FINAL REPORT

CONFIRMATION STUDY OF FORMER ATLAS MISSILE SITES FOR POTENTIAL TOXIC AND HAZARDOUS WASTE CONTAMINATION

FORMER ATLAS SITE S-12
MOOERS FORKS, NEW YORK

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GLOSSARY OF ABBREVIATIONS

AWQC - Ambient Water Quality Criteria
CERCLA - Comprehensive Environmental Response Compensation and Liability Act
CONUS - Continental United States
DAA - Defense Appropriations Act
DERA - Defense Environmental Restoration Account
DERP - Defense Environmental Restoration Program
DOD - Department of Defense
EPA - Environmental Protection Agency
GSA - General Services Administration
HRS - Hazardous Ranking System
ICBM - Intercontinental Ballistic Missile
IRP - Installation and Restoration Program
MCL - Maximum Contaminant Level
MCLG - Maximum Contaminant Level Goal
NPL - National Priority List
PA - Preliminary Assessment
PAH - Polynuclear Aromatic Hydrocarbon
POL - Petroleum, Oils, and Lubricants
RCRA - Resource Conservation and Recovery Act
RI - Remedial Investigation
RI/FS - Remedial Investigation Feasibility Study
SI - Site Inspection
USACE - United States Army Corps of Engineers
USEPA - United States Environmental Protection Agency
USGS - United States Geological Survey

EXECUTIVE SUMMARY

The Department of Defense (DOD) is investigating former ATLAS missile sites throughout the United States for potential toxic and hazardous waste contamination. This report documents the contamination evaluation investigation performed at ATLAS Missile Site S-12, located in Mooers Forks, New York. The field investigation consisted of installing and sampling three ground-water monitoring wells, sampling surface soils, and sampling water from the missile silo at the installation. The samples were analyzed for purgeable aromatics, purgeable halocarbons, base/neutral extractables, and metals. The analytical data for this inventory study are summarized in Section 4.0 of the report and are fully presented in the Appendices.

Evaluation of the test results from the site investigation at ATLAS SITE S-12 indicate the following conclusions:

- Arsenic, barium, and chromium were present at low concentrations in the ground-water samples collected at the site. The barium concentration in sample MW-1202 slightly exceeded the MCL and may be indicative of contamination resulting from ATLAS activities. However, the concentrations of arsenic and chromium detected in the ground-water do not indicate contamination.

- The chlorinated compounds trichloroethylene, trans-1,2-dichloroethylene, and 1,1,2,2-tetrachloroethane were detected in the ground-water samples from MW-1201 and MW-1203. These compounds are common industrial solvents which are typically used as degreasers. Maintenance operations at the ATLAS facility may have used chlorinated solvents. Additionally, research indicates that trans-1,2-dichloroethylene may be produced by the anaerobic decomposition of trichloroethylene (Cline and Viste, 1984).

The concentrations of trichloroethylene and trans-1,2-dichloroethylene are below regulatory criteria. The ambient water quality criteria is for 1,1,2,2-tetrachloroethane is 0.0017 mg/l. Because the water quality criteria for 1,1,2,2-tetrachloroethane is significantly below the measurable detection limit, its concentration in MW-1201 must be assumed to exceed the criteria. The presence of the chlorinated solvents in the ground-water samples may be related to DOD activities at the site.

- Benzene, toluene, and the polynuclear aromatic hydrocarbons (PAH's) acenaphthene, anthracene, fluoranthene, naphthalene, pyrene, and phenanthrene were detected at low concentrations in the ground-water sample from MW-1201. A strong petroleum odor and an oil sheen were observed on sample MW-1201 when collected. Benzene, toluene, and the PAH's are constituents of petroleum-based fuels. The presence of these compounds may be indicative of traces of fuel which have entered the ground water. Fuel contamination may be related to past DOD activities or to present fuel storage and handling practices by the Town of Mooers Forks.

- Concentrations of chromium and lead were detected in the silo water sample collected at Site S-12. The concentrations of both constituents exceeded the MCLs for drinking water. The concentrations of chromium and lead in the silo water may be a result of ATLAS facility operations or of the deterioration of the silo interior subsequent to deactivation of the site by the DOD.

- Concentrations of arsenic, barium, cadmium, chromium, lead, and mercury were detected in soil sample S-2. This sample was collected from a drainage swale which received the discharge from the silo sump system. Discharge from the silo sump system may have contributed to elevated concentrations of metals in the soil at ATLAS Site S-12.

- The potential for contamination as a result of activities subsequent to DOD ownership is comparable to the potential for contamination during DOD ownership. Municipal vehicles (Town of Mooers Forks) are presently maintained on site and diesel fuel is stored and dispensed at the site. The constituents found in the ground water at the site, that is, chlorinated solvents, benzene, toluene, and PAH's, may also be present in materials which are used in the operation of the maintenance facility.

The following preliminary conclusions and recommendation have been made based on the preceeding findings.

(1) Concentrations of the chlorinated solvents trichloroethylene, trans-1,2-dichloroethylene, and 1,1,2,2-tetrachloroethane were present in the ground water and may be related to DOD activities.

(2) The concentrations of benzene, toluene, and the PAH's detected in MW-1201 may be indicative of fuel present in the ground water.

(3) Lead and chromium concentrations in the silo water exceed the MCLs and may be due to ATLAS operations or silo deterioration.

(4) Elevated levels of arsenic, barium, cadmium, chromium, lead and mercury detected in the soil are most likely a result of discharge from the silo sump system.

Based on the samples collected from the site, contamination which may be a result of DOD activity was present in the ground water, silo water, and soil. Therefore, it is recommended that ATLAS Site S-12 in Mooers Forks, New York, be referred to the Missouri River Division (MRD) for further study.

1.0 PROGRAM BACKGROUND

The U.S. Army Corps of Engineers (USACE) contracted with Law Environmental, Inc., Government Services Division (Contract No. DACW 41-86-D-0115) to perform a contamination evaluation investigation at former ATLAS Site S-12 in Mooers Forks, New York. This report documents the investigation that was performed at that site. The report is divided into six sections that discuss background information, existing site conditions, field investigation program, analytical results, data interpretation and preliminary determinations. The following material in this section of the report presents an overview of the ATLAS missile program and a comparison of this investigation program with other Federal investigation programs.

1.1 OVERVIEW OF THE ATLAS MISSILE SYSTEM

1.1.1 Background

The ATLAS Missile System was the foundation for the United States Intercontinental Ballistic Missile (ICBM) and space launch vehicle programs during the late 1950's and early 1960's. The ATLAS Missile Program began in 1946 under the code name Project MX774. The program evolved through several phases of improved engines, modified fuels, strategic missile deployment, varied launch configurations, and a space launch vehicle. The phase which influences the Defense Environmental Restoration Program involves the deployment of ATLAS Missiles at operational sites within the continental United States.

The Research and Development (R&D) phase of the ATLAS Missile Program was conducted at Cape Canaveral, Florida. The most memorable event associated with ATLAS during the R&D phase was the December 18, 1958, launch into orbit. During this mission, a recorded Christmas message was radioed back to earth from President Eisenhower. At that time ATLAS was on a high priority track to become an operational part of the ICBM Program. The

first two versions of the missile ATLAS A and ATLAS B were produced during this R&D phase.

ATLAS D was the first operational version of the missile; it was deployed at Vandenberg AFB, California; Warren AFB, Wyoming, and Offutt AFB, Nebraska. The subsequent E&F versions were also deployed at operational units in the U.S.

During the evolution of ATLAS versions D, E, and F, the launch mode for the missile was also evolving. The R&D versions of ATLAS had stationary launch facilities at Cape Canaveral and Vandenberg. However, the operational missile had to be deployed at remote sites, where it was not feasible to provide the stationary launch facilities. Therefore, ATLAS D was designed to be moved to the launch pad by a transporter, which subsequently erected the missile to its vertical launch position and then arched away from the missile at launch. The installations which deployed ATLAS D's were above ground facilities and provided no protection from attack.

The next improvement for ATLAS was the E version which was designed to survive a nearby nuclear explosion, which would produce up to 25 PSI overpressure to the launch facility. This criteria resulted in enclosing the missiles in "coffin like" vaults and redesigning the lifting truss to position the missile for launch. The missile vaults were partially buried, with protective doors that retracted from above the missile for launching. The launch operations were conducted from a buried control structure. ATLAS E sites were considered "semi-hard" sites.

The final improvement to the ATLAS Missiles System was to harden the facilities to provide protection for 100 PSI overpressure which would be produced by a nearby nuclear explosion. This resulted in emplacing the missile vertically in underground silos and isolating the missile from the silo within a spring mounted crib. The silo top was enclosed by heavy doors which were opened

for missile launch. The ATLAS F version was deployed at the hard sites. The launch mode was to elevate the missile above the silo door (top). Figure 1-1 shows a typical hardened ATLAS site with the missile in the launch position. Facilities at the surface of the hardened ATLAS sites included one or two quonset huts used for maintenance, and the launch control center entrance. Integrated ATLAS F facilities such as control rooms, crew quarters, and propellant storage were buried below ground. Figure 1-2 is an artist's sketch of a hardened ATLAS site showing the underground and surface facilities.

The ATLAS D, E and F versions were deployed at 13 squadrons located near 11 Air Force bases. The ATLAS deployments are summarized below:

		Number of Missiles		
Air Force Base	Location	D Model	E Model	F Model
Vandenberg	Lompoc, CA	6		
Warren	Cheyenne, WY	6	9	9
Offutt	Omaha, NE	9		
Fairchild	Spokane, WA		9	
Forbes	Topeka, KS		9	
Schilling	Silina, KS			12
Lincoln	Lincoln, NE			12
Altus	Altus, OK			12
Dyess	Abilene, TX			12
Walker	Roswell, NM			12
Plattsburgh	Plattsburgh, NY (Includes ATLAS Site S-12 at Mooers Forks, New York)			12

FIGURE 1-1

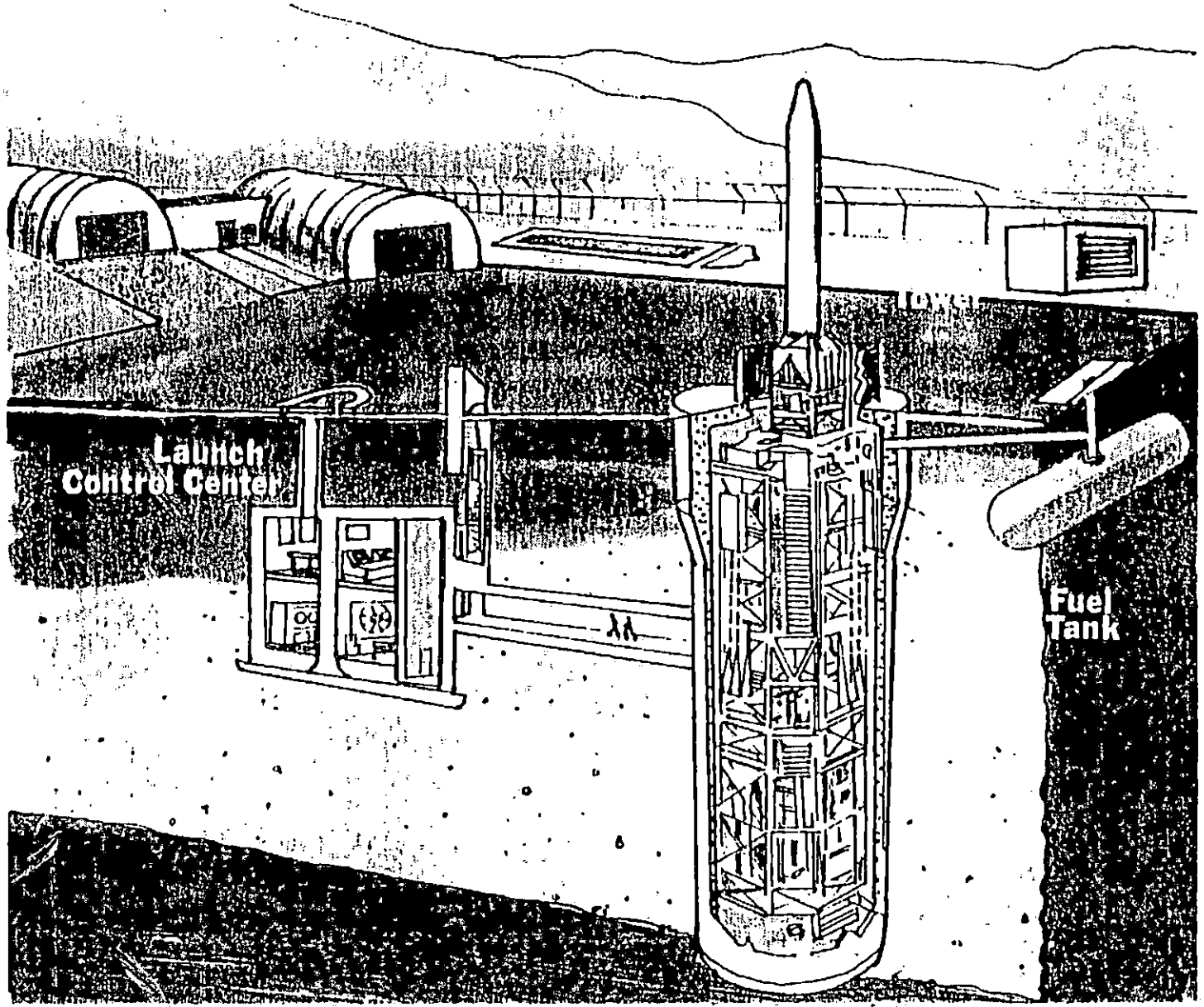
TYPICAL ATLAS SITE

ATLAS SITE S-12 MOOERS FORKS, NEW YORK

FIGURE 1-2

ATLAS GENERIC SITE

ATLAS SITE S-12 MOOERS FORKS, NEW YORK



In addition to locating the ATLAS missile squadrons at selected Air Force bases, each squadron dispersed its missiles to improve system survivability; except for early "soft" operational units at Vandenberg AFB, and Warren AFB which were not dispersed. The non-dispersed sites allowed up to three missiles to be controlled by a single control room. Subsequent semi-dispersed sites also allowed multiple missile control from a single control room. Extensive communications systems were involved with the semi-dispersed sites. The Fairchild AFB communications system for ATLAS incorporated a microwave system that was hardened to withstand 25 PSI overpressure and linked nine sites dispersed over 8,000 square miles. The preponderance of ATLAS sites were ATLAS F's which were hardened and dispersed. These "hard" sites each had individual control functions.

The ATLAS used liquid propellant - kerosene and oxygen. These were generally stored in separate below ground tanks remote from the launcher or silo. The ATLAS F version utilized a unitary concept of deployment; that is, the missile was equipped with on-board tanks and the propellant could be stored in its onboard tanks or transferred from adjacent storage in minimal time. The missile also required that a positive pressure be maintained interior of the missile to enhance structural rigidity both in prelaunch and during flight. This positive pressure was provided by helium which was stored in the ATLAS F silo and on-board the missile.

The ATLAS Missile Program provided an important element of the U.S. defense system during a period of rapid evolution in ICBM systems. However, this evolutionary period was short lived. The first operational ATLAS system was at Vandenberg in September 1959. The last operational squadron was at Plattsburgh in December 1962. By 1965, the Plattsburgh squadron was dismantling their silos and the records indicate the silo equipment was sold for salvage. By 1966, the ATLAS F's were obsolete and were returned to the USAF for use in the military space program.

Therefore, the missile system was in place for only 3 to 5 years. During operational status, the ATLAS sites could have contributed to environmental contamination from fuel storage or site maintenance activities.

1.1.2 ATLAS Missile System Operations

A typical ATLAS F site (Figure 1-3) generally consisted of about 10 acres within a security fence. The major facility at the site was the underground silo which was 174 feet deep x 69 feet diameter. The silo was constructed of thick reinforced concrete walls. Two hydraulically-operated doors sealed the top of the silo. These doors were made of steel reinforced concrete, designed to withstand a nearby nuclear blast. The silo doors remained closed (Figure 1-4) during normal operation but were opened (Figure 1-5) to raise the ATLAS missile into firing position.

The ATLAS missile was supported in a spring-mounted crib which was suspended in the silo. The missile was 82 1/2 feet long and 10 feet in diameter. The silo space below the missile was used for propellant storage, missile support and fuel loading equipment. The silo also contained seven operations levels adjacent to the missile: lifting system, hydraulic power and air handling, launch control electronics, HVAC, diesel generator/fuel day tank, diesel generator, propellant loading. The silo configured in this manner comprised a unitary concept where all critical elements were contained within the silo.

About 150 feet away from the silo, an ATLAS F site contained a below grade Launch Control Center (LCC). The LCC was a 2 story structure approximately 40 feet in diameter. It provided personnel quarters and communications to the missile and to command and control centers. A reinforced concrete enclosed stairway (Figure 1-6) led down to the LCC.

FIGURE 1-3

TYPICAL ATLAS SITE PLAN

ATLAS SITE S-12 MOOERS FORKS, NEW YORK

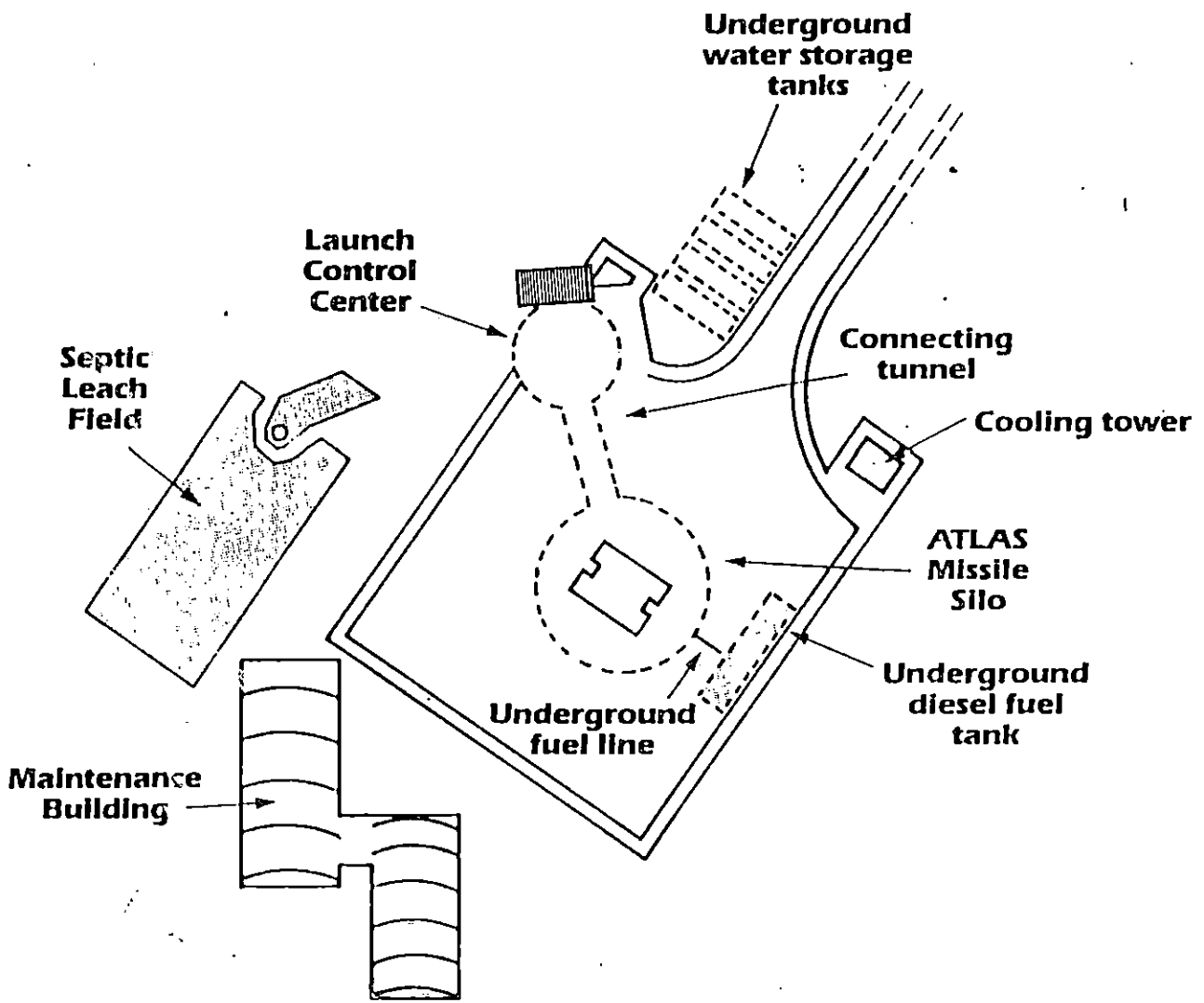


FIGURE 1-4

SILO DOORS (CLOSED)

ATLAS SITE S-12 MOORES FORKS, NEW YORK

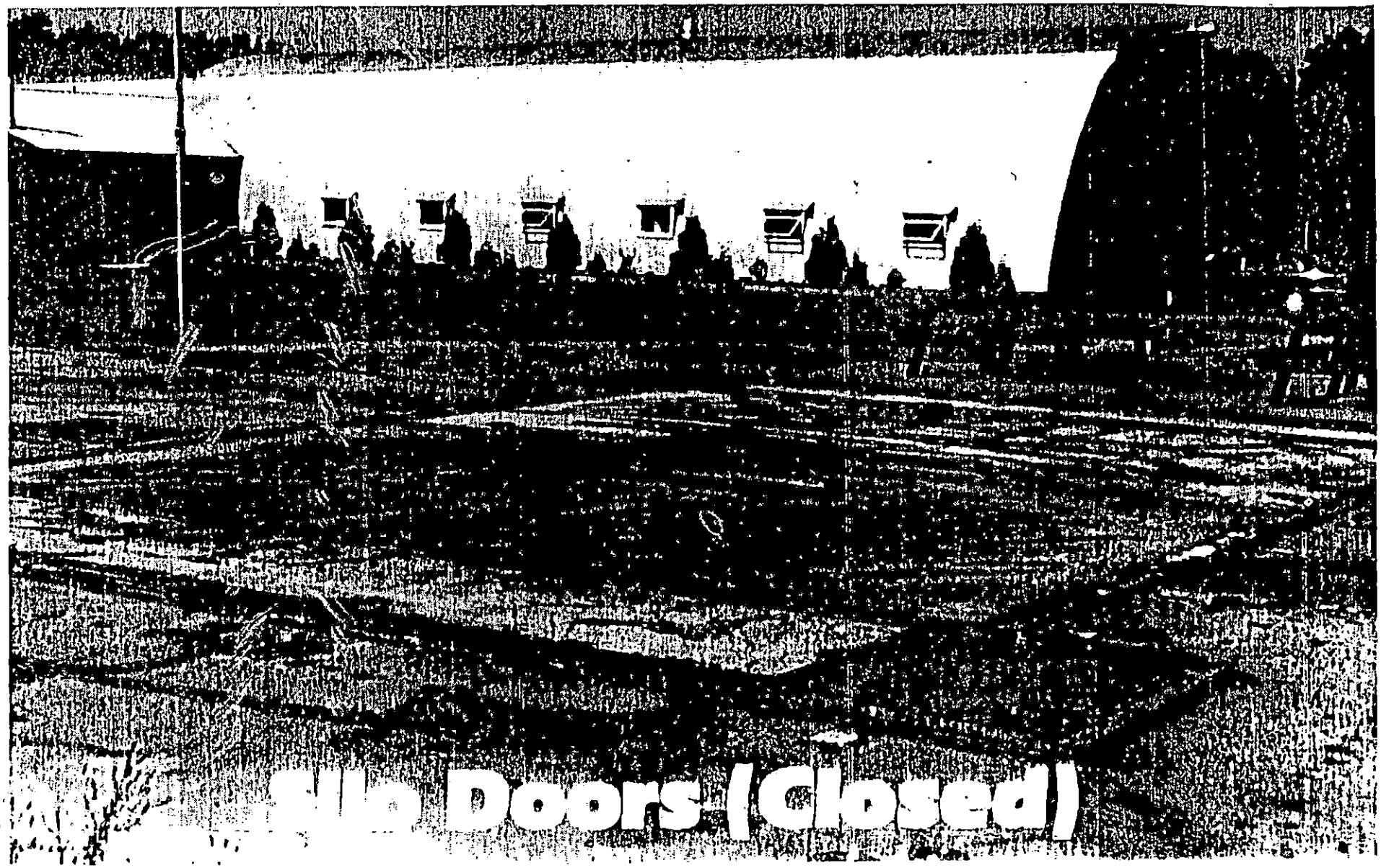


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FIGURE 1-5

SILO DOORS (OPEN) WITH BLAST SHIELD

ATLAS SITE S-12 MOOERS FORKS, NEW YORK

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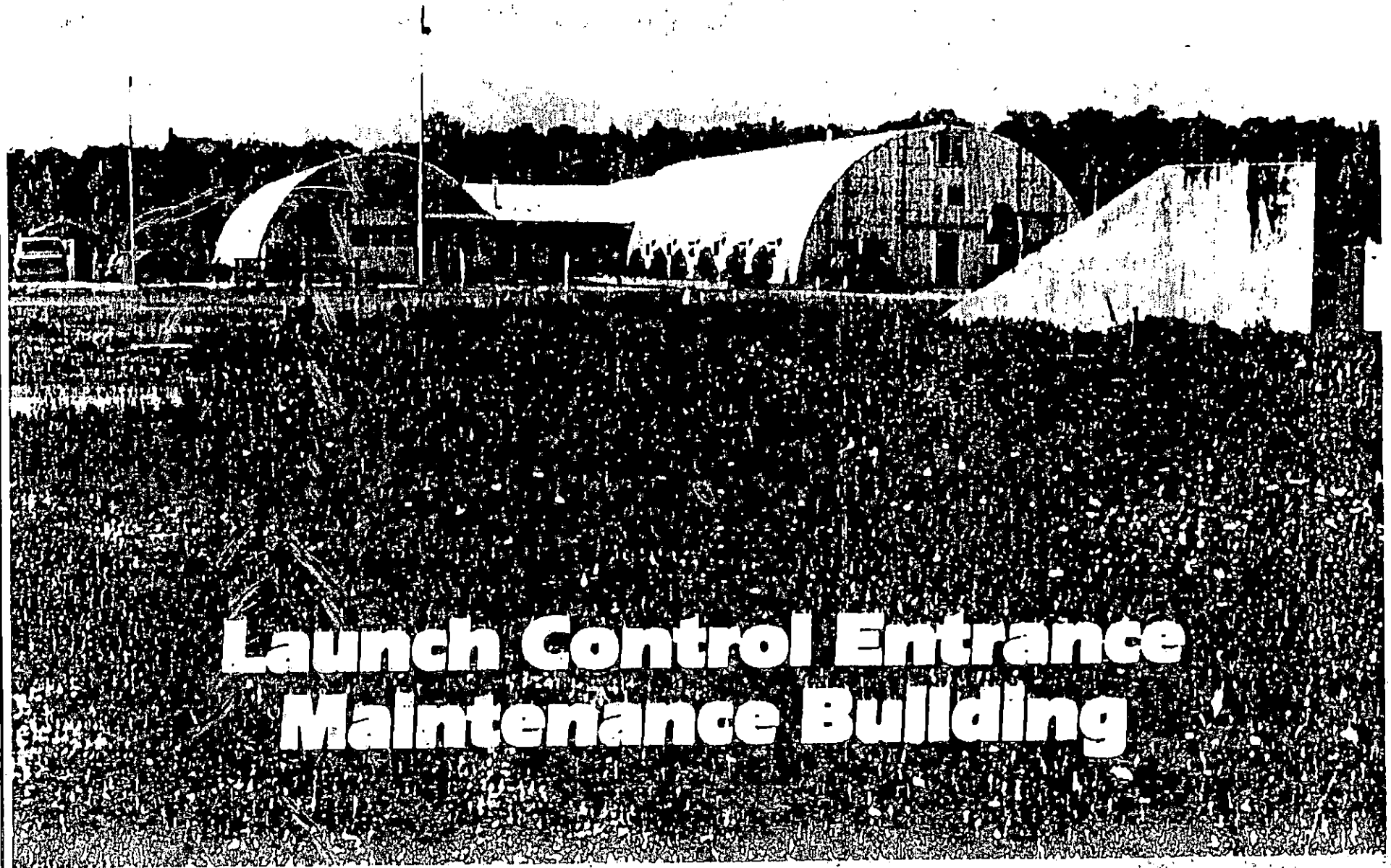
FIGURE 1-6

LAUNCH CONTROL ENTERANCE MAINTENANCE BUILDING

ATLAS SITE S-12 MOOERS FORKS, NEW YORK



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The ATLAS F sites included facilities and equipment to maintain the missiles. The maintenance facility was a steel structure located at grade, near the silo (Figure 1-6). During site operations missile components could be removed from the silo and maintained within this facility. The maintenance building, security systems, and waste treatment facilities were the only above-grade facilities at a site.

The waste-water treatment and disposal practices were different at each site. Spray fields and percolation basins were used in areas where soil and climate was appropriate for sanitary waste treatment.

The unitary silo provided a means for fuel storage within the silo. However, there are indications that fuel may have also been stored in underground tanks remote from the silo at some sites. Another below grade tank was the diesel fuel storage for the diesel generators. Generally, steel tanks were provided within about 100 feet of the silo for this purpose.

1.1.3 Waste Generation

The ATLAS operational site activities which produced wastes or potential contaminants included:

propellant storage
diesel fuel storage
hydraulic systems
maintenance: petroleum, oil, lubricants, solvents, equipment operations, personnel, sanitary systems

The propellant storage included below grade tanks for kerosene and liquid oxygen. The duration of the ATLAS as an operational system was limited to three to five years. Therefore, underground tank leakage due to deterioration was unlikely. The most likely source of contamination from storage was spillage

during tank filling and possibly faulty connections in conveyance lines. The liquid oxygen was stored under cryogenic conditions and spillage or leakage was very improbable. Furthermore, loss of oxygen would not have produced a toxic condition. Propellants were also stored on board the ATLAS F's and in their silos. As such, spillage of kerosene inside the silo would have been discharged to the silo exterior through the silo discharge system.

Diesel fuel was stored in underground tanks for all of the deployed ATLAS F sites. Diesel fuel was used in the on-site generator to supply power for control room and launch activities. At remote ATLAS F sites, where public electric power was not available, on-site generators supplied normal operating power as well as emergency power. Leakage from underground tanks, spillage during tank filling and escape of fuel during maintenance or repairs of generators could have produced contamination at the diesel storage tank location or adjacent to the silo.

Each ATLAS silo contained an enormous hydraulic lift system to move the missile from its cold storage position in the bottom of the silo, to the hot launch configuration at the surface. When the ATLAS system was decommissioned, some of the hydraulic fluid may have remained in the storage tanks, pressure lines, pumps and rams. Subsequent deterioration of the system may allow remnant hydraulic fluid to leak into the silo, and ultimately into the environment.

Maintenance of the missile and equipment at the launch sites was the most probable source for contamination. The sites contained hydraulic systems, pumps, generators, electronics, heating, ventilating, air conditioning, refrigeration, and other systems that required continuous maintenance to maintain operational reliability. Maintenance activities included the use of solvents, petroleum, oil, and lubricants (POL). The release of these potential contaminants could have resulted from the

discharge of these materials when the floors were cleaned or from the silo sump discharge line. It is also possible that some POL accumulations which were retained for routine proper disposal were accidentally or intentionally spilled within the site boundaries.

The support crew for the remote sites involved about 20 people, producing sanitary waste that was treated on site. The ATLAS sites commonly had a spray field or aeration basin to treat and discharge sanitary sewage. Typically, sanitary sewage disposal fields do not result in hazardous or toxic materials that persist in the shallow subsurface zones. Therefore, it is unlikely that this waste stream produced this type of contamination.

The lowest level in the ATLAS F silo was the "Sump Level." Two automatically actuated 100 GPM capacity sump pumps located at this location remove liquids from the silo. The liquids were pumped through pipes that were routed up the silo wall and exited through the silo wall at level 2. The ultimate disposition of the silo effluent appears to have been to a drainage ditch, which was located far enough away from the silo to avoid interaction with the silo backfill and the launch control center. The USAF Operational Readiness Training Manual designates the ATLAS F complex into four quadrants, quadrant I contains the cooling tower and water plant, quadrant II contains the launch control center, quadrant III contains the electrical and communication stub-ups and quadrant IV contains the sump discharge areas. Quadrants II and IV are diagonally opposite each other. Therefore, it appears that the sump discharge usually occurs on the silo quadrant opposite the launch control center. This discharge may have been integrated with the area storm water management system and carried off-site by surface channels.

1.2 PROGRAM COMPARISON

The Department of Defense (DOD) conducts a number of industrial processes and manufacturing operations that are similar to those of private industry. In the late 1970's, DOD became aware of the negative impacts of what were previously considered acceptable disposal practices of waste materials associated with these processes and operations. In response to that knowledge, programs were developed between 1975 and 1978 by each service component to identify and assess potential contamination on active military installations. Authority to address problems of other than active installations was lacking because funds could not be spent on sites not owned by DOD.

The passage of the 1984 Defense Appropriations Act changed this situation. Specific language in the Act directed DOD to extend its efforts to include sites formerly used by DOD. The Act also broadened the definition of "hazard" to include structures and debris which were to be abandoned or had been abandoned upon termination of the site's military use.

The Act directed that the Secretary of Defense to assume overall management of the program to assure consistent approach and adequate resource allocation. A Defense Environmental Restoration Account (DERA) was established which provides the resources for the evaluation and characterization of potential chemical contamination at former DOD Sites.

Sites located on active DOD installations are being investigated under the Installation and Restoration Program (IRP). Sites either previously or presently owned by DOD not located on active DOD installations are handled separately from the IRP effort. In order to present a perspective of the formerly used (non-IRP) site investigation program, it is necessary to compare such efforts to the EPA's Superfund program and the DOD's IRP.

Figure 1-7 presents a block diagram illustration of the following investigative programs presently being conducted by various Federal agencies.

- EPA Superfund
- DOD/IRP
- DOD Non-IRP

Under Superfund, a Preliminary Assessment (PA) is conducted; it consists of a desk-top study and site visit which leads to a Site Inspection (SI). The SI usually includes limited sampling activities. After completion of the SI, a Hazard Ranking is performed and if the site scores above a certain number, it becomes a candidate for the National Priority List (NPL). Additional site investigations are conducted during the Remedial Investigation (RI), which is a comprehensive study to determine the extent of contaminants and their rate of movement.

The DOD's IRP study consists of a records search and site visit to establish a potential list of sites possibly contaminated at an active installation. A Hazard Ranking System (HRS) is utilized to determine which sites will be investigated in order of environmental and/or public health importance.

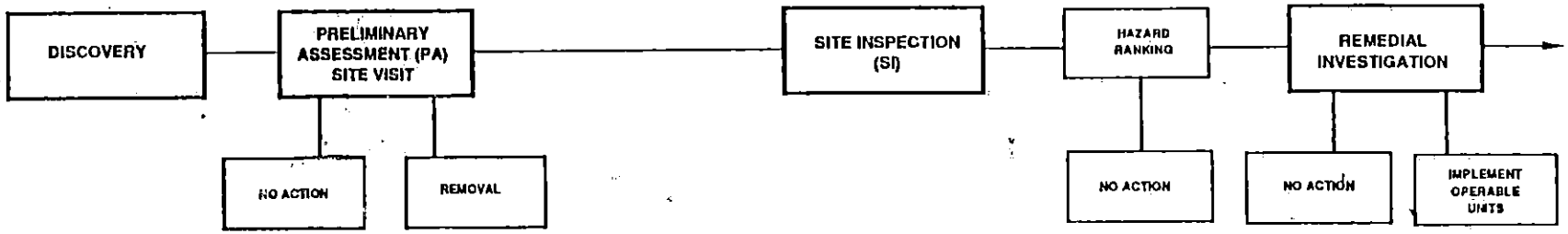
The Non-IRP effort, under which the NIKE Sites are categorized, also has an Inventory Study. Unlike the IRP and Superfund programs, it is a real estate oriented effort to determine ownership of the site. In addition, certain studies are performed dealing with demolition of structures previously used by the DOD.

A similar task is evident for each phase of the three programs; that is, the Site Inspection (EPA); the Confirmation Study (IRP) and the Confirmation Study (NON-IRP). Each of these studies are similar in terms of investigative depth. Some soil and water sampling is accomplished and a few monitoring wells may be installed. The principle purposes for each study, however, may

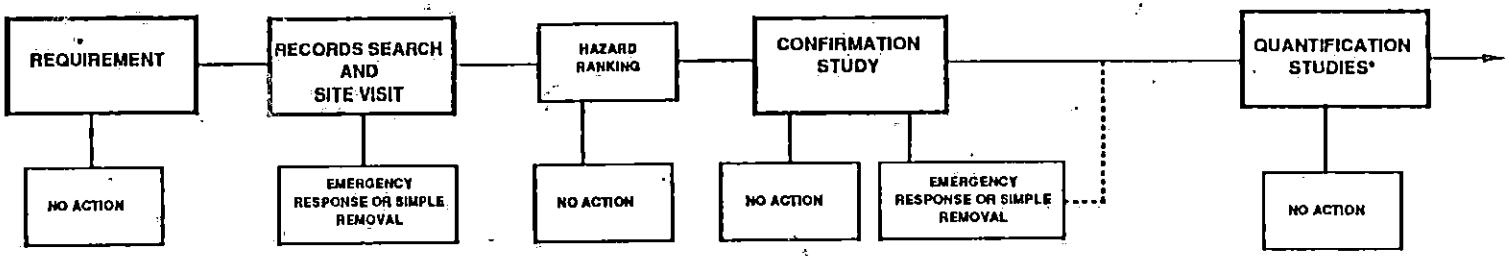
GOVERNMENT ENVIRONMENTAL PROGRAMS

ATLAS SITE S-12 MOOERS FORKS, NEW YORK

EPA SUPERFUND

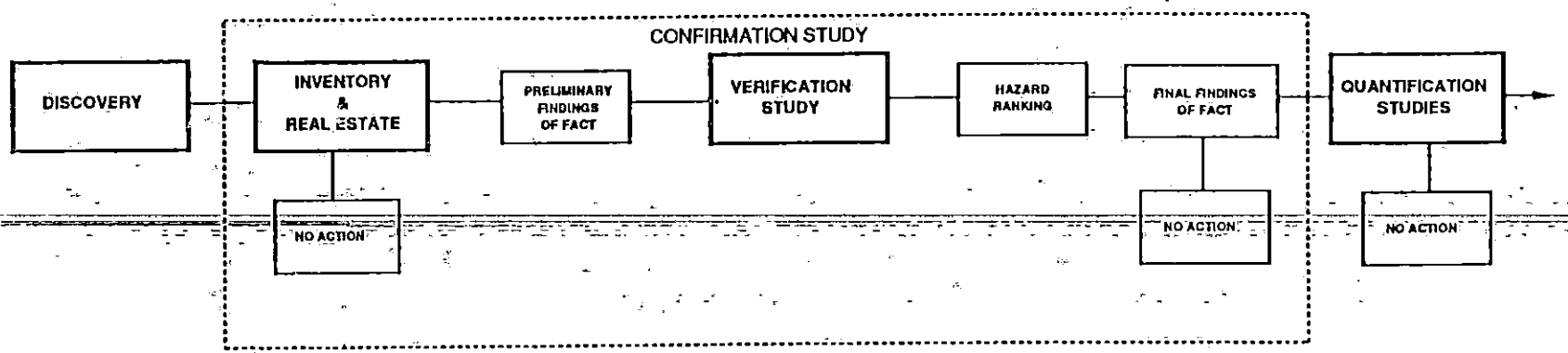


DOD - IRP



FEASIBILITY STUDY

DOD - NON IRP



* MAY BE ACCOMPLISHED IN PHASES

be somewhat different from the others. For example, the purpose of a Non-IRP Confirmation Study is to make a preliminary determination of whether contamination exists and if it was caused by DOD operations.

The Remedial Investigation (RI) under the Superfund Program is the most complex field investigation effort. It correlates with the Quantification Studies under IRP and Non-IRP efforts.

In summary, the scope of effort for a Confirmation Study of a Non-IRP Site is shown on Figure 1-7 surrounded by the dotted lines. It can easily be seen that this type of study is very preliminary and cannot be compared with the project requirements for an RI, especially one with an NPL rating.

*****

2.0 SITE CONDITIONS

2.1 PROJECT OBJECTIVES

The text of the Scope of Work (SOW) for this confirmation study, dated May 20, 1987, is contained in Appendix L of this report. Item 2.0 of the SOW describes the purpose of this evaluation as follows: "to provide a preliminary determination of the presence or absence of chemical contamination which may have resulted from Department of Defense activities at the site." To fulfill this purpose, Law Environmental, Inc., performed these work elements:

- conducted site visit to collect background information;
- prepared work plan and safety plan;
- installed ground-water monitoring wells;
- collected and analyzed ground-water, silo water and soil samples;
- evaluated physical and chemical data;
- prepared an engineering report including a hazard ranking system (HRS) report.

Details of the work performed in each of these elements are described in the following sections of this report. Work Plans with detailed descriptions of field and laboratory procedures are presented in in Appendix H and Appendix I, respectively. This section of the report describes pertinent background information including a write-up of the site visit, site location information, site physiography, land use, and current and past ownership and use of the site.

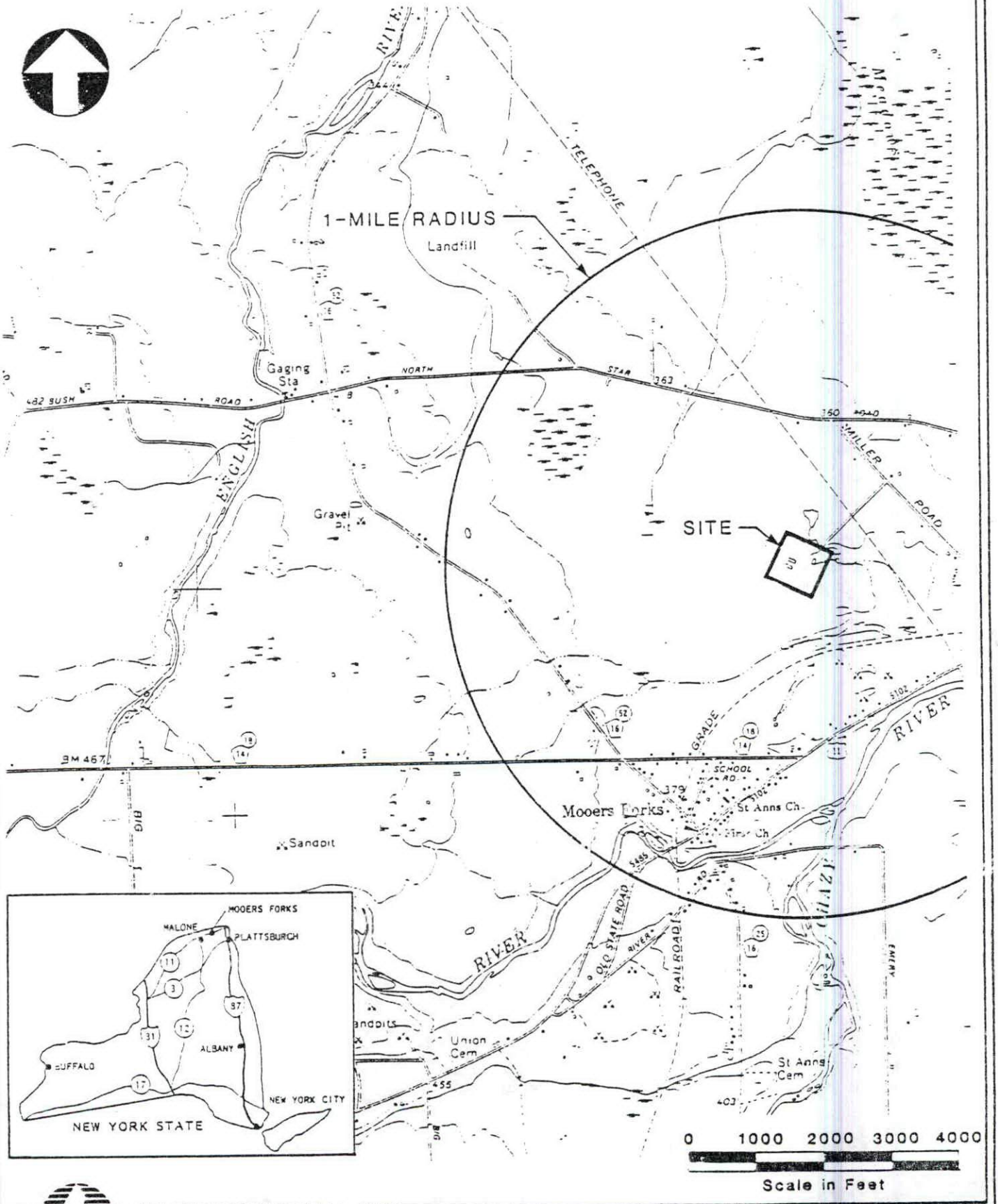
2.2 SITE VISIT SUMMARY

A site visit in accordance with Task 2 of the ATLAS contamination evaluation SOW was performed by Mr. Louis S. Karably of Law

FIGURE 2-1

SITE LOCATION MAP

ATLAS SITE S-12 MOOERS FORKS, NEW YORK



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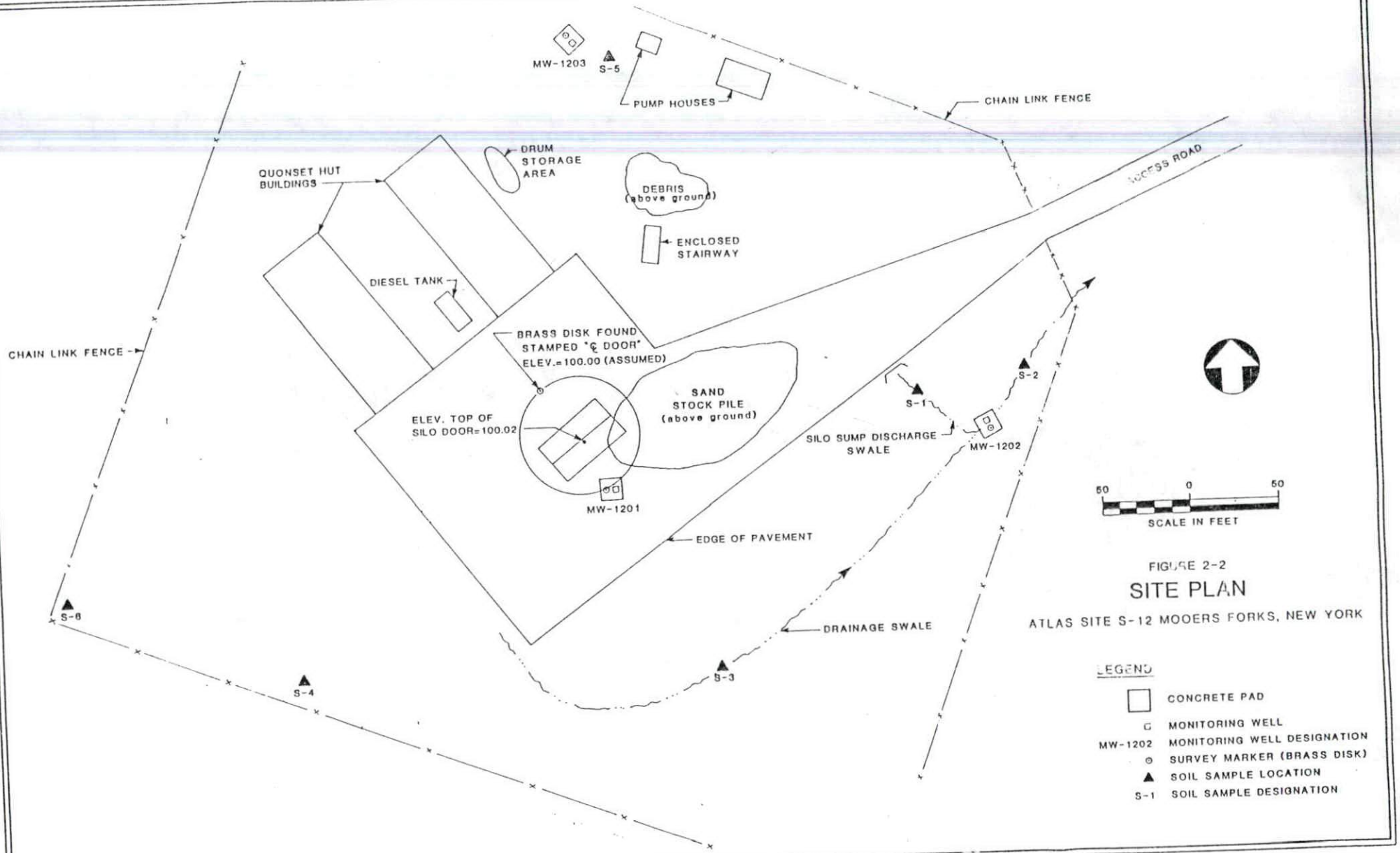

FIGURE 2-2

SITE PLAN

ATLAS SITE S-12 MOOERS FORKS, NEW YORK

FIGURE 2-3

PUMP HOUSE & LAUNCH CONTROL CENTER ENTRANCE

ATLAS SITE S-12 MOOERS FORKS, NEW YORK

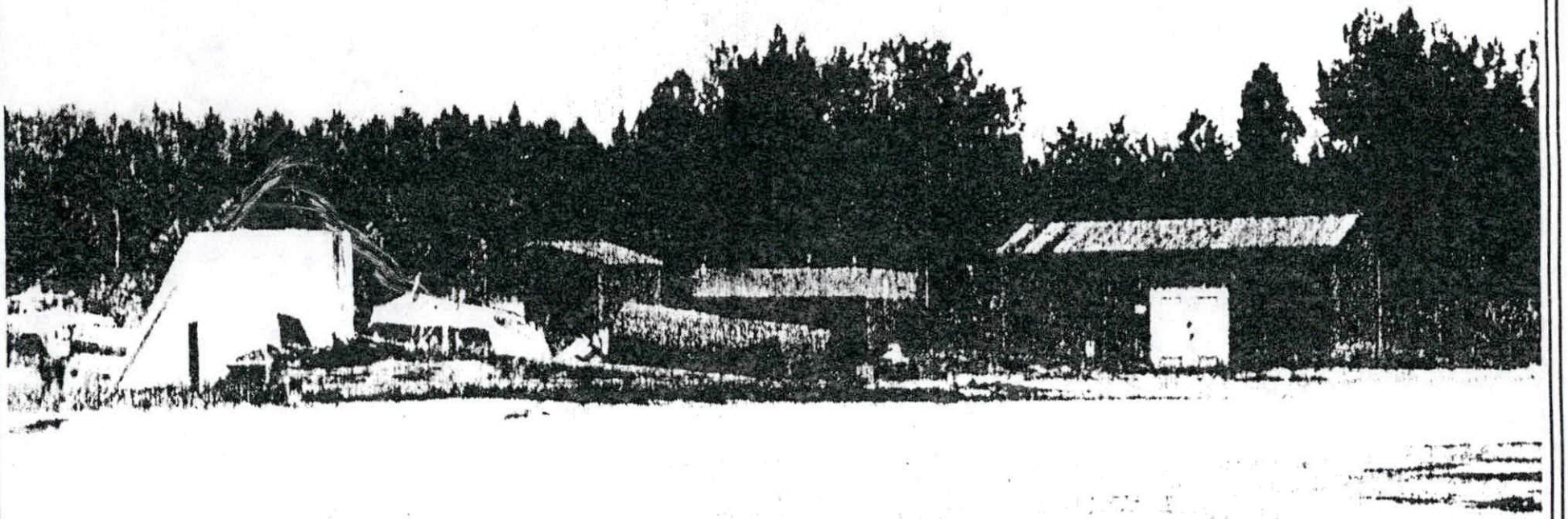

FIGURE 2-4

ENTRANCE TO LAUNCH CONTROL CENTER

ATLAS SITE-12 MOOERS FORKS, NEW YORK

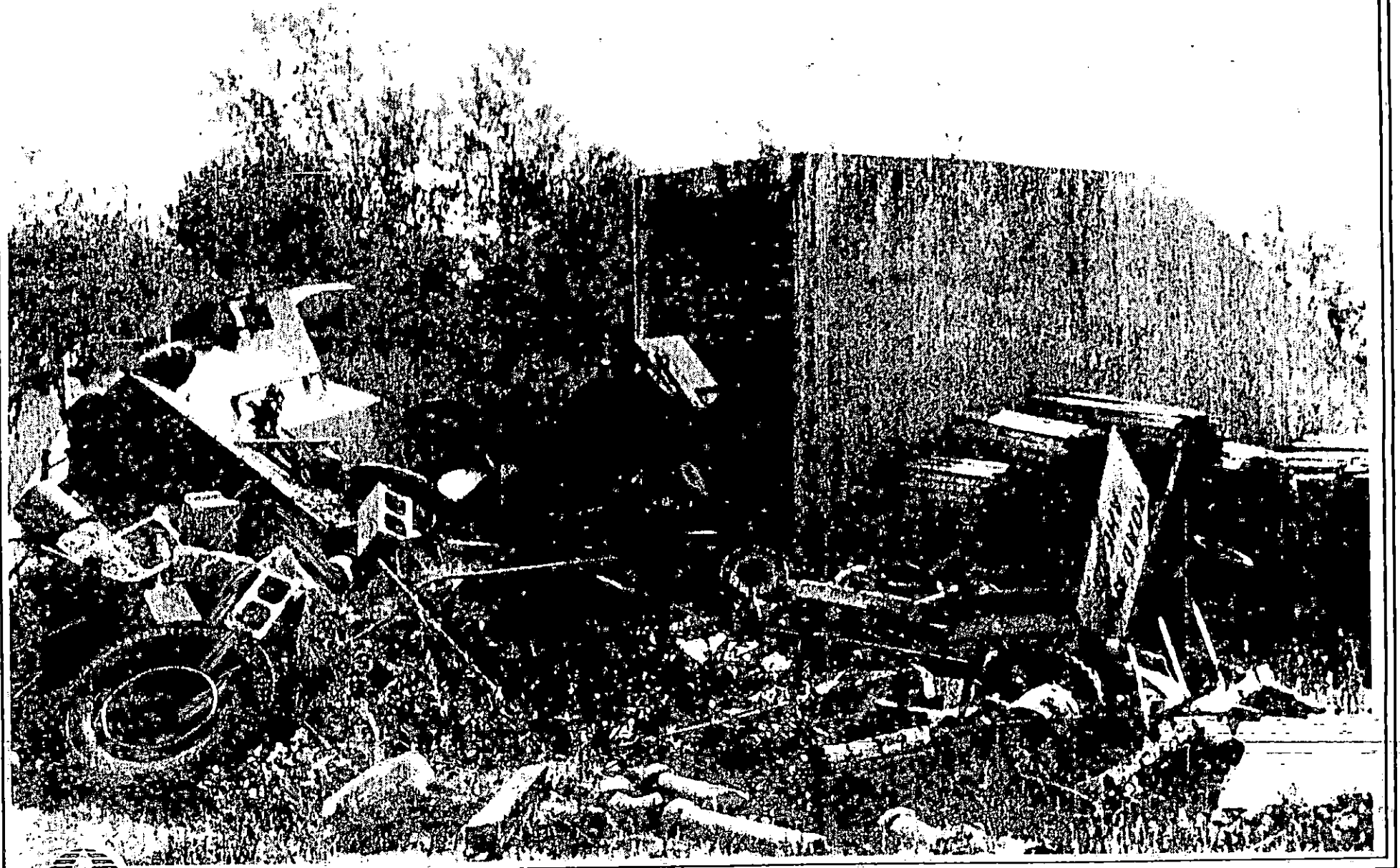

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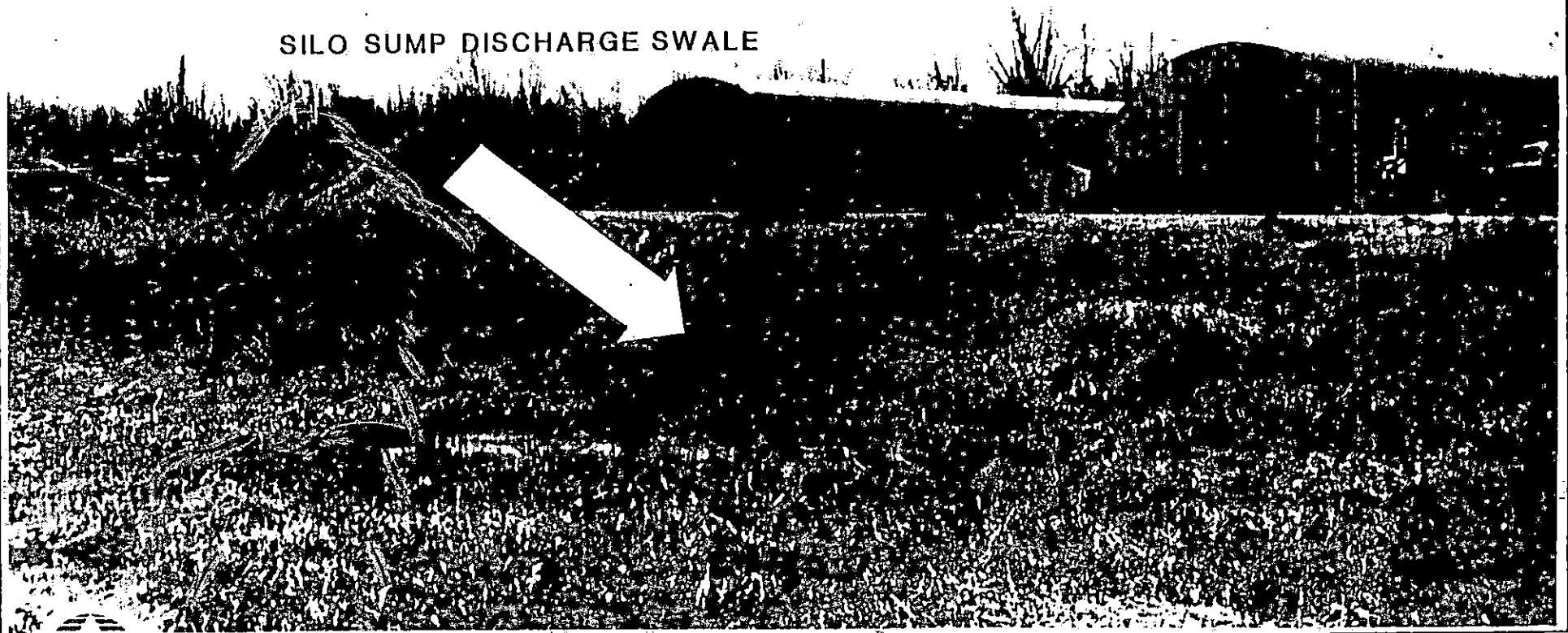
FIGURE 2-5

SILO SUMP DISCHARGE AREA

ATLAS SITE-12 MOOERS FORKS, NEW YORK



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Environmental, Inc. in June, 1987. The site visit involved a meeting with USACE personnel from the Kansas City District and a visual inspection of the ATLAS site. The following information was collected during the site visit.

- Former ATLAS site S-12 is located north of U.S. Highway 11 in the town of Mooers Forks, New York, in Clinton County (Figure 2-1). Access to the site from Plattsburgh is north on U.S. Highway 9 and west on U.S. Highway 11 to Duprey Road. After turning right on Duprey Road and left on Miller Road, the site is located at the end of the access road. Approximate mileage from Plattsburgh is 30 miles.

- The surficial geology at the site consists of glacial deposits over Paleozoic sedimentary rock made up of dense dolostone and sandstone (Isachsen Y., and Fisher, D., 1970).

- The topography of the site slopes gently to the east. Surface water drainage in the immediate vicinity of the site appears to follow the topography. An unnamed stream directs surface water runoff east then south to the Great Chazy River. Ground-water flow was anticipated to be east to southeast based on the topography of the area.

- Structures and buildings present (1988) at the site (Figure 2-2) include the missile silo, fuel tanks, two pump houses, two quonset huts, and a buried concrete launch control center. The pump houses and the entrance to the underground launch control center are shown in Figure 2-3. A view of the entrance to the launch control center is shown on Figure 2-4. The debris surrounding the entrance is apparently the result of the current owner's activities.

- The silo sump discharge line appears to be located to the east of the silo. Figure 2-5 shows the silo discharge area on the east side of the silos and the quonset huts on the

west side of the silos. Discharge from the silo sump system appears to be directed to a swale which leads east into a nearby stream.

- One concrete and steel subsurface missile silo is present in the center of the facility. The silo is approximately 70 feet in diameter and 187 feet deep with 12 foot thick concrete walls. The silo doors are closed. Figure 2-6 shows the silo doors in the closed position. Pavement covers a 150 square foot area around the concrete missile silo pad.

2.3 SITE LOCATION AND ENVIRONMENTAL FEATURES

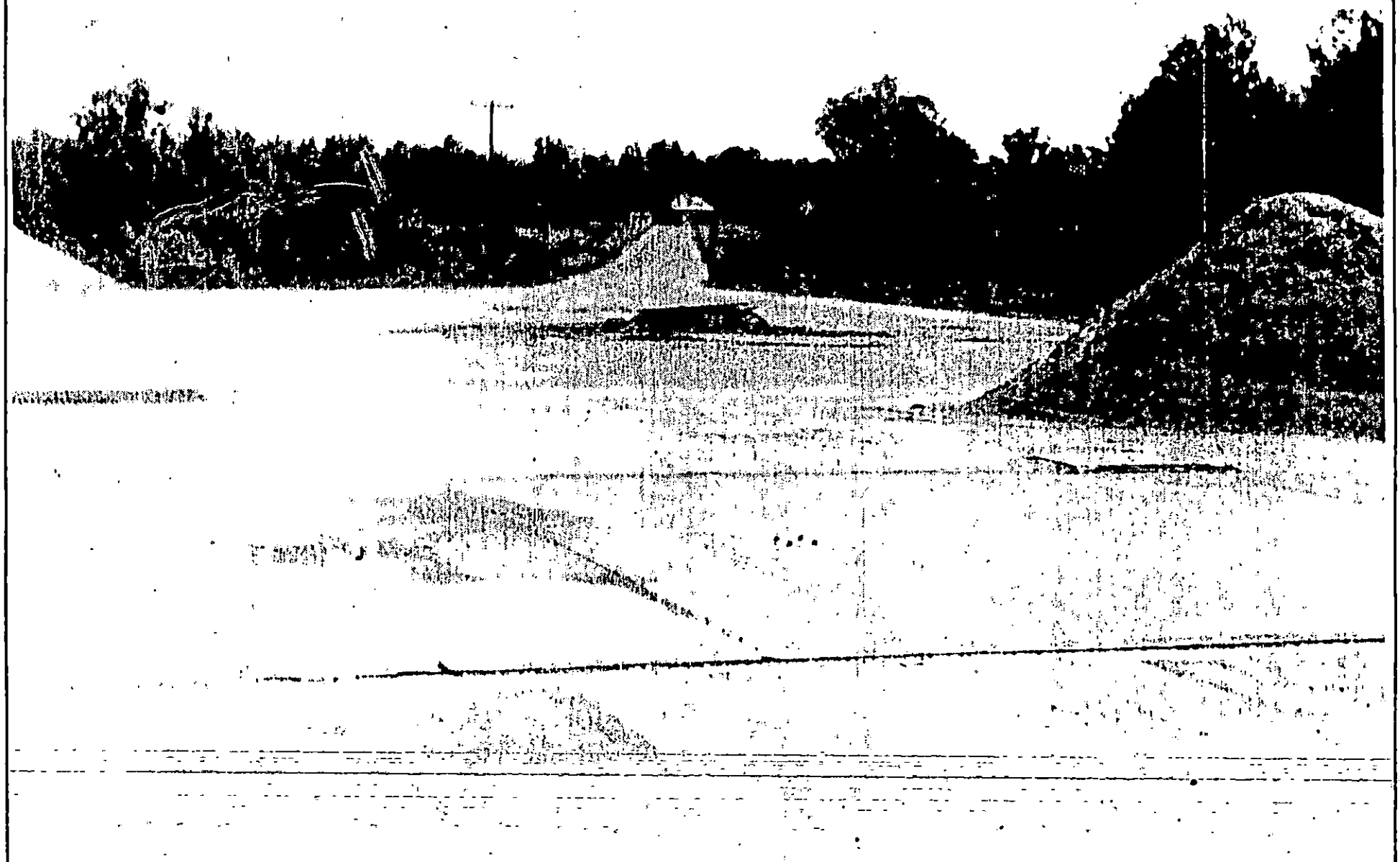
Atlas Site S-12 is located in Mooers Forks, New York, approximately two miles south of the Canada-United States border. The site is contained in the St. Lawrence Valley physiographic province adjacent to the Adirondack province. In this region the Pre-cambrian crystalline mountains of the Adirondacks are bordered by foothills of Paleozoic sedimentary rock that descend northward to the St. Lawrence Lowlands (Denny, 1974). The site lies on the northern flank of the Adirondack Mountains in a region characterized by rolling lowlands with isolated rocky hills.

Although no bedrock was encountered in the borings drilled at the site, the Geologic Map of New York (1970) indicates that the site lies near the contact between the Cambrian Age Potsdam Formation and the Ordovician Age Theresa Formation. The Theresa Formation underlines the lowlands and is characterized by interbedded dolostone (dolomite limestone), limestone, sandstone, and shale. The more rugged foothills between the lowlands and the Adirondack Mountains is underlain by the highly indurated Potsdam Formation. This formation is composed primarily of quartz sandstone, but also contains some arkose and shale beds.

FIGURE 2-6

SILO DOORS IN CLOSED POSITION

ATLAS SITE-12 MOOERS FORKS, NEW YORK



As part of the confirmation investigation, three shallow ground-water monitoring wells were installed at the site. Firm to dense silty, gravelly sands were encountered in each of the borings. No bedrock was encountered during the installation of the wells. Site stratigraphy and shallow ground-water conditions are discussed in Section 5.1 of this report.

Ground water in the study area occurs in both the unconsolidated glacial deposits and the consolidated older rocks. The yield of wells drilled in glacial material is highly variable and depends predominantly on lithology. Wells drilled in poorly sorted till tend to have low yield, but may still provide adequate domestic supplies. Wells set in sandy glacial drift material tend to be more productive. Ground water in the crystalline bedrock is present only in secondary joints and fractures. The yield of wells set in bedrock depends primarily on the number of joints which the well intercepts. Ground-water quality in the study area is generally good. Water from the glacial deposits tends to be mineralized and may contain significant concentrations of dissolved iron. The crystalline bedrock produces water of potable quality (Giese and Hobba, 1970).

The topography of the Adirondack region has been molded by a number of glacial episodes; the last of which, the Wisconsin, occurred as recently as 12,000 years ago. Ground moraine, formed as the glacier scoured the underlying bedrock, is areally the most prevalent glacial deposit. Also important are glaciofluvial deposits, such as drift, formed by meltwater depositing sand and gravel ahead of the glacial front. These two types of glacial deposits are found in the region surrounding the site (Denny, 1974).

The topography of the site is relatively uniform. Relief is less than 10 feet. The greatest change in elevation occurs east of the silo pad where the ground drops approximately four feet. The silo sump discharges to this low area and surface drainage from

most of the site is directed there. A swale leads east from this low area and directs surface water flow into a stream which is a tributary of the Great Chazy River. A marshy area borders the northwest perimeter of site. The marshy area has developed in a poorly-drained, low lying area which accumulates ground water and surface run-off. Drainage from the marshy area is directed eventually into the Great Chazy River.

The climate of the Adirondack region is characterized by cold, harsh winters and relatively mild summers. According to climatological data from a station approximately 15 miles south of the site, the mean annual temperature for the region is 44° F. Annual precipitation is approximately 33 inches with an additional 81 inches of snowfall per year. The rainfall is evenly distributed throughout the year but most occurs between June and October.

2.4 LAND USE

ATLAS Site S-12 lies north of the Adirondack Forest Preserve and south of the Canadian border. Land use in the immediate vicinity of the site is primarily rural residential. Single family residences predominate adjacent to site on Miller Road. Immediately adjacent to the facility are a number of residences on relatively large plots of land, some farms, and unused woodlands. The Town of Mooers Forks is located approximately one-mile south of the site. The estimated population within a one mile radius of the site is approximately 380. This estimate is based on a house count (assuming 2.3 people per house) from the New York Department of Transportation 7.5-minute Altona Quadrangle (1979).

2.5 OWNERSHIP AND PRIOR USE

Atlas Site S-12 was originally acquired in 1960 by the DOD for the purpose of constructing a missile launching facility. Site S-12 was one of twelve sites located throughout the region and

collectively known as the Plattsburgh Atlas Missile Complex. All the ATLAS sites in the Plattsburgh Complex were deactivated by September, 1965.

The 9.22 acres which comprise the site were conveyed by the General Services Administration (GSA) to the Town of Mooers Forks in 1967. The Town of Mooers Forks is presently (1988) using the site as a vehicle maintenance garage. Mooers Forks stores highway equipment, maintains and stores vehicles, and stores various material at the site. Highway sand is stockpiled adjacent to the missile silo. An active diesel fuel storage tank is located between the quonset huts and a number of drums, associated with the current use of the site, are stored north of the huts. Debris and equipment are scattered throughout the site. Figure 2-2 shows the location of the active diesel tank, the sand stockpile, and some debris. The town apparently plans to continue the present use of the facility. Currently, the town uses the two quonset huts and pumphouses, but does not use the missile silo or launch control center.

*****

SECTION 3.0 - SITE INVESTIGATION

3.1 INTRODUCTION

Prior to initiating any field activities, a site visit was performed by personnel from Law Environmental, Inc. Monitoring wells and other sampling locations were selected during the site visit. These locations are shown in Figure 2-2. These locations were selected as monitoring stations based upon data gathered during the initial site visit to optimally determine if contamination exists at the site.

3.2 WORK PLANS

After the site visit and selection of proposed sampling stations, work plans were developed to describe planned site investigation procedures. Specific work plans developed for ATLAS Site S-12 were:

- Monitoring Well Installation Plan (Appendix H)
- Sampling and Analytical - QA/QC (Appendix I)
- Safety, Health and Emergency Response Plan (Appendix J)

These plans were the working documents that provided guidance for the field investigation procedures. The Work Plans were sent to the Missouri River District Corps of Engineers for review and were approved. The field investigation program began in October, 1987. The approved plans are presented in the Appendices H, I, and J, respectively, to this report.

For convenience, a brief outline of field techniques are presented in the following paragraphs along with field data gathered during the monitoring well installation activities, and the sampling program. Specific details regarding field methods are presented in the Appendices.

3.3 MONITORING WELL INSTALLATION

Three shallow ground-water monitoring wells were installed to investigate specific subsurface areas at ATLAS Site S-12. Soil samples were taken during the installation of each monitoring well. The wells were installed and completed according to the approved Monitoring Well Installation Plan (contained in Appendix H). The following sections briefly discuss monitoring well drilling, construction, development and permeability testing.

3.3.1 Monitoring Well Locations

The locations of monitoring wells installed at Site S-12 are shown in Figure 2-2. Each location is discussed below:

- Monitoring Well MW-1201

  Monitoring Well MW-1201 was installed west of the underground missile silo (Figure 2-2). The well was positioned to monitor ground water in the vicinity of the missile silo and the nearby fuel storage tanks.

- Monitoring Well MW-1202

  Monitoring Well MW-1202 is east of most of the site in an area apparently downgradient from all the facilities (Figure 2-2). The well is located in a swale which carried the silo sump discharge away from the site. This location was chosen to monitor the ground water migrating off the site.

- Monitoring Well MW-1203

  Monitoring Well MW-1203 is near the quonset huts in the northern portion of the site (Figure 2-2). The well was positioned to monitor the ground water in the vicinity of activities at these buildings.

3.3.2 Monitoring Well Construction

The Monitoring Well Installation Plan for ATLAS Site S-12 states that the soil test boring should be terminated after penetrating about 10 feet into the water table or at auger refusal. A well was constructed after drilling the borehole to the specified depth. The monitoring well was constructed in each borehole with the following materials: 2-inch inner diameter (ID) Polyvinyl Chloride (PVC), threaded, flush-joint, No. 10 slot (0.010 inch) pre-manufactured screen; 2-inch PVC, threaded, flush-joint, solid riser pipe; non-carbonate silica sand; bentonite pellets; grout mixture (cement, bentonite, and water); steel security cap with lock; and, protective steel posts. A concrete pad (4 inches x 3 feet x 3 feet) was constructed around each well.

An Acker "Soil Max" rig was used to install the monitoring wells at Site S-12. The rig was equipped with 6.5-inch ID, 12-inch outer diameter (OD) hollow stem augers. No unusual circumstances occurred during the drilling program that necessitated changes to the basic program described in the Monitoring Well Installation Plan (see Appendix H). The monitoring wells were installed between October 30 and November 3, 1987. Each well was installed as follows: complete the boring with hollow stem augers, sampling with a split-spoon sampler continuously for the first 10 feet of the boring, then every five feet to the termination depth; assemble the 2-inch PVC screen and risers inside the hollow stem augers; add the sand pack and bentonite seal through the annular space between the augers and the PVC casing; remove the augers from the borehole; wet the bentonite pellets and allow swelling for 30 minutes; mix and add cement-bentonite grout; and construct surface protection system (pad, steel casing, and protective posts). Table 3-1 shows pertinent information on well construction details.

A copy of the daily log of activities is contained in Appendix A along with the final test boring records, field boring logs, and geotechnical analytical data. The daily logs contain information

TABLE 3-1

WELL CONSTRUCTION DATA
ATLAS SITE S-12
MOCERS FORKS, NEW YORK

Well Number	Depth[1]	Screened Interval[1]	Sand Pack[2]	Bentonite Layer[2]	Grout Layer[2]	Date Installed
MW-1201	15.3	5.3 - 15.3	12.3	2.2	0.8	11/02/87
MW-1202	16.7	6.7 - 16.7	12.2	2.5	2.2	10/30/87
MW-1203	15.0	5.0 - 15.0	11.9	1.9	1.0	11/03/87

NOTES:

(1) Depth below ground surface.
(2) Thickness of material in well column.

All values in feet.

regarding quantities and types of material used at the site; the test boring records show relevant stratigraphic data on each well and well construction information; the field boring logs are copies of the actual log completed by the field geologist; and the geotechnical analytical results contain grain size analyses, moisture content and Atterberg limits (where applicable) for two samples for each boring. These data are discussed in greater detail in Section 5.0.

3.4 MONITORING WELL DEVELOPMENT

Well development was accomplished between November 16 and November 17, 1987. The purpose of well development is two-fold: to remove fine particles (silt and clay) that were introduced into the well during the drilling process and to improve the hydraulic connection between the aquifer and the well. After allowing the grout seal and pad to cure, each well at ATLAS Site S-12 was developed manually using a PVC bailer and by surging with a surge block. Well development data are summarized in Tables 3-2 and 3-3. Forms completed in the field during well development are presented in Appendix D. Data recorded in the field included: date, static water level, quantity of water standing in the well (including the sand pack), water quality data details, physical characteristics of water, development equipment, surge techniques and water quantity removed. The wells were allowed to stabilize for at least 24 hours before collecting water quality samples. Table 3-3 shows measurements for specific parameters used to monitor the development water (pH, specific conductance, temperature) during different stages of well development. No major variations in these parameters were noted during well development. However, a strong petroleum odor was evident during development of MW-1201.

3.4.1 Water Levels

Static water level measurements were obtained during the permeability testing. These data, along with surveyed well-head

TABLE 3-2

WELL DEVELOPMENT DATA
ATLAS SITE S-12
MOOERS FORKS, NEW YORK

Well No.	Development Process[1]	Quantity of Water in Well[2] (gals.)	Quantity of Water Removed (gals.)	Time for Removal (hours/minutes)	Turbidity	Date
MW 1201	Surging, bailing, pumping	6.3	33.0	7/30	Moderately turbid	11/17/87
MW 1202	Surging, bailing, pumping	13.0	65.0	16/30	Very - Mod. turbid	11/16 to 11/17/87
MW 1203	Surging, bailing, pumping	8.2	43.0	11/45	Slightly turbid	11/16 to 11/17/87

Notes:

(1) All of the monitoring wells were developed using three separate techniques: surging with a 1.5 inch PVC surge block; bailing with a 1" x 5' PVC bailer; and, pumping with a 1.7 inch PVC hand pump.

(2) Quality of water in well casing and annulus.

TABLE 3-3

GROUND-WATER QUALITY MEASUREMENTS
ATLAS SITE S-12
MOGERS FORKS, NEW YORK

Well Number	pH	Specific Conductance umhos/cm	Temperature °C	Date
MW-1201	7.2	1300	11.5	11/17/87
MW-1202	6.9	5000	10.0	11/17/87
MW-1203	7.0	1200	10.5	11/17/87

NOTES:

All measurements reflect readings at the end of well development

TABLE 3-4

GROUND-WATER LEVEL SUMMARY
ATLAS SITE S-12
MOCERS FORKS, NEW YORK

Well No.	TOC (1) (feet)	Water Surface (feet below TOC)	Date	Water Level (feet)	Coordinates (2)	
					Northing	Easting
MW-1201	101.77	8.51	12/15/87	93.26	11,035.473	11,577.277
MW-1202	93.19	1.95	12/15/87	91.24	11,250.667	11,606.858
MW-1203	99.63	5.60	12/15/87	94.03	11,021.628	11,832.226

Notes:

(1) TOC - Top of well casing elevation based on an arbitrary bench mark established on site and referenced on the site survey in Appendix L. Datum assumed to be 100 feet mean sea level (msl).

(2) Coordinates based on local grid system established on site and referenced in the site survey in Appendix L.

levels, are presented in Table 3-4. The water levels in the monitoring wells at the site are between 1.95 feet and 8.51 feet below the top of the PVC casings. These water level measurements represent ground water levels ranging from 91.24 to 94.03 feet based on an assumed arbitrary datum established at the site. This data and ground-water flow are discussed in Section 5.1

3.4.2 Site Survey

Well-head elevations at ATLAS Site S-12 were surveyed during January, 1988, by Laberge Engineering and Consulting Group Ltd. The surveying firm is located in Plattsburgh, New York. State plane coordinates or vertical control were not available near the site. A disk near the silo was used as an arbitrary benchmark and assigned an assumed elevation of 100.00 ft. msl. Water levels and well coordinates are based on this arbitrary reference benchmark. Field notes and the completed site survey are contained in Appendix K.

3.5 HYDRAULIC CONDUCTIVITY TESTING

A hydraulic conductivity test known as a "slug test" was performed on each well after well development and before sampling. The test consists of inserting a slug (solid PVC rod) into the water column in the well to raise the water level (slug-in test) or removing a slug of water from the water column to lower the water level (slug-out test). The recovery to static water level is recorded over time. Test results were measured using an Enviro-Labs EL-200 Data Logger hydrologic monitoring device. Data was evaluated using the Bouwer and Rice (1976) technique to calculate the hydraulic conductivity for each well. Data and hydraulic conductivity computations for each well test are presented in Appendix D.

Table 3-5 shows the range of permeabilities measured in monitoring wells at ATLAS Site S-12. Values range from 10^{-5}

TABLE 3-5

HYDRAULIC CONDUCTIVITY DATA SUMMARY
ATLAS SITE S-12
MOOERS FORKS, NEW YORK

Well No	SWL[1] (from TOC)	Type Test	Hydraulic Conductivity[2] (cm/s)	Date Test Performed
MW-1201	8.51	Slug in	1.95×10^{-3}	12/15/87
		Slug out	2.08×10^{-3}	
MW-1202	1.95	Slug in	2.46×10^{-4}	12/15/87
		Slug out	7.36×10^{-5}	
MW-1203	5.60	Slug in	1.17×10^{-4}	12/15/87
		Slug out	3.36×10^{-5}	

NOTES:

(1) SWL - Static Water Level from TOC (Top of Casing)
(2) From Bouwer and Rice (1976) calculation. Data and complete results are contained in Appendix D.

centimeters/second (cm/s) to 10^{-3} cm/s. The data reflect the wide range of grain sizes (silt to sandy gravel) found in the glacial material.

3.6 SAMPLING PROGRAM

Sampling at ATLAS Site S-12 was performed in three episodes. Geotechnical sampling was performed during the drilling program which occurred between October 30 and November 3, 1987. Soil samples for chemical analysis were collected on November 12, 1987. Ground-water and silo water samples were collected on December 9, 1987. Specific sampling protocol are contained in Appendix I - the Sampling and Analysis Plan. Information relative to field drilling and sampling activities is presented here.

3.6.1 Geotechnical Data

Drilling at ATLAS Site S-12 was initiated on October 30, 1987. The wells were drilled with a Acker "Super Max" truck-mounted drilling rig. Overburden samples were obtained with a split-spoon sampler at various depths. Two samples from each boring were analyzed for grain size distribution, moisture content, and Atterberg limits. The laboratory results are presented in Table 3-6.

3.6.2 Ground-Water Sampling

Prior to collecting samples, monitoring wells were purged with a 1.5 inch x 3 foot teflon bailer. Work plan specifications required that a minimum of five well casing volumes of water be removed from each well. Table 3-7 shows purging data for the site.

Ground-water samplers were collected from each of the three monitoring wells. A Field Sampling Report, for each well is

TABLE 3-6

SOIL LABORATORY DATA SUMMARY
ATLAS SITE S-12
MOORES FORKS, NEW YORK

I.D. Number	Sample Interval(ft)	Percentage Sand/Gravel	Percentage Silt/Clay	Unified Soil Classification	Percentage Moisture	Atterberg Limits LL	PL	PI
MW-1201 # 3	4.0 - 6.0	91.6	8.4	GW-SW	4.1	----NONPLASTIC----		
MW-1201 # 7	14.0 - 16.0	88.4	4.6	SP-SM	19.1	----NONPLASTIC----		
MW-1202 # 1	0.0 - 2.0	84.1	15.9	SM	9.2	----NONPLASTIC----		
MW-1202 # 5	8.0 - 10.0	73.5	26.5	SM	6.4	----NONPLASTIC----		
MW-1203 # 2	2.0 - 4.0	85.3	24.7	SM	26.8	----NONPLASTIC----		
MW-1203 # 5	9.0 - 11.0	68.8	31.2	SM	7.9	----NONPLASTIC----		

NOTES:

LL - Liquid Limit
PL - Plastic Limit
PI - Plasticity Index

Classification	Percentage Silt/Clay
SP, SW, GP or GW	<5
SP-SM	5-12
SP-SC	5-12
SM	>12
SC	>12
ML or CL	>50
MH	>50

TABLE 3-7

WELL PURGING DATA SUMMARY
ATLAS SITE S-12
MOCERS FORKS, NEW YORK

Well No.	SWL[1] (feet)	Well Depth Below TOC (feet)	Quantity in Well[2] (gals)	Quantity Purged (gals)	Well Volumes Purged	Date
MW-1201	7.38	17.14	1.6	8.0	5.0	12/09/87
MW-1202	1.88	19.07	2.7	13.8	5.1	12/09/87
MW-1203	4.64	16.98	2.0	10.0	5.0	12/09/87

NOTES:

(1) SWL - Depth in feet from Top of Casing (TOC) to Static Water Level (SWL) measured 12/09/87.

(2) Quantity in well casing. One casing volume = (Total depth of well - SWL) x 0.16 gal/ft.

included in Appendix F. Ground-water samples that were collected from each of the monitoring wells included the following: field samples, a duplicate field sample from well MW-1201 (Quality Control), and a Quality Assurance sample for the USACE. In addition, a rinsate sample was collected to test field cleaning procedure. Table 3-8 lists the numbers and types of water samples taken at ATLAS Site S-12 and the parameters for analysis. Analytical results for the ground water samples are contained in Section 4.2.

3.6.3 Silo Water Samples

To access the underground silo, a three inch diameter hole was drilled through the silo door. Water had filled the silo to a level approximately seven feet below the silo doors. Water in the silo was sampled with a 1.5 inch x 3 foot teflon bailer. The bailer was lowered into the silo water until it was submerged only slightly. The silo water was dark colored and contained small floating debris. The silo water was poured from the bailer into the sample bottles. No sampling difficulties were encountered and both the field sample and duplicate were collected using the same procedure. The samples were preserved within five minutes of sampling.

Samples collected from the silo included a field sample, a QC duplicate sample, a QA duplicate, and a sample equipment rinsate. Table 3-9 lists the silo samples collected and the analytical parameters. Analytical results for the silo water are presented in Section 4.3.

3.6.4 Shallow Soil Sample Locations S-1 through S-6

Shallow soil samples were collected at six locations on the site using a stainless steel hand auger. The sample depths ranged between 0.5 to 2.0 feet for all soil samples. Analytical results for these samples are presented in Section 4.4. Figure 2-2 shows the sampling locations. Table 3-10 lists numbers and types

TABLE 3-8

GROUND-WATER
SAMPLES AND PARAMETERS FOR ANALYSIS
ATLAS SITE S-12
MOORES FORKS, NEW YORK

Sample Type	Number of Samples	Parameters		
		Purgeable Aromatics and Halocarbons	Base/Neutral Extractables	Total Metals
Field Sample	3	x	x	x
Quality Control (AE)				
Duplicate	1	x	x	x
Sampling blank	1	x	x	x
Trip blank	1	x	-	-
Quality Assurance (USACE)				
Duplicate	1	x	x	x
Sampling blank	1	x	x	x
Trip blank	1	x	-	-

NOTES:

AE - Law Environmental, Inc.
USACE - United States Army Corps of Engineers
x - Indicates sample was collected for chemical analysis.
- - Indicates no sample was collected.

TABLE 3-9

SILO WATER
SAMPLES AND PARAMETERS FOR ANALYSIS
ATLAS SITE S-12
MOORES FORKS, NEW YORK

Sample Type	Number of Samples	Parameters		
		Purgeable Aromatics and Halocarbons	Base/Neutral Extractables	Total Metals
Field Sample	1	x	x	x
Quality Control (A-E)				
Duplicate	1	x	x	x
Sampling blank	1	x	x	x
Trip blank	1(a)	x	-	-
Quality Assurance (USACE)				
Duplicate	1	x	x	x
Sampling blank	1	x	x	x
Trip blank	1(a)	x	-	-

NOTES:

A-E Law Environmental, Inc.
USACE United States Army Corps of Engineers
x Indicates sample was collected for chemical analysis.
- Indicates no sample was collected.
(a) One trip blank was analyzed for both ground and silo water samples.

TABLE 3-10

SOIL SAMPLES AND
PARAMETERS FOR ANALYSIS
ATLAS SITE S-12
MOORS FORKS, NEW YORK

Sample Type	Number of Samples	Parameters		
		Purgeable Aromatics and Halocarbons	Base/Neutral Extractables	Total Metals
Field Sample	6	x	x	x
Quality Control (AE)				
Duplicate	1	x	x	x
Sampling blank	1	x	x	x
Trip blank	1	x	-	-
Quality Assurance (USACE)				
Duplicate	1	x	x	x
Sampling blank	1	x	x	x
Trip blank	1	x	-	-

NOTES:

AE Law Environmental, Inc.
USACE United States Army Corps of Engineers
x Indicates sample was collected for chemical analysis.
- Indicates no sample was collected.

of soil samples collected and the parameters for analysis. Below is a description of the location and the purpose for each location.

- Soil sample S-1 was taken at the sump discharge. This location was selected to monitor the soil around the silo sump.

- Soil sample S-2 was collected downgradient from well MW-1202 in a swale which carried the the silo discharge off the site. This location was beyond the silo sump and was selected to further monitor the silo sump area.

- Soil sample S-3 was located southeast of the silo in a small drainage swale. This location was intended to monitor the soil which may have been effected by the silo drainage system.

- Soil sample S-4 was located along the southwestern fence border of the site, in another small drainage area. This location was chosen to monitor the drainage area.

- Soil sample S-5 was slightly downgradient of well MW-1203 near the northern fence border. This location was intended to monitor the soil near MW-1203 and the quonset huts.

- Soil sample S-6 was the background sample. Results from the background sample are the basis for comparison of soil analytical results. The sample was taken in the southwest corner of the site. This location was isolated from the eastern part of the site where contamination was more likely.

3.6.4.1 Sampling Procedure

Soils for chemical analysis were collected with a stainless steel hand auger. The auger portion itself was about a foot long and

three inches wide. At approximately one to two foot depth, the filled auger sample was put in a stainless steel bowl. Using a stainless steel spoon, the 40-ml vials for purgeable aromatics and purgeable halocarbons (volatile organics) were filled directly from the hand auger. There was no mixing of the soil at this point. After all samples for volatile organics were taken, the rest of the sample was emptied into the bowl. At sampling locations which were chosen for duplicate samples, a second auger-full of soil was acquired. This soil was mixed with the remains of the first auger in the stainless steel bowl using a stainless steel spoon. Samples for total metals and base neutral extractables were taken from this mixed soil. Specific sampling procedures are outlined in the Sampling and Analysis Plan (Appendix I).

Soil sampling included collection of the following samples: six field samples; one duplicate field sample at S-1, a soil rinsate, and a trip blank (filled in the laboratory before shipment to the site). Quality control samples were also collected for the USACE. The equipment was cleaned prior to collecting each sample to aid in preventing cross-contamination between sampling locations.

*****

4.0 TEST RESULTS

Samples for chemical analysis were collected from the silo water, ground water, and soil at ATLAS Site S-12. The analytical program used and the results of the analyses performed on samples collected from the site are presented in the following section. Interpretation of the data is presented in Section 5.0.

4.1 GROUND WATER ANALYTICAL RESULTS

Three monitoring wells were sampled in accordance with the Work Plan specifications (Appendix I). Table 4-1 lists the analytical methods used for ground-water samples and the detection limits for these methods. Samples from the wells were analyzed for purgeable aromatics, purgeable halocarbons, base/neutral extractables, and metals. Table 4-2 lists the analytical results for ground-water samples, including the rinsate, the duplicate and the travel blanks. Appendix E contains the complete analytical laboratory results.

The ground-water results in Table 4-2 show that the purgeable organic compounds benzene, toluene, trichloroethylene, trans-1,2-dichloroethylene, 1,1,2,2-tetrachloroethane, methylene chloride, and chloroform were detected in the ground water samples collected at the site. All but one of the purgeable organic compounds were detected at concentrations below the measurable detection limit of 0.005 mg/l. Trans-1,2-dichloroethylene was present in MW-1201 at 0.013 mg/l and in MW-1203 at 0.023 mg/l. Methylene chloride was found in the three monitoring wells and the method blank. Chloroform was detected in the rinsate sample but not in any of the field samples.

Ten base/neutral extractable compounds were detected in the ground-water samples. Six of these, the Polynuclear Aromatic Hydrocarbons (PAH's), naphthalene, acenaphthene, phenanthrene,

Table 4-1
Analytical Methods for Water Samples
ATLAS Site S-12
MOOERS FORKS, NEW YORK

Parameter	Method[1]	Detection Limit (mg/L)[2]
Purgeable Aromatics	8240 (GC/MS)	0.005
Purgeable Halocarbons	8240 (GC/MS)	0.005 - 0.01
Base/Neutral Extractables	8270 (GC/MS)	0.01 - 0.05
Metals:		
Arsenic (As)	7060 (Furnace AA)	0.005
Barium (Ba)	6010 (ICP)	0.010
Cadmium (Cd)	6010 (ICP)	0.005
Chromium (Cr)	6010 (ICP)	0.010
Lead (Pb)	6010 (ICP)	0.005
Mercury (Hg)	7470 (Cold Vapor)	0.0002
Selenium (Se)	7741 (Furnace AA)	0.010
Silver (Ag)	6010 (ICP)	0.010

NOTES:

(1) Source: EPA September, 1986

(2) For Ecology and Environment, Inc., laboratory equipment and analytical procedures.

TABLE 4-2

POSITIVE ANALYTICAL RESULTS FOR GROUND WATER

ATLAS SITE S-12

MOGERS FORKS, NEW YORK

ALL RESULTS IN MG/L

SAMPLED 12/9/87

	Sample Designation						
Parameter	MW-1201	MW-1200[1]	MW-1202	MW-1203	M&R Rinsate	Trip Blank	Method Blank
Purgeable Aromatics and Halocarbons							
Benzene	<0.005[2]	<0.005	ND	ND	ND	ND	ND
Toluene	<0.005	<0.005	<0.005	ND	<0.005	ND	ND
Methylene chloride	<0.005	ND	<0.005	<0.005	ND	ND	<0.005
Chloroform	ND	ND	ND	ND	<0.005	ND	ND
Trans-1,2-dichloroethylene	0.013	0.013	ND	0.023	ND	ND	ND
Trichloroethylene	ND	ND	ND	<0.005	ND	ND	ND
1,1,2,2,-Tetrachloroethane	<0.005	ND	ND	ND	ND	ND	ND
Base/Neutral Extractables							
Naphthalene	<0.010	<0.010	ND	ND	ND	NT	ND
Acenaphthene	<0.010	<0.010	ND	ND	ND	NT	ND
Phenanthrene	0.010	0.013	ND	ND	ND	NT	ND
Anthracene	<0.010	ND	ND	ND	ND	NT	ND
Fluoranthene	<0.010	<0.010	ND	ND	ND	NT	ND
Pyrene	<0.010	<0.010	ND	ND	ND	NT	ND
Di-n-butyl phthalate	<0.010	<0.010	ND	<0.010	<0.010	NT	ND
Bis (2-ethyl hexyl) phthalate	0.013	<0.010	<0.010	ND	0.017	NT	0.021
Di-n-octyl phthalate	0.047	0.026	0.049	0.042	0.023	NT	0.037
Dimethyl Phthalate	ND	ND	ND	ND	ND	NT	<0.010
Metals (Total)							
Arsenic (As)	0.010	0.014	0.006	0.005	ND	NT	NT
Barium (Ba)	0.414	0.481	1.15	0.242	ND	NT	NT
Chromium (Cr)	0.026	0.039	0.018	ND	ND	NT	NT
Lead (Pb)	ND	ND	ND	ND	0.005	NT	NT

NOTES:

(1) Ground water duplicate sample from MW-1201.

(2) <0.005 and <0.010 indicates compound present below measurable detection limit.

NT = Not Tested

ND = Not Detected

anthracene, fluoranthene, and pyrene, were only detected in monitoring well MW-1201. All the PAH's, except for phenanthrene, were found below the measurable detection limit of 0.010 mg/l. Phenanthrene was detected at 0.010 mg/l in sample MW-1201 and at 0.013 mg/l in the duplicate sample. The other four base/neutral compounds, dimethyl phthalate, di-n-butyl phthalate, di-n-octyl phthalate, and bis (2-ethyl hexyl) phthalate, were widely distributed in the samples. The phthalates were present in the field samples, the rinsate sample, and the method blank.

The ground-water sample from MW-1201 contained five purgeable organics, including benzene and toluene, and six PAH's. Benzene, toluene, and the PAH's are constituents of fuel. When MW-1201 was sampled, a strong petroleum odor was detected and an oil sheen was observed on the sample's surface. Petroleum odors and a oil sheen were also observed on the water from MW-1201 during development.

The metals arsenic, barium, chromium, and lead were detected in the samples analyzed. Lead was found only in the rinsate sample. Low concentrations of the other metals were detected in each monitoring well.

No other purgeable organic compounds, base/neutral extractables, or metals were detected in the ground-water samples collected at Site S-12. The analytical results are evaluated in Section 5.2. QA/QC results are discussed in Section 4.4.

4.2 SILO WATER RESULTS

Water contained in the underground silo was sampled in accordance with the Work Plan specifications. Analytical methods used for the ground-water samples were also used on the silo water samples. Table 4-3 presents the positive analytical results for the silo samples. Appendix E contains the complete analytical laboratory results.

TABLE 4-3
POSITIVE ANALYTICAL RESULTS FOR SILO WATER
ATLAS SITE S-12
MOCERS FORKS, NEW YORK
ALL RESULTS IN MG/L
SAMPLED 12/9/87

Parameter	Sample Designation			
	SW	SWD[1]	SWR Rinsate	Method Blank
Purgeable Aromatics and Halocarbons				
methylene chloride	<0.005[2]	<0.005	<0.005	<0.005
Base Neutral Extractables				
Bis (2-ethyl hexyl) phthalate	0.025	0.066	0.020	0.021
Di-n-octyl phthalate	0.047	0.083	0.060	0.037
Di-n-butyl phthalate	<0.010	<0.010	<0.010	ND
Dimethyl phthalate	ND	ND	ND	<0.010
Metals (Total)				
Arsenic (As)	0.012	ND	ND	NT
Barium (Ba)	0.285	0.192	ND	NT
Cadmium (Cd)	0.007	ND	ND	NT
Chromium (Cr)	0.286	0.126	ND	NT
Lead (Pb)	0.825	0.269	ND	NT

NOTES:

(1) Silo water duplicate sample.
(2) <0.005 and <0.010 indicates compound present below measureable detection limit.

NT = Not Tested
ND = Not Detected

Table 4-3 shows that only one purgeable organic, methylene chloride, was detected in the silo water samples. Methylene chloride was present below the measurable detection limit of 0.005 mg/l in the silo sample, the duplicate, the rinsate, and the method blank.

Four base/neutral extractables, all phthalates, were detected in the silo water samples. Bis (2-ethyl hexyl) phthalate, di-n-butyl phthalate, and di-n-octyl phthalate were present in the silo sample, the duplicate, and the rinsate sample. Dimethyl phthalate was detected only in the method blank. Three of the four phthalates detected were found in the method blank.

Five metals were detected in the silo water samples. The concentrations of arsenic, barium, and cadmium were relatively low. The concentrations of chromium and lead were slightly elevated and exceeded Federal criteria.

No other purgeable organic compounds, base/neutral extractables, or metals were detected in the silo water samples collected at Site S-12. The analytical results are evaluated in Section 5.2. QA/QC results are discussed in Section 4.4.

4.3 SOIL ANALYTICAL RESULTS

Six shallow soil samples were collected at ATLAS Site S-12 and analyzed for purgeable aromatics, purgeable halocarbons, base/neutral extractables, and metals. The analytical methods used are shown in Table 4-4.

Test results in Table 4-5 show that methylene chloride was the only purgeable organic compound which was detected in the soil samples. Methylene chloride was present in the six field samples, the duplicate sample, the rinsate, the trip blank, and the method blank. The highest methylene chloride concentration detected, 2.1 mg/kg, was present in the method blank.

Table 4-4
Analytical Methods for Soil
ATLAS SITE S-12
MOHERS FORKS, NEW YORK

Parameter	Method[1]	Detection Limit (mg/kg)[2]
Purgeable Aromatics	8240 (GC/MS)	0.5 - 1.0
Purgeable Halocarbons	8240 (GC/MS)	0.5 - 1.0
Base/Neutral Extractables	8270 (GC/MS)	0.33 - 4.0
Metals:		
Arsenic (As)	7060 (Furnace AA)	1.0
Barium (Ba)	6010 (ICP)	1.0
Cadmium (Cd)	6010 (ICP)	1.0
Chromium (Cr)	6010 (ICP)	1.0
Lead (Pb)	6010 (ICP)	0.5
Mercury (Hg)	7471 (Cold Vapor)	0.1
Selenium (Se)	7740 (Furnace AA)	1.0
Silver (Ag)	6010 (ICP)	2.0

NOTES:

(1) Source: EPA, September, 1986.
(2) For Ecology & Environment, Inc., laboratory equipment and analytical procedures.

TABLE 4-5
POSITIVE ANALYTICAL RESULTS FOR SOIL
ATLAS SITE S-12
MOCERS FORKS, NEW YORK
ALL RESULTS IN MG/KG

Parameter	Sample Designation									
	S-1	S-D[1]	S-2	S-3	S-4	S-5	S-6[2]	Rinsate	Trip Blank	Method Blank
Purgeable Aromatics and Halocarbons										
Methylene chloride	0.76	2.10	1.80	1.70	1.50	1.70	1.80	0.007	0.007	2.10
Base/Neutral Extractables										
Di-n-butyl phthalate	<0.33[3]	<0.33	<0.66	0.39	<0.33	<0.33	<0.33	ND	NT	0.53
Bis(2-ethyl hexyl) phthalate	ND	<0.33	<0.66	<0.33	<0.33	ND	ND	0.06	NT	<0.33
Di-n-octyl phthalate	ND	0.36	<0.66	ND	ND	<0.33	<0.33	0.075	NT	<0.33
Butyl Benzyl phthalate	ND	ND	<0.66	ND	ND	ND	ND	ND	NT	ND
Metals										
Arsenic (As)	ND	ND	9.63	3.55	1.56	1.98	2.13	ND	NT	NT
Barium (Ba)	8.36	7.75	168	30.8	26.1	30.6	40.0	ND	NT	NT
Cadmium (Cd)	ND	ND	1.77	ND	ND	ND	ND	ND	NT	NT
Chromium (Cr)	2.10	ND	14.2	5.86	5.48	4.40	6.01	ND	NT	NT
Lead (Pb)	3.15	3.30	656	6.55	4.73	6.78	4.83	ND	NT	NT
Mercury (Hg)	ND	ND	0.95	ND	ND	ND	ND	ND	NT	NT

NOTES:
(1) Duplicate sample from S-1.
(2) Background soil sample.
(3) <0.33 and <0.66 indicates compound present below measurable detection limit.

NT = Not Tested
ND = Not Detected

Four phthalate compounds were detected in the soil samples collected at the site. Di-n-butyl phthalate was found at concentrations ranging from less than the measurable detection limit of 0.33 mg/kg to 0.53 mg/kg in all the samples analyzed except the rinsate. Bis (2-ethyl hexyl) phthalate and di-n-octyl phthalate were detected in a majority of the samples and the method blank. Butyl benzyl phthalate was only detected in sample S-2.

Arsenic, barium, cadmium, chromium, lead and mercury were detected in the soil samples collected at the site. The metals concentrations in sample S-2 were substantially higher than those in the other samples. In sample S-2 the lead concentration was 656 mg/kg and the chromium concentration was 1.77 mg/kg. Cadmium and mercury were only detected in sample S-2.

No other purgeable organic compounds, base/neutral extractables, or metals were detected in the soil samples collected from Site S-12. The analytical results are evaluated in Section 5.2. QA/QC results are discussed in Section 4.4.

4.5 QUALITY ASSURANCE/QUALITY CONTROL RESULTS

Quality Assurance/ Quality Control (QA/QC) procedures for this site were established in the Work Plans contained in Appendices I and J of this report. QA/QC criteria are established for sampling methods and testing procedures as well as documentation of control and organizational responsibility.

Five types of QA/QC samples for ATLAS Site S-12 were analyzed by the laboratory. These samples consisted of duplicates, replicates, spikes, travel blanks and sampler rinsates. In addition to these samples, the laboratory has established internal QA samples which are used to analyze method controls, instrument calibration and internal QA procedures. Complete analytical results and QA/QC results are in Appendices E and F, respectively.

Duplicates of a ground-water sample, the silo water sample, and a soil sample were collected at the site. The ground-water sample duplicate was taken at Monitoring Well MW-1201. No purgeable aromatics, or purgeable halocarbons were present in the ground-water duplicate above the measurable detection limit. Results from the ground-water duplicate are generally consistent with the field sample. One compound, di-n-octyl phthalate, showed a 45 percent difference between the original and duplicate analyses. Large differences are common for constituents detected at low concentrations. The following results were obtained for ground-water parameters present above the detection limits in MW-1201 and the duplicate.

Parameter	MW-1201	MW-120D (duplicate)
Phenanthrene	0.010 mg/l	0.013 mg/l
Bis (2-ethyl hexyl) phthalate	0.013 mg/l	<0.010 mg/l
Di-n-octyl phthalate	0.047 mg/l	0.026 mg/l
Arsenic	0.018 mg/l	0.016 mg/l
Barium	0.253 mg/l	0.256 mg/l
Chromium	0.052 mg/l	0.049 mg/l

The silo duplicate results were as little as 33 percent of the original field sample results. The phthalate compounds were found in higher concentrations in the duplicate sample, while the metals were found in lesser concentrations in the duplicate than in the original sample. Although the comparison between the original and duplicate samples indicates some discrepancy between the two analyses, the results are within the same magnitude.

Differences may be attributed to heterogeneities in the media sampled. Fragments of floating debris were present in the silo water. These large-scale heterogeneities can cause the discrepancy observed between the original and duplicate analyses. The following results were obtained for silo water parameters which were present above the measurable detection limit in the silo water sample and duplicate.

Parameter	SW	SW-D (duplicate)
Bis (2-ethyl hexyl) phthalate	0.025 mg/l	0.066 mg/l
Di-n-octyl phthalate	0.047 mg/l	0.083 mg/l
Arsenic	0.012 mg/l	ND
Barium	0.285 mg/l	0.192 mg/l
Cadmium	0.007 mg/l	ND
Chromium	0.286 mg/l	0.126 mg/l
Lead	0.825 mg/l	0.269 mg/l

The soil sample duplicate was collected from sample location S-1. One purgeable organic compound and one base/neutral extractable compound were detected in the soil sample and duplicate. The variation in the results of the two organic analyses may not reflect site conditions. These results will be discussed in detail in Section 4.5. Agreement between the sample and duplicate metals analyses was generally good. Chromium, however, was detected in the field sample and not in the duplicate sample. The heterogeneous nature of soil typically causes a wide range of results. The following presents results for the constituents

which were present above the measurable detection limit in the soil sample and duplicate.

Parameter	S-1	S-D (duplicate)
Methylene	0.76 mg/kg	2.10 mg/kg
Di-n-octyl phthalate	ND	0.36 mg/kg
Barium	8.36 mg/kg	7.75 mg/kg
Chromium	2.10 mg/kg	ND
Lead	3.15 mg/kg	3.30 mg/kg

Replicate samples are aliquots of a single sample that are split on arrival at the laboratory or when analyzed. Replicates are taken from the same sample bottle and extracted and analyzed as two separate samples. Results of the replicate analyses are compared to the original samples, yielding a relative percent difference. One water samples (SWR) was replicated for metals analysis; the results showed zero relative percent difference. One soil sample (S-1) was replicated for metals, purgeables, and base/neutral extractables. The relative percent differences for these parameters ranged from 0 to 45 percent for metals and 0 to 4.9 percent for organics. Metals in soils, when replicated can show high relative percent differences. This is due to the heterogeneity of the soil.

Sample and matrix spikes are known amounts of analyte that are added to a sample. Both the sample and the spiked sample are analyzed and the results compared. Percent recoveries are calculated to determine the amount of analyte added. If the spike analyses is accurate, the percent recovery should equal the amount of analyte actually added. The spike technique is routinely used in the laboratory to calibrate equipment. Table 4-6 shows the results of the sample and matrix spike analyses. For total metals in water, percent recovery for sample spikes

ranged from 88 to 110 percent. Percent recovery for total metals in soil ranged from 73 to 116 percent. All sample spike analyses, except one, were within EPA QC advisory limits (EPA, January 20, 1984). Matrix spike analyses were performed only for organic compounds in a water matrix. The percent recovery for the matrix spike analyses ranged from 78 to 88 percent. These results are shown in Table 4-6. The results of the matrix spike analyses are within EPA advisory limits (EPA, November 24, 1986).

Surrogate spikes are compounds which are similar to the analyte in chemical composition, extraction and chromatography, but which are not normally found in the field sample (EPA, September 1986). A common tracer element used in surrogate spikes is deuterium. The surrogate spike sample is analyzed and the percent recovery of the added chemical is computed. Table 4-7 shows the results of the surrogate spike analyses. Surrogate spike recoveries for both purgeable organics and base/neutral extractables in soil and water were within advisory limits established by the EPA (November 24, 1986).

A travel or trip blank consisting of de-ionized water was analyzed for purgeable organic compounds (purgeable aromatics and halocarbons) in ground water and soils. Tables 4-2 and 4-4 contain results of the trip blank analyses. The soil trip blank contained 0.007 mg/l methylene chloride. Methylene chloride was found in the laboratory method blanks and throughout the samples. Analytical data for the travel blanks and method blanks is included in Appendix E of this report.

A rinsate was sample collected from the ground-water (Teflon bailer) and soil samplers (stainless steel hand auger) to monitor field cleaning techniques. Sampler rinsates consisted of de-ionized water which was collected after being passed through the sampler and subsequently analyzed for the same parameters as the field samples. Tables 4-2, 4-3, and 4-5 contain results of the rinsate sample analyses. The ground-water rinsate contained toluene, chloroform, and di-n-butyl phthalate at concentrations

TABLE 4-6
QUALITY CONTROL: PERCENT RECOVERY
FOR SPIKE SAMPLES
ATLAS SITE S-12
MOORES FORKS, NEW YORK

Parameter	Medium	Percent Recovery (range)	EPA QC Limits (1) (range)
SAMPLE SPIKE			
Total Metals	Water	88 - 110	75 - 125
Total Metals	Soil	73 - 116	75 - 125
MATRIX SPIKE			
Organics	Water	78 - 88	61 - 145

NOTES:

(1) EPA advisory limits expressed as a percentage.
Source: Inorganics - EPA, January 20, 1984
Organics - EPA, November 24, 1986

TABLE 4-7
QUALITY CONTROL: PERCENT RECOVERY
FOR SURROGATE SPIKE SAMPLES
ATLAS SITE S-12
MOORES FORKS, NEW YORK

Parameter	Medium	Percent Recovery (range)	EPA QC Limits (1) (range)
PURGEABLE ORGANICS	Water	82 - 120	24 - 127
	Soil	84 - 110	28 - 142
BASE/NEUTRAL EXTRACTABLES	Water	50 - 163	24 - 127
	Soil	42 - 142	28 - 142

NOTES:

(1) EPA advisory limits expressed as a percentage.
Source: Organics - EPA, November 24, 1986

below the measurable detection limit. Di-n-octyl phthalate and bis (2-ethyl hexyl) phthalate were detected in the the groundwater rinsate at concentrations above the measurable detection limit. Methylene chloride and di-n-butyl phthalate were found in the silo rinsate, but at concentrations below the measurable detection limit. Bis (2-ethyl hexyl) phthalate was detected in the silo rinsate at 0.020 mg/l and di-n-octyl phthalate was detected at 0.060 mg/l. Methylene chloride, di-n-octyl phthalate, and bis (2-ethyl hexyl) phthalate were found in the soil rinsate in concentrations above the measurable detection limit. The rinsate analyses is used to monitor the effectiveness of sampling apparatus cleaning and to document any potential cross-contamination. The phthalate compounds which occur in the rinsate samples were also found in the method blanks. Most likely, the presence of phthalates in the rinsate does not indicate field conditions. Chloroform was present in the rinsate sample, but not in any field samples. Based on the nature of the methylene chloride and phthalate contamination in the rinsates and the lack of other constituents in the field samples, the bailer cleaning appears to have been adequate. The source of the methylene chloride and phthalates will be discussed in Section 4.5.

Document control was used in this investigation to provide QA/QC for sampling protocol and sample Chain-Of-Custody. Documents were completed and signed in the field by the sampling personnel to adhere to QA/QC guidelines.

Field Sampling Reports were completed at each sampling location. These documents included sample identification, number and type of sample containers, and preservation method. The Field Sampling Reports also indicate the personnel, the sampling method, and specific sampling protocol. The Field Sampling Reports for ATLAS Site S-12, contained in Appendix F, document the QA/QC data for sampling.

Chain-of-Custody Reports were maintained for each of the sample shipment containers used to transport samples to the laboratory. The reports were completed by field personnel and the technician who received the samples at the laboratory. These reports indicate that all the samples were received by the laboratory in satisfactory condition for the designated tests. Chain-of-Custody Reports are contained in Appendix F.

A sample tracking record is shown in Table 4-8. All samples were analyzed within the holding times specified by the Work Plans.

4.5 FACTORS INFLUENCING RESULTS

Low levels of methylene chloride, di-n-butyl phthalate, di-n-octyl phthalate, and bis (2-ethyl hexyl) phthalate were detected in many of the ground water, silo water, and soil samples collected at Site S-12. These constituents were also present in the rinsate samples, trip blanks, and method blanks for each media. Toluene was detected in the rinsate sample for ground-water analyses. Chloroform was found in the ground-water rinsate, but not in any field samples. The results of the Quality Control analyses and communication with the analytical laboratory indicate that the presence of methylene chloride, the phthalate compounds, toluene, and chloroform at ATLAS Site S-12 does not reflect contamination at the site but may indicate procedural contamination of the samples arising in the laboratory. A letter from Ecology and Environment, Inc., outlining the potential sources of laboratory contamination is contained in Appendix F.

Methylene chloride is a solvent commonly used in analytical laboratories. Volatilized methylene chloride may be absorbed by the samples from the ambient laboratory atmosphere or may be present in trace quantities in methanol used during the extraction process. Methylene Chloride was detected in the method blanks for soil and water samples. According

TABLE 4-8
SAMPLE TRACKING RECORD
ATLAS SITE S-12
MOCERS FORKS, NEW YORK

ANALYSIS	MEDIA	DATE SAMPLED	LAB RECEIPT	DATE ANALYZED	SPECIFIED MAX. HOLDING PERIOD[1]	MAXIMUM HOLDING PERIOD
METALS	Soil	11/12	11/13	11/20 - 12/18	6 months	37 days
	Ground water	12/9	12/10	12/11 - 15	6 months	6 days
	Silo water	12/9	12/10	12/11 - 15	6 months	6 days
EXTRACTABLES	Soil	11/12	11/13	11/17-18(ext),11/30-12/7[2]	7 days until extrac-	6 (ext), 25 days
	Ground water	12/9	12/10	12/16 (ext),1/4	tion & 40 days after	7 (ext), 26 days
	Silo water	12/9	12/10	12/16 (ext),1/4	extraction	7 (ext), 26 days
PURGEABLE ORGANICS	Soil	11/12	11/13	11/21 - 22	14 days	10 days
	Ground water	12/9	12/10	12/17 - 22	14 days	12 days
	Silo water	12/9	12/10	12/17 - 22	14 days	12 days

NOTES:

(1) Mercury specified maximum holding time 28 days
(2) Dates given for extraction (ext) and analysis

to information provided by Ecology and Environment, compounds present in the method blank indicate a laboratory source.

Phthalate compounds occur in plastics, rubber, and PVC. Ecology and Environment, Inc., attributes the phthalate contamination detected in the samples to the use of plastic gloves during solvent rinsing in the extraction laboratory. Phthalates were detected in a majority of the samples collected at the site, including the method blanks.

Toluene was detected in the ground-water rinsate. Communication with the laboratory indicates that the toluene detected in these quality assurance samples is an artifact of the methanol used in the laboratory during sample preparation.

Chloroform was only detected in the rinsate for ground-water samples. No field samples were shown to contain chloroform. It is likely that the deionized water used to collect the rinsate sample was contaminated with chloroform. Therefore, the chloroform detected in the samples does not indicate contamination at the site.

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5.0 EVALUATION OF SITE CHARACTERISTICS

5.1 EVALUATION OF TEST RESULTS

ATLAS SITE S-12 is located in the Adirondack region of northern New York State. The study area lies on the northern flank of the Adirondack Mountains in a region of rolling foothills underlain by Paleozoic sedimentary rock. In the vicinity of the site, glacially-derived sands and gravels overlie the Paleozoic limestones and sandstones.

The site lies within the Adirondack Forest Preserve. Land use and development within the preserve are strictly controlled. Woodlands and farms comprise the predominant land uses around the site. The unincorporated village of Mooers Forks is located less than one mile southwest of the site.

Currently (1988), the site is being used by the town of Mooers Forks as a vehicle maintenance garage. Municipal vehicles are being stored and maintained at the site. Highway material is being stockpiled within the site. A large volume of sand is currently stored adjacent to the silo doors. Debris and equipment is scattered throughout the site. An above-ground fuel tank is located between the quonset huts and a number of drums are stored northeast of the huts.

The potential for contamination at the site as a result of current site activities is comparable to the potential when the site was an operational ATLAS base. Municipal vehicles are repaired and cleaned at the garage. A diesel tank is currently being used and slight discolorations in the soil around the tank were observed. Constituents such as chlorinated solvents and petroleum products are associated with current uses of the site and with DOD-related activities.

The ground surface at the site generally slopes gently to the east. Maximum topographic relief within the facility is less than 10 feet. Surface run-off from most of the site area is directed to two drainage swales east of the silos. The swales combine near the eastern boundary of the site. Surface water from drainage swales is directed east to a stream which is a tributary of the Great Chazy River.

Ground water at Site S-12 occurred between zero and 6.5 feet below the ground surface. Site-relative water table elevations are approximately 94.03 ft. in MW-1203 and 91.24 ft. in MW-1202. Monitoring well MW-1201 is down gradient from the missile silo facilities and quonset huts. Well MW-1202 is located in a ditch which carried the silo sump discharge and is apparently down gradient from all the site facilities. Based on the water table contours from the three monitoring wells, well MW-1203 is up gradient from a majority of the site. The water table contours are shown on Figure 5-1. Based on water level data from the three monitoring wells, ground water flow is east to southeast.

The ground water which was sampled at the site was contained in the surficial glacial material. This material consisted of poorly sorted silts, sands, and gravels which had a hydraulic conductivity which ranged between 3×10^{-5} to 2×10^{-3} cm/sec. The ground water in the surficial aquifer would most likely contain releases from any potential contamination sources at the ATLAS facility.

5.2 EVALUATION OF ANALYTICAL DATA

The analytical results for this investigation are summarized in Tables 4-2, 4-3, and 4-5 of this report. Appendix E contains the complete laboratory results. Tables 5-1, 5-2, and 5-3 list the

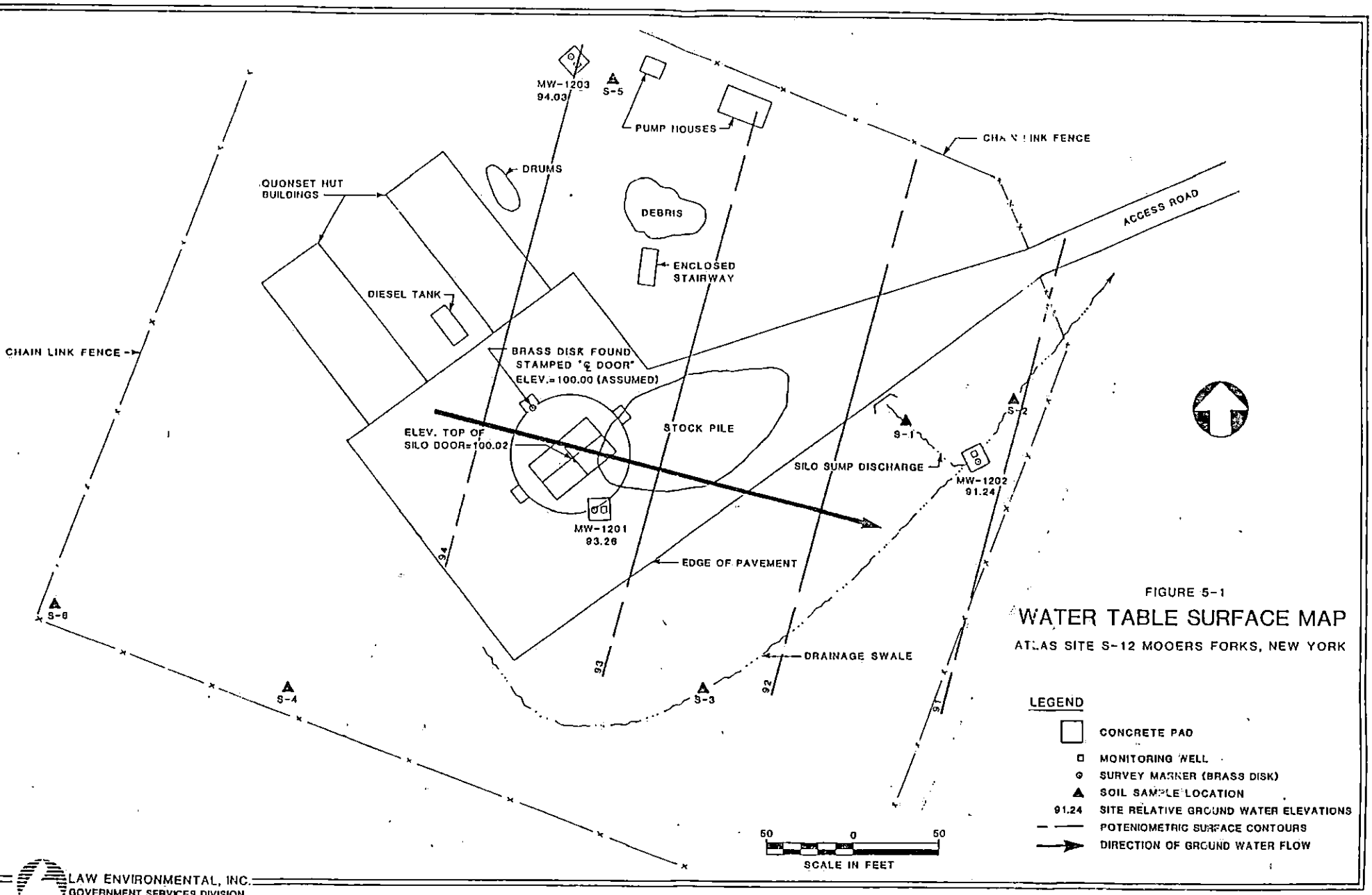

FIGURE 5-1

WATER TABLE SURFACE MAP

ATLAS SITE S-12 MOOERS FORKS, NEW YORK

LAW ENVIRONMENTAL, INC.
GOVERNMENT SERVICES DIVISION

Table 5-1

SUMMARY OF GROUND-WATER CONSTITUENT CONCENTRATIONS

COMPARED TO CURRENT STANDARDS AND CRITERIA

ATLAS Site S-12

MOORES FORKS, NEW YORK

Parameter	Maximum Concentration Detected (mg/l)	Location Detected	Regulatory Criteria Federal (mg/l)	Regulatory Criteria State (mg/l)
Purgeable Organics				
Trans-1,2-dichloroethylene	0.023	MW-1203	0.07(2)	0.05(7)
Trichloroethylene	<0.005(1)	MW-1203	0.005(4)	0.010(6)
1,1,2,2-tetrachloroethane	<0.005	MW-1201	0.00017(4)	0.005(7)
Benzene	<0.005	MW-1201	0.005(3)	Not detectable
Toluene	<0.005	MW-1201	2.0(2)	0.005(7)
Base Neutral Extractables				
Acenaphthene	<0.010	MW-1201	3.1×10^{-7}(5)	0.05(7)
Anthracene	<0.010	MW-1201	3.1×10^{-7}(5)	0.05(7)
Fluoranthene	<0.010	MW-1201	3.1×10^{-7}(5)	0.05(7)
Naphthalene	<0.010	MW-1201	3.1×10^{-7}(5)	0.05(7)
Phenanthrene	0.013	MW-1201	3.1×10^{-7}(5)	0.05(7)
Pyrene	<0.010	MW-1201	3.1×10^{-7}(5)	0.05(7)
Metals (Total)				
Arsenic	0.014	MW-1201	0.05(4)	0.025(6)
Barium	1.150	MW-1202	1.00(4)	1.0(6)
Chromium	0.039	MW-1201	0.05(4)	0.05(6)

NOTES:

(1) "<" signifies that constituent was detected but at a concentration below the measurable detection limit.

(2) Proposed Maximum Contaminant Level Goal (MCLG), EPA, Federal Register, November 13, 1985.

(3) Maximum Contaminant Level (MCL), EPA, Federal Register, July 8, 1987.

(4) Maximum Contaminant Level (MCL) from EPA, National Primary Drinking Water Regulations, 1987.

(5) EPA Ambient Water Quality Criteria adjusted for drinking water, Superfund Public Health Evaluation Manual, October, 1986.

(6) Water Quality Standard, New York State Department of Environmental Conservation, NY Code of Rules and Regulations, August 2, 1985.

(7) Maximum Contaminant Level (MCL), New York State Department of Health, Proposed Standards Limiting Organic Chemical Concentration in Drinking Water, January 1988.

Table 5-2
SUMMARY OF SILO WATER CONSTITUENT CONCENTRATIONS
COMPARED TO CURRENT STANDARDS AND CRITERIA
ATLAS Site S-12
MOERS FORKS, NEW YORK

Parameter	Maximum Concentration Detected (mg/l)	Regulatory Criteria (mg/l)	
		Federal	State
Metals (Total)			
Arsenic	0.012	0.05	0.025
Barium	0.285	1.00	1.0
Cadmium	0.007	0.01	0.01
Chromium	0.286	0.05	0.05
Lead	0.825	0.05	0.025

NOTES:

(1) Maximum Contaminant Level (MCL) from EPA, National Primary Drinking Water Regulations, 1985.

(2) Water Quality Standard, New York Department of Environmental Conservation, NY Code of Rules and Regulations, August 2, 1985.

Table 5-3
SUMMARY OF SOIL CONSTITUENT CONCENTRATIONS
COMPARED TO AVERAGE BACKGROUND CONCENTRATIONS
ATLAS Site S-12
MOORES FORKS, NEW YORK
ALL RESULTS IN MG/KG

Parameter	Maximum Soil Concentration	Average Background Concentration[1] Average	(Range)
Metals (Total)			
Arsenic	9.63	6	(0.1 - 40)
Barium	168.00	500	(100 - 3000)
Cadmium	1.77	0.06	(0.01 - 0.7)
Chromium	14.20	100	(5.0 - 3000)
Lead	656.00	10	(2.0 - 200)
Mercury	0.95	0.03	(0.01 - 0.3)

NOTES:

(1) Source: Trace Elements in Biochemistry, H. J.M. Bowen, 1966.

maximum ground water, silo water, and soil concentrations of the parameters detected at ATLAS S-12. For comparison, the tables containing ground and silo water results also list Federal regulatory criteria. The table containing soil analytical results (Table 5-3) lists typical ranges for those parameters in the continental United States.

5.2.1 GROUND-WATER RESULTS

Five purgeable organics, trans-1,2-dichloroethylene, trichloroethylene, 1,1,2,2-tetrachloroethane, benzene, and toluene, were detected in the ground-water samples. Of these, only trans-1,2-dichloroethylene was present above the measurable detection limit of 0.005 mg/l. Trans-1,2-dichloroethylene was detected in MW-1201 and its duplicate MW-120D, at 0.013 mg/l and in MW-1203 at 0.023 mg/l. The detected concentrations of trans-1,2-dichloroethylene are below the Federal Maximum Contaminant Level Goal (MCLG) (EPA, November 13, 1985) and the New York State Proposal Maximum Contaminant Level (MCLG) for unspecified organic contaminants (New York Department of Health, January 1988). The concentrations of trichloroethylene, 1,1,2,2-trichloroethane, and toluene are below the Federal and State standards. New York State does not allow detectable levels of benzene in ground water, therefore the level of benzene in MW-1201 exceeds the state criteria. The benzene concentration in well MW-1201 represents a significant level of contamination.

Trans-1,2-dichloroethylene, trichloroethylene, and 1,1,2,2-tetrachloroethane are chlorinated solvents which may have been used during operations at the ATLAS Facility. Benzene and toluene are volatile organic compounds which are constituents of petroleum-based fuel. Also, a petroleum-like odor and oily sheen was observed on water from MW-1201 during development and sampling. The five purgeable organic compounds detected in the groundwater samples may be a result of DOD activities. However, current use of the site by the Town of Mooers Forks also may have contributed to the observed contamination.

The Polynuclear Aromatic Hydrocarbons (PAH's) acenaphthene, anthracene, fluoranthene, naphthalene, pyrene, and phenanthrene, may be indicative of contamination at the site. The PAH's were all detected in monitoring well MW-1201. Concentration of the PAH's ranged from less than 0.010 mg/l to 0.013 mg/l.

The State of New York has proposed an MCL of 0.05 mg/l for unspecified organic compounds (New York Department of Health, January 1988). The concentrations of PAHs detected in the ground-water samples do not exceed the state's proposed MCL. An Ambient Water Quality Criteria (AWQC) for PAH's, based on toxicological data, is 3.1×10^{-7} mg/l. However, the AWQC alone cannot be used to evaluate water quality data; elements such as hydrologic conditions, background concentration, diffusion, and receptor characteristics must be factored into the AWQC.

PAH's are constituents of diesel fuel and gasoline (Verschueren, 1983). A petroleum odor and an oily sheen where detected on the water sample from MW-1201 which was sent to the laboratory for analysis. The presence of the PAHs, in MW-1201, as with benzene and toluene, appears to confirm the conclusion that fuel has contaminated the ground water at ATLAS Site S-12 The fuel may have originated from former ATLAS operations or from fuels currently stored on site by the Town of Mooers Forks.

Arsenic, barium, and chromium were detected in the ground water collected at ATLAS Site S-12. The concentrations of arsenic and chromium in all the monitoring wells are below the New York State and Federal MCLs established for those constituents. The concentration of barium in sample MW-1202, 1.15 mg/l, exceeded the MCL of 1.0 mg/l. No sources of barium have been identified at ATLAS facilities, however the concentration detected in sample MW-1202 may be indicative of contamination. The concentrations of arsenic and chromium in the ground water most likely do not indicate contamination, but the barium concentration in MW-1202 may be related to DOD activities.

5.2.2 SILO WATER RESULTS

Five metals, arsenic, barium, cadmium, chromium, and lead were detected in the silo water. The concentrations of arsenic, barium, and cadmium are below MCLs. The concentration of chromium in the silo water, 0.286 mg/l, exceeds both State and Federal MCLs. Lead was found in the silo water at 0.825 mg/l, while the New York State MCL for lead is 0.025 mg/l. The concentrations of lead and chromium in the silo water may be a result of facility operations or corrosion of metals and dissolution of paints and solder in the silo interior subsequent to deactivation of the ATLAS facility.

5.2.3 SOIL RESULTS

Arsenic, barium, cadmium, chromium, lead, and mercury were detected in the soil samples collected at ATLAS Site S-12. The concentrations of these metals were within background levels established by Bowen (1966) and near the concentrations of the background samples except for sample S-2. Soil sample S-2 had substantially higher concentrations of arsenic, barium, chromium, and lead. The lead concentration in S-2 was almost 100 times that of the next lowest concentration detected in the soil samples. Cadmium and mercury were only detected in S-2. Soil sample S-2 was collected from a swale which directed the silo discharge fluid from the drainpipe east of the silo off the site. Therefore, the discharge from the silo sump system may have caused elevated concentrations of arsenic, barium, cadmium, chromium, lead, and mercury in the soils at ATLAS Site S-12.

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6.0 PRELIMINARY CONCLUSIONS AND RECOMMENDATION

The objective of this investigation was to perform an inventory of the ground water, silo water, and soils at ATLAS Site S-12 to assess whether contamination exists that might be related to former DOD activities. Evaluation of the test results from the site investigation at ATLAS SITE S-12 indicate the following conclusions:

- Arsenic, barium, and chromium were present at low concentrations in the ground-water samples collected at the site. The barium concentration in sample MW-1202 slightly exceeded the MCL and may be indicative of contamination resulting from ATLAS activities. However, the concentrations of arsenic and chromium detected in the ground-water do not indicate contamination.

- The chlorinated compounds trichloroethylene, trans-1,2-dichloroethylene, and 1,1,2,2-tetrachloroethane were detected in the ground-water samples from MW-1201 and MW-1203. These compounds are common industrial solvents which are typically used as degreasers. Maintenance operations at the ATLAS facility may have used chlorinated solvents. Additionally, research indicates that trans-1,2-dichloroethylene may be produced by the anaerobic decomposition of trichloroethylene (Cline and Viste, 1984). The concentrations of trichloroethylene and trans-1,2-dichloroethylene are below New York State and Federal regulatory criteria. However, the presence of the chlorinated solvents in the ground-water samples may be related to DOD activities at the site.

- Benzene, toluene, and the Polynuclear Aromatic Hydrocarbons (PAH's) acenaphthene, anthracene, fluoranthene, naphthalene, pyrene, and phenanthrene were detected at low concentrations in the ground-water sample from MW-1201. A strong petroleum

odor and an oil sheen were observed on sample MW-1201 when collected. Benzene, toluene, and the PAH's are constituents of petroleum-based fuels. The presence of these compounds may be indicative of traces of fuel which have entered the ground water. Fuel contamination may be related to past DOD activities or to present fuel storage and handling practices by the Town of Mooers Fork.

- Concentrations of chromium and lead were detected in the silo water sample collected at Site S-12. The concentrations of both constituents exceeded the MCLs established by the State of New York for ground water. The concentrations of chromium and lead in the silo water may be a result of ATLAS facility operations or of the deterioration of the silo interior subsequent to deactivation of the site by the DOD.

- Concentrations of arsenic, barium, cadmium, chromium, lead, and mercury were detected in soil sample S-2. This sample was collected from a drainage swale which received the discharge from the silo sump system. Discharge from the silo sump system may have contributed to elevated concentrations of metals in the soil at ATLAS Site S-12.

- The potential for contamination as a result of activities subsequent to DOD ownership is comparable to the potential for contamination during DOD ownership. Municipal vehicles of the Town of Mooers Forks are presently maintained on site and diesel fuel is stored and dispensed at the site. The constituents found in the ground water at the site, that is, chlorinated solvents, benzene, toluene, and PAH's, may also be present in materials which are used in the current operation of the maintenance facility.

The following preliminary conclusions and recommendation have been made based on the preceding findings.

Concentrations of the chlorinated solvents trichloroethylene, trans-1,2-dichloroethylene, and 1,1,2,2-tetrachloroethane were present in the ground water and may be related to DOD activities. The concentrations of benzene, toluene, and the PAH's detected in MW-1201 may be indicative of fuel present in the ground water. Lead and chromium concentrations in the silo water exceed the Federal and State MCL's regulations and may be due to ATLAS operations or silo deterioration. Elevated levels of arsenic, barium, cadmium, chromium, lead, and mercury detected in the soil are most likely a result of discharge from the silo sump system.

Based on the samples collected from the site, contamination which may be a result of DOD activity was present in the ground water, silo water, and soil. Therefore, it is recommended that ATLAS Site S-12 in Mooers Forks, New York, be referred to the Missouri River Division (MRD) for further study.

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