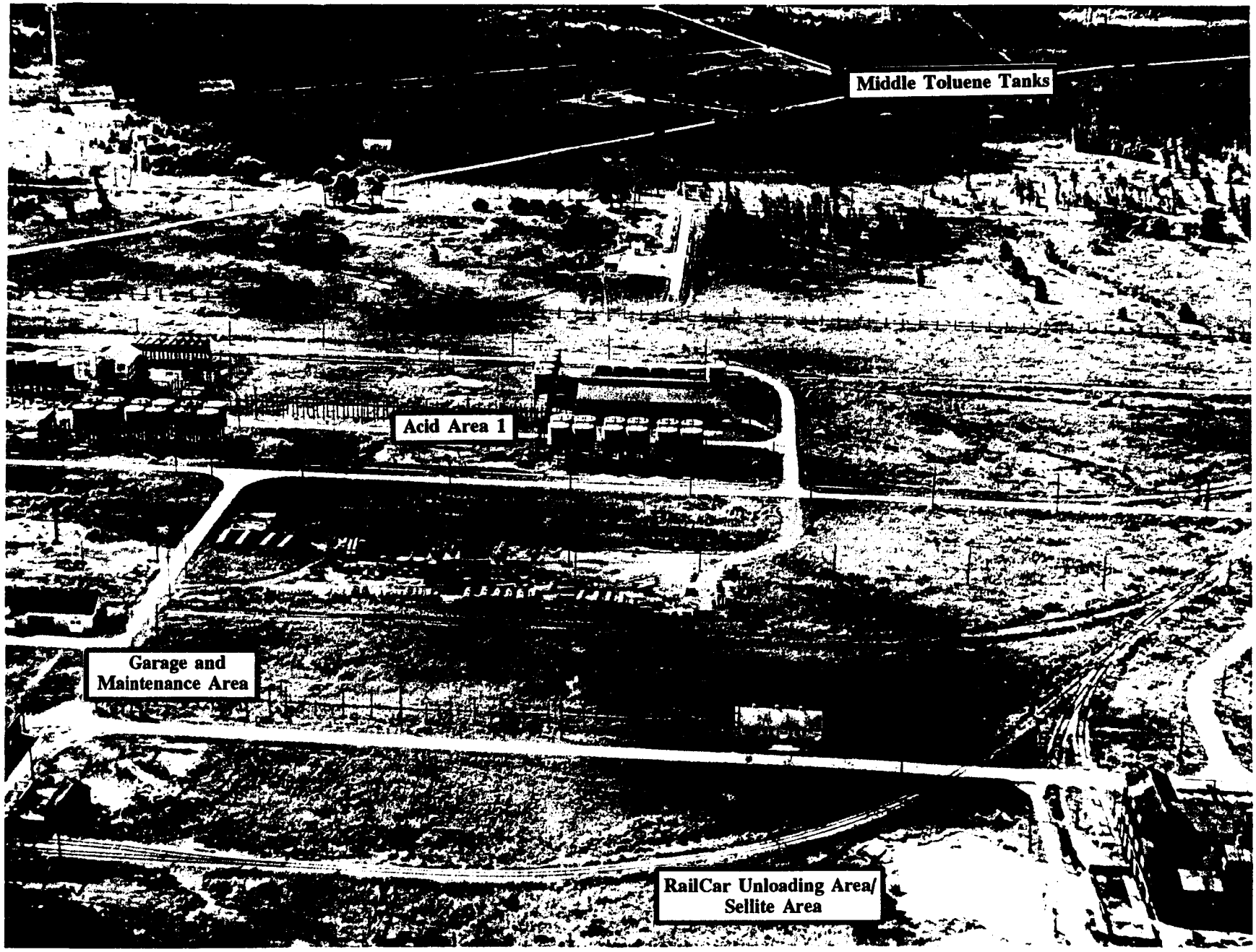


Figure 9-2. Rail Car Unloading Area/Sellite Area, 1958

Figure 9-3. Rail Car Unloading Area/Sellite Area, 1995

9.1.2.1 Operational Period (1941-1945)

The Rail Car Unloading Area was constructed in 1941 and was in use until the end of World War II when the PBOW was decommissioned. The site is believed to have been used for unloading toluene from rail cars. It is estimated that more than 400 million pounds of toluene were unloaded from rail cars at this site during the PBOW operational period. Additional chemicals may have been unloaded from railroad cars or stored in this area.

The nearby Sellite Area was used for the production and storage of sellite, used during the TNT washing process (D&M 1995).

9.1.2.2 Post-Operational Period

Following World War II, PBOW was in a standby condition from 1945 to 1946. The decommissioning of the Rail Car Unloading Area was begun in 1945 when ordnance manufacturing ceased. No other post-operational activities are known to have occurred in this area. However its proximity to the Garage and Maintenance Area may have led to its use for informal staging of equipment and supplies.

9.2 PHYSICAL CHARACTERISTICS

The physical characteristics of the Rail Car Unloading Area includes surface features, geology, and hydrology. The physical characteristics of PBOW in general are described in Section 1.0.

9.2.1 Surface Features

The Rail Car Unloading Area is located on relatively flat terrain with a gentle northward slope, at an approximate elevation of 635 feet above MSL. The location is grassland (Warner, et. al. 1990) with lush vegetation surrounding the area. Approximately 1/4 acre of the area is bare and supports little vegetation (SAIC 1991), possibly due to toluene spills during the unloading process. However, no areas of stressed vegetation were observed during 1995 field reconnaissances conducted by Dames & Moore or CEORN. The area around the sulfur piles at the Sellite Area was observed to be relatively devoid of vegetation.

Structures which existed at the Rail Car Unloading Area during PBOW operations have been removed. Broken timbers were found near the Sellite Area, suggesting the former presence of a wooden structure (MK 1994a), which has been confirmed by historical photographs (D&M 1995). Buildings 7121 (maintenance shop), 7123 (locomotive shop), 7132 (vehicle service station), 7122 (carpenters shop), 7143 (chemical laboratory), and 9208 (warehouse) are located east of the Rail Car Unloading Area. Also, an abandoned single railroad track is located on the northern and western portions of the site. Site records do not indicate that other waste disposal activities occurred at the Rail Car Unloading Area either during PBOW operations or following World War II. However, some sulfur pieces observed to the west of the site may be related to the unloading area or to the former sellite manufacturing process.

9.2.2 Geology

The glacial deposits underlying the Rail Car Unloading Area are described on borehole lithologic logs for monitoring wells installed in and near the sites. The borehole lithologic log for monitoring well MK-MW-

19 at the Rail Car Unloading Area indicates an upper silty sand layer (poorly graded) with weathered shale fragments from the surface to a depth of 13 feet.

9.2.3 Hydrology

The hydrology of the Rail Car Unloading Area has been interpreted from topographic maps and monitoring wells installed at and near the site. Aquifer tests have not been conducted in the wells at the Rail Car Unloading Area, and therefore hydrogeologic parameters are not defined.

9.2.3.1 Surface Water

Surface runoff at the Rail Car Unloading Area generally flows north to drainage ditches or streams. A tributary of Ransom Brook passes west of the site and flows northward off PBOW.

9.2.3.2 Ground Water

During the construction of monitoring well MK-MW-19 at the Rail Car Unloading Area, ground water was encountered at an initial depth of about 3.5 feet. Based on ground water elevations measured in monitoring wells at PBOW (MK 1994a), ground-water flow in the surficial aquifer is in a northerly direction in this area (Figure 14-2).

9.2.3.3 Monitoring Wells

A single monitoring well MK-MW-19 was installed on the east edge of the Rail Car Unloading Area (Figure 9-1) (MK 1994a). Other wells were installed just east of the site to evaluate contamination in the former USTs at the Garage and Maintenance Facility. These wells include:

- EB-GM-01, EB-GM-02, EB-GM-03, EB-GM-04, EB-GM-05, and EB-GM-06 (EBASCO 1991).
- MK-GM-01, MK-GM-02, MK-GM-03, and MK-GM-04 (MK 1994b).

Detailed information on monitoring wells at PBOW is included in Section 14.0.

9.3 CONTAMINANTS OF CONCERN (COCs)

COCs for the Rail Car Unloading/Sellite Areas were determined on the basis of past operational activities and results of environmental investigations conducted at the sites.

9.3.1 Contaminants Resulting from PBOW Activities

Based on the past site activities, toluene is the most likely COC at the Rail Car Unloading Area (SAIC 1991). However, other chemicals in addition to toluene may have been unloaded in this area, and the occurrence of sulfur piles in the Sellite Area suggests the possibility of contamination from sulfur compounds resulting from PBOW activities.

No post-operational activities are known to have taken place in the Rail Car Unloading Area. However, the site is adjacent to an area from which USTs have been removed and there may have been contamination if there were any leakage. Also, activities at the Garage and Maintenance Area may have contributed contaminants such as fuels, other petroleum compounds, and solvents.

9.3.2 Transport Mechanisms

Possible mechanisms for the transport of contaminants in the Rail Car Unloading Area include:

- Surface transport of liquid phase contaminants in precipitation runoff to nearby ditches and streams.
- Migration of contaminants from soils and surface water to shallow ground water.
- Migration of contaminants in shallow ground water to off-site locations and to the deeper limestone aquifers in bedrock.
- Transport of vapors in the atmosphere.
- Contaminant transport via the food chain.

9.3.3 Action Levels

Action levels apply to clean-up goals established by PBOW RODs, USEPA regulations, ARARs (i.e., MCLs and NPDES), or determined from risk-based calculations. Action levels have not been established for the Rail Car Unloading Area.

9.4 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination at the Rail Car Unloading Area and Sellite Area has been investigated to a limited extent in the Site Inspection conducted by Morrison Knudsen (1994a). The results of this investigation are summarized in this section.

9.4.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined. There are no monitoring wells located directly upgradient of the Rail Car Unloading Area to provide ground-water background values for the site. Monitoring well IT-MW-01 is located near the southern boundary of PBOW and may serve as a background well for the PBOW site in general.

9.4.2 Sediment and Surface Water Investigations

One sediment sample (MK-SD-09) and one surface water sample (MK-SW-09) were collected in Ransom Brook adjacent to the Rail Car Unloading Area. This location was selected as a possible point of entry to surface waters for contaminants from the Rail Car Unloading Area. No organic compounds were detected in the surface water sample, but acetone was detected at a concentration of 94 ppb in the sediment sample. Other VOCs, SVOCs, and nitroexplosive compounds were detected in the sediments, but most were below the quantitation limit. Table 9-1 summarizes the results of the sediment analyses.

9.4.3 Surface Soil Investigations

Two surface soil samples, MK-SS-15 and MK-SS-16, were collected near the Rail Car Unloading Area west of the Garage and Maintenance Facility on the north side of Maintenance Road. Only minor VOCs and SVOCs were detected in these samples, primarily sample MK-SS-16.

Three surface soil samples, MK-SS-34, MK-SS-35, and MK-SS-36, were obtained from the Sellite Area just west of the Rail Car Unloading Area near the intersection of Maintenance Road and the abandoned rail spur (Figure 9-1). Each of these samples contained minor quantities of toluene, and samples MK-SS-35 and MK-SS-34 contained moderate levels of bis(2-ethylhexyl)phthalate and coal tar derivatives. Table 9-2 summarizes the analytical results for the surface soil samples.

Table 9-1. Sediment Sampling Analytical Results, Rail Car Unloading Area[a]

Compound	MK-SD-09
Acetone	94
2-Butanone	11J
Benzo(a)anthracene	46J
Benzo(b)fluoranthene	59J
Benzo(k)fluoranthene	26J
Benzoic acid	10J
Chloromethane	4J
Chrysene	43J
Methylene chloride	5J
Phenanthrene	23J
Toluene	13J

[a]Units in µg/kg.
J Estimated value.

Source: Morrison Knudsen, 1994a (Chapter 4).

9.4.4 Subsurface Soil Investigations

A single subsurface soil sample was collected for analysis from the borehole for monitoring well MK-MW-19 (soil boring MK-SB-11). No VOCs were detected, however, a number of SVOC compounds, including PAH, were detected (Table 9-3).

9.4.5 Ground-Water Investigations

One ground water monitoring well, MK-MW-19, was installed along the western edge of the Garage and Maintenance Area near the Rail Car Unloading Area. The well was drilled to a depth of 13 feet and encountered ground water initially at a depth of 3.5 feet. The analysis of ground water collected from this well showed levels of 1,1-dichloroethane, 1,1,1-trichloroethane, and toluene (Table 9-4).

Table 9-2. Surface Soil Sampling Analytical Results, Rail Car Unloading Area[a]

Compound	MK-SS-15	MK-SS-16	MK-SS-34	MK-SS-35	MK-SS-35D	MK-SS-36
Acenaphthylene	U	U	U	190J	NA	U
Anthracene	U	U	U	98J	NA	U
Benzo(a)anthracene	U	27J	220J	920	NA	89J
Benzo(a)pyrene	U	22J	130J	680	NA	U
Benzo(b)fluoranthene	U	34J	310J	2400	NA	U
Benzo(ghi)perylene	U	U	63J	280J	NA	U
Benzo(k)fluoranthene	U	18J	130J	800	NA	U
Bis(2-ethylhexyl)phthalate	110J	U	1200	4800	NA	23,000E
Chrysene	U	28J	310J	1500	NA	97J
Dibenzo(a,h)anthracene	U	U	U	91J	NA	U
Fluoranthene	U	64J	460	2100	NA	180J
Indeno(1,2,3-cd)pyrene	U	U	85J	430	NA	U
Methylene chloride	U	2J	U	U	U	U
Phenanthrene	U	25J	110J	460	NA	48J
Pyrene	U	46J	410	1500	NA	130J
Toluene	0J	2J	54B	82J	43J	25B
Trichloroethene	U	U	U	1J	NA	1J

[a]Units in µg/kg.
B Analyte is found in the associated blank as well as the sample.
D Duplicate sample.
J Estimated value.
NA Not analyzed.
U Compound was analyzed for but not detected.
Source: Morrison Knudsen, 1994a (Chapter 4).

Table 9-3. Subsurface Soil Sampling Analytical Results, Rail Car Unloading Area[a]

Compound	MK-SB-11
1,1,1-Trichloroethane	2J
2-Methylnaphthalene	79J
Acenaphthylene	60J
Anthracene	56J
Benzo(a)anthracene	260J
Benzo(a)pyrene	230J
Benzo(b)fluoranthene	340J
Benzo(ghi)perylene	100J
Benzo(k)fluoranthene	160J
Benzoic acid	28J
Bis(2-ethylhexyl)phthalate	60J
Chlorobenzene	1BJ
Chrysene	240J
Dibenzo(a,h)anthracene	27J
Fluoranthene	510
Indeno(1,2,3-cd)pyrene	140J
Phenanthrene	220J
Pyrene	390

[a]Units in µg/kg.
B Analyte is found in the associated blank as well as the sample.
J Estimated value.

Source: Morrison Knudsen, 1994a (Chapter 4).

These solvents are likely related to past UST leakage rather than to activities at the Rail Car Unloading Area (MK 1994a). SVOCs were also detected at low levels in the ground water.

Table 9-4. Ground Water Sampling Analytical Results, Rail Car Unloading Area[a]

Compound	MK-MW-19
1,1-Dichloroethane	18
1,1-Dichloroethene	8
1,1,1-Trichloroethane	360E
Bis(2-ethylhexyl)phthalate	3J
Toluene	2J

[a]Units in µg/ℓ.
J Estimated value.
E Compound exceeded CLP calibration range but was within instrumental linear range.

Source: Morrison Knudsen, 1994a (Chapter 4).

9.5 CURRENT STATUS OF SITE CHARACTERIZATION

This section describes the current status of site characterization at the Rail Car Unloading Area/Sellite Area, including additional investigations that may be necessary to define source areas of contamination, characterize potential migration pathways, or identify potential receptors and exposure pathways. Any further investigations suggested here are not intended to be requirements for future work at this AOC. They are suggested for consideration for future work, to be implemented only if determined necessary through the site scoping process.

9.5.1 Physical Characteristics

The geologic characteristics of the glacial sediments underlying the Rail Car Unloading Area were determined from boreholes drilled for the installation of monitoring well MK-MW-19 (MK 1994a). The boring for this well was drilled to 13 feet without encountering bedrock. Additional borings in this area should include at least one drilled to bedrock to characterize glacial sediments and determine the depth to bedrock.

9.5.2 Nature and Extent of Contamination

The presence of contamination has been examined at the Rail Car Unloading Area and the Sellite Area from six surface soil samples one sediment and surface water sample, and one borehole and monitoring well (MK 1994a). Suggestions for additional investigations to establish the nature and extent of contamination at the Rail Car Unloading Area include the following:

- A systematic examination of soils to delineate the extent of soil contamination should be considered in future scoping.
- Sediment and surface water samples have been analyzed from Ransom Brook. Drainage ditches adjacent to the Rail Car Unloading Area have not been sampled. This work should be considered for future work.
- The monitoring well installed at the Rail Car Unloading Area (MK-MW-19) was sampled and analyzed, but the contamination detected may have been from the nearby former UST area rather than from the Rail Car Unloading Area. Additional monitoring wells at and downgradient to the site should be considered in future scoping.

9.5.3 Background Data

It is suggested that further work at this site include background sampling and analysis.

9.6 POTENTIAL HAZARDS TO HUMAN HEALTH AND THE ENVIRONMENT

No formal risk assessment, either human health or environmental, has been conducted for the Rail Car Unloading Area. Information on the nature and magnitude of soil, sediment, and surface-water contamination sufficient to conduct a risk assessment with respect to these media does not exist. A hazard ranking was conducted for the Rail Car Unloading Area (SAIC 1991) in which scores for the various transport pathways ranged from 3.84 to 9.70, well below the USEPA-designated hazard ranking score of 28.5, at which point a site becomes eligible for inclusion in the NPL.

9.7 FEASIBILITY STUDIES

A feasibility study has not been conducted for the Rail Car Unloading Area or the Sellite Area.

9.8 REMEDIAL ACTIONS

No remedial actions have been conducted at the Rail Car Unloading Area or the Sellite Area.

9.9 WETLANDS ASSESSMENTS

Potential wetlands make up about 1.5 percent of the total habitats at PBOW. A wetlands survey has not been conducted at the Rail Car Unloading Area, however, a site-wide wetlands delineation is planned in the near future (Bower 1995).

9.10 PLANNED ACTIVITIES

A focused Remedial Investigation (RI) is planned for portions of PBOW (D&M 1994) to determine whether contamination is present in the areas to be investigated. Although neither the Rail Car Unloading Area or the Sellite Area are specifically targeted for this study, a site-wide ground-water investigation is planned to evaluate the presence and nature of contamination in the surficial and bedrock aquifers underlying the site. Also, a background soil quality assessment will be done to establish background levels of constituents of concern in site soils, particularly levels of metals. Following the RI, human health and environmental risk assessments may be conducted.

9.11 RECOMMENDATIONS

Additional investigations are recommended at the Rail Car Unloading Area to further delineate the nature and extent of contamination. Surface and subsurface soil sampling is recommended to evaluate the extent of soil contamination. Additional sediment and surface water sampling is also recommended for the ditches adjacent to the site. Monitoring wells should be installed at the site and at the Sellite Area between the site and Ransom Brook to monitor possible ground-water contamination and determine the direction of ground-water flow.

10.0 ACID AREAS

10.1 BACKGROUND

The acid areas at PBOW have not been identified as AOCs in previous studies conducted at PBOW. However, because of the activities conducted at these areas during the operation of PBOW, the acid areas have potential for sediment, surface water, surface soil, subsurface soil, and ground water contamination.

10.1.1 Description

During the operation of PBOW, acid areas were used by the Army for the manufacturing of nitric and sulfuric acids. These acids were used in various stages of the manufacture of TNT and pentolite.

Three areas of acid manufacturing have been identified at PBOW: Acid Area #1, Acid Area #2, and Acid Area #3, shown in Figures 10-1, 10-2, and 10-3. Acid Area #1 is located in the central portion of PBOW, south of the Garage and Maintenance Area. Acid Area #2 is located in the westernmost portion of PBOW, south of Maintenance Road and just east of Patrol Road, northwest of Pipe Creek. Acid Area #3 is located in the northwestern portion of PBOW, along Ransom Road north of Maintenance Road. Each acid area is roughly rectangular in shape and covers an area of approximately ten acres.

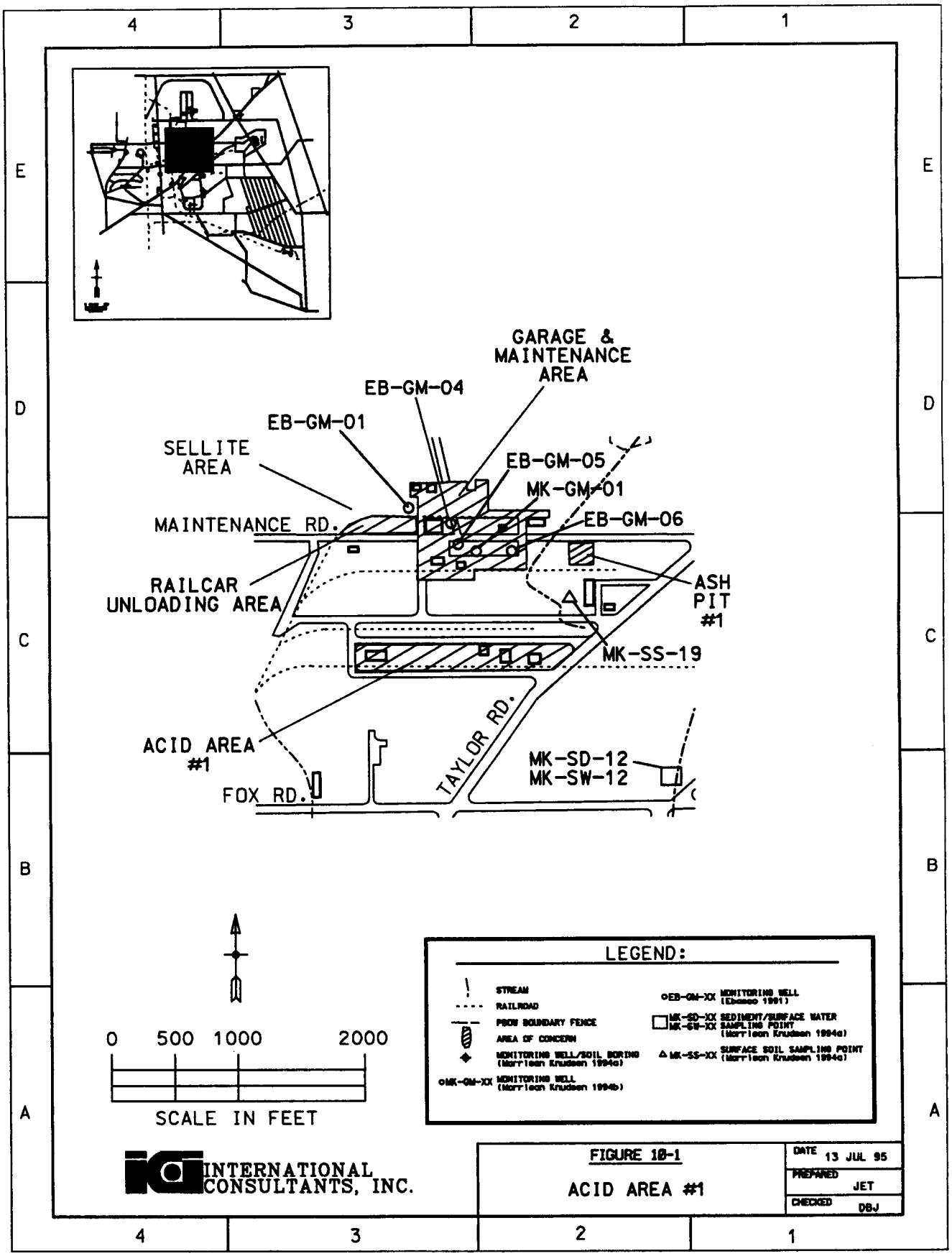
Figures 10-4 and 10-5 are photographs taken in 1958 of the acid areas. Acid Areas #1 and #3 are shown in Figure 10-4 and Acid Area #2 is shown in Figure 10-5. The buildings and structures have been removed from these areas, as shown in the recent (1995) photographs of Acid Areas #2, #3, and #1, which are shown in Figures 10-6, 10-7, and 10-8, respectively.

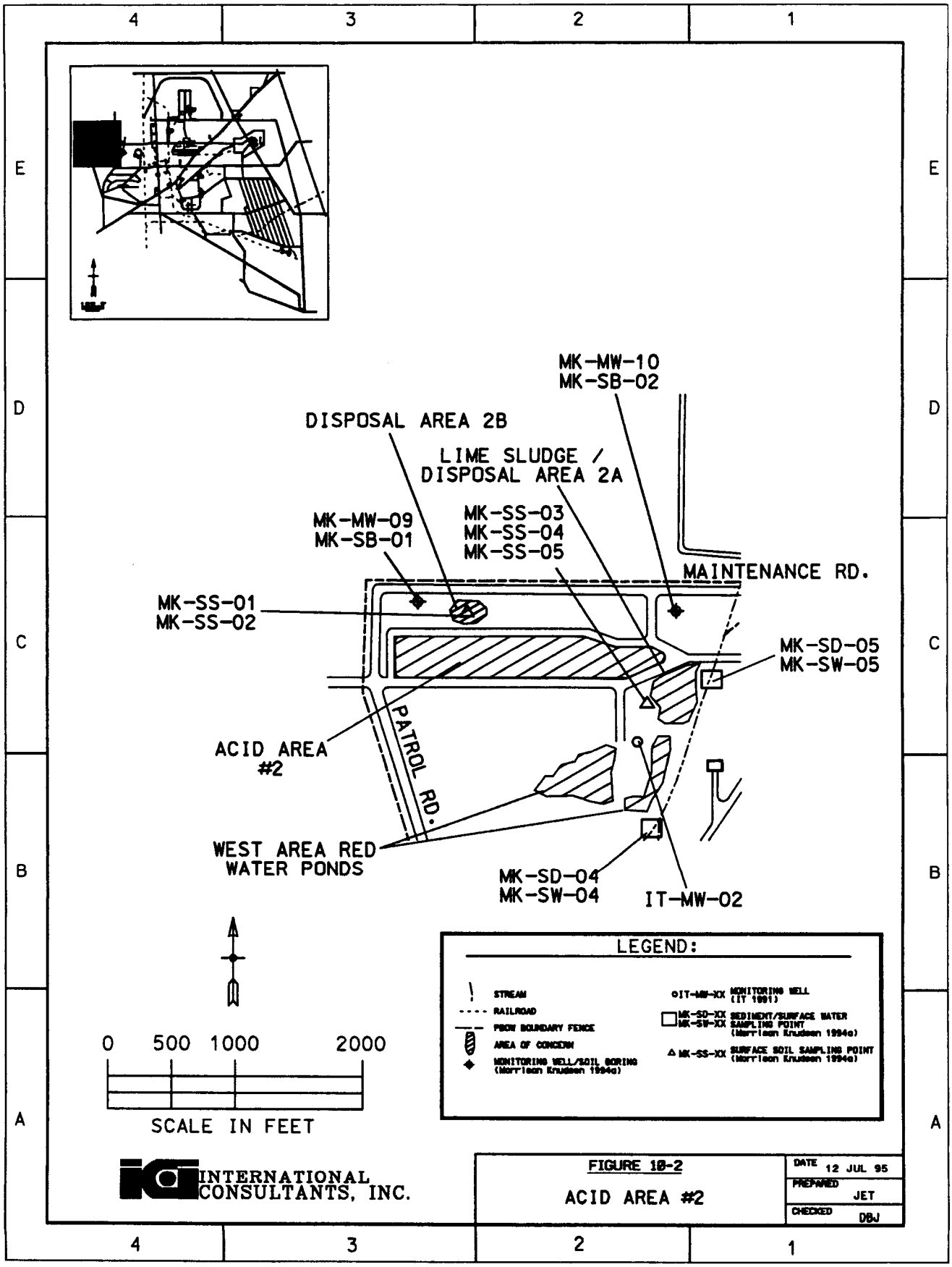
10.1.2 History

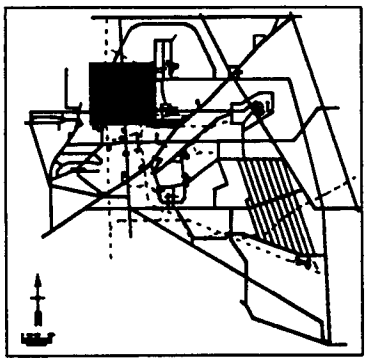
The history of activities at Acid Areas #1, #2, and #3 are divided into two periods: the operational period of PBOW, and the post-operational period, including post-World War II decommissioning activities.

10.1.2.1 <u>Operational Period (1941-1945)</u>

The acid manufacturing facilities were constructed in 1941 and operated until 1945. During this time, the acid areas were used for manufacturing and storing nitric and sulfuric acids for use in the manufacture of TNT, DNT, and pentolite.


GARAGE & MAINTENANCE AREA
EB-GM-04
EB-GM-01
SELLITE AREA
EB-GM-05
MK-GM-01
MAINTENANCE RD.
EB-GM-06
RAILCAR UNLOADING AREA
ASH PIT #1
MK-SS-19
TAYLOR RD.
ACID AREA #1
MK-SD-12
MK-SW-12
FOX RD.
0 500 1000 2000
SCALE IN FEET
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
MK-GM-XX MONITORING WELL (Morrison Knudsen 1994b)
EB-GM-XX MONITORING WELL (Ebasco 1991)
MK-SD-XX MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
INTERNATIONAL CONSULTANTS, INC.
FIGURE 10-1
ACID AREA #1
DATE 13 JUL 95
PREPARED JET
CHECKED DBJ


MK-MW-10
MK-SB-02
DISPOSAL AREA 2B
LIME SLUDGE /
DISPOSAL AREA 2A
MK-MW-09
MK-SB-01
MK-SS-03
MK-SS-04
MK-SS-05
MAINTENANCE RD.
MK-SS-01
MK-SS-02
MK-SD-05
MK-SW-05
ACID AREA
#2
PATROL RD.
WEST AREA RED
WATER PONDS
MK-SD-04
MK-SW-04
IT-MW-02
LEGEND:
STREAM
RAILROAD
PBOW BOUNDARY FENCE
AREA OF CONCERN
MONITORING WELL/SOIL BORING
(Morrison Knudsen 1994a)
IT-MW-XX MONITORING WELL
(IT 1991)
MK-SD-XX
MK-SW-XX SEDIMENT/SURFACE WATER
SAMPLING POINT
(Morrison Knudsen 1994a)
MK-SS-XX SURFACE SOIL SAMPLING POINT
(Morrison Knudsen 1994a)
0 500 1000 2000
SCALE IN FEET
INTERNATIONAL
CONSULTANTS, INC.
FIGURE 10-2
ACID AREA #2
DATE 12 JUL 95
PREPARED JET
CHECKED DBJ



ACID AREA #3

PENTOLITE RD.

RANSOM RD.

MAINTENANCE RD.

MK-SS-33

ASH PIT #3

0 500 1000 2000

SCALE IN FEET

LEGEND:

- STREAM
- RAILROAD
- PBOW BOUNDARY FENCE
- AREA OF CONCERN
- MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
- MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)

INTERNATIONAL CONSULTANTS, INC.

FIGURE 10-3

ACID AREA #3

DATE 12 JUL 95

PREPARED JET

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ICA
RA
6-D
5-58

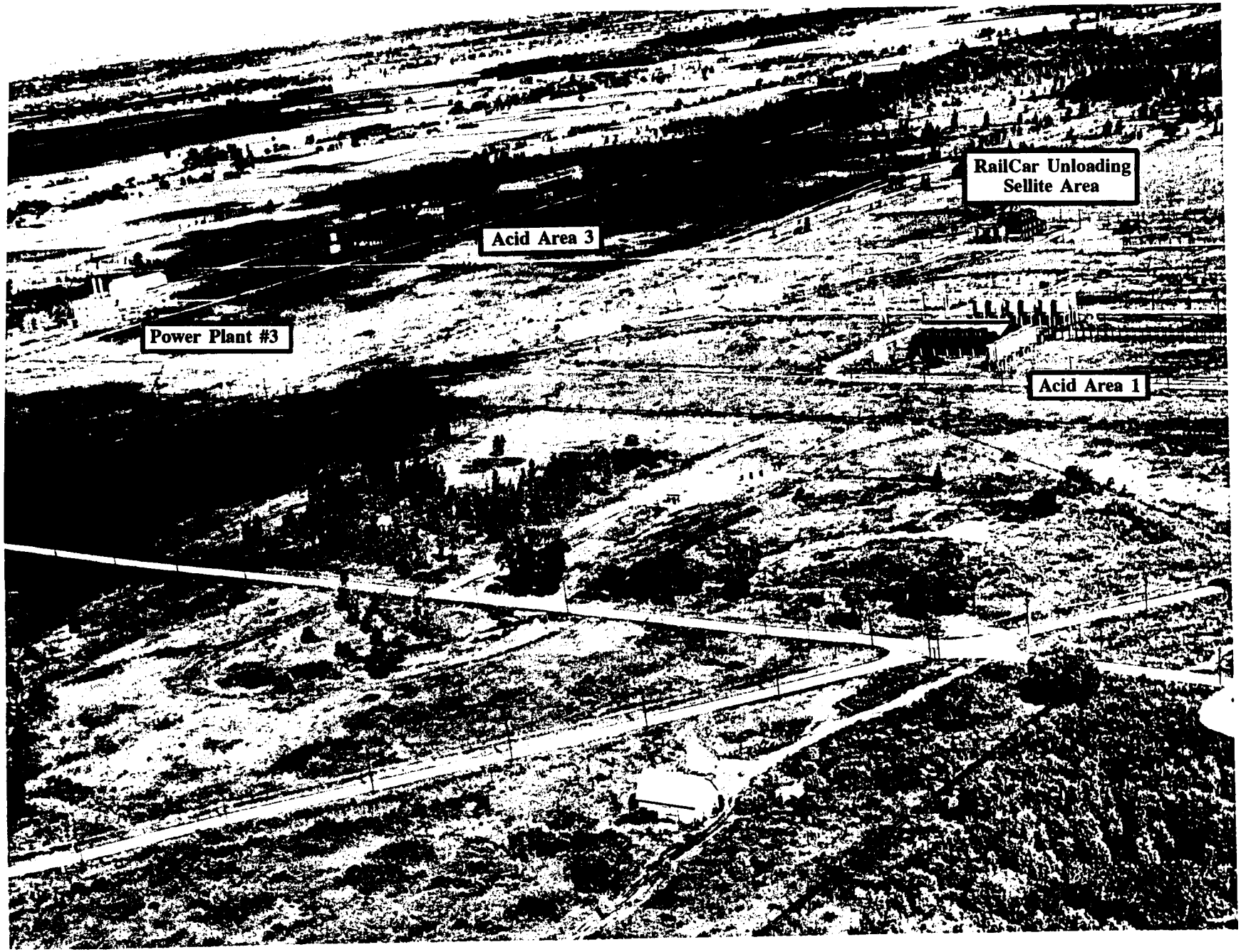


Figure 10-4. Acid Areas #1 and #3, 1958

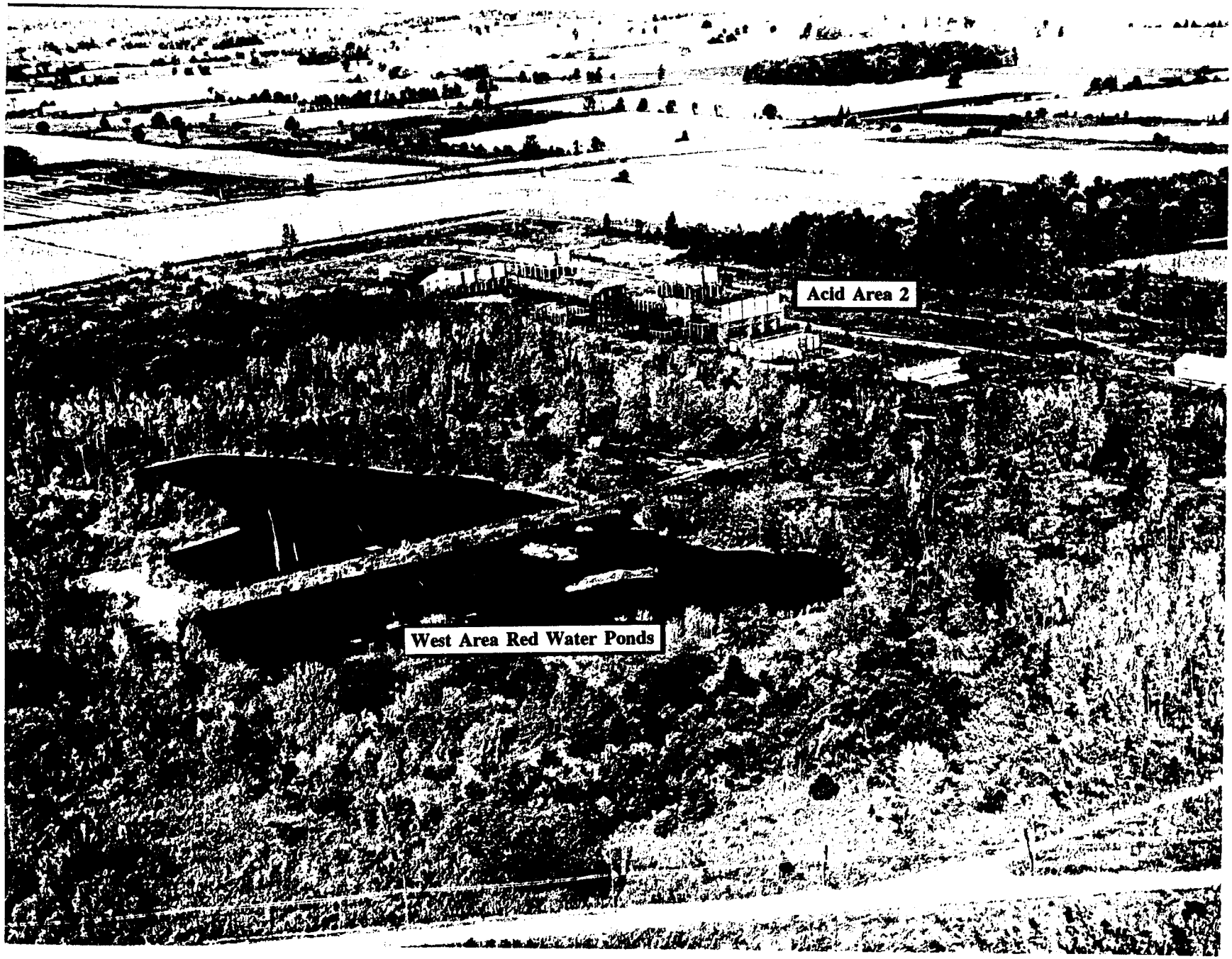


Figure 10-5. Acid Area #2, 1958

Figure 10-6. Acid Area #2, 1995

Figure 10-7. Acid Area #3, 1995

Figure 10-8. Acid Area #1, 1995

10.1.2.2 Post-Operational Period

Following World War II, PBOW was in a standby condition from 1945 to 1946. The decommissioning of the acid areas was begun in 1945, along with the rest of PBOW, when ordnance manufacturing ceased. Additional use of these areas has not been determined.

10.2 PHYSICAL CHARACTERISTICS

The physical characteristics of the acid areas include surface features, geology, and hydrology. The physical characteristics of PBOW in general are described in Section 1.0.

10.2.1 Surface Features

The PBOW site is located on what was originally a relatively flat lake bottom resulting from glacial melt waters. The general slope is northward toward Lake Erie. Acid Area #1 lies at an elevation of

approximately 635 feet, Acid Area #2 has an elevation of 643 feet, and Acid Area #3 has an elevation of 635 feet. Diverse vegetation can be observed at PBOW. There are significant areas of grassland, brushland and woodland in a well mixed array. Some potential wetlands, structured areas and open water areas also exist at PBOW. All the acid areas are located in grasslands (Warner, et. al. 1990).

Abandoned single track rail spurs can be seen at each of the acid areas, as well as foundations of buildings and other structures. Warehouse buildings, used for storage by NASA, remain at each of the areas. In addition, Buildings 8134 (pump house), 5131 (air compressor building), and 8931 (incinerator) are located at Acid Area #1 in support of the Garage and Maintenance Area. Site records do not indicate that waste disposal activities occurred at the acid areas.

10.2.2 Geology

Because ground-water monitoring wells have not been installed at the acid areas, limited information concerning site-specific geology can be inferred. Monitoring wells MK-MW-09 and MK-MW-10 (MK 1994a) were installed north of Acid Area #3, penetrating brown silty clay to their total depth of about 15 feet. Boreholes drilled for a UST investigation at the Garage and Maintenance Area, north of Acid Area #1, encountered, silty sand, brown silty clay, and grey silty clay from the surface to about 16 feet. Acid Areas 1, 2, and 3 fall within the Arkport-Galen Association of soils. These soils occur mostly in the northwestern half of PBOW. They are light colored, well-drained soils with high permeability and low available moisture content.

10.2.3 Hydrology

The hydrology of the acid areas has been interpreted from topographic maps, soil borings, and monitoring wells installed at and near the sites.

10.2.3.1 Surface Water

Precipitation runoff in Acid Area #1 flows either north toward a tributary of Plum Brook, or west toward Ransom Brook. Surface Runoff in the area of Acid Area #2 mostly flows eastward to join a tributary of Pipe Creek. Surface runoff in Acid Area #3 flows west toward a tributary of Pipe Creek.

10.2.3.2 Ground Water

No ground water monitoring wells have been installed at the acid areas, therefore, no water levels and ground-water gradients are known for these areas. Two monitoring wells (MK-MW-09, and MK-MW-10) are located downgradient of Acid Area #2. Ground water was encountered at a depth of nine feet below ground surface during installation of monitoring well MK-MW-09 and six feet below ground surface for well MK-MW-10. Ground water was encountered at a depth of about eight feet in the UST wells north of Acid Area #1.

10.2.3.3 Monitoring Wells

No monitoring wells have been installed at the acid areas. However, monitoring wells MK-MW-09 and MK-MW-10, drilled for Disposal Area 2B and the Lime Sludge Disposal Area, respectively, are located downgradient of Acid Area #2 and can be used to monitor contaminants from this area (Figure 10-2). Monitoring wells installed at the former UST site at the Garage and Maintenance Area are downgradient of Acid Area #1 and may serve as monitoring wells for this area. Detailed information on monitoring wells at PBOW is included in Section 14.0.

10.3 CONTAMINANTS OF CONCERN (COCs)

COCs for the acid areas were determined on the basis of past operational activities and on the results of environmental investigations conducted at the sites.

10.3.1 Contaminants Resulting from PBOW Activities

Because the acid areas were used for manufacturing and storing nitric and sulfuric acid, there is a potential for contamination from spills or improper disposal of acids at these sites. The resulting COCs may include heavy metals as well as sulfates and nitrates.

Other waste disposal is not believed to have occurred at the acid areas either during PBOW operations or following decommissioning of the site, although there is a possibility of accidental contaminant releases related to other unknown activities. The proximity of Acid Area #2 to the West Area Red Water Ponds, Disposal Area 2B, and the lime sludge area may have resulted in additional contamination.

10.3.2 Transport Mechanisms

Possible transport mechanisms in the acid areas include:

- Surface transport of liquid phase in precipitation runoff to Pipe Creek, Ransom Brook, or Plum Brook.
- Migration of contaminants from soils to surface water to shallow ground water.
- Migration of contaminants in shallow ground water to off-site locations and to deeper bedrock aquifers.
- Contaminant transport via the food chain.

10.3.3 Action Levels

Action levels apply to clean-up goals established by PBOW RODs, USEPA regulations, ARARs (i.e., MCLs and NPDES levels), or are determined from risk-based calculations. Action levels have not been established for the acid areas.

10.4 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination at the acid areas have not been investigated. However, the Site Inspection conducted by Morrison Knudsen (1994a) included sampling points near the acid areas.

10.4.1 Acid Area #1

10.4.1.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined. Background values also have not been determined for the acid areas.

10.4.1.2 Sediment and Surface Water Investigations

No sediment or surface water sampling was conducted specifically for the acid areas.

10.4.1.3 Surface Soil Investigations

No surface soil samples have been collected at the acid areas.

10.4.1.4 Subsurface Soil Investigations

No subsurface soil samples have been collected at the acid areas.

10.4.1.5 Ground-Water Investigations

No ground water samples were collected from the acid areas.

10.4.2 Acid Area #2

10.4.2.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined. Background values also have not been determined for either of the acid areas.

10.4.2.2 Sediment and Surface Water Investigations

No sediment or surface water sampling was conducted specifically for the acid areas. However, MK-SW-21, MK-SD-21 and MK-SW-06 and MK-SD-06 are downgradient of Acid Area #2 and may be used to help evaluate this AOC. Analysis of both the sediment samples indicated the presence of only SVOCs (PAH). No contamination was detected in the surface water samples.

10.4.2.3 Surface Soil Investigations

No surface soil samples have been collected at the acid areas.

10.4.2.4 Subsurface Soil Investigations

No subsurface soil samples have been collected at the acid areas.

10.4.2.5 Ground-Water Investigations

No ground water samples were collected from the acid areas. Ground-water samples from monitoring wells MK-MW-09 and MK-MW-10, located downgradient of Acid Area #2, did not contain detectable contamination (MK 1994a).

10.4.3 Acid Area #3

10.4.3.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined. Background values also have not been determined for either of the acid areas.

10.4.3.2 Sediment and Surface Water Investigations

No sediment or surface water sampling was conducted specifically for the acid areas.

10.4.3.3 Surface Soil Investigations

No surface soil samples have been collected at the acid areas.

10.4.3.4 Subsurface Soil Investigations

No subsurface soil samples have been collected at the acid areas.

10.4.3.5 Ground-Water Investigations

No ground water samples were collected from the acid areas.

10.5 CURRENT STATUS OF SITE CHARACTERIZATION

This section describes the current status of site characterization at the acid areas, including additional investigations that may be necessary to define source areas of contamination, characterize potential migration pathways, or identify potential receptors and exposure pathways. Any further investigations suggested here are not intended to be requirements for future work at this AOC. They are suggested for

consideration for future work, to be implemented only if determined necessary through the site scoping process.

10.5.1 Physical Characteristics

Physical characteristics have not been determined specifically for the acid areas, however the geology and hydrology can be inferred from nearby boreholes and the general characteristics of the PBOW site. Scoping for future work at the acid areas should consider boreholes to determine geologic and hydrologic characteristics, and a reconnaissance of each site to determine surface features.

10.5.2 Nature and Extent of Contamination

The acid areas have not been examined for the presence of contamination. Scoping for future studies should consider sampling of surface and subsurface soils, sediment and surface water, and ground water. A reconnaissance of each site should also be considered to detect signs of surface contamination.

10.5.3 Background Data

It is suggested that further work at this site include background sampling and analysis.

10.6 POTENTIAL HAZARDS TO HUMAN HEALTH AND THE ENVIRONMENT

No formal risk assessment, either to human health or the environment, has been conducted for the acid areas.

10.7 FEASIBILITY STUDIES

A feasibility study has not been conducted for the acid areas.

10.8 REMEDIAL ACTIONS

Remedial actions have not been conducted at the acid areas.

10.9 WETLANDS ASSESSMENTS

Potential wetlands make up about 1.5 percent of the total habitats at PBOW. A wetlands survey has not been conducted at the acid areas, however, a site-wide wetlands delineation is planned in the near future (Bower 1994).

10.10 PLANNED ACTIVITIES

A focused Remedial Investigation (RI) is planned for portions of PBOW (D&M 1994) to determine whether contamination is present in the areas to be investigated. Although the acid areas are not specifically targeted for this study, a site-wide ground-water investigation is planned to evaluate the presence and nature of contamination in the surficial and bedrock aquifers underlying the site. Also, a background soil quality assessment will be done to establish background levels of constituents of concern in site soils, particularly levels of metals. Following the RI, human health and environmental risk assessments may be conducted.

10.11 RECOMMENDATIONS

An investigation of the acid areas is needed to determine the nature and extent of contamination. A Preliminary Assessment (PA) of the acid areas should first be conducted to evaluate the potential for contamination at these sites. If the need for additional investigations is indicated by the PA, a Site Inspection (SI) should be conducted to determine if contamination is present, and the nature of the contamination. Sediment and surface soil sampling and analysis, in particular, are recommended for the SI. Additional studies at the acid areas will depend on the results of the SI, but may include further examination of sediment, surface and subsurface soils, and ground water.

11.0 PENTOLITE AREA

11.1 BACKGROUND

The Pentolite Area at PBOW has not been identified as an AOC in previous studies conducted at PBOW. However, because of the activities conducted at this site during the operation of PBOW, the Pentolite Area has potential for sediment, surface water, surface soil, subsurface soil, and ground water contamination.

11.1.1 Description

During the operation of PBOW, the Pentolite Area was used by the Army for the manufacturing of pentolite. Pentolite was produced from March 1943 through August 1945 when PBOW ceased operation (D&M 1995).

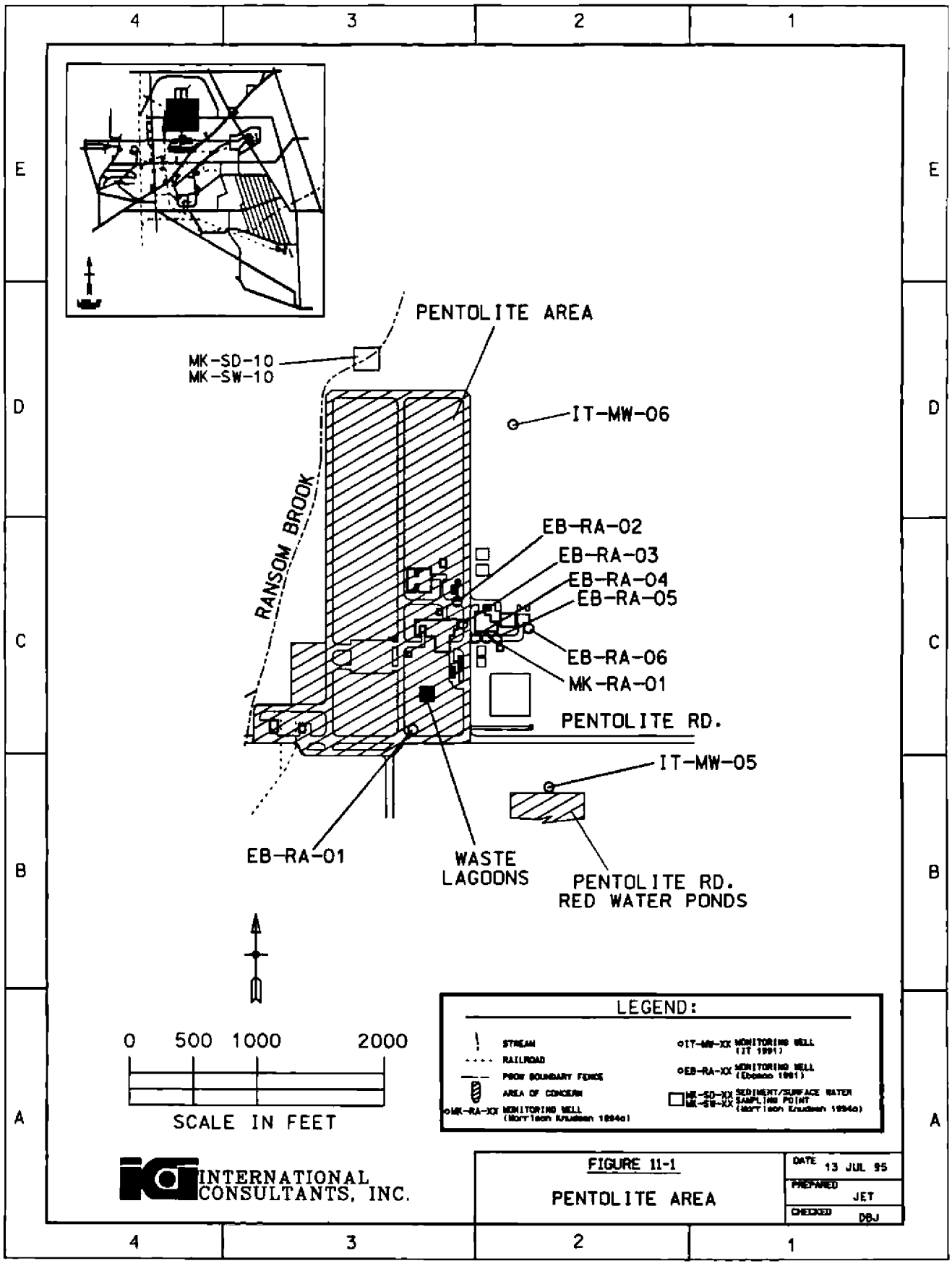
The former Pentolite Area is located in the central-north portion of PBOW, as shown in Figure 11-1. It lies within the boundaries of Ransom Road on the west, Pentolite Road on the south, and Patrol Road on the north and east. The exact size and shape of the site has not been determined, and the area has been altered for the construction of the Plum Brook Reactor Facility (PBRF). A 1989 photograph of the Pentolite Area is shown in Figure 3-4.

11.1.2 History

The history of activities at the Pentolite Area is divided into two periods: the operational period of PBOW, and the post-operational period, including post-World War II decommissioning activities.

11.1.2.1 Operational Period (1941-1945)

The Pentolite Area manufacturing facility, constructed in 1941 and operated until 1945, was the only area at PBOW used for the production of pentolite. The area contained three pentolite lines with a designated capacity of 7,000 pounds per 24 hours. Two basins received wastewater generated during pentolite production. The volume of wastewater, specific treatment details, and sludge details are not known (D&M 1995). The PA conducted by SAIC (1991) indicates that the wastewater generated during the manufacturing of pentolite probably contained significant concentrations of pentaerythrinol (PE), pentaerythrinol tetranitrate (PETN), acetone, and TNT. A flow diagram illustrating the pentolite production process is shown in Figure 11-2.


PENTOLITE AREA
MK-SD-10
MK-SW-10
IT-MW-06
RANSOM BROOK
EB-RA-02
EB-RA-03
EB-RA-04
EB-RA-05
EB-RA-06
MK-RA-01
PENTOLITE RD.
IT-MW-05
EB-RA-01
WASTE LAGOONS
PENTOLITE RD. RED WATER PONDS
0 500 1000 2000
SCALE IN FEET
LEGEND:
STREAM
RAILROAD
PROW BOUNDARY FENCE
AREA OF CONCERN
MK-RA-XX MONITORING WELL (Morrison Knudsen 1994a)
IT-MW-XX MONITORING WELL (IT 1991)
EB-RA-XX MONITORING WELL (Ebasco 1991)
MK-SD-XX MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
INTERNATIONAL CONSULTANTS, INC.
FIGURE 11-1
PENTOLITE AREA
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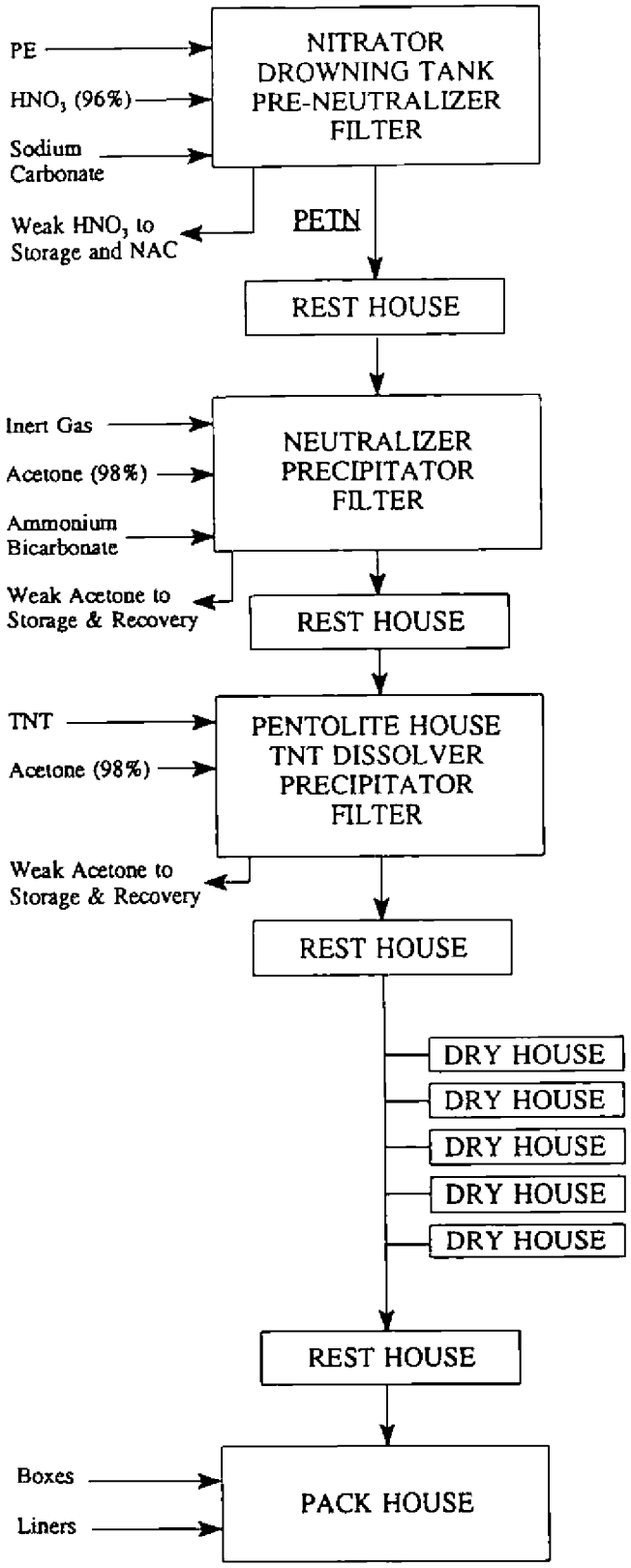


1. PE feed into HNO_3 bath starting nitration.
2. After nitration is complete, material is drowned causing precipitation of PETN.
3. Run through Pre-neutralizer where sodium carbonate is used as neutralizing agent.
4. Material is filtered. PETN placed in buggies.
5. Weak HNO_3 from filter to storage and Concentrator.

Rest House is used to ensure continual operation, thus Neutralizer may draw on stock in Rest House while Nitrator is shut down.

---

1. PETN dissolved in tank of acetone.
2. Material run into Precipitators. Ammonium bicarbonate and water added. Process kept warm by water jacket.
3. Material agitated during precipitation and blanket of inert gas introduced to prevent conflagration.
4. PETN filtered, washed and refiltered then shoveled into buggies.
5. Spent acetone from Filter to Recovery.

---

1. TNT dissolved in acetone.
2. PETN is shoveled into Precipitator and made into a "slurry" with water.
3. TNT solution added and precipitation takes place.
4. Pentolite filtered, placed in Tote Boxes and sent to dryers.
5. Weak acetone to Recovery.

---

1. Pentolite is packed in Drying Racks and allowed to remain 8 to 12 hours.
2. Placed in canisters and sent to Pack House. (Two Pack Houses for three lines.)

---

1. Pentolite packed 50 pounds per box, 10,000 pounds per lot. (Approximately 300 pounds per batch.)

Source: PBS Archives, Original dated 1/29/43

Figure 11-2. PENTOLITE PRODUCTION SCHEMATIC

11.1.2.2 Post-Operational Period

Following World War II, PBOW was in a standby condition from 1945 to 1946. The decommissioning of the Pentolite Area was begun in 1945 when ordnance manufacturing ceased. All buildings in the Pentolite Area were removed or burned in place (D&M 1995). In 1956, the Pentolite Area was selected by NASA as the site for the construction of the PBRF. The entire pentolite area was graded to meet reactor site specifications, and potentially contaminated soil was removed or dispersed during construction. Between 1963 and 1973, NASA operated the PBRF under an agreement with the Atomic Energy Commission (AEC). NASA currently holds a license with the Nuclear Regulatory Commission (NRC) for safe, protective storage of the reactor.

11.2 PHYSICAL CHARACTERISTICS

The physical characteristics of the Pentolite Area include surface features, geology, and hydrogeology. The general physical characteristics of PBOW are described in Section 1.0

11.2.1 Surface Features

The Pentolite Area is located on generally flat terrain with an elevation of approximately 625 feet above MSL. The Pentolite Area is located partly in brushland and partly in potential wetlands (Warner, et. al. 1990). The site is now occupied by the reactor building and support facilities, and is covered mostly with mowed grasses and ornamental shrubs. A security fence surrounds the PBRF.

11.2.2 Geology

The glacial deposits underlying the Pentolite Area are described on borehole lithologic logs for monitoring wells installed at a former UST area at the PBRF (Ebasco 1991, MK 1994c, IT 1991a). The borehole lithologic logs indicate an upper fine sand and silty sand to a depth of about 6-8 feet, followed by silty clay to a depth of approximately 10 to 16 feet.

11.2.3 Hydrology

The hydrology of the Pentolite Area has been interpreted from topographic maps, soil borings, and monitoring wells installed at and near the sites.

11.2.3.1 Surface Water

Precipitation runoff in the Pentolite Area currently flows either east toward Hemming Dutch, or west toward Ransom Brook. During the construction of PBRF, part of the Pentolite Area was excavated and backfilled, altering the drainage patterns of the area.

11.2.3.2 Ground Water

Ground water was encountered at a depth of 4-6 feet below ground surface during installation of the monitoring wells at a nearby former UST site. The ground-water gradient in this area is generally to the north (MK 1994a).

11.2.3.3 Monitoring Wells

Six monitoring wells were installed by Ebasco (1991) (EB-RA-01, EB-RA-02, EB-RA-03, EB-RA-04, EB-RA-05, EB-RA-06) and one monitoring well was installed by Morrison Knudsen (1994c) (MK-RA-01) to investigate the former UST site at the PBRF (Figure 11-1). One well was installed by IT (1991a) (IT-MW-06) to monitor ground-water quality at a downgradient location for PBOW in general, and may be used to monitor ground water from the former Pentolite Area. Detailed information on monitoring wells at PBOW is included in Section 14.0.

11.3 CONTAMINANTS OF CONCERN (COCs)

COCs for the Pentolite Area were determined on the basis of past operational activities (Section 11.1.2), and on the results of environmental investigations conducted at the sites.

11.3.1 Contaminants Resulting from PBOW Activities

Because of its past history the Pentolite Area may be a source of contamination from PE, PETN, acetone, and TNT. Previous investigations of the Waste Lagoons at the Pentolite Area (Section 6.0) indicate the presence of acetone in sediment samples downstream from the Pentolite Area (MK 1994a).

No waste disposal activities are known to have occurred at the Pentolite Area during PBOW activity or following World War II. During the construction of PBRF, soil at the area was tilled and moved, possibly causing shallow soil and surface water contamination. It is not known if soil was moved off-site from this construction area.

An accidental fuel oil spill at PBRF was reported in 1976, when approximately 50 to 75 gallons of No. 2 fuel oil leaked from an above-ground storage tank (AST) which fed fuel to a boiler in a service building. In addition, leakage from USTs in the former UST area at the Reactor Facility may have contributed petroleum products and solvents to the soil and ground water at the site.

11.3.2 Transport Mechanisms

Possible transport mechanisms in the Pentolite Area include:

- Surface transport of liquid phase in precipitation runoff to Hemming Ditch or Ransom Brook.
- Migration of contaminants from soils to surface water to shallow ground water.
- Migration of contaminants in shallow ground water to off-site locations and to deeper bedrock aquifers.
- Contaminant transport via the food chain.

11.3.3 Action Levels

Action levels apply to clean-up goals established by PBOW RODs, USEPA regulations, ARARs (i.e., MCLs and NPDES), or determined from risk-based calculations. Action levels have not been established for the Pentolite Area.

11.4 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination at the Pentolite Area has not been investigated. However, the Site Investigation conducted by Morrison Knudsen (1994a) included areas near the Pentolite Area, and investigations at the former UST site at PBRF may provide inferences on the nature and extent of contamination.

11.4.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined. Background values also have not been determined specifically for the Pentolite Area.

11.4.2 Sediment and Surface Water Investigations

No sediment or surface water sampling was conducted specifically for the Pentolite Area. However, one sediment sample (MK-SD-15) and one surface water sample (MK-SW-15) were collected in Hemminger Ditch downgradient from the Waste Lagoons (Section 6.0). This sampling point is a possible point of entry to surface waters for contaminants from the Reactor Facility, and may also be a point of entry for contaminants from the Pentolite Area. Analysis of the sediment samples indicated the presence of acetone (66 ppb) along with minor amounts (2J) of chloroform. No contamination was detected in the surface water sample.

11.4.3 Surface Soil Investigations

No surface soil samples have been collected at the Pentolite Area.

11.4.4 Subsurface Soil Investigations

No subsurface soil samples have been collected at the Pentolite Area.

11.4.5 Ground-Water Investigations

Ground water monitoring wells were installed at the former UST site at the PBRF (Ebasco 1991, MK 1994c, IT 1991a). However, samples from these wells were analyzed for petroleum-related products, not for the Pentolite Area COCs.

11.5 CURRENT STATUS OF SITE CHARACTERIZATION

This section describes the current status of site characterization at the Pentolite Area, including additional investigations that may be necessary to define source areas of contamination, characterize potential migration pathways, or identify potential receptors and exposure pathways. Any further investigations suggested here are not intended to be requirements for future work at this AOC. They are suggested for consideration for future work, to be implemented only if determined necessary through the site scoping process.

11.5.1 Physical Characteristics

Physical characteristics have not been determined specifically for the Pentolite Area, however the geology and hydrology can be inferred from boreholes drilled at the former UST site, and from the general characteristics of the PBOW site. Scoping for future work at this AOC should consider boreholes to determine geologic and hydrologic characteristics, and a reconnaissance of the site to determine features remain from PBOW operations.

11.5.2 Nature and Extent of Contamination

The Pentolite Area has not been examined for the presence of contamination related to PBOW activities. Scoping for future studies should consider sampling of surface and subsurface soils, sediment and surface water, and ground water. A reconnaissance of the site should also be considered to detect signs of surface contamination.

11.5.3 Background Data

Background data have not been collected for the Pentolite Area, and should be considered for future studies of this AOC.

11.6 POTENTIAL HAZARDS TO HUMAN HEALTH AND THE ENVIRONMENT

No formal risk assessment, either human health or environmental, has been conducted for the Pentolite Area.

11.7 FEASIBILITY STUDIES

A feasibility study has not been conducted for the Pentolite Area.

11.8 REMEDIAL ACTIONS

No remedial actions have been conducted at the Pentolite Area.

11.9 WETLANDS ASSESSMENTS

Potential wetlands make up about 1.5 percent of the total habitats at PBOW. A wetlands survey has not been conducted at the Pentolite Area, however, a site-wide wetlands delineation is planned in the near future (Bower 1994).

11.10 PLANNED ACTIVITIES

A focused Remedial Investigation (RI) is planned for portions of PBOW (D&M 1994) to determine whether contamination is present in the areas to be investigated. Although the Pentolite Area is not specifically targeted for this study, a site-wide ground-water investigation is planned to evaluate the presence and nature of contamination in the surficial and bedrock aquifers underlying the site. Also, a background soil quality assessment will be done to establish background levels of constituents of concern in site soils, particularly levels of metals. Following the RI, human health and environmental risk assessments may be conducted.

11.11 RECOMMENDATIONS

An investigation of the Pentolite Area is needed to determine the nature and extent of contamination. A Preliminary Assessment (PA) of this AOC should first be conducted to evaluate the potential for contamination at the site. If the need for additional investigations is indicated, a Site Inspection (SI) should be conducted to determine if contamination is present, and the nature of the contamination. Surface and subsurface soil sampling and analysis, in particular, are recommended for the SI. Additional studies at the Pentolite Area will depend on the results of the SI, but may include further examination of surface and subsurface soils, and ground water.

12.0 GARAGE AND MAINTENANCE AREA

12.1 BACKGROUND

The Garage and Maintenance Area has not been identified as an AOC in previous studies conducted at PBOW. However, the activities conducted at this location during the operation of PBOW indicate that the Garage and Maintenance Area has potential for sediment, surface water, surface soil, subsurface soil, and ground water contamination.

12.1.1 Description

During the operation of PBOW, the Garage and Maintenance Area was likely used by the Army for the general maintenance of equipment and vehicles. The Garage and Maintenance Area was operational between 1941 to 1945, becoming decommissioned when PBOW ceased operations. The former Garage and Maintenance Area is located in the central portion of PBOW along Maintenance Road, as shown in Figure 12-1. Figure 12-2 is a recent photograph of the area.

12.1.2 History

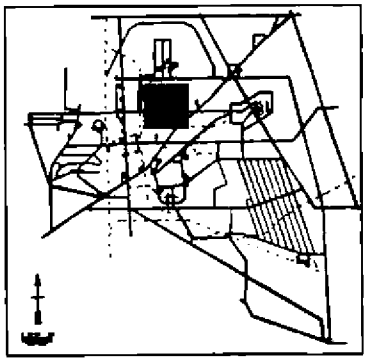
The history of activities at the Garage and Maintenance Area is divided into two periods: the operational period of PBOW, and the post-operational period, including post-World War II decommissioning activities.

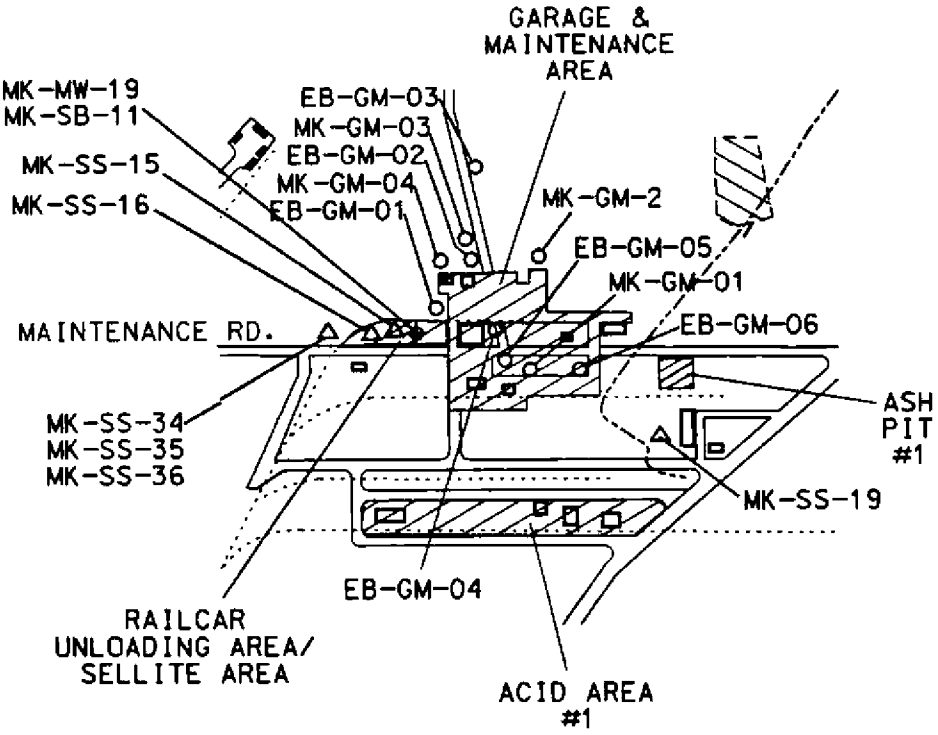
12.1.2.1 Operational Period (1941 - 1945)

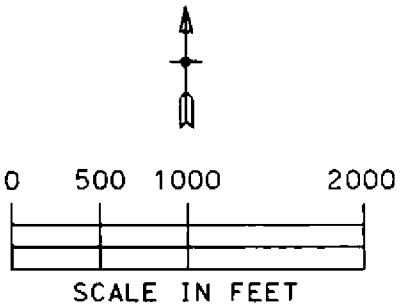
The Garage and Maintenance Area was constructed in 1941 and operated until 1945. During this time, the Garage and Maintenance Area was used for the maintenance of equipment and vehicles, possibly including rail cars. USTs were installed in this area for gasoline, solvents, and waste oil (Table 12-1) (SAIC 1991).

12.1.2.2 Post-Operational Period

Following World War II, PBOW was in a standby condition from 1945 to 1946. The decommissioning of the Garage and Maintenance Area was likely begun in 1945 when ordnance manufacturing ceased. The







LEGEND:

- STREAM
- RAILROAD
- PBS BOUNDARY FENCE
- AREA OF CONCERN
- MONITORING WELL/SOIL BORING (Morrison Knudsen 1994)
- MK-GM-XX MONITORING WELL (Morrison Knudsen 1994a)
- EB-GM-XX MONITORING WELL (Ebasco 1991)
- MK-SD-XX / MK-SW-XX SEDIMENT/SURFACE WATER SAMPLING POINT (Morrison Knudsen 1994a)
- MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994a)
- MIS-IDENTIFIED ASH PIT (SAIC 1991; MK 1994a)

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FIGURE 12-1

GARAGE AND MAINTENANCE AREA

DATE 13 JUL 95
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Figure 12-2. The Garage and Maintenance Area, 1995

area is currently used in support of NASA activities. Additional USTs were installed at this site in 1964 and 1982 for the storage of solvents and diesel fuel (Table 12-1).

12.2 PHYSICAL CHARACTERISTICS

The physical characteristics of the Garage and Maintenance Area include surface features, geology, and hydrogeology. The general physical characteristics of PBOW are described in Section 1.0.

Table 12-1. USTs at the Garage and Maintenance Area

Building	Number of Tanks Removed	Tank ID Numbers	Date Installed	Tank Capacity (gal)	Former Contents
7121	1	28	1942	3,000	Waste oil, solvents
7121	3	29, 30, 31	1964	700	Acetone, TCE, TCA
7121	1	32	1942	1,500	Waste oil, solvents
7122	3	33, 34, 35	1942	9,000	Gasoline
7122	1	36	1982	9,000	Diesel fuel

Source: SAIC, 1991.

12.2.1 Surface Features

The Garage and Maintenance Area is on relatively flat terrain with an average elevation of about 635 feet above MSL. The area is located partly in grassland and partly in a structured area (Warner, et. al. 1990).

Many of the original buildings from PBOW were left at the site, and are currently being used by NASA. Rail spurs are located to the north and south.

12.2.2 Geology

Monitoring wells were installed in the Garage and Maintenance Area in support of the UST removals conducted in the early 1990s (Ebasco 1991, MK 1994b, IT 1991a). The borehole lithologic logs for these monitoring wells indicate an upper fine sand with a trace of silt and gravel in the upper two to six feet, followed by clayey silt to a depth of approximately 16 to 18 feet, followed by a mixture of sand, gravel, silt and clay to bedrock. Bedrock was encountered at a depth of approximately 27 feet.

12.2.3 Hydrology

The hydrology of the Garage and Maintenance Area has been interpreted from topographic maps, soil borings, and monitoring wells installed at and near the site.

12.2.3.1 Surface Water

Precipitation runoff in the Garage and Maintenance Area flows either east toward Plum Brook, or west toward Ransom Brook.

12.2.3.2 Ground Water

Ground water was encountered at depths between four and ten feet in monitoring wells installed at the former UST area and the Garage and Maintenance Area. Based on the sitewide ground-water map prepared by Morrison Knudsen (1994b), ground-water flow is generally in a northeastern direction in this part of the site.

12.2.3.3 Monitoring Wells

Six monitoring wells were installed by Ebasco (EB-GM-01, EB-GM-02, EB-GM-03, EB-GM-04, EB-GM-05, EB-GM-06) (Ebasco 1991) and four were installed by Morrison Knudsen (MK-GM-01, MK-GM-02, MK-GM-03, MK-GM-04) (MK 1994b) in support of the UST closure in the Garage and Maintenance Area (Figure 12-1). Also, monitoring well MK-MW-19 was installed to the west in the Rail Car Unloading Area (Section 9.0). Detailed information on monitoring wells at PBOW is included in Section 14.0.

12.3 CONTAMINANTS OF CONCERN (COCs)

COCs for the Garage and Maintenance Area were determined on the basis of past operational activities and results of environmental investigations conducted at the sites.

12.3.1 Contaminants Resulting from PBOW Activities

The Garage and Maintenance Area may be a source of contamination from petroleum products and solvents, especially gasoline, acetone, TCE, and TCA. Investigations of former UST areas indicate the presence of BTEX compounds in ground water (Ebasco 1991). Four USTs were installed after PBOW

closure, three in 1964 for the storage of solvents (acetone, TCE, and TCA), and one in 1982 for diesel fuel. Storage and use of these chemicals may have contributed to contamination at the site.

12.3.2 Transport Mechanisms

Possible transport mechanisms in the Garage and Maintenance Area include:

- Surface transport of liquid phase in precipitation runoff to Plum Brook or Ransom Brook.
- Migration of contaminants from soils to surface water and to shallow ground water.
- Migration of contaminants in shallow ground water to off-site locations and to deeper bedrock aquifers.
- Contaminant transport via the food chain.

12.3.3 Action Levels

Action levels apply to clean-up goals established by PBOW RODs, USEPA regulations, ARARs (i.e., MCLs and NPDES), or are determined from risk-based calculations. Action levels have not been established for the Garage and Maintenance Area.

12.4 NATURE AND EXTENT OF CONTAMINATION

Contamination at the Garage and Maintenance Area has been investigated through the UST studies and closure assessments (Ebasco 1991; MK 1994b). Also, the Site Inspection conducted by Morrison Knudsen (1994) included locations near the Garage and Maintenance Area which may have been affected by contamination from this site.

12.4.1 Background Data

Background chemical analytical values for COCs in various media for PBOW in general have not yet been determined. Background values have not been determined for the Garage and Maintenance Area.

12.4.2 Sediment and Surface Water Investigations

No sediment or surface water sampling has been conducted for the Garage and Maintenance Area, although sampling was conducted in Plum Brook and Ransom Brook for the Site Inspection (MK 1994a).

12.4.3 Surface Soil Investigations

No surface soil samples have been collected specifically from the Garage and Maintenance Area.

12.4.4 Subsurface Soil Investigations

No subsurface soil samples have been collected from boreholes at the Garage and Maintenance Area. However, soil samples collected from pits during the UST removal indicated various levels of VOC contamination (Ebasco 1991).

12.4.5 Ground-Water Investigations

Investigations of the former UST locations at the Garage and Maintenance Area indicate the presence of BTEX compounds in the ground water. Benzene was detected at a concentration of 58 ppb in monitoring well EB-GM-01 (Ebasco 1991).

12.5 CURRENT STATUS OF SITE CHARACTERIZATION

This section describes the current status of site characterization at the Garage and Maintenance Area, including additional investigations that may be necessary to define source areas of contamination, characterize potential migration pathways, or identify potential receptors and exposure pathways. Any further investigations suggested here are not intended to be requirements for future work at this AOC. They are suggested for consideration for future work, to be implemented only if determined necessary through the site scoping process.

12.5.1 Physical Characteristics

Geological characteristics at the Garage and Maintenance Area have been characterized on borehole logs for the monitoring wells installed to investigate the former UST locations at the site. Locations of remnant PBOW buildings and structures have not been completely identified, and a reconnaissance of the area should be considered in future scoping.

12.5.2 Nature and Extent of Contamination

The Garage and Maintenance Area has not been examined for the presence of contamination related to PBOW activities. Monitoring wells have been installed to investigate former UST areas,, but analysis of samples was limited to UST-related contaminants. Scoping for future studies should consider sampling of surface and subsurface soils, and sediment and surface water. Assuming that the existing UST wells are usable, samples should be taken for relevant COCs. A reconnaissance of the site should also be considered to detect signs of surface contamination.

12.5.3 Background Data

Background data have not been collected for the Garage and Maintenance Area, and should be considered for future studies of this AOC.

12.6 POTENTIAL HAZARDS TO HUMAN HEALTH AND THE ENVIRONMENT

No formal risk assessment, either to human health or the environment, has been conducted for the Garage and Maintenance Area.

12.7 FEASIBILITY STUDIES

A feasibility study has not been conducted for the Garage and Maintenance Area.

12.8 REMEDIAL ACTIONS

With the exception of the UST removals, no remedial actions have been performed at the Garage and Maintenance Area.

12.9 WETLANDS ASSESSMENTS

Potential wetlands make up to about 1.5 percent of the total habitats at PBOW. There are no wetlands identified at the Garage and Maintenance Area. A site-wide wetlands delineation is planned (Bower 1995).

12.10 PLANNED ACTIVITIES

A focused Remedial Investigation (RI) is planned for portions of PBOW to evaluate the presence and nature of contamination in the areas to be investigated (D&M 1994). Although the Garage and Maintenance Area is not specifically targeted for this study, a site-wide ground-water investigation is planned to evaluate the presence and nature of contamination in the bedrock aquifer underlying the site. Also, a background soil quality assessment will be done to establish background levels of constituents of concern in site soils, particularly levels of metals (D&M 1994). Following the RI, human health and environmental risk assessment may be conducted.

12.11 RECOMMENDATIONS

An investigation of the Garage and Maintenance Area is needed to determine the nature and extent of contamination. A Preliminary Assessment of this AOC should first be conducted to evaluate the potential for contamination at the site. If the need for additional investigations is indicated, a Site Inspection (SI) should be conducted to determine if contamination is present, and the nature of the contamination. Surface and subsurface soil sampling and analysis, in particular, are recommended for the SI. Additional studies at the Garage and Maintenance Area will depend on the results of the SI, but may include further examination of surface and subsurface soils, and ground-water sampling from existing wells.

13.0 TNT RAIL CAR LOADING AREAS

13.1 BACKGROUND

The TNT Rail Car Loading areas have not been identified as AOCs in previous studies conducted at PBOW. However, the activities that may have been conducted at these areas during the operation of PBOW indicate that the TNT loading areas may have potential for sediment, surface water, surface soil, subsurface soil, and ground water contamination.

13.1.1 Description

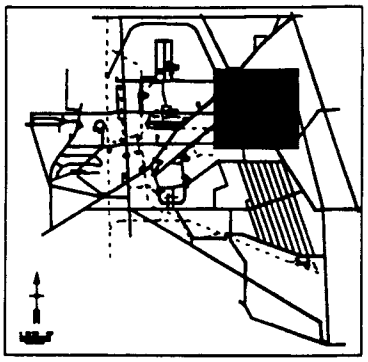
During the operation of PBOW, TNT was loaded onto rail cars for shipment from the site. The locations of these TNT Rail Car Loading Areas are unknown, and reference to them has not been found in site documents. However, it is suspected that there was a loading area at each of the TNT manufacturing areas, located along now-abandoned rail spurs (Figures 13-1, 13-2, and 13-3). A possible location of the TNT Area B Rail Car Loading Area is shown in Figures 13-4 and 13-5.

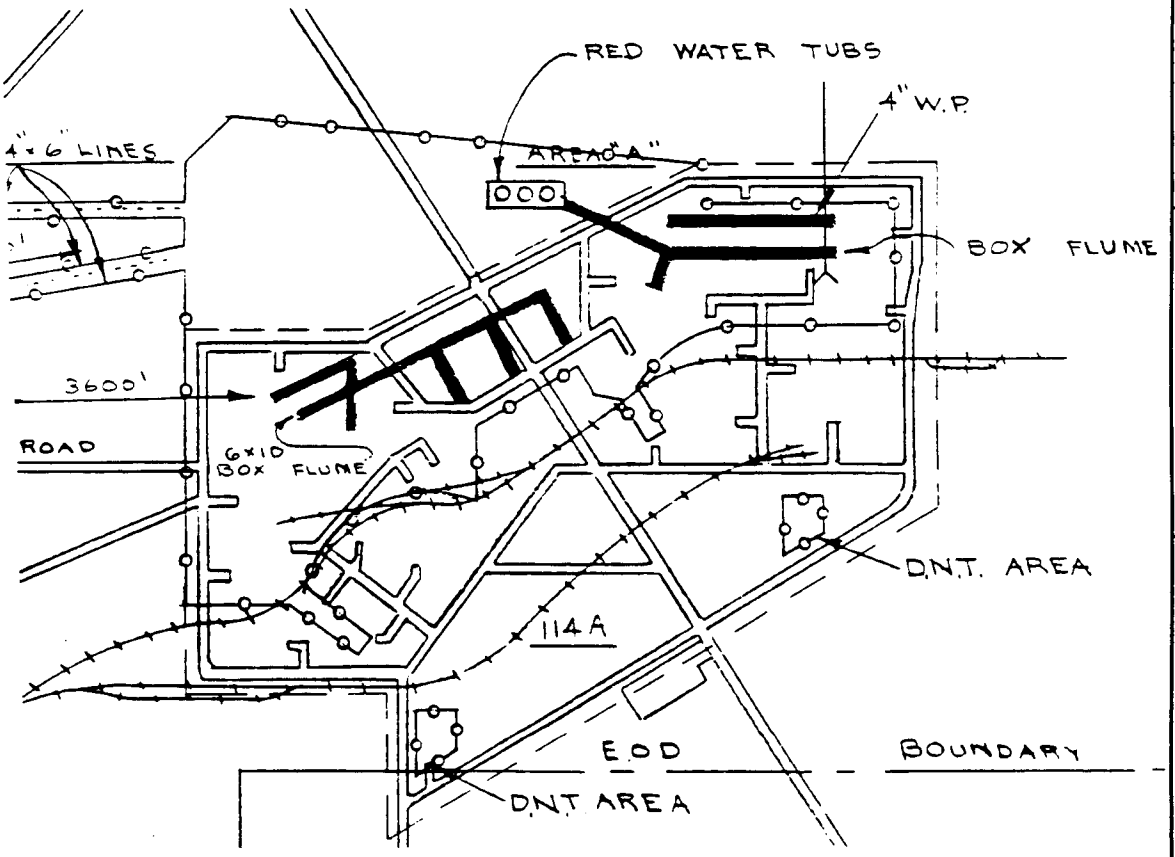
13.1.2 History

The history of activities at the TNT Rail Car Loading Areas is divided into two periods: the operational period of PBOW, and the post-operational period, including post-World War II decommissioning activities.

13.1.2.1 Operational Period (1941 - 1945)

The TNT Rail Car Loading Areas were constructed and operated during the operational period of PBOW, from 1941 until 1945. The interconnected single-track rail lines throughout PBOW and individual railroad spurs located within each TNT area indicate that TNT was loaded in the manufacturing areas, shipped to other parts of the PBOW for further packing or assembly, if required, and then shipped off the site or stored temporarily in magazines. The presence of the remnants of blast-protection walls adjacent abandoned rail tracks at the southern end of TNT Area B suggests this as a possible location of a TNT Rail Car Loading Area.





NOTE:
ENLARGED AREA FROM THE HISTORICAL MAP (FIG. 4-1)

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FIGURE 13-1
RAIL SPUR LOCATIONS IN TNT AREA A

DATE 13 JUL 95
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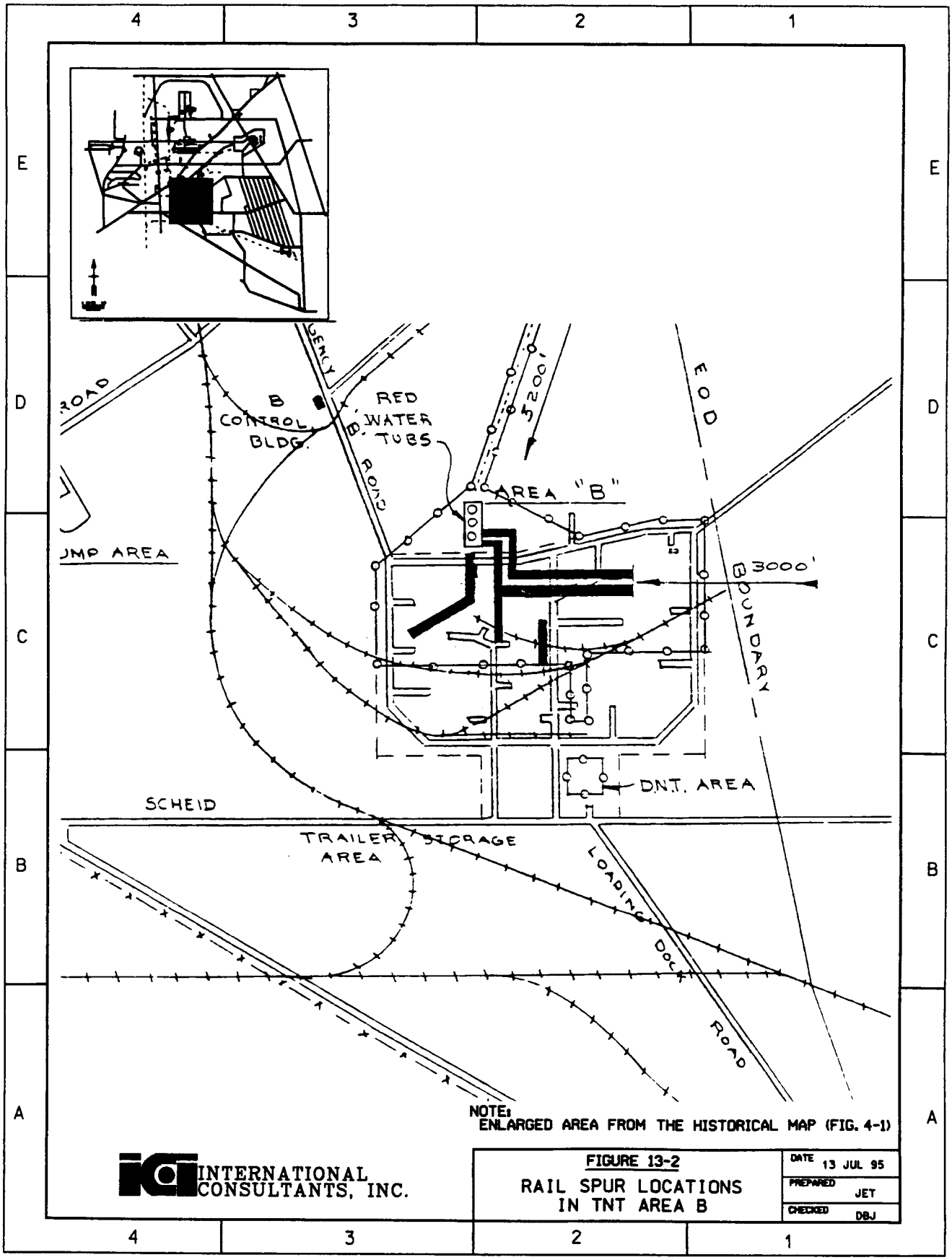

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FIGURE 13-2
RAIL SPUR LOCATIONS IN TNT AREA B

DATE 13 JUL 95
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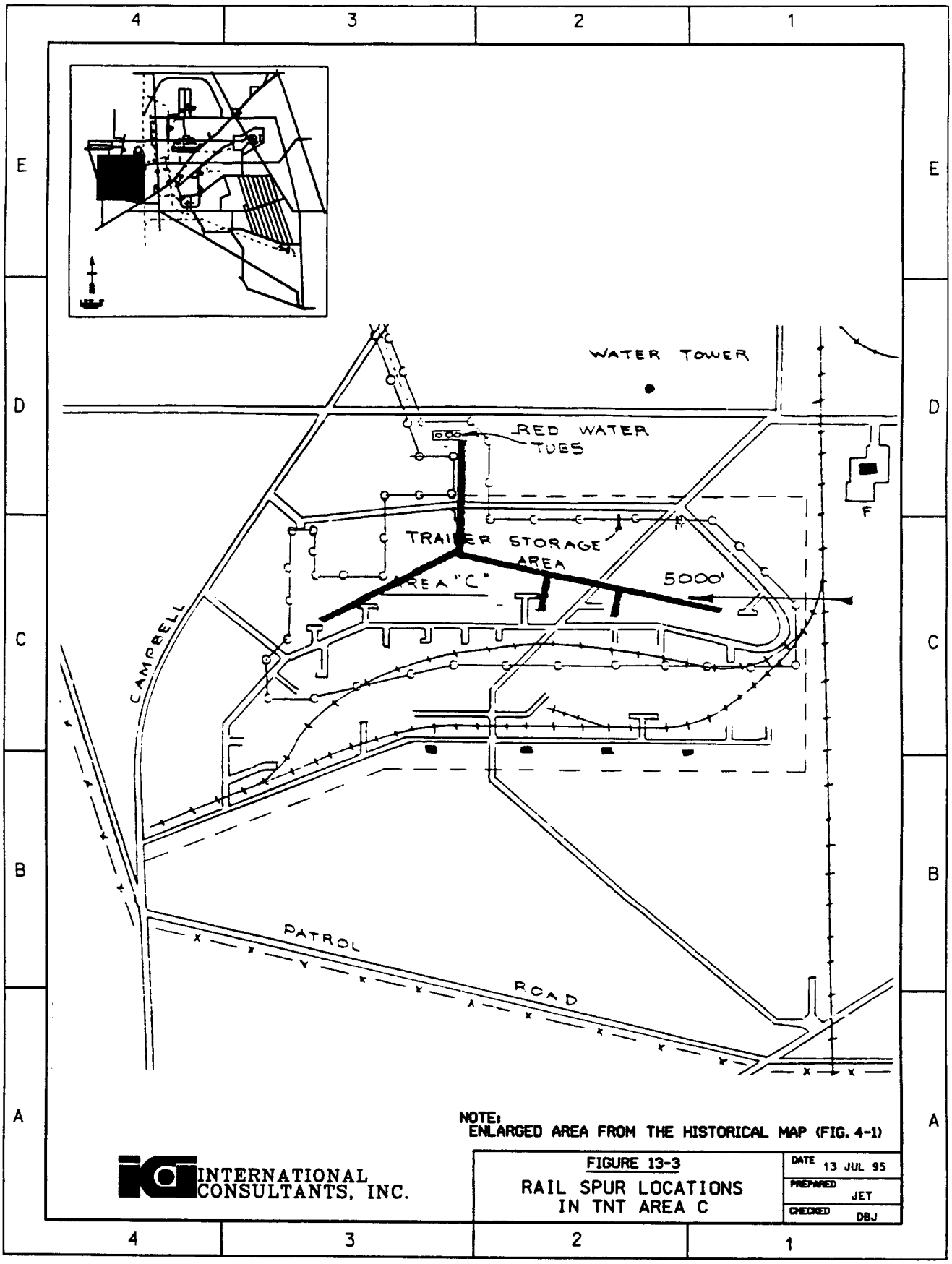
WATER TOWER
RED WATER TUBES
TRAILER STORAGE AREA
AREA "C"
5000'
CAMPBELL
PATROL ROAD
F
NOTE:
ENLARGED AREA FROM THE HISTORICAL MAP (FIG. 4-1)
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FIGURE 13-3
RAIL SPUR LOCATIONS IN TNT AREA C
DATE 13 JUL 95
PREPARED JET
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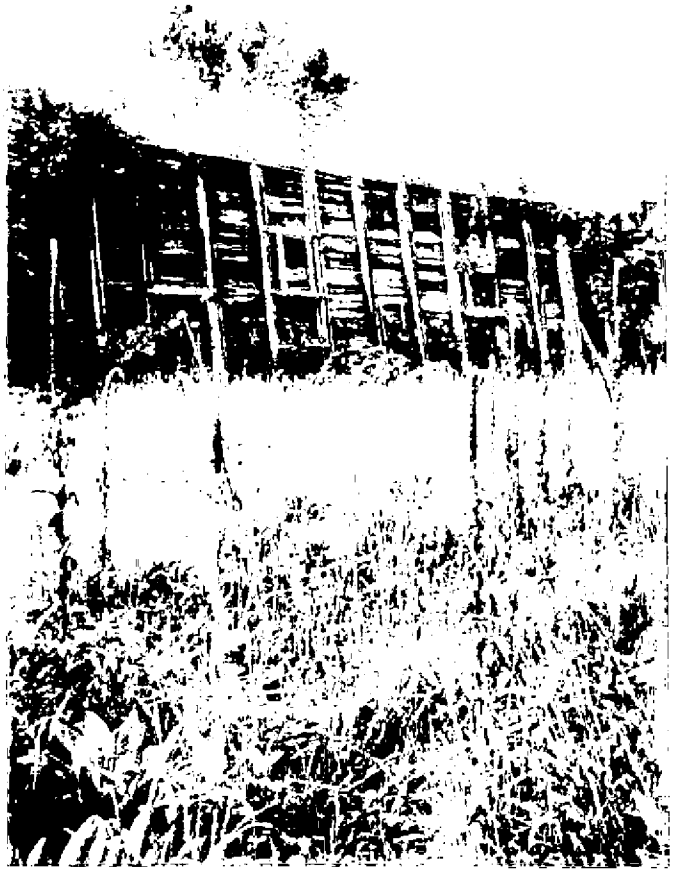


Figure 13-4. Possible TNT Area B Rail Car Loading Area, 1995 (Rail Tracks In Foreground)

Figure 13-5. Foundation Near TNT Area B Loading Area, 1995

13.1.2.2 Post-Operational Period

Following World War II, PBOW was decommissioned, and the rail loading areas were abandoned. Construction of facilities in support of NASA activities may have affected the loading areas, particularly at TNT Area A.

13.2 PHYSICAL CHARACTERISTICS

Because the TNT Rail Car Loading Areas are assumed to be located within the TNT areas, the physical characteristics of each loading area is the same as its respective TNT area (Section 2.0). The general physical characteristics of PBOW are described in Section 1.0.

13.3 CONTAMINANTS OF CONCERN (COCs)

COCs for the TNT Rail Car Loading Areas were determined on the basis of assumed past operational activities and the results of environmental investigations conducted at the TNT areas.

13.3.1 Contaminants Resulting from PBOW Activities

Based on the past site activities, nitroexplosives and residue from the TNT manufacturing process are likely COCs at the sites of the TNT Rail Car Loading Areas. Previous investigations at the three TNT Areas have shown that nitroexplosives, toluene, and acetone may be present in the sediments, soils, surface water, and ground water in these areas (SAIC 1991), some of which may be related to releases from loading activities.

It is not known if post-PBOW activities might have affected the loading areas, although there is a possibility of accidental contaminant releases related to D&D or other activities.

13.3.2 Transport Mechanisms

Possible transport mechanisms in the TNT Rail Car Loading Areas include:

- Surface transport of liquid phase in precipitation runoff to Pipe Creek.
- Migration of contaminants from soils to surface water to shallow ground water.

- Migration of contaminants in shallow ground water to off-site locations and to deeper bedrock aquifers.
- Contaminant transport via the food chain.

13.3.3 Action Levels

Action levels apply to clean-up goals established by PBOW RODs, USEPA regulations, ARARs (i.e., MCLs and NPDES), or are determined from risk-based calculations. Action levels have not been established for the TNT Rail Car Loading Areas.

13.4 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination at the TNT Rail Car Loading Areas has not been independently investigated. However, the Site Inspection conducted by Morrison Knudsen (1994a) included the TNT areas in which the TNT loading areas lie. The results of past investigations conducted at the TNT areas are included in Section 2.0.

13.5 CURRENT STATUS OF SITE CHARACTERIZATION

This section describes the current status of site characterization at the TNT Rail Car Loading Areas, including additional investigations that may be necessary to define source areas of contamination, characterize potential migration pathways, or identify potential receptors and exposure pathways. Any further investigations described here are not intended to be requirements for future work at this AOC. They are suggested for consideration for future work, to be implemented only if determined necessary through the site scoping process.

13.5.1 Physical Characteristics

The geologic characteristics of the glacial sediments underlying TNT Areas A and B were determined from boreholes drilled for the installation of monitoring wells (Section 2.0). In addition to the suggestions for additional characterization at the TNT Areas discussed in Section 2.5.1, a reconnaissance of the sites should be conducted in an attempt to locate the loading areas.

13.5.2 Nature and Extent of Contamination

The presence of contamination has been examined at the TNT Rail Car Loading Areas through the Site Inspection conducted by Morrison Knudsen (1994a). In addition to the suggestions for additional characterization at the TNT Areas discussed in Section 2.5.2, a reconnaissance of the sites should be conducted in an attempt to locate the loading areas and evaluate their potential role in site contamination.

13.5.3 Background Data

Background data have not been collected for the TNT Rail Car Loading Areas, and should be considered for future studies of this AOC.

13.6 POTENTIAL HAZARDS TO HUMAN HEALTH AND THE ENVIRONMENT

No formal risk assessment, either to human health or the environment, has been conducted for the TNT Rail Car Loading.

13.7 FEASIBILITY STUDIES

Feasibility studies have not been conducted for the TNT Rail Car Loading.

13.8 REMEDIAL ACTIONS

No remedial actions have been performed at the TNT Rail Car Loading.

13.9 WETLANDS ASSESSMENTS

Potential wetlands make up to about 1.5 percent of the total habitats at PBOW. Some TNT Rail Car Loading Areas could potentially be located in wetlands (Warner, et. al. 1990). A site-wide wetlands delineation is planned (Bower 1995).

13.10 PLANNED ACTIVITIES

A focused Remedial Investigation (RI) is planned for TNT Areas to evaluate the presence and nature of contamination in these areas to be investigated (D&M 1994). Sample locations have been chosen in areas where there is a high probability of contamination, based on historical information on the locations of

buildings and process lines, including TNT Rail Car Loading Areas in some instances. Twenty-six shallow subsurface sampling locations are planned for each TNT Area. Shallow monitoring wells will also be installed at the TNT Areas: two at TNT Area A, one at TNT Area B, and four at TNT Area C. Ground water will be tested for explosive residues, total metals, and dissolved metals. Eight new bedrock wells are also planned for various locations at PBOW. The bedrock ground-water samples will be tested for VOCs and SVOCs in addition to the parameters listed for the shallow wells. Sediment sampling in ditches at TNT Area C is also planned. Following the RI, human health and environmental risk assessment may be conducted for the TNT areas, including the TNT Rail Car Loading Areas.

13.11 RECOMMENDATIONS

The focused RI for the TNT Areas may be sufficient to determine the nature and extent of contamination at these sites, including the TNT loading areas. However, the locations of the TNT Rail Car Loading Areas are not known, and a reconnaissance of the areas should be conducted to locate the loading areas and evaluate their potential for contributing to the contamination at the TNT Areas. Further work at the TNT Rail Car Loading Areas may best be conducted as a subset of investigations of the respective TNT Areas, depending on the actual locations of the loading areas.

14.0 SITEWIDE GROUND WATER

14.1 SITE BACKGROUND

The potential for ground-water contamination at PBOW has been documented in several environmental investigations conducted at the site (IT 1991a; SAIC 1991; EBASCO 1991; H+GCL 1992; MK 1994a). Ground-water contamination may have resulted from both activities related to the operation of PBOW as well as later activities. This section provides descriptive and historic background information on PBOW in general that may be related to potential contamination of the ground water.

The history of activities at PBOW is divided into two periods: the operational period of PBOW, and the post-operational period, including post-World War II decommissioning activities.

14.1.1 Operational Period (1941 - 1945)

The original PBOW site was acquired by DOD in 1938 for the manufacture of ordnance (TNT, DNT, and pentolite). Ordnance production began on December 16, 1941 and continued through late 1945, ceasing operation following the war.

TNT was manufactured in a three-stage process involving the nitration of toluene by the addition of nitric and sulfuric acid. A wash process involving the use of "sellite," a mixture of sodium sulfite and sodium hydrogen sulfite, was used to remove impurities and various unwanted oxidation products from the TNT, generating waste "red water" as a byproduct. The wastewater was transported via buried pipelines and flumes to treatment facilities, and from there to wastewater ponds ("red water ponds"). The manufacturing and storage of acid and sellite, and the storage of process chemicals including toluene and acetone, also occurred at PBOW in support of the ordnance manufacturing. Approximately 925 million pounds of nitric acid, 63.5 million pounds of sulfuric acid and over 425 million pounds of toluene were used to manufacture over one million pounds of explosives between 1941 and 1945 (SAIC 1991). The possibility of spillage or leakage during storage, transport, and manufacturing of chemicals, wastes, and ordnance may have contributed to the contamination of ground water at the site.

14.1.2 Post-Operational Period

After TNT production ceased at the end of World War II, the site was placed in standby condition from 1945 to 1946. During that period, the Army conducted D&D on many buildings and structures. In 1955, a second period of D&D was initiated, which involved removal and relocation of all explosives to a burning ground where they were burned; burning of buildings and structures in place; and flushing and dismantling of steam lines, drain lines, and waste lines. Site decommissioning may have contributed to ground-water contamination at the site.

In mid to late 1956, The National Advisory Committee for Aeronautics leased sections of the site from DOD. In 1956, an agreement was made to construct and operate the Plum Brook Reactor Facility on 500 acres of land. NASA took over the entire property in 1962 after Ravenna Arsenal certified that PBOW had been completely decontaminated and was suitable for unrestricted future use. Research and test activities were conducted by NASA at PBOW throughout the 1960s and early 1970s. Activities at the NASA test facilities may have contributed to ground-water contamination, especially at waste disposal sites, burning grounds and fire training areas, and areas of underground storage tanks.

14.2 PHYSICAL CHARACTERISTICS

The physical characteristics of PBOW include surface features, geology, and hydrology, described in detail in Section 1.0. The physical characteristics are summarized here as they relate to ground-water flow at the site and in the vicinity.

14.2.1 Surface Features

The PBOW is located on what was originally a relatively flat lake bottom resulting from glacial melt waters. The ground surface slopes northward toward Lake Erie at an average gradient of less than six percent. Surface elevations at the site range from approximately 685 feet above MSL in the southwestern edge of the site near the intersection of Taylor Road and Patrol Road, to approximately 625 feet above MSL in the extreme northern portion of the site at the intersections of Patrol Road and Taylor Ditch, Hemminger Ditch, and Plum Brook. Vegetation at PBOW consists primarily of grassland, brushland, and woodlands. Some parts of PBOW also have structural, open-water, and wetland areas. Where NASA construction activities have disturbed the former PBOW works, the vegetation is primarily maintained grasses and ornamental plants.

14.2.2 Geology

The unconsolidated glacial deposits underlying PBOW are described on lithologic logs for boreholes drilled for subsurface soil sampling and for the installation of monitoring wells. The site is situated on the glacial lacustrine plain of ancient Lake Maumee, and the glacial sediments consist of sands, silts, and clays in varying proportions, interpreted as a combination of glacial drift and lacustrine deposits. In general, the coarser-grained sediments occur near the top of the sequence, including fine-grained yellow sands that have been described in the upper portion of the sediments, particularly in the northern areas of PBOW. The lower portions of the unconsolidated sediments are dominated by silt and clay deposits, with discontinuous layers and lenses of fine sand.

The glacial deposits are underlain by a gently eastward-dipping sequence of Paleozoic sedimentary rocks of Devonian age which make up the bedrock sequence in this area. Columbus Limestone and Delaware Limestone form the bedrock surface in the western part of the site, and Plum Brook Shale/Prout Limestone and the Ohio Shale are the uppermost bedrock units in the eastern portion of the site (MK 1994a). The bedrock surface beneath PBOW dips toward the northeast. Bedrock occurs at depths from zero to more than 30 feet, with shallower occurrences generally in the southern portion of the site. Monitoring well borings west of Ransom Road intersected bedrock limestone at depths ranging from two feet to 19 feet, and borings east of Ransom Road and south of Fox Road encountered bedrock shale at depths ranging from four feet to ten feet. North of Fox Road near the Rail Car Unloading Area and the Garage and Maintenance Building, Well EB-GM-02 intersected shale at a depth of 19 feet.

14.2.3 Hydrology

The hydrology and hydrogeology of PBOW have been interpreted from topographic maps, soil borings, and monitoring wells installed at the site. This section summarizes the surface water hydrology and the subsurface hydrogeology as they relate to ground water as an area of concern. A more detailed description of the hydrology is provided in Section 1.0. A conceptual model of the ground-water system at PBOW is presented in Section 14.6.

14.2.3.1 <u>Surface Water</u>

Eleven streams pass through or originate on PBOW. The streams flow northward and northeastward to converge into Ransom Brook, Storrs Ditch, Plum Brook, and Sawmill Creek, which all flow into Lake Erie. The drainage pattern is dendritic where streams are incised to bedrock; the drainage pattern on glacial deposits is erratic and poorly to moderately developed. Additionally, ditches totaling approximately

380,000 linear feet are within PBOW (MK 1994a). During periods of high ground-water levels, the streams apparently receive part of their volume from ground water. Seventeen isolated ponds and reservoirs, and three red water ponds (Section 3.0), are located on the site which are probably fed by shallow surficial ground water (MK 1994a).

14.2.3.2 Ground Water

The thin layer of glacial and lacustrine deposits overlying bedrock is not considered to be a major aquifer, although it does contain discontinuous layers of sand and gravel which may be water-bearing (MK 1994a). Water level depths encountered in boreholes at the site ranged from less than three feet to greater than 15 feet, with most water levels occurring between five and ten feet below the surface. A number of boreholes drilled at the site did not encounter ground water either because of shallow bedrock or extensive low-permeability layers in the glacial till.

Two principal bedrock aquifers occur in the PBOW area, both of which supply drinking water to portions of Erie County. A highly productive carbonate aquifer is used in the western portion of the county, and a poorly productive clastic aquifer is used to the east. The transition between the aquifers occurs beneath PBOW. The glacial deposits at PBOW overlie both aquifers (MK 1994a).

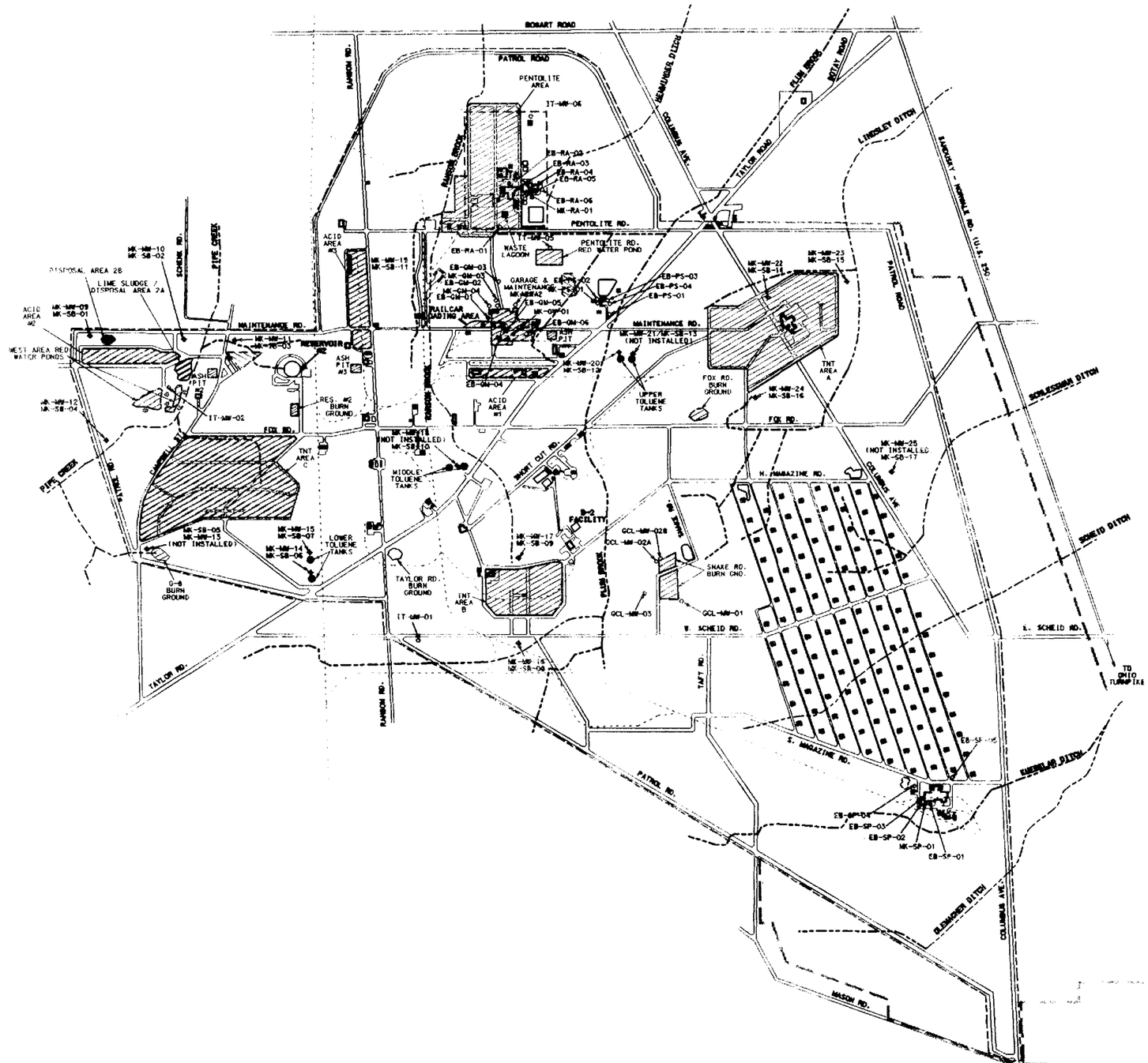
14.2.3.3 Monitoring Wells

A total of 50 monitoring wells have been installed at PBOW in support of environmental investigations and UST removal actions. Figure 14-1 shows the locations of wells at PBOW, and Table 14-1 provides a summary of monitoring well information for the site.

14.3 CONTAMINANTS OF CONCERN (COCs)

The COCs for ground water were determined on the basis of past operational activities and results of environmental investigations conducted at PBOW.

Previous investigations and field observations at PBOW indicate the possible presence of nitroexplosives and nitroaromatic compounds; VOCs, especially toluene and acetone; SVOCs; acids and acid derivatives; and heavy metals (IT 1989; SAIC 1991; MK 1994a). Compounds detected in ground water at PBOW are summarized in Table 14-2.



PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

0 500 1000 2000
SCALE IN FEET

LEGEND:

- STREAM
- RAILROAD
- PBS BOUNDARY FENCE
- AREA OF CONCERN
- MONITORING WELL/SOIL BORING (Morrison Knudsen 1994a)
- MONITORING WELLS:
  - IT = IT Corp. (1991)
  - EB = Ebasco (1991)
  - MK = Morrison Knudsen (1994b, c)
  - GCL = H+GCL (1992)
- △ MK-SS-XX SURFACE SOIL SAMPLING POINT (Morrison Knudsen 1994)
- MIS-LOCATED AOC (Sampled by M-K, 1994)
- PBOW PROPERTY BOUNDARY

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FIGURE 14-1
LOCATIONS of MONITORING WELLS at PBOW

DATE	12 JUL 95
PREPARED	JET
CHECKED	DBJ

Table 14-1. Monitoring Wells at PBS

Reference	Well ID	Location	Depth (ft)	Screened Interval (ft)	Casing Elevation (ft)	Depth to Bedrock (ft)	Water Level Elev. (Date)	Comments
IT, 1991	IT-MW-01	South Boundary	9.5	4 - 9	678.24	9	673.21 (10/21/89)	For background data
	IT-MW-02	West RW Ponds	18.3	6 - 16	639.54	19	628.82 (10/21/89)	Slug test conducted in well
	IT-MW-05	Pentolite Pond	21	8.5 - 18.5	635.53	(not reached)	619.75 (10/21/89)	
	IT-MW-06	North Boundary	18.5	6 - 16	632.97	(not reached)	619.51 (10/21/89)	Auger refusal
M-K, 1994	MK-MW-09	Disposal Area 2B	15	10 (length)	645.91	(not reached)	639.1 (1993)	(Borehole SB-1)
	MK-MW-10	No. of Lime Sludge Area	14	10 (length)	641.25	(not reached)	633.9 (1993)	(Borehole SB-2)
	MK-MW-11	No. of Burn Ground #1	13	10 (length)	638.00	(not reached)	628.2 (1993)	(Borehole SB-3)
	MK-MW-12	SW of West Area RW Ponds	13	10 (length)	641.73	13	630.6 (1993)	(Borehole SB-4)
	MK-MW-13	Burn Ground #2				2		(Borehole SB-5) Well not installed
	MK-MW-14	Toluene Tanks 655/645	11.5	5 (length)	681.93	12	673.2 (1993)	(Borehole SB-6)
	MK-MW-15	Toluene Tanks 655/645	9	5 (length)	681.45	9	673.1 (1993)	(Borehole SB-7)
	MK-MW-16	South of TNT Area "B"	8	5 (length)	674.64	8	666.3 (1993)	(Borehole SB-8)
	MK-MW-17	North of TNT Area "B"	6	4 (length)	661.90	6	658.9 (1993)	(Borehole SB-9)
	MK-MW-18	Toluene Tank 435				9		(Borehole SB-10) Well not installed
	MK-MW-19	Rail Car Unloading Area	13	10 (length)	639.85	(not reached)	632.1 (1993)	(Borehole SB-11)
	MK-MW-20	Toluene Tank 265	23	15 (length)	637.86	(not reached)	630.0 (1993)	(Borehole SB-12)
	MK-MW-21	Toluene Tank 255				(not reached)		(Borehole SB-13) Well not installed
	MK-MW-22	TNT Area "A"	9.5	5 (length)	638.95	(not reached)	628.0 (1993)	(Borehole SB-14)
	MK-MW-23	TNT Area "A"	16	10 (length)	640.01	(not reached)	622.4 (1993)	(Borehole SB-15)
	MK-MW-24	TNT Area "A"	9.5	5 (length)	657.59	(not reached)	650.1 (1993)	(Borehole SB-16)
	MK-MW-25	East edge of site				4		(Borehole SB-17) Well not installed
Ebasco, 1989	EB-SP-01	UST Area 4 (SPF)	9.5	4.25-9.25	657.14	9	650.63 (5/9/91)	
	EB-SP-02	UST Area 4 (SPF)				7		Well not installed - bedrock
	EB-SP-03	UST Area 4 (SPF)	9.5	4.25-9.25	659.85	7	653.73 (5/9/91)	
	EB-SP-04	UST Area 4 (SPF)	9.5	4.25-9.25	660.17	7	652.85 (5/9/91)	
	EB-SP-05	UST Area 4 (SPF)	9.5	4.25-9.25	659.18	7	653.35 (5/9/91)	
	EB-SP-06	UST Area 4 (SPF)	9	3.75-8.75	660.40	8	653.27 (5/9/91)	
	EB-RA-01	UST Area 1 (Reactor Area)	16	5.5-15.5	634.88	(not reached)	628.23 (5/9/91)	
	EB-RA-02	UST Area 1 (Reactor Area)	20	7.75-17.75	634.76	(not reached)	627.78 (5/9/91)	
	EB-RA-03	UST Area 1 (Reactor Area)	22	6.75-21.75	634.36	(not reached)	620.23 (5/9/91)	
	EB-RA-04	UST Area 1 (Reactor Area)	10	4.75-9.75	634.40	(not reached)	626.13 (5/9/91)	
	EB-RA-05	UST Area 1 (Reactor Area)	10	4.75-9.75	634.00	(not reached)	626.48 (5/9/91)	
	EB-RA-06	UST Area 1 (Reactor Area)	10	3.7-8.7	633.47	(not reached)	626.83 (5/9/91)	

Table 14-1. Monitoring Wells at PBS

Reference	Well ID	Location	Depth (ft)	Screened Interval (ft)	Casing Elevation (ft)	Depth to Bedrock (ft)	Water Level Elev. (Date)	Comments
	EB-GM-01	UST Area 2 (General Maint.)	27	6.5-26.5	641.22	27	633.57 (5/9/91)	
	EB-GM-02	UST Area 2 (General Maint.)	29	8.5-28.5	638.09	27	631.99 (5/9/91)	
	EB-GM-03	UST Area 2 (General Maint.)	18	7.75-17.75	639.61	(not reached)	632.93 (5/9/91)	
	EB-GM-04	UST Area 2 (General Maint.)	16	5.5-15.5	637.02	(not reached)	631.92 (5/9/91)	
	EB-GM-05	UST Area 2 (General Maint.)	18	7.5-17.5	640.50	(not reached)	633.45 (5/9/91)	
	EB-GM-06	UST Area 2 (General Maint.)	18	7.5-17.5	640.39	(not reached)	633.07 (5/9/91)	
	EB-PS-01	UST Area 3 (Pump Station)				(not reached)		Well not installed - no water
	EB-PS-02	UST Area 3 (Pump Station)	18	7.5-17.5	639.24	(not reached)	633.44 (5/9/91)	
	EB-PS-03	UST Area 3 (Pump Station)	18	7.5-17.5	637.94	(not reached)	633.20 (5/9/91)	
	EB-PS-04	UST Area 3 (Pump Station)	16	5.5-15.5	638.66	(not reached)	633.07 (5/9/91)	
M-K, 1993	MK-RA-01	UST Area 1 (Reactor Area)	15	NR	NR	NR	NR	MK-MW-01 on MK (1994) map
	MK-GM-01	UST Area 2 (General Maint.)	15	NR	NR	NR	NR	MK-MW-1 on MK (1994) map
	MK-GM-02	UST Area 2 (General Maint.)	15	NR	NR	NR	NR	MK-MW-02 on MK (1994) map
	MK-GM-03	UST Area 2 (General Maint.)	15	NR	NR	NR	NR	MK-MW-03 on MK (1994) map
	MK-GM-04	UST Area 2 (General Maint.)	15	NR	NR	NR	NR	MK-MW-04 on MK (1994) map
	MK-GM-05	UST Area 2 (General Maint.)	12.5	NR	NR	NR	NR	Not on MK (1994) map
	MK-PS-01	UST Area 3 (pump Station)	15	NR	NR	NR	NR	MK-MW-07 on MK (1994) map
	MK-SP-01	UST Area 4 (SPF)	7.5	NR	NR	NR	NR	MK-MW-08 on MK (1994) map
H+GCL, 1992	GCL-MW-01	Snake Road Burn Ground	11.43	6-11	674.74	9	669.06 (3/14/92)	
	GCL-MW-02A	Snake Road Burn Ground	23	12-22	672.86	7	667.76 (3/14/92)	Well completed in shale bedrock
	GCL-MW-02B	Snake Road Burn Ground	10	4.8-9.8	673.07	6	668.02 (3/14/92)	
	GCL-MW-03	Snake Road Burn Ground	10.6	4.5-9.5	671.52	6	667.07 (3/14/92)	

Sources: EBASCO 1989; IT 1991a; H+GCL 1992; Morrison Knudsen 1993; Morrison Knudsen 1994a
NR: Well information not reported in source document

Table 14-2. Ground-Water Sampling Analytical Results[a]

Compound	Units	IT-MW-01[b,c]	IT-MW-02[c,d]	IT-MW-05[c]	IT-MW-06[c]	MK-MW-20[e]	MK-GM-04[f]	EB-GM-02[g]	EB-GM-04[g]	EB-GM-05[g]
VOCs:										
1,1-dichloroethane	µg/ℓ	U	U	U	U	U	18	U	48.5	112
1,1-dichloroethene	µg/ℓ	U	U	U	U	U	1.74	U	51.6	52.9
1,1,1-trichloroethane	µg/ℓ	U	U	U	U	U	U	9.88	551	1130
1,1,2-trichloroethane	µg/ℓ	U	U	U	U	U	U	U	2.13	1.25
2-Butanone	µg/ℓ	U	U	U	U	33J	U	U	U	U
Acetone	µg/ℓ	82	12	7J	U	110J	U	U	U	U
Benzene	µg/ℓ	U	U	U	U	10J	U	U	U	U
Carbon disulfide	µg/ℓ	2J	U	U	9	U	U	U	U	U
Chloroethane	µg/ℓ	U	U	U	U	U	U	U	4.13	2.17
Chloroform	µg/ℓ	U	U	U	U	U	U	U	U	U
cis-1,2-dichloroethene	µg/ℓ	U	U	U	U	U	U	U	2.93	U
Methylene chloride	µg/ℓ	U	U	U	U	U	U	U	U	U
Tetrachloroethene	µg/ℓ	U	U	U	U	U	U	U	5.72	U
Toluene	µg/ℓ	2J	U	U	U	36,000D	U	U	U	U
Total xylenes	µg/ℓ	U	U	U	U	8J	U	U	U	U
Trichloroethene	µg/ℓ	U	U	U	U	U	U	U	13.4	5.6

Table 14-2. (Continued)

Compound	Units	IT-MW-01[b,c]	IT-MW-02[c,d]	IT-MW-05[c]	IT-MW-06[c]	MK-MW-20[e]	MK-GM-04[f]	EB-GM-02[g]	EB-GM-04[g]	EB-GM-05[g]
SVOCs:										
2-methylphenol	µg/ℓ	U	U	U	U	520D	U	U	U	U
2-nitroaniline	µg/ℓ	U	2J	U	U	U	U	U	U	U
2,4-dinitrotoluene	µg/ℓ	U	160	U	U	U	U	U	U	U
2,6-dinitrotoluene	µg/ℓ	U	27	U	U	U	U	U	U	U
3-nitroaniline	µg/ℓ	U	13J	U	U	U	U	U	U	U
4-methylphenol	µg/ℓ	U	U	U	U	190D	U	U	U	U
4-nitrophenol	µg/ℓ	U	3J	U	U	U	U	U	U	U
Benzoic acid	µg/ℓ	U	U	U	U	13J	U	U	U	U
Benzyl alcohol	µg/ℓ	U	U	U	U	13	U	U	U	U
bis(2-ethylhexyl)phthalate	µg/ℓ	U	2J	2J	U	U	U	U	U	U
Nitrate	ppm	0.07	U	U	0.12	U	NA	NA	NA	NA
Sulfate	ppm	130	950	U	60	U	NA	NA	NA	NA

[a]Only samples with detectable compounds are included on table
[b]Well installed for background conditions.
[c]IT 1991a.
[d]Well installed at West Area Red Water Ponds.
[e]Well installed adjacent to Toluene Tank 255 near TNT Area A (MK 1994a).
[f]Morrison Knudsen 1994b.
[g]EBASCO 1991.

D Analysis at a secondary dilution factor.
J Estimated value.
U Compound was analyzed for but not detected.
NA Compound not analyzed for.

Other activities may have released petroleum-derived VOCs and SVOCs, especially from former UST areas; SVOCs and metals from burning grounds and fire training areas; asbestos from insulated pipelines; and pesticides and PCBs.

14.4 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination at PBOW has been investigated in a confirmation study conducted by IT Corporation (1991) and in a Site Inspection conducted by Morrison Knudsen (1994a). Additional investigations at PBOW have focused on specific areas of potential contamination such as Snake Road Burn Ground (H+GCL 1992) and underground storage tanks (EBASCO 1991).

14.4.1 Background Data

Background chemical analytical values for COCs in ground water for PBOW have not yet been determined. Two monitoring wells, IT-MW-01 (IT 1991a) and MK-MW-16 (MK 1994a), were installed near the southern boundary of the site to serve as background wells for PBOW in general, but additional sampling points are needed to establish background values with statistical validity.

14.4.2 Ground-Water Investigations

Fifty monitoring wells have been installed at PBOW to investigate the nature of ground-water contamination in the surficial aquifer (Section 14.2.3.3). The bedrock aquifer has not been investigated at PBOW. Results of chemical analyses of ground water are provided in Table 14-2, and are summarized below:

- Analysis of ground water from well IT-MW-02 at the West Area Red Water Ponds detected low levels of acetone, 2,6-DNT, and 2,4-DNT, attributable to contamination from the ponds (Section 3.0). Well IT-MW-02 also contained elevated levels of sulfate, possibly representing contamination from sulfuric acid (IT 1991a).

- Ground water from well MK-MW-20 located at the site of the toluene tanks near TNT Area A (Tanks 255 and 265), had elevated levels of toluene, 2-methylphenol, benzyl alcohol, and 4-methylphenol (MK 1994a).

- Minor quantities of acetone were detected in the monitoring wells at Snake Road Burn Ground, and benzene was detected in one well (H+GCL 1992).

- Analyses of ground water from former UST areas revealed contamination only near the Garage and Maintenance Area (EBASCO 1991). The contaminants chloroethane, dichloroethane, dichloroethene, trichloroethane, and trichloroethene were detected in several wells at this location.

14.5 CURRENT STATUS OF SITE CHARACTERIZATION

This section describes the current status of site characterization of PBOW ground water, including additional investigations that may be necessary to define source areas of contamination, characterize potential migration pathways, or identify potential receptors and exposure pathways. Any further investigations suggested here are not intended to be requirements for future work, but are suggested for consideration for future work, to be implemented only if determined necessary through the site scoping process.

14.5.1 Physical Characteristics

Fifty monitoring wells have been installed at PBOW in support of a variety of environmental investigations. The general lithology of the glacial deposits has been well-characterized from the borehole lithologic logs for these wells. Suggestions for additional characterization of PBOW ground water include:

- Because only a few boreholes have penetrated bedrock at the site, the thickness of the glacial deposits and the nature of the underlying bedrock are not well known site-wide. Additional bedrock wells are suggested for future work at the site.

- Aquifer testing has been conducted in only one well, IT-MW-02, and therefore hydrogeologic characteristics are not known for PBOW in general. Additional aquifer testing in existing or planned shallow and bedrock wells should be considered in future scoping.

- Bedrock wells have not been installed at PBOW, and bedrock aquifer characteristics and the relationship between the bedrock aquifer and the shallow unconfined aquifer are not known. The installation and testing of bedrock wells should be considered for future work at the PBOW.

- The relationship between surface water and the shallow ground-water system has not been well defined, and ground-water data should be collected to prepare ground-water flow nets for PBOW.

14.5.2 Nature and Extent of Contamination

The nature and extent of contamination in ground water has been examined through the sampling and analysis of 50 monitoring wells installed at PBOW. Many of the monitoring wells at PBOW were located specifically for former UST areas, and were not analyzed for all of the COCs identified for ground water. The general nature and extent of ground-water contamination across the site is known only from 21 shallow wells at PBOW (IT 1991a; MK 1994a). Additional shallow and bedrock wells are needed to characterize the nature and extent of contamination at PBOW.

14.5.3 Background Data

Suggestions for additional investigations to establish the nature and extent of contamination of PBOW ground water include the following:

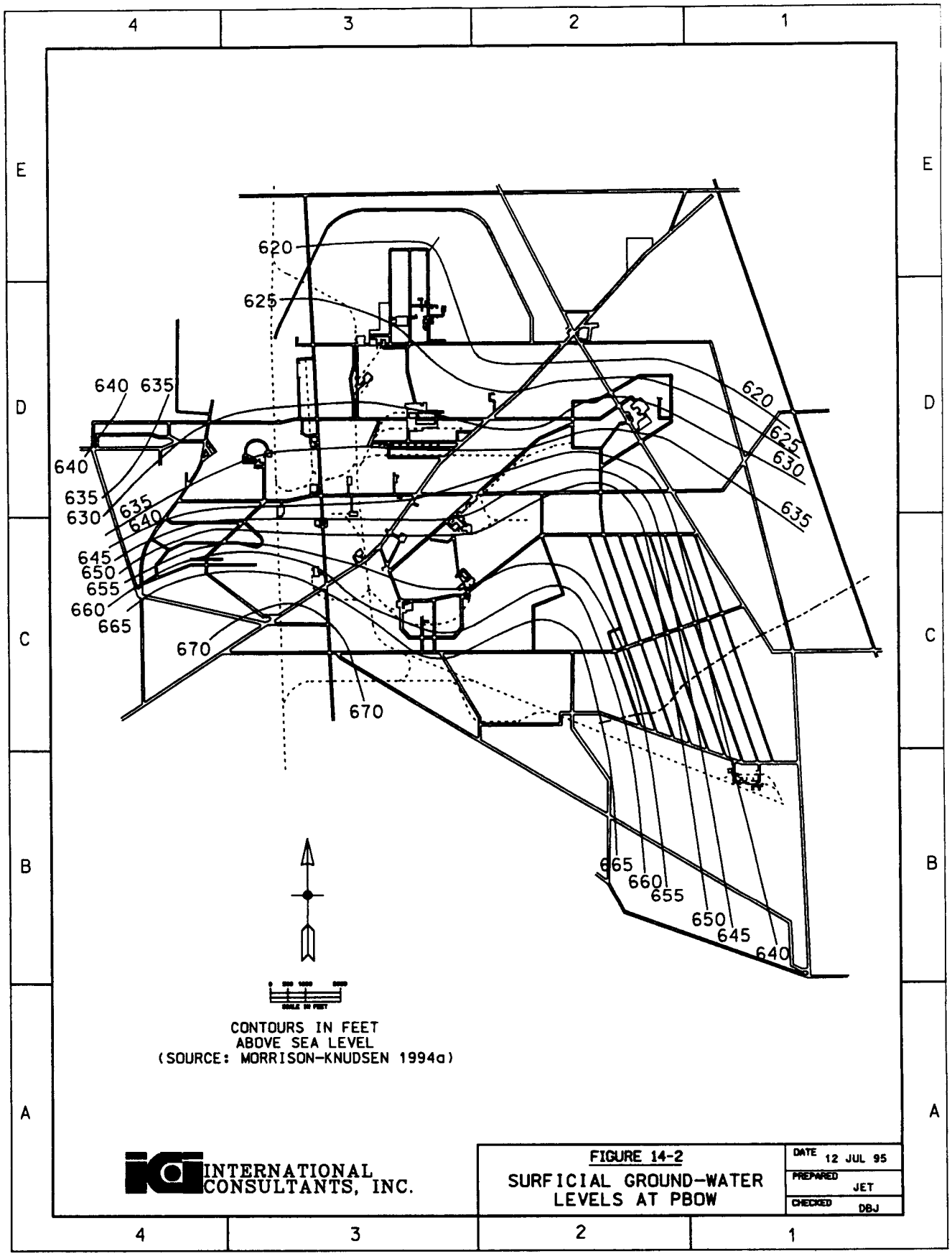
- Results of analyses of samples of ground water collected from areas at PBOW thought to be free of possible contamination from past activities have not been statistically evaluated to judge their usefulness as background data.
- Additional background sampling sites for ground water are suggested to establish site-wide background conditions at PBOW.

14.6 GROUND-WATER MODEL

A conceptual ground-water model for PBOW has been developed for this SMP from published documents and the results of environmental investigations conducted at the site. The conceptual model represents the current understanding of the site hydrogeology, and will be updated as new data are acquired.

Ground water at PBOW occurs principally in two distinct aquifers: an upper surficial aquifer of unconsolidated glacial and lacustrine sediments overlying bedrock, and a deeper bedrock aquifer. The thin layer of glacial and lacustrine deposits is not considered to be a major aquifer, and is not used as a source of potable water. The bedrock aquifer actually consists of two principal aquifers, both of which supply drinking water to portions of Erie County. A highly productive limestone (carbonate) aquifer is used as a domestic water source in the western portion of the county, and a poorly productive shale (clastic) aquifer is used to the east. The transition between the western carbonate aquifer and the eastern clastic aquifer occurs beneath PBOW, and glacial deposits at PBOW overlie both aquifers (MK 1994a).

Depths to the surficial aquifer encountered in boreholes at the site ranged from less than three feet to greater than 15 feet, with most water levels occurring between five and ten feet below the surface. A number of boreholes did not encounter ground water either due to shallow bedrock or extensive low-permeability layers in the glacial till. Based on the ground-water elevations measured in monitoring wells at the site, the surficial ground water flows generally in a northerly or northeasterly direction (MK 1994a), as shown in Figure 14-2, but local variations are common, especially near surface bodies of water (e.g., see H^{+}GCL 1992). The average hydraulic gradient across the site is approximately 0.001 ft/ft.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CONTOURS IN FEET
ABOVE SEA LEVEL
(SOURCE: MORRISON-KNUDSEN 1994a)
INTERNATIONAL
CONSULTANTS, INC.
FIGURE 14-2
SURFICIAL GROUND-WATER
LEVELS AT PBOW
DATE 12 JUL 95
PREPARED JET
CHECKED DBJ

Hydraulic conductivity in the glacial deposits is expected to vary considerably depending on the nature of the aquifer material. A rising head slug test was performed in monitoring well IT-MW-02 in October 1990, providing a value for hydraulic conductivity of K = 0.25 feet per day (IT 1991a).

Correlations between surface water and ground-water levels have not been systematically observed at PBOW. However, communication between the shallow ground water and the surface water in the West Area Red Water Ponds is suggested by the presence of red water observed in a trench constructed downgradient of the ponds in a search for old sewer lines (Bower 1995). Also, the pond levels remain relatively high year-round, suggesting their replenishment by ground water.

Bedrock monitoring wells have not been installed at the site and the characteristics of the bedrock aquifer at PBOW have not been established. However, the bedrock aquifer has been characterized regionally, and it is assumed that these regional characteristics prevail at the PBOW site. In the bedrock, ground water that occurs in the carbonate aquifer is present in a network of interconnected fractures, bedding plane joints, and solution channels, with some solution caverns in the shallow portions of the limestone. The direction of ground-water flow in the carbonate aquifer is to the north toward Lake Erie. The clastic bedrock aquifer in the eastern portion of PBOW consists of relatively fine-grained material, and consequently has low ground-water yields. Fractures in the shale locally may increase the storativity and transmissivity of the clastic aquifer (MK 1994a).

It is not known if there is direct communication between the surficial ground water and ground water in the bedrock aquifer. However, a connection between the two is indicated by the following: Snake Road Burning Ground water levels in adjacent deep (installed in the upper bedrock) and shallow (installed in glacial sediments) monitoring wells suggest a downward flow gradient, with ground water flowing from the surficial aquifer to at least the upper portions of the bedrock (H^+GCL 1992).

14.7 PLANNED ACTIVITIES

A focused Remedial Investigation (RI) is planned for portions of PBOW (D&M 1994), and will include the installation and sampling of surficial and bedrock monitoring wells. Shallow monitoring wells will be installed at 19 locations to sample ground water at the TNT Areas and the Red Water Ponds, and bedrock wells are planned for eight locations scattered about the site. Ground-water samples will be analyzed for VOCs, SVOCs, explosive residues, total metals, and dissolved metals. Following the RI, human health and environmental risk assessments may be conducted.

14.8 RECOMMENDATIONS

The sitewide ground-water investigation planned for the focused RI (D&M 1994) should be sufficient to determine the nature and extent of contamination of the surficial and bedrock ground water at the site. The following recommendations for additional work should be considered in future scoping:

- If significant contamination is found in the ground water, additional monitoring wells, both surficial and bedrock, may be needed to track contaminant migration or determine contaminant source areas.
- Aquifer testing has been done in only one monitoring well at PBOW, well IT-MW-02 (IT 1991a). Additional aquifer testing should be considered for wells installed in both the surficial and bedrock aquifers for the sitewide ground-water investigation (D&M 1994).
- Additional ground-water background data may be needed to support a risk assessment.
- If significant contamination is detected in the ground water at PBOW, hydrologic and transport modelling may be required to predict contaminant fate and transport at the site.

15.0 RANKINGS OF AREAS OF CONCERN

The Hazard Ranking System (HRS) is used by the EPA's superfund program to assess the relative threat associated with actual or potential releases of hazardous substances. The HRS is the primary screening tool to determine if a site is to be included on the National Priorities List (NPL). The NPL identifies sites that are priorities for further investigation and that are a potential risk to public health or to the environment. A site scoring 28.5 or greater on the HRS is eligible for the NPL and for a long term remedial action financed under CERCLA. The 28.5 HRS score does not represent a specified level of risk, but is merely a cutoff point that serves as a screening-level indicator for the highest priority releases or threatened releases. Sites that score below 28.50 are normally addressed by non-CERCLA Federal and State authorities.

15.1 HAZARD RANKING SYSTEM INVESTIGATIONS AT PBOW

Two HRS assessments have been performed for AOCs at PBOW: a Preliminary Assessment by SAIC in 1991 and a Site Inspection by Morrison Knudsen in 1994 (MK 1994a). A total site HRS score of 0.0 was calculated by IT Corporation (IT 1991a), but this was based on the assumption that no drinking water is extracted from the surficial aquifer at or downgradient from the site. This assumption has not been proven and may be invalid.

15.1.1 SAIC Preliminary Assessment, 1991

In their Preliminary Assessment of PBOW, SAIC identified 14 AOCs which were potentially contaminated, some of which are the responsibility of NASA. These were ranked using an abbreviated version of the HRS provided by EPA Region V, to quantify the potential hazards resulting from identified sources at PBOW. A number of assumptions were made in the preliminary rankings to compensate for the limited data, including:

- Waste characterization values were assumed based on the type of site and the expected quantity of waste.
- Estimates of site volume or area were assumed due to a lack of specific information on almost all the sites.
- The Likelihood of Release category was assumed based on the source type and the proximity to the media being ranked.

- There are no designated habitats for any threatened or endangered species within PBOW.
- None of the sites released airborne contaminants.

15.1.2 Morrison Knudsen Site Inspection, 1994

The Site Inspection conducted by Morrison Knudsen in 1994 identified five Project Management Units (PMUs) at PBOW. The PMUs were delineated primarily on the basis of surface drainage patterns and the geographic layout, similarities in suspected contamination, and similarity in age, type, and usage of the AOC. During the Site Inspection, Morrison Knudsen used the *Preliminary Ranking Evaluation Score (PREscore)*, Version 2.0 computer program to assist in the HRS site scoring of PBOW. This program calculates HRS factors from raw data, retrieves values from hazardous substance look-up tables, calculates site scores, and generates HRS documentation and other records. Due to the similarity of waste throughout the site and common ownership, proximity of sources to each other, and similarity of targets, PBOW was scored as one site rather than as individual areas (MK 1994a).

15.2 HAZARD RANKING SYSTEM INVESTIGATION RESULTS

15.2.1 SAIC Preliminary Assessment, 1991

The HRS evaluation of PBOW by SAIC in 1991 included the ground water migration pathway, surface water migration pathway, soil exposure pathway, air migration pathway, and the overall site score. Individual AOCs were scored separately for each exposure pathway. Scores are presented in Table 15-1. Only one operable unit, the Red Water Ponds, scored near the cut-off score of 28.5. The other AOCs received low scores primarily because low values were assigned to the Target and Waste Characteristics Factor Values. Although Target Demographic Values were reasonably accurate, the Waste Characteristic Factor Values were not as representative because limited information was available on waste quantities. Because, the division of PBOW into 14 AOCs may have diluted the effect of HRS scoring, an overall score for PBOW was generated incorporating all identified sources and overall site conditions. This scoring produced a site score of 34.8, developed from a ground-water pathway score of 33.3, a surface water pathway score of 28.7, a soil exposure pathway score of 28.7, and an air pathway score of 45.5. Based on this approach, the PBOW cumulative score exceeded the cut-off value of 28.5.

15.2.2 Morrison Knudsen Site Inspection, 1994

The HRS evaluation of PBOW by Morrison Knudsen (1994a) included the ground-water migration pathway, the surface water pathway, the soil exposure pathway, and the air migration pathway, resulting

Table 15-1. Plum Brook Station Transport Pathway Scores Using Hazard Ranking System Ranked by Overall Score (SAIC 1991)

Site	Ground Water	Surface Water	Soil	Air	Overall Score
Red Water Ponds	26.66	12.00	12.00	30.30	21.90
Waste Lagoons (Pentolite Area)	8.53	3.84	5.20	9.70	7.22
Rail Car Unloading Area	8.53	3.84	5.20	9.70	7.22
UST Removal Areas	8.53	3.84	5.20	9.70	7.22
Toluene Storage Tank Areas	8.53	3.84	5.20	9.70	7.22
Disposal Areas 2A and 2B	4.80	2.16	3.80	5.45	4.24
Lime Sludge Disposal Area	4.80	2.16	3.80	5.45	4.24
Fly Ash Spoil Piles (Ash Pits)	4.80	2.16	3.80	5.45	4.24
TNT Areas	4.80	2.16	3.80	5.45	4.24
Disposal Area 1B	4.80	2.16	3.80	5.45	4.24
Burn Grounds	4.36	2.16	3.80	5.45	4.12
Underground Wastewater Flumes	4.36	2.16	3.80	5.45	4.12
SPF Rubble Pile	4.36	2.16	3.80	5.45	4.11
Asbestos Contamination	2.97	2.16	3.80	5.45	3.80

Source: SAIC, 1991.

in an overall score of 7.99. The individual pathway score for ground water was 2.09; for surface water, 0.18; for soil exposure, 15.88; and for air migration, 9.22. Individual PMUs were also scored separately, as presented in Table 15-2. All individual scores were below the overall site score, except PMU3 with Plum Brook Creek as its major surface water body. These high scores are due to the presence of several coal tar derivatives that were detected in sediment samples collected near the intersection of the streams with asphalt roads. The column of Table 15-2 labelled *PMU3** represents the PMU3 scores without including the semi-volatile results related to the coal tar derivatives.

15.3 CONCLUSIONS AND PRIORITIZATION

The AOCs presented in Table 15-1 are listed in the order of their HRS scores, suggesting a priority ranking of the AOCs with respect to site remediation. Because the ranking shown in Table 15-1 was conducted prior to the Site Inspection, the HRS scores of the individual AOCs may change with the addition of this new information. Also, the records review conducted by Dames and Moore (1995) provided additional historical information and revised the locations of some of the potential source areas, which also may affect the rankings.

Of the 41 potential sources of environmental contamination in 13 AOCs discussed in Part B of this SMP (Sections 2.0 through 14.0), 25 have documented contamination in surface and subsurface soils, three have shown no contamination in either surface or subsurface soils, and 13 have not been sampled in these media. Sediment and ground-water contamination has been detected at numerous locations, and in some cases this contamination may be correlated with specific sites which may affect their HRS scores and priority rankings. Elevated levels of COCs have not been detected in any of the surface water samples analyzed from the site. Sampling at many of the sites and AOCs has not been sufficient to determine their significance as potential source areas of contamination, or their priority ranking for site remediation.

Because there is a lack of information on some of the AOCs at PBOW, it is recommended that a Site Inspection be conducted to evaluate the presence of contamination in these areas. These AOCs include the Acid Areas, the Pentolite Area, and the Garage and Maintenance Area. In addition, the historical evaluation conducted by Dames & Moore (1995) suggested alternate locations for some sites, including Ash Pit #1, Ash Pit #2, and Reservoir #2 Burn Ground. A Site Inspection of these sites is also recommended.

Table 15-2. Plum Brook Station Transport Pathway Scores Using Hazard Ranking System Ranked by Overall Score (MK 1994)

Site	Ground Water	Surface Water	Soil	Air	Overall Score
Entire Facility with Plum Brook as Main Surface Water Pathway	2.09	42.84	12.88	9.22	22.86
Project Management Unit 3	0.65	42.84	12.88	5.18	22.52
Entire Facility with Pipe Creek as Main Surface Water Pathway	2.09	0.18	12.88	9.22	9.99
Project Management Unit 1	1.18	0.18	12.88	9.22	7.94
Project Management Unit 3*	0.65	4.38	12.88	5.18	7.29
Pentolite Road Red Water Ponds	0.65	4.38	12.88	4.03	7.10
Project Management Unit 2	0.65	0.18	12.88	1.44	6.49
West Area Red Water Ponds	2.09	0.11	7.24	3.12	4.08
TNT Area B	0.65	0.06	7.24	1.44	3.71
Project Management Unit 5	0.07	0.04	4.00	0.58	2.02
Project Management Unit 4	0.00	0.00	0.00	0.00	0.00

* Ranking calculation of PMU3 without semivolatiles

Source: Morrison Knudsen, 1994a.

Based on previous investigations and historical activities at PBOW, the following preliminary prioritization for remedial action is recommended for the AOCs described in this SMP:

Priority 1: Ground Water, Red Water Ponds, and TNT Areas.

Priority 2: Underground Wastewater Flumes, Burn Grounds, Toluene Tank Areas, Acid Areas, and Pentolite Area.

Priority 3: Ash Pits, Waste Lagoons, Garage and Maintenance Area, and Rail Car Loading Areas.

15.4 DOD RELATIVE RISK EVALUATION

Each AOC at PBOW will also undergo a risk evaluation using the DOD Relative Risk Evaluation process which is designed to assess the relative risks of DERP sites. The goal of the evaluation is to ensure that sites with a higher risk (relative to other sites) are generally considered first in the prioritization process, and that available funds in DERP are directed to those sites. The evaluation of relative risk is used in conjunction with other management concerns, such as regulatory agreements, to assist in the sequencing of restoration activities. The evaluation results in a ranking of sites or AOCs into high, medium, or low categories, based on relative risk. This ranking is not a substitute for a baseline risk assessment, nor does it serve to place a site or AOC into a "no further risk" category. It is, rather, a relative evaluation of site information at one point in time, based on a quantitative analysis of three factors: contaminant hazards, migration pathways, and receptors.

This evaluation framework will be used at PBOW to assess both the relative risk of each AOC within the site, and to assess the relative risk present at PBOW compared to other sites within the DERP program.

16.0 POTENTIAL INTERACTIONS OF AREAS OF CONCERN

Many contaminant source areas at PBOW are likely to be physically interrelated, particularly with regard to potential groundwater and surface water pathways. This section discusses the possible interactions of the AOCs, emphasizing, in particular, the potential for the intermingling of contaminants as ground water and surface water move across the site. Also included are the potential impacts each AOC has on the other, in terms of contaminant transport via surface water runoff, air transport, and ground-water flow.

16.1 SURFACE WATER

Eleven streams pass through or originate on PBS property. The streams flow northward and northeastward toward Lake Erie. The major surface water flow on PBOW is via Plum Brook, Ransom Brook, Pipe Creek, Lindsley Ditch, and Hemminger Ditch. The potential for contamination of each of these surface water pathways increases as it flows past each of the AOCs along its route, as does the complexity of its potential contamination. The following presents the AOCs found along each surface water pathway, listed in approximate order with the AOC furthest upgradient presented first. Surface water runoff directions were evaluated from site maps and topographic maps, and have not been verified in the field. Some AOCs are listed twice because their surface runoff flow appears to be to two different streams. The listing also includes potential contaminants from each AOC.

- <u>Plum Brook</u>
  - Snake Road Burn Ground: heavy metals
  - TNT Area B: nitroaromatics
  - Upper Toluene Tank Area: toluene
  - Acid Area #1: acids and acid residues
  - Ash Pit and Power Plant #1: heavy metals
  - Garage and Maintenance Area: petroleum products
  - Pentolite Road Red Water Ponds: nitroaromatics

- <u>Ransom Brook</u>
  - TNT Area B: nitroaromatics
  - Lower Toluene Tank Area: toluene
  - Taylor Road Burn Ground: asbestos, waste oils, solvents
  - Middle Toluene Tank Area: toluene
  - Acid Area #1: acids and acid residues
  - Rail Car Unloading Area/Sellite Area: toluene and inorganic chemicals

- <u>Pipe Creek</u>
  - G-8 Burn Ground: nitroaromatics, acids, asbestos, waste oils, solvents
  - Lower Toluene Tank Area: toluene
  - TNT Area C: nitroaromatics
  - West Area Red Water Ponds: nitroaromatics

	Ash Pit and Power Plant #2: heavy metals Acid Area #2: acids and acid residues Reservoir #2 Burn Ground: nitroaromatics, acids, asbestos, oil, solvents Ash Pit and Power Plant #3: heavy metals Acid Area #3: acids and acid residues
• Lindsley Ditch	Fox Road Burn Ground: nitroaromatic compounds, heavy metals TNT Area A: nitroaromatic compounds
• Hemminger Ditch	Waste Lagoons: nitroaromatics, acetone, toluene Pentolite Area: nitroaromatics, acetone, toluene

Using Pipe Creek as an example, the first contaminant source (i.e., furthest upstream source) that may contribute to it is the G-8 Burn Ground and perhaps the Lower Toluene Tank Area, where the creek could pick up levels of nitroaromatic compounds, acids, asbestos, waste oils, solvents, and toluene. Further downstream, runoff from TNT Area C enters the creek which could add nitroaromatic compounds. Further downstream, contaminants may be contributed from the West Area Red Water Ponds, Ash Pit #2, and Acid Area #2, in that order. Finally, runoff from Reservoir #2 Burn Ground, Ash Pit #3, and Acid Area #3 flows through drainages to a tributary of Pipe Creek which joins the creek downstream of the Red Water Ponds and Ash Pit #2, potentially contributing additional nitroaromatics, acids, asbestos, waste oil, and heavy metals to Pipe Creek.

Table 16-1 provides an alternative means of visualizing surface water interactions of the various AOCs at PBOW. For each AOC listed in the left column of the table, AOCs that are upstream are indicated with a gray box in the horizontal row for the AOC of interest. For example, TNT Area C has two upstream AOCs: G-8 Burn Ground and Lower Toluene Tanks. In like manner, reading down the column for TNT Area C indicates that TNT Area C is upstream to six AOCs: West Area Red Water Ponds, Reservoir #2 Burn Ground, Ash Pit and Power Plant #2, Ash Pit and Power Plant #3, Acid Area #2, and Acid Area #3.

16.2 GROUND WATER

Ground-water flow at PBOW is, in general, toward the north and northeast, based on water level measurements conducted as part of the Site Inspection (MK 1994a). A contour map of ground-water levels is provided in Figure 14-2. Ground-water contamination from an AOC could potentially affect ground-water quality at downgradient locations, and the mixing of contaminant plumes is possible as ground water moves beneath the site. The ground-water map shown in Figure 14-2 was used to evaluate the potential effects of upgradient sources on downgradient sites. The ground-water map is only an

Table 16-1 Potential Surface Water Interactions Among AOCs

AFFECTED AOCS	UPSTREAM AOCs																											
	TNT Area A	TNT Area B	TNT Area C	Pentolite Rd. Red WaterPond	West Area Red Water Pond	Waste Water Flumes, TNT Area A	Waste Water Flumes, TNT Area B	Waste Water Flumes, TNT Area C	Reservoir #2 Burn Ground	G-8 Burn Ground	Fox Road Burn Ground	Taylor Road Burn Ground	Snake Road Burn Ground	Waste Lagoons	Ash Pit and Power Plant #1	Ash Pit and Power Plant #2	Ash Pit and Power Plant #3	Lower Toluene Tanks	Middle Toluene Tanks	Upper Toluene Tanks	Rail Car Unloading/Sellite Area	Acid Area #1	Acid Area #2	Acid Area #3	Garage and Maintenance Area	TNT Rail Car Loading Area A	TNT Rail Car Loading Area B	TNT Rail Car Loading Area C	Pentolite Area
TNT Area A	■										▒																		
TNT Area B		■																											
TNT Area C			■							▒								▒											
Pentolite Rd. Red Water Pond		▒		■			▒						▒		▒					▒		▒			▒		▒		
West Area Red Water Pond			▒		■			▒		▒								▒										▒	
Wastewater Flumes, TNT Area A						■					▒																		
Wastewater Flumes, TNT Area B							■																						
Wastewater Flumes, TNT Area C								■		▒								▒											
Reservoir #2 Burn Ground			▒		▒			▒	■	▒								▒										▒	
G-8 Burn Ground										■								▒											
Fox Road Burn Ground											■																		
Taylor Road Burn Ground		▒					▒					■															▒		
Snake Road Burn Ground		▒					▒						■														▒		
Waste Lagoons														■															
Ash Pit and Power Plant #1		▒					▒						▒		■					▒		▒					▒		
Ash Pit and Power Plant #2			▒		▒			▒	▒	▒						■		▒										▒	
Ash Pit and Power Plant #3			▒		▒			▒	▒	▒						▒	■	▒					▒					▒	
Lower Toluene Tanks																		■											
Middle Toluene Tanks		▒					▒					▒							■								▒		
Upper Toluene Tanks		▒					▒						▒							■							▒		
Rail Car Unloading/Sellite Area		▒					▒					▒							▒		■	▒			▒		▒		
Acid Area #1		▒					▒					▒	▒						▒	▒		■					▒		
Acid Area #2			▒		▒			▒	▒	▒						▒		▒					■					▒	
Acid Area #3			▒		▒			▒	▒	▒						▒	▒	▒					▒	■				▒	
Garage and Maintenance Area		▒					▒					▒	▒		▒				▒	▒		▒			■		▒		
TNT Rail Car Loading Area A											▒															■			
TNT Rail Car Loading Area B																											■		
TNT Rail Car Loading Area C										▒								▒										■	
Pentolite Area		▒					▒					▒		▒					▒			▒					▒		■

approximation of the actual ground-water gradient at PBOW, and must be interpreted liberally in assigning upgradient sources for the AOCs. As more information is gathered, the ground-water gradients will be refined which will likely change the interpretations presented here.

The following presents a preliminary listing of upgradient source areas for each of the AOCs at PBOW, with the closest upgradient source listed first in each case. For example, ground water at the Pentolite Road Red Water Ponds may mix with ground water from the Garage and Maintenance Area (closest upgradient source area), Ash Pit #1, Acid Area #1, and TNT Area B (farthest upgradient source area), based on the ground-water map of Figure 14-2.

- TNT Area A (including wastewater flumes and TNT loading areas):
  Fox Road Burn Ground
  Snake Road Burn Ground

- TNT Area B (including wastewater flumes and TNT loading areas):
  none

- TNT Area C (including wastewater flumes and TNT loading areas):
  Lower Toluene Tanks

- Pentolite Road Red Water Ponds:
  Garage and Maintenance Area
  Ash Pit and Power Plant #1
  Acid Area #1
  TNT Area B

- West Area Red Water Ponds:
  TNT Area C
  Acid Area #2

- Reservoir #2 Burn Ground:
  TNT Area C
  Lower Toluene Tanks

- G-8 Burn Ground:
  none

- Fox Road Burn Ground:
  Snake Road Burn Ground

- Taylor Road Burn Ground:
  none

- Snake Road Burn Ground:
  none

- Waste Lagoons:
  Garage and Maintenance Area
  Rail Car Unloading/Sellite Area

- Ash Pit and Power Plant #1:
  TNT Area B

- Ash Pit and Power Plant #2:
  TNT Area C

- Ash Pit and Power Plant #3:
  none

- Lower Toluene Tanks:
  none

- Middle Toluene Tanks:
  TNT Area B
  Taylor Road Burn Ground

- Upper Toluene Tanks:
  Snake Road Burn Ground

- Rail Car Unloading/Sellite Area:
  Garage and Maintenance Area
  Middle Toluene Tanks

- Acid Area 1:
  TNT Area B

- Acid Area 2:
  West Area Red Water Ponds
  Ash Pit and Power Plant #2

- Acid Area 3:
  Ash Pit and Power Plant #3

- Garage and Maintenance Area:
  Acid Area #1
  TNT Area B

- Pentolite Area:
  - Waste Lagoons
  - Acid Area #3
  - Ash Pit and Power Plant #3
  - Rail Car Unloading/Sellite Area
  - Middle Toluene Tanks

Table 16-2 provides an alternative means of visualizing ground-water interactions of the various AOCs at PBOW. For each AOC listed in the left column of the table, AOCs that are upgradient are indicated with a gray box in the horizontal row for the AOC of interest. For example, TNT Area A has two upgradient AOCs: Fox Road Burn Ground and Snake Road Burn Ground. In like manner, reading down the column for TNT Area A indicates that TNT Area A is upgradient to no AOCs.

Table 16-2 Potential Ground Water Interactions Among AOCs

AFFECTED AOCS	UPGRADIENT AOCs																												
	TNT Area A	TNT Area B	TNT Area C	Pentolite Rd. Red WaterPond	West Area Red Water Pond	Waste Water Flumes, TNT Area A	Waste Water Flumes, TNT Area B	Waste Water Flumes, TNT Area C	Reservoir #2 Burn Ground	G-8 Burn Ground	Fox Road Burn Ground	Taylor Road Burn Ground	Snake Road Burn Ground	Waste Lagoons	Ash Pit and Power Plant #1	Ash Pit and Power Plant #2	Ash Pit and Power Plant #3	Lower Toluene Tanks	Middle Toluene Tanks	Upper Toluene Tanks	Rail Car Unloading/Sellite Area	Acid Area #1	Acid Area #2	Acid Area #3	Garage and Maintenance Area	TNT Rail Car Loading Area A	TNT Rail Car Loading Area B	TNT Rail Car Loading Area C	Pentolite Area
TNT Area A	■										▒		▒																
TNT Area B		■																											
TNT Area C			■															▒											
Pentolite Rd. Red Water Pond		▒		■			▒								▒							▒			▒		▒		
West Area Red Water Pond			▒		■			▒															▒					▒	
Wastewater Flumes, TNT Area A						■					▒		▒																
Wastewater Flumes, TNT Area B							■																						
Wastewater Flumes, TNT Area C								■										▒											
Reservoir #2 Burn Ground			▒					▒	■									▒										▒	
G-8 Burn Ground										■																			
Fox Road Burn Ground											■		▒																
Taylor Road Burn Ground												■																	
Snake Road Burn Ground													■																
Waste Lagoons														■							▒				▒				
Ash Pit and Power Plant #1		▒					▒								■												▒		
Ash Pit and Power Plant #2			▒					▒								■												▒	
Ash Pit and Power Plant #3																	■												
Lower Toluene Tanks																		■											
Middle Toluene Tanks		▒					▒					▒							■								▒		
Upper Toluene Tanks													▒							■									
Rail Car Unloading/Sellite Area																			▒		■				▒				
Acid Area #1		▒					▒															■					▒		
Acid Area #2					▒											▒							■						
Acid Area #3																	▒							■					
Garage and Maintenance Area		▒					▒															▒			■		▒		
TNT Rail Car Loading Area A											▒		▒													■			
TNT Rail Car Loading Area B																											■		
TNT Rail Car Loading Area C																		▒										■	
Pentolite Area														▒			▒		▒		▒			▒					■

17.0 LONG-TERM MONITORING

Reserved for future use.

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