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U.S. AIR FORCE
INSTALLATION RESTORATION PROGRAM
PHASE I: RECORDS SEARCH

AIR NATIONAL GUARD, CAMP EDWARDS (ARNG), U.S. AIR FORCE AND VETERAN'S ADMINISTRATION FACILITIES AT MASSACHUSETTS MILITARY RESERVATION, MASSACHUSETTS

FINAL REPORT: TASK 6

DECEMBER 11, 1986

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U.S. AIR FORCE

INSTALLATION RESTORATION PROGRAM

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Prepared by the

OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TENNESSEE 37881

Operated by

MARTIN MARIETTA ENERGY SYSTEMS, INC.
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Submitted by

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EXECUTIVE SUMMARY

INTRODUCTION

The Department of Defense (DOD) has developed a program to identify and evaluate past hazardous material disposal sites on DOD property, to control the migration of hazardous contaminants, and to control hazards to health or welfare that may result from these past disposal operations. This program is known as the Installation Restoration Program (IRP) and consists of four phases: Phase I: Initial Assessment/Records Search; Phase II: Confirmation and Quantification; Phase III: Technology Base Development; and Phase IV: Operations/Remedial Actions. The National Guard Bureau (NGB), under the auspices of the Air National Guard (ANG), enlisted the services of and provided funding to the Oak Ridge National Laboratory (ORNL) for the purpose of conducting the Massachusetts Military Reservation (MMR) IRP. The E.C. Jordan Co., ORNL's Region I Contractor, was tasked with this responsibility. The E.C. Jordan Co. (Jordan) conducted a Phase I study of the ANG; Camp Edwards/Army National Guard (ARNG); United States Air Force (USAF); and Veterans Administration (VA) facilities at MMR. This volume contains the Initial Assessment/Records Search of these facilities.

The United States Coast Guard (USCG) also occupies facilities at MMR. USCG facilities at MMR are described in a separate Initial Assessment/Records Search.

INSTALLATION DESCRIPTION

The MMR is located on the upper or western portion of Cape Cod in Barnstable County, Massachusetts, approximately 60 miles south of Boston and immediately southeast of the Cape Cod Canal. The towns of Bourne, Falmouth, Sandwich, and Mashpee intersect on MMR property.

MMR occupies approximately 20,000 acres and consists of several cooperating command units. These are the Massachusetts ARNG, the Massachusetts ANG, the USAF, the VA, and the USCG.

MMR is divided into three major areas: 1) The Cantonment Area; 2) The Range, Maneuver, and Impact area; and 3) The Massachusetts National Cemetery. The cantonment consists of approximately 5,000 acres and represents the location of most ANG and ARNG administration and operational facilities, including flight lines, aircraft maintenance, vehicle maintenance, housing, and support facilities. The largest area of MMR is the range, maneuver, and impact area, which comprises the northern 70 percent of MMR (14,236 acres). The Massachusetts National Cemetery and its support facilities constitute the third major area and is located along the western edge of MMR. This area consists of 750 acres under the control of the VA. Cape Cod Air Force Station (AFS), commonly known as Precision Acquisition Vehicle Entry - Phased Array Warning System (PAVE-PAWS), consists of 87 acres and is located in the northern portion of the range area.

Military use of portions of MMR began as early as 1911. During the period 1911-1935, the Massachusetts National Guard periodically camped to conduct maneuvers and weapons training in portions of the Shawme Crowell State Forest. In 1935 the Commonwealth of Massachusetts purchased the area now occupied by MMR for permanent training facilities. The majority of activity at MMR has occurred since 1935 and includes operations by the U.S. Army, U.S. Navy (USN), the USCG, the USAF, the Massachusetts ARNG and ANG, and the VA.

In general, two different types of operations have dominated military activity at MMR: 1) mechanized army training, maneuvers, and maintenance support and 2) military aircraft operations, maintenance, and support. Level of activity has varied over the MMR operational history. The most intensive Army activity occurred during WWII (1940-1944) and during demobilization following the war. During the last two years of WWII, the USN utilized the MMR runways, flight line, and housing areas for advanced naval aviation carrier-based flight training.

The most intensive aircraft operations occurred from 1955 to 1970 when large numbers of surveillance and air defense aircraft operated from the base. During this latter period, the USAF operated 45 EC-121 (Super Constellation) Airborne Early Warning and Control Aircraft and a Fighter-Interceptor Wing (FIW) from the base.

A major military hospital was operated from WWII to 1970 at MMR. This hospital was a major orthopedic rehabilitation center during the period immediately following WWII. In the early 1970's the hospital was decommissioned and torn down.

The intensive periods of activity also occurred under separate organizational control and were staged in two separate portions of the cantonment area. The WWII period of activity occurred under U.S. Army control when MMR had been federalized and was known as Camp Edwards. Large-scale motor pool activities and troop billeting occurred in the center of the cantonment, designated as the Inner and Outer Truck Road areas. These operations were carried out in units surrounding a central parade ground. Air operations at Otis Field during WWII were reportedly of a relatively low level of intensity. The period of most intensive aircraft operations occurred along the expanded flight line areas located in the southeastern portion of the cantonment and was under USAF control. From 1962 to 1972 a Boeing Michigan Aeronautical Research Center (BOMARC) air defense missile installation was located at MMR. During the 1970's the Strategic Air Command (SAC) also utilized the runways at MMR for parking of refueler aircraft. At this time, MMR was known as Otis AFB.

In 1970 the airborne surveillance activity was phased out. The air defense mission was carried on by the USAF until 1973 when this mission, as well as management of MMR, was transferred to the 102nd FIW of the Massachusetts ANG. Since 1973 the mission and level of activity of the ANG have been consistent.

Other major operations have been ongoing at MMR. ARNG and U.S. Army reserve training has been carried out at variable levels since the early 1950's. The USCG began operations at Air Station Cape Cod (ASCC) at MMR in 1970. Operations at ASCC have been described in a separate Phase I Report. Since 1978 the

USAF has operated the PAVE-PAWS missile and space vehicle tracking system from Cape Cod AFS located at the north end of MMR. In addition, the VA acquired 750 acres located in the western portion of MMR in 1978 to develop the National Cemetery of Massachusetts. The National Cemetery began operations in 1980.

Figure E-1 is a generalized chronology of the major operational unit histories at MMR since 1935. Included on this figure are chronological summaries of two major ARNG tenants, AVCO and the U.S. Department of Agriculture (USDA). AVCO, Inc., has operated a test firing range since 1968, primarily for testing of armor detection, weapons guidance, and antiarmor warhead systems. The USDA has operated a laboratory since 1960, primarily for studying biological control measures for the gypsy moth.

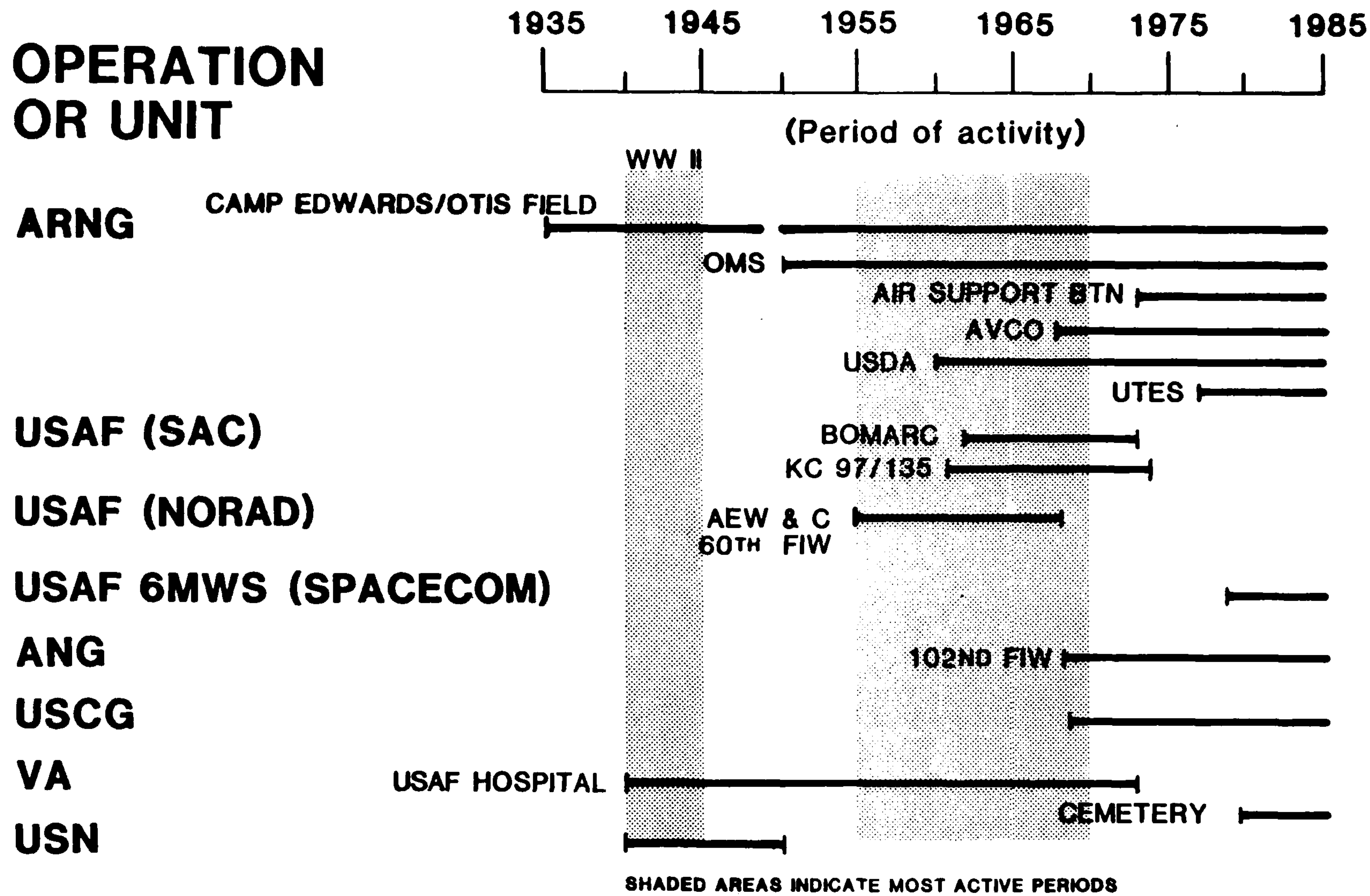
ENVIRONMENTAL SETTING

The MMR is situated on upper Cape Cod in the Coastal Plain province. The support and operational facilities lie on a broad, flat, gently sloping outwash plain. The Range, Impact, and Maneuver Area and the areas on the western portion of the MMR lie mainly on hummocky, morainal terrain. Throughout the MMR, numerous kettle holes dot the landscape. The reservation contains two named ponds (Osborne Pond and Edmunds Pond) and several other small water bodies. Surface water runoff is virtually nonexistent due to the high permeability of the soils and the relatively flat topography. In the southern portion of MMR, however, intermittent streams or drainage swales exist. A storm sewer system drains large, impervious hard-stand areas of the flight line, hangar, and runway area. Because of the large, impervious collection area, flow in the intermittent drainages is initiated during periods of heavy rainfall. The intermittent stream courses lead off-base toward Ashumet Pond and Johns Pond.

Soils on the MMR consist of a mixture of sandy to sandy-loam surface soil and subsoil with a substratum of sand and gravel. In the moraine areas, many large boulders are present. The soils are highly permeable and are susceptible to infiltration by contaminants.

A federally designated, sole source aquifer exists under unconfined conditions beneath the MMR. This aquifer occurs in the unconsolidated sand and gravel deposits and supplies the Upper Cape. By virtue of its location on the highest elevation of this system, MMR represents a major recharge area. Groundwater flows radially from MMR. The predominant flow direction from the facilities in the cantonment area and flight line is to the south. The water table averages generally 50 ft. below the surface in the cantonment area. Depth to groundwater is greater in higher elevations in the range area. Recharge to the aquifer is from precipitation and inflow from adjacent zones of the aquifer. Discharge is to lakes and ponds, rivers, and the ocean, in addition to utilization as potable water supply.

Groundwater quality at MMR has been closely monitored. Several wells, including potable supply wells, show detectable concentrations of volatile organic priority pollutant compounds (VOCs), predominantly the solvents tetrachloro



E.C.JORDAN CO.
CONSULTING ENGINEERS

GENERALIZED CHRONOLOGY OF OPERATIONS AT MMR

INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

TASK 6

FIGURE 2.2-1

ethylene (PCE) and trichloroethylene (TCE). Trihalomethanes were also detected but in much lower concentrations. In addition to VOCs, oil and grease and other petroleum-related hydrocarbons were detected in several monitoring wells. Overall, contamination of the groundwater beneath MMR has been detected. Because of the groundwater flow rate of 1 to 2 ft./day, there is potential for contamination to migrate off-base. Organic compounds have been identified to the south of MMR. The distribution and sources of the on- and off-base groundwater contamination are currently under study as components of the overall MMR IRP.

Water quality in Ashumet Pond, downstream and downgradient of the reservation, shows a trend toward eutrophication, which results from impact of excess nitrogen and phosphorus. In addition, toluene and TCE have been detected in the waters of a cranberry bog located immediately north of Ashumet Pond.

Average annual rainfall at MMR is approximately 48 inches and net precipitation (total rainfall minus evaporation and other losses) is 21 inches. The 1-year, 24-hour rainfall event is 2.7 inches. The value of 21 inches/yr. for net precipitation indicates a significant potential for infiltration, as well as surface runoff and the occurrence of permanent surface water features. The 1-yr., 24-hour rainfall event of 2.7 inches indicates a significant potential for runoff and erosion. These data indicate that contamination at MMR could migrate by both surface water and groundwater pathways. The high permeability of the soils and the low topographic gradient, however, greatly reduce potential for surface water contamination migration.

Twenty percent of MMR consists of developed land, whereas the remaining 80 percent remains undeveloped and provides a natural habitat for wildlife. Forests on MMR exist in the undeveloped areas and are classified as pine-oak climax forests. The two larger ponds support populations of warm-water species of fish. Wildlife management at MMR consists of a deer hunting season administered by the Massachusetts Division of Fisheries and Wildlife.

There are currently no known federal endangered or threatened wildlife species occurring on MMR. There are three species of birds that are classified as either State Endangered, State Threatened, or Species of Special Concern by the Massachusetts Division of Fisheries and Wildlife. These are the upland sandpiper, the marsh hawk, and the grasshopper sparrow. There are also two areas on MMR that support rare plants.

As a result of the hydrogeological environment and soil characteristics, conditions at MMR are conducive to contaminant migration. Contaminants would primarily migrate vertically through the soils to the groundwater. Contaminant transport by surface water would be very limited due to the surficial permeability. Contaminants entering the groundwater could potentially contaminate the sole source aquifer used as potable water by residents of Cape Cod.

METHODOLOGY

During the course of the Phase I investigation, interviews were conducted with base personnel (past and current) familiar with past waste disposal practices;

historical aerial photographs were examined, and file searches were performed for past hazardous waste activities; information was gained from local, state, and federal agencies; and ground reconnaissance inspections were conducted at suspected past hazardous waste activity sites. An aerial reconnaissance was conducted to identify suspected sites not apparent from ground reconnaissance.

Sites that were identified as potentially containing hazardous contaminants resulting from past activities, based on the review of industrial, laboratory, and disposal operations, were assessed to determine if potential for contaminant migration exists. Sites for which it was concluded that the potential for contamination and/or contamination actually exists were further evaluated. Sites not reflecting both of the these conditions were dropped from further consideration. Sites with potential for contamination and for contaminant migration were evaluated using the USAF Hazard Assessment Rating Methodology (HARM), in which factors such as site characteristics, waste characteristics, potential for contaminant migration, and waste management practices are considered. The details of the rating procedure are presented in Appendix G. The HARM system is designed to prioritize sites at an installation to indicate the relative need for follow-up action (Phase II).

Since the intent of the HARM system is to identify potential for contamination, it is expected that not all sites ranked and selected for Phase II study will show contamination during the verification program. As applied to the Phase I studies at MMR, the HARM constitutes an extremely conservative approach to site evaluation. This is because of three environmental factors specific to MMR. First, MMR is a major recharge area for a designated sole source aquifer. As a result, the receptor subscores for all sites are high compared with most installations. Second, the unconsolidated surface substrate is extremely permeable. Minimal surface water transport occurs, but groundwater movement is rapid. The pathways subscore is, therefore, also relatively high although the severity of this score is mitigated due to the presence of a thick vadose zone (approximately 50 ft in the cantonment area). Third, the HARM lists petroleum-related aliphatic and aromatic hydrocarbons as persistent. The length of time that these compounds, as well as halogenated solvents, persist after a spill or disposal may be much shorter at MMR than most areas because the soils are very low in organic content and may not retard migration. Under these environmental conditions the HARM may overrate the chemical characteristics subscore by overrating persistence. The low soil organic content and probable low levels of nitrogen and phosphorus, however, would tend to reduce the capacity or rate for microbiological degradation or transformation.

Because of these environmental conditions, some sites at MMR may receive high ranking scores when residual contamination is no longer present. This is especially likely where the disposal or spill occurred relatively long ago. Contaminants at such sites may have migrated into the groundwater or deep into the vadose zone. Generalized groundwater contamination at MMR may exist as a result of contaminants that have migrated from sources that no longer actively contribute to contamination of the groundwater. In the absence of site-specific data regarding persistence, etc., such an approach is warranted; however, the factors that tend to reduce persistence frequently promote migration. Because of this factor, discounting the potential for contamination based on the previous discussion would be premature, especially for a sole source aquifer.

Sixty-one sites were identified as potentially containing hazardous contamination due to past activities on ANG, Camp Edwards/ARNG, USAF, and VA facilities at MMR. These sites and their evaluations are identified and summarized in Table E-1. Locations of these sites are shown in the text of the report in Section 5.0. Forty-six of the 61 sites were considered to have a potential for contamination and/or contaminant migration and were ranked using the HARM system.

Three sites located off-base adjacent to MMR were identified as having potential for contamination and contaminant migration. Because of the locations of these sites adjacent to documented groundwater contamination and to on- and off-base receptors, these sites have been included in the overall Phase I assessment program. The rationale for inclusion of these sites is described in Section 5.0 of the report.

Because of the large number of sites assessed at MMR, Matrix Table E-1 has been placed at the end of the Executive Summary text. Detailed descriptions of each site and factors considered in the evaluation and ranking are presented in Section 4.2. Conclusions regarding the sites located on the facilities of each command unit (ANG, Camp Edwards/ARNG, and VA) that have potential for contaminant migration and received HARM ratings are summarized in Tables E-2 through E-4. The ranked site locations are shown for each command unit and the off-base sites in Figures E-2 through E-4. No disposal sites were identified on the USAF facilities at Cape Cod AFS. HARM ratings for individual sites are tabulated in Section 5.0.

RECOMMENDATIONS

Recommended further actions at selected sites are intended to be used as a guide in the development and implementation of Phase II studies. Phase II as well as Phase IV-A, studies are ongoing at MMR as components of the overall IRP. Recommendations for Phase II studies consider data being gathered within these programs. Recommendations developed for further assessment of the HARM-rated sites are presented in Section 6.0. Based on the rationale presented in Section 6.0, Phase II studies are recommended at a total of 37 of the 46 HARM-ranked sites. Of that total, seven sites are recommended for limited Phase II studies, and eight have Phase II studies either already in progress or in the work plan development stage. Three off-base sites adjacent to MMR were included in the assessment because of the MMR-IRP requirement for completely characterizing the sources potentially contributing to off-base and on-base groundwater contamination. If residual contamination is observed at any of these off-base sites, it will be necessary for the MMR, the DOD, federal and state regulatory agencies, and local health officials to identify potential contributors to these unrestricted sites to properly assign responsibility for required remedial actions. For sites in which the disposal ceased prior to 1965 and for sites similar to those where more-recent disposal activity has occurred, no Phase II studies are recommended initially. Recommendations for the 46 sites are summarized in Tables E-2 through E-4.

TABLE E-1
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES
ON MMR

Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
SD-1	Runway/Aircraft Maintenance Storm Drainage Ditch	1955-1970 (major activity) 1970-present (less activity)	Solvents, fuel components including lead discharged from stormwater outfall. Potential for contamination; potential for migration. Received a HARM rating. Phase II studies recommended.
SD-2	Runway/Aircraft Maintenance Storm Drainage Ditch	1955-1970 (major activity) 1970-present (less activity)	Solvents, fuel components including lead discharged from stormwater outfall. Weathered POL sludge found in ditch downgradient. Potential for contamination; potential for migration. Received a HARM rating. Phase II studies recommended and work plan under review.
SD-3	Coal and Ash Pile Runoff Storm Drainage Ditch	1956-present (ash) 1984-present (coal)	Ash particulates, coal pile runoff. Potential for contamination; potential for migration. Received a HARM rating. Limited Phase II studies recommended. Referred to base environmental programs.
SD-4	Hangar 158, Aircraft Maintenance, Storm Drainage Ditch	1955-1970 (major activity) 1970-present (less activity)	Solvents, fuel spills, fuel components including lead washed to floor drains and storm drainage system. Potential for contamination; potential for migration. Received a HARM rating. Phase II studies recommended.
SD-5	Aquafarm Drainage Swale	1940-present	TCE, other halogenated solvents, nonhalogenated solvents, JP-4, MOGAS, and AVGAS. Received discharges from former Non-Destructive Inspection Lab (NDI) 1955-1978. Potential for contamination; potential for migration. Indirect evidence of contaminant migration. Received a HARM rating. Phase II studies recommended and work plan under review.
LF-1	Main Base Landfill	1944-present	Solvents, fuels, waste oil, ordnance, pesticides, other refuse. Potential for contamination. Contaminant migration observed. Received a HARM rating. Phase II studies are ongoing.
LF-2	Probable Former Sanitary Landfill (See Figure 5.0-2)	1940-1944	Possible solvents, POL, paints, domestic refuse. Site is assessed in conjunction with Site FTA-2.

TABLE E-1 (CONT'D)
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES
ON MMR

Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
LF-3	Northern Range Area Dump	Unknown to present	Access unrestricted to general public. Possible non-MMR disposal of hazardous wastes. Potential for contamination; potential for contaminant migration. Received a HARM rating. No Phase II monitoring recommended. Referred to base environmental programs for future action.
LF-4	John's Pond Dump - Off-base Site	Unknown to present	Access unrestricted. Drums of unknown origin (18-20) were observed at this location. Potential for contamination; potential for migration. Received a HARM rating. Phase II studies recommended.
LF-5	Landfill No. 5; Rubble landfill at VA Hospital	Unknown	Rubble landfill. No potential for contamination. No potential for contaminant migration. No HARM rating. No Phase II studies recommended.
LF-6	Former USN Construction Landfill	1940's	Rubble landfill. No potential for contamination. No potential for contaminant migration. No HARM rating. No Phase II studies recommended.
LF-7	Radar Tube Burial Site	1955-1970	Low level radioactivity (10^{-7} - 10^{-9} pCi). Potential for contamination; potential for contaminant migration. Received a HARM rating. No Phase II studies recommended.
CS-1	North Truck Road Motor Pool	1941-1946	Waste solvents, fuels and oils, antifreeze, paint, and battery electrolyte (metals including lead). Potential for contamination; potential for contaminant migration. Received a HARM rating. No Phase II studies recommended unless studies of more recent motor pools indicate residual contamination.
CS-2	East Truck Road Motor Pool	1941-1946	Waste solvents, fuels and oils, antifreeze, paint, and battery electrolyte (metals including lead). Potential for contamination; potential for contaminant migration. Received a HARM rating. No Phase II studies recommended unless studies of more recent motor pools indicate residual contamination.

TABLE E-1 (CONT'D)
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES
ON MMR

Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
CS-3	South Truck Road Motor Pool	1941-1973	Waste solvents, fuels and oils, antifreeze, paint, and battery electrolyte (metals including lead). Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies recommended.
CS-4	West Truck Road Motor Pool and Former Defense Revitalization and Marketing Office (DRMO)	1941-1983	Waste solvents, fuels and oils, antifreeze, paint, industrial chemicals, battery electrolytes (lead), battery cases, scrap metals, transformers. Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies recommended.
CS-5	Former Refueler Maintenance Shop/Weapons Repair Facility	1941-1967	Waste solvents, fuels and oils, antifreeze, paints, battery electrolytes (lead). Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies recommended.
CS-6	Current ANG Motor Pool/ Vehicle Maintenance Shop	1967-present	Waste solvent and oil spills. Washed to floor drains and to drainage ditch. Limited potential for contamination. Potential for contaminant migration. Received a HARM rating. No Phase II studies recommended.
CS-7	Organizational Maintenance Shop-6 (OMS)	1966-present	Waste solvents and oil waste, battery electrolytes. Organic wastes contained and disposed of off-site. Used electrolyte disposed of to sanitary sewer system. No potential for contamination; no potential for contaminant migration. No HARM rating. No Phase II studies recommended.
CS-8	OMS-22	1950-present	Waste solvents and oil, waste battery electrolyte. Prior to 1970, wastes may have been disposed of at this site. Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies recommended.
CS-9	Former Main USAF Motor Pool	1941-1946 U.S. Army; 1955-1967 USAF	Waste solvents, oil and fuel, battery electrolytes. Potential for contamination; potential for migration. Received a HARM rating. Phase II studies recommended.

TABLE E-1 (CONT'D)
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES
ON MMR

Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
CS-10	Unit Training Equipment Shop (UTES) BOMARC Site	1962-1973 (BOMARC) 1978-present (UTES)	Spills or waste fuels, oil, solvents, battery electrolytes. Waste electronic parts, cleaner (halogenated solvents), UDMH degradation products. Potential for contamination. Indirect evidence of contamination migration. Received a HARM rating. Phase II studies recommended.
CS-11	ARNG Pesticide Shop (Former ANG Pesticide Shop)	1970-present	Pesticide residues. Potential for contamination. Potential for contaminant migration. Received a HARM rating. Limited Phase II studies recommended.
CS-12	VA Roads and Grounds Shop	1980-present	Spills of waste petroleum, oils, and lubricants (POL) and solvents. Spills of pesticide. Potential for contamination; potential for contaminant migration. Received a HARM rating. Referred to Base Environmental Programs. No Phase II studies recommended.
CS-13	Former Contractors Yard near Well J off-base site	1954-1984	Leaking drums with unknown substances. Potential for contamination. Indirect evidence for contaminant migration. Received a HARM rating. Phase II studies recommended.
CS-14	Bldg. 156 Vapor Degreaser Leaching Pit	1955-1969	PCE and TCE. Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies recommended.
CS-15	Former Engine Run-up Area	1949-present	Waste fuel and petroleum distillate solvents. Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies recommended.
CS-16	Sewage Treatment Plant	1936-present	Metals, VOCs. Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies at this site are currently ongoing.
CS-17	Former Sewage Sludge Disposal Area	1941-1960	Metals. Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies at this site are currently ongoing.

TABLE E-1 (CONT'D)
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES
ON MMR

Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
CS-18	Propellant Burning Trenches	1940's to present	Lead, 2,4 dinitrotulene. Potential present for contamination; potential for contaminant migration. Received a HARM rating. No Phase II studies recommended. Recommended to Base Environmental Programs.
FS-1	Aviation gasoline (AVGAS) Fuel Valve Test Dump Site	1955-1959	Fuel components (VOC, lead, hydrocarbons). Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies have been recommended and a work plan is currently under review.
FS-2	Railroad Fuel Pumping Site	1955-1965	Fuel components (VOC, lead, hydrocarbons). Potential for contamination. Evidence of contaminant migration. Received a HARM rating. Phase II studies have been recommended and a work plan is currently under review.
FS-3	Johns Pond Road Fuel Dumping	1955-1962	Fuel components (VOC, lead, hydrocarbons). Potential for contamination; potential for contaminant migration. Site is off-base. Received a HARM rating. Phase II studies recommended.
FS-4	Current Product Tanks 100, 101	1956-present	AVGAS leak (VOC, lead, hydrocarbons). Potential for contamination; potential for contaminant migration. Received a HARM rating. Limited Phase II studies recommended.
FS-5	Aircraft Parking Apron near Aquafarm	Early 1960's	AVGAS (lead, VOCs, hydrocarbons). Site is included with assessment of SD-5; not separately ranked.
FS-6	Airfield Apron	Early 1960's	AVGAS (lead, VOCs, hydrocarbons). Site is included with assessment of SD-2. Not separately ranked.
FS-7	Current Product Tank 115	1970-1985	Fuel oil (VOC, hydrocarbons). Potential for contamination; potential for contaminant migration. Received a HARM rating. Limited Phase II studies recommended.
FS-8	Airfield Apron	Early 1960's	AVGAS (lead, VOCs, hydrocarbons). Site is included with assessment of SD-2. Not separately ranked.

TABLE E-1 (CONT'D)
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES
ON MMR

Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
FS-9	Current Product Tank 108	1952-present	Motor gasoline MOGAS (VOCs, lead, hydrocarbons). Potential for contamination; potential for contaminant migration. Received a HARM rating. Referred to Base Environmental Programs. Limited Phase II studies recommended.
FS-10	Fuel Storage Area	Early 1960's	Jet aircraft fuel JP-4 (VOCs, hydrocarbons). Site is included with assessment of SD-2. Not separately ranked.
FS-11	Fuel Storage Area	Early 1960's	JP-4 (VOCs, hydrocarbons). Site is included with assessment of SD-2. Not separately ranked.
FS-12	Leak in fuel Line in Range	1972	JP-4 (VOCs, hydrocarbons). Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies recommended.
FS-13	Leak in Fuel Line in Cantonment Area	1972	JP-4 (VOCs, hydrocarbons). Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies recommended.
FS-14	Fuel Spill in Range (E-3)	1985	MOGAS (VOCs, lead, hydrocarbons). Potential for contamination; potential for contaminant migration. Contaminated soil excavated. Received a HARM rating. Limited Phase II studies recommended.
FS-15	Runway #5 Spill	Early 1960's	AVGAS (VOCs, lead, hydrocarbons). Potential for contamination. No potential for contaminant migration. Site not ranked. No Phase II recommendations.
FS-16	Army Helicopter Maintenance (Bldg 2816)	1982	JP-4 (VOCs, hydrocarbons). Potential for contamination. No potential for contaminant migration. Site not ranked. No Phase II recommendations.
FS-17	WWII Motor Pool/Transfer Point	?-present	MOGAS (VOCs, lead, hydrocarbons). Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies recommended.

TABLE E-1 (CONT'D)
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES
ON MMR

Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
FS-18	Fuel Transfer Point	?-present	MOGAS (VOCs, hydrocarbons, lead). Potential for contamination; potential for contaminant migration. Received a HARM rating. Limited Phase II studies recommended.
FS-19	Former MOGAS/Fuel Storage	?-1985	MOGAS (VOCs, hydrocarbons, lead). Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies recommended.
FS-20	Current Product Tank #88	1968-Present	MOGAS (VOCs, hydrocarbons, lead). Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies recommended.
FS-21	Current Product Tank #90	1954-Present	MOGAS (VOCs, hydrocarbons, lead). Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies recommended.
FS-22	ANG Motor Pool	Sept. 1984	JP-4 (VOCs, hydrocarbons). Potential for contamination. No potential for contaminant migration. Site not ranked. No Phase II action recommended.
FS-23	South Truck Road	1965	JP-4 (VOCs, hydrocarbons) Site is included with assessment of CS-3. Not separately ranked.
FS-24	BOMARC Area	1985	Diesel fuel (VOCs, hydrocarbons). Potential for contamination. No potential for contaminant migration. Site not ranked. No Phase II action recommended.
FTA-1	Current Fire Fighter Training Area	1958-1985	POL, solvents, metals, transformer fluids, hydraulic fluids. Direct evidence of contamination. Direct evidence of contaminant migration. Received a HARM rating. Phase II studies are ongoing at this site.

TABLE E-1 (CONT'D)
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES
ON MMR

Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
FTA-2	Former Fire Fighter Training Area	1948-1956	POL, solvents, metals, hydraulic fluid, transformer oil. Direct evidence of contamination. Indirect evidence of contaminant migration. Received a HARM rating. Phase II studies recommended.
FTA-3	Former Fire Fighter Training Area	1956-1958	POL, solvents, metals, hydraulic fluid, transformer oils. Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies recommended.
CY-1	Former U.S. Army Coal Storage Yard	1940-1957	Coal pile leachate. Organics, metals, acidity, sulfur. Potential for contamination; potential for contaminant migration. Received a HARM rating. No Phase II studies recommended.
CY-2	Former USAF and ANG Coal Storage Yard	1957-1984	Coal pile leachate. Organics, metals, acidity, sulfur. Potential for contamination; potential for contaminant migration. Received a HARM rating. Phase II studies recommended.
CY-3	Former Hospital Coal Storage Yard and Ash Disposal Area	1946-1972	Coal pile leachate. Organics, metals, acidity, sulfur. Potential for contamination; potential for contaminant migration. Received a HARM rating. No Phase II studies recommended.
CY-4	Current Coal Storage Yard and Ash Disposal Area	1955-present	Coal pile leachate. Organics, metals, acidity, sulfur. Assessed in conjunction with SD-3.

TABLE E-2

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS REGARDING CAMP EDWARDS/ARNG RANKED DISPOSAL SITES (Keyed to Figure E-2)

Site Designation	Site Description	Site Type	Potential for Contamination	Potential for Migration	Referred To Base Environmental Program	Recommended For Phase II Action
CS - 10	UTES/BOMARC	Chemical spill/disposal site	Yes	Yes	No	Phase II studies recommended
FS - 19	Former MOGAS/Fuel Storage Point	Fuel spill/disposal site	Yes	Yes	No	Phase II studies recommended
CS - 3	South Truck Road Motor Pool	Chemical spill/disposal site	Yes	Yes	No	Phase II studies recommended
CS - 4	West Truck Road Motor Pool	Chemical spill/disposal site	Yes	Yes	No	Phase II studies recommended
CS - 8	OMS #22	Chemical spill/disposal site	Yes	Yes	No	Phase II studies recommended
CS - 5	Former Refueler Maintenance Shop	Chemical spill/disposal site	Yes	Yes	No	Phase II studies recommended
FS - 21	Current Product Tank 90	Fuel spill/disposal site	Yes	Yes	No	Phase II studies recommended
FS - 20	Current Product Tank 88	Fuel spill/disposal site	Yes	Yes	No	Phase II studies recommended
FS - 7	Current Product Tank 115	Fuel spill/disposal site	Yes	Yes	No	Limited Phase II studies recommended
FS - 17	Former WWII Motor Pool Transfer Pt.	Fuel spill/disposal site	Yes	Yes	No	Phase II studies recommended
FS - 14	Spill in Range (F-3)	Fuel spill/disposal site	Yes	Yes	No	Limited Phase II studies recommended
FS - 12	Leak in Fuel Line in Range	Fuel spill/disposal site	Yes	Yes	No	Phase II studies recommended
CS - 11	Pesticide Shop	Chemical spill/disposal site	Yes	Yes	No	Limited Phase II studies recommended
CY - 1	Former Army Coal Yard	Coal storage yard	Yes	Yes	No	No Phase II studies recommended
FS - 9	Current Product Tank 108	Fuel spill/disposal site	Yes	Yes	No	Limited Phase II studies recommended
FS - 18	Fuel Transfer Point	Fuel spill/disposal site	Yes	Yes	No	Limited Phase II studies recommended
LF - 3	Northern Range Area Dump	Landfill	Yes	Yes	Yes	No Phase II studies recommended
CS - 18	Propellant Burning Trenches	Chemical spill/disposal site	Yes	Yes	Yes	No Phase II studies recommended
LF - 7	Radar Tube Burial Site	Landfill	Yes	Yes	No	No Phase II studies recommended

TABLE E-3

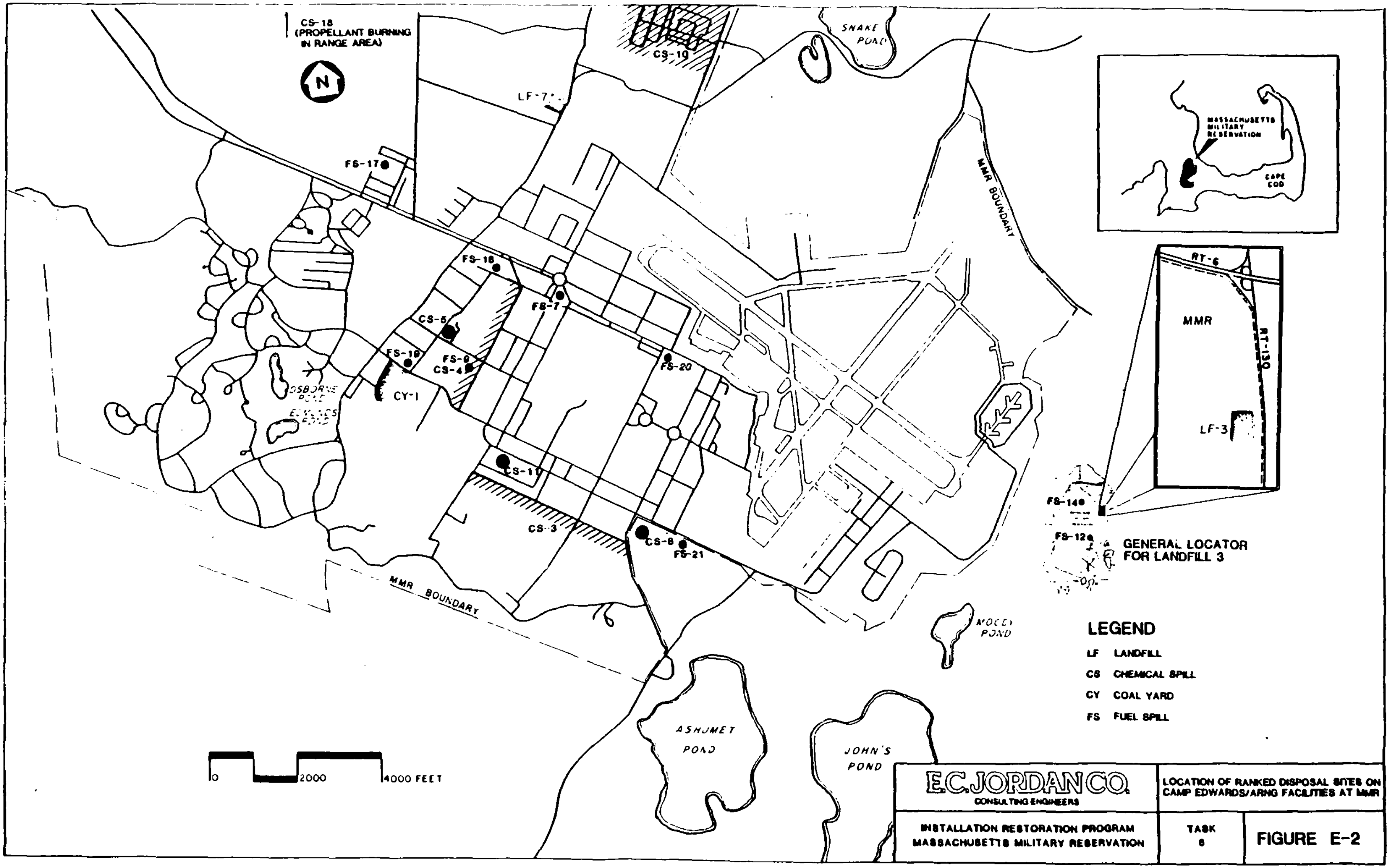
SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS REGARDING ANG RANKED DISPOSAL SITES (Keyed to Figure E-3)

Site Designation	Site Description	Site Type	Potential for Contamination	Potential for Migration	Referred To Base Environmental Program	Recommended For Phase II Action
FTA - 1	Current Fire Fighting Training Area	Fire Fighter Training Area	Yes	Yes	No	Phase II studies in progress
LF - 1	Main Base Landfill	Landfill	Yes	Yes	No	Phase II studies in progress
FTA - 2	Former Fire Fighter Training Area (1948-1956)	Fire Fighter Training Area	Yes	Yes	No	Phase II studies recommended
FS - 2	Railroad Fuel Pumping Area	Fuel spill/disposal site	Yes	Yes	No	Phase II work plan under review
FS - 1	AVGAS Fuel Valve Test Dump Site	Fuel spill/disposal site	Yes	Yes	No	Phase II work plan under review
SD - 5	Aquafarm Drainage Swale	Storm drainage disposal site	Yes	Yes	No	Phase II work plan under review
SD - 4	Hangar 158, Aircraft Maintenance Storm Drainage Ditch	Storm drainage disposal site	Yes	Yes	No	Phase II studies recommended
CS - 16	Sewage Treatment Plant	Chemical spill/disposal site	Yes	Yes	No	Phase II studies in progress
SD - 2	Runway/Aircraft Maintenance Storm Drainage Ditch	Storm drainage disposal site	Yes	Yes	No	Phase II work plan under review
CS - 15	Former Engine Run-up Area	Chemical spill/disposal site	Yes	Yes	No	Phase II studies recommended
CS - 2	East Truck Road Motor Pools	Chemical spill/disposal site	Yes	Yes	No	No Phase II studies recommended
FTA - 3	Former Fire Fighter Training Area (1956-1958)	Fire Fighter Training Area	Yes	Yes	No	Phase II studies recommended
SD - 1	Runway/Aircraft Maintenance Storm Drainage Ditch	Storm drainage disposal site	Yes	Yes	No	Phase II studies recommended
CS - 14	Bldg. 156 Vapor Degreaser Leaching Pit	Chemical spill [illegible]posal site	Yes	Yes	No	Phase II studies recommended
CS - 9	Former Main USAF Motor Pool	Chemical spill/disposal site	Yes	Yes	No	Phase II studies recommended
SD - 3	Coal/Ash Runoff Drainage Ditch	Storm drainage disposal site	Yes	Yes	Yes	Limited Phase II studies recommended
FS - 13	Leak in Fuel Line-Cantonment Area	Fuel spill/disposal site	Yes	Yes	No	Phase II studies recommended
FS - 4	Current Product Tanks 100, 101	Fuel spill/disposal site	Yes	Yes	No	Limited Phase II studies recommended
CY - 2	Former USAF/ANG Coal Yard	Coal storage yard	Yes	Yes	No	Phase II studies recommended
CS - 17	Former Sewage Sludge Disposal	Chemical spill/disposal site	Yes	Yes	No	Phase II studies in progress
CS - 1	North Truck Road Motor Pool	Chemical spill/disposal site	Yes	Yes	No	No Phase II studies recommended
CS - 6	Current ANG Motor Pool	Chemical spill/disposal site	Yes	Yes	No	No Phase II studies recommended

TABLE E-4

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS REGARDING VA AND OFF-BASE RANKED DISPOSAL SITES

Site Designation	Site Description	Site Type	Potential for Contamination	Potential for Migration	Referred To Base Environmental Program	Recommended For Phase II Action
VA (Keyed to Figure E-4)						
CS - 12	VA Roads and Ground Shop	Chemical spill/disposal site	Yes	Yes	Yes	No Phase II studies recommended
CY - 3	Former Hospital Coal Yard and Ash Disposal	Coal storage yard	Yes	Yes	No	No Phase II studies recommended
Off-Base Sites (Keyed to Figure E-3)						
CS - 13	Former Contractors Yard Near Well J	Chemical spill/disposal site	Yes	Yes	Yes	Phase II studies recommended
LF - 4	Johns Pond Dump	Landfill	Yes	Yes	No	Phase II studies recommended
FS - 3	Johns Pond Road Fuel Dump Site	Fuel spill/disposal site	Yes	Yes	No	Phase II studies recommended



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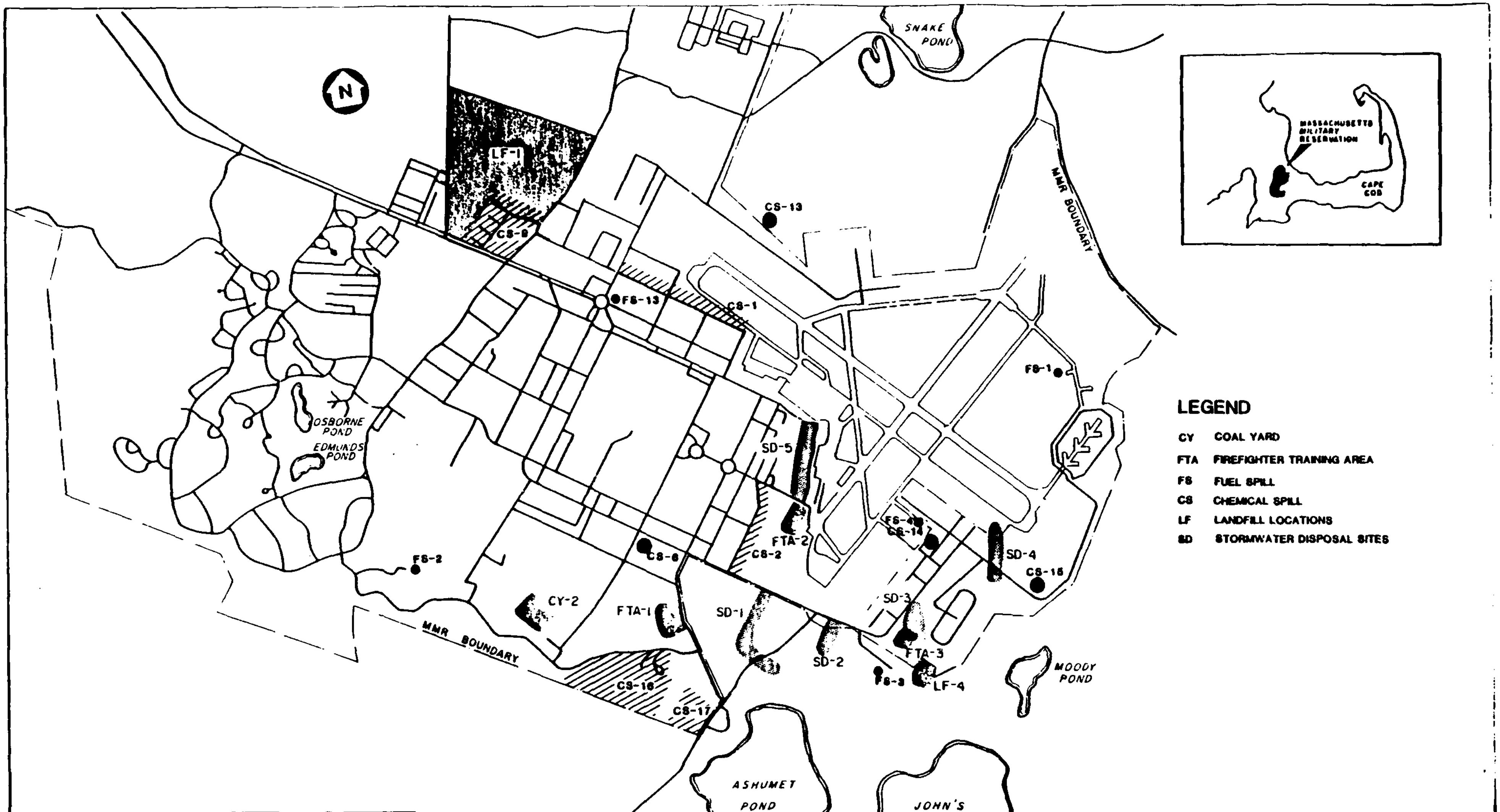
INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

LOCATION OF RANKED DISPOSAL SITES ON CAMP EDWARDS/ARNG FACILITIES AT MMR

TASK 6

FIGURE E-2



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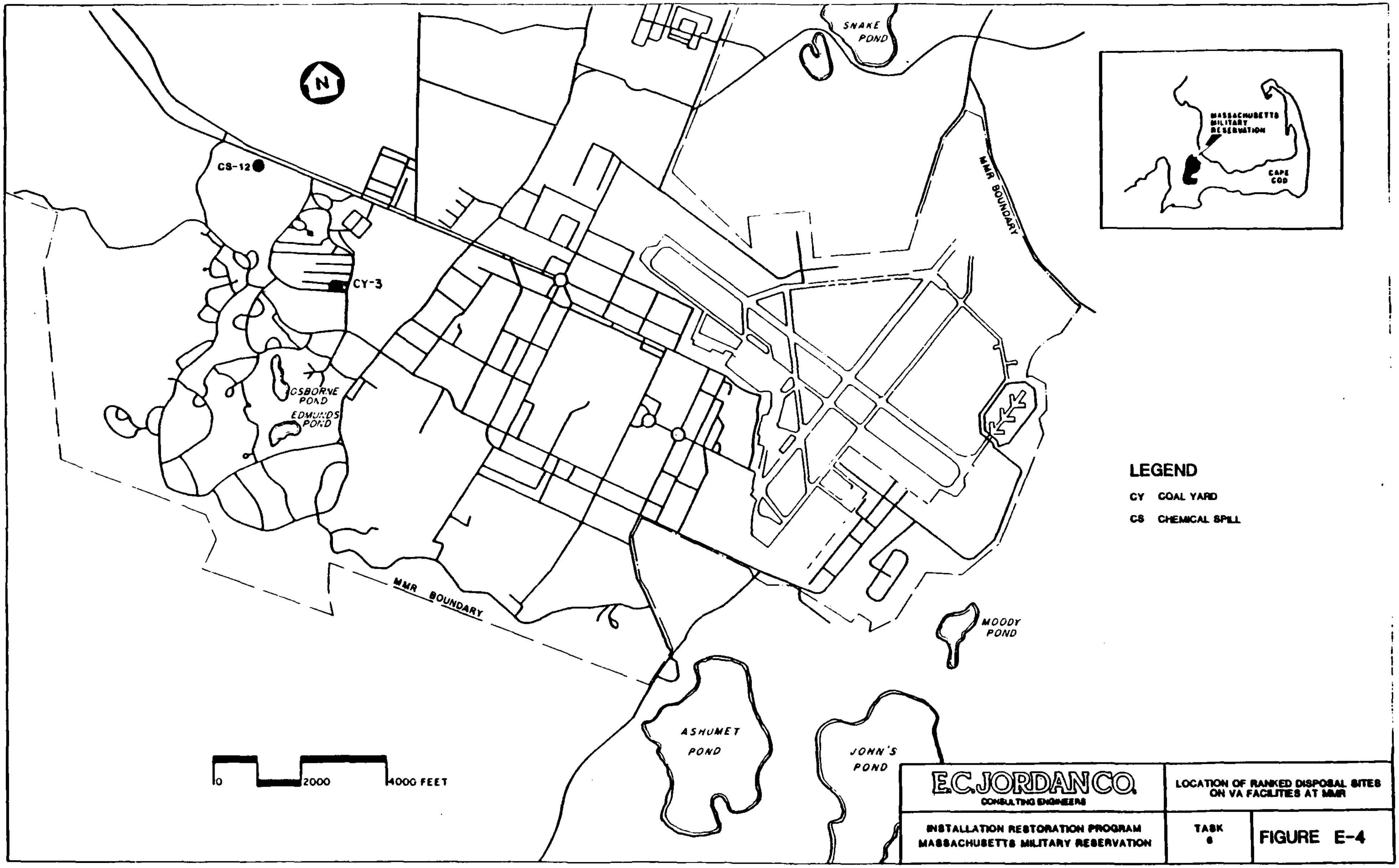
INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

LOCATION OF RANKED DISPOSAL SITES ON ANG FACILITIES AT MMR AND OFF-BASE

TASK 6

FIGURE E-3



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LOCATION OF RANKED DISPOSAL SITES ON VA FACILITIES AT MMR

INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

TASK 6

FIGURE E-4

1.0 INTRODUCTION

1.1 BACKGROUND

The U.S. Air Force (USAF), due to its primary mission in the defense of the United States, has long been engaged in operations dealing with toxic and hazardous materials. Federal, state, and local governments have developed strict regulations requiring disposers to identify the locations and contents of disposal sites and take action to eliminate the hazards in an environmentally responsible manner. The primary federal legislation governing disposal of hazardous waste is the Resource Conservation and Recovery Act (RCRA) of 1976, as amended. Under Sec. 6003 of the Act, federal agencies are directed to assist the U.S. Environmental Protection Agency (EPA), and under Sec. 3012 state agencies are required to inventory past disposal sites and make the information available to the requesting agencies. To ensure compliance with these hazardous waste regulations, the Department of Defense (DOD) developed the Installation Restoration Program (IRP). The current DOD IRP policy is contained in Defense Environmental Quality Program Policy Memorandum (DEQPPM) 81-5, dated Dec. 11, 1981, and implemented by USAF message dated Jan. 21, 1982. DEQPPM 81-5 reissued and amplified all previous directives and memoranda on the IRP. DOD policy is to identify and fully evaluate suspected problems associated with past waste disposal practices and to control hazards to health and welfare that resulted from these past operations. The IRP will be the basis for response actions on USAF installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as clarified by Executive Order 12316. CERCLA is the primary federal legislation governing remedial action at the past hazardous waste disposal sites.

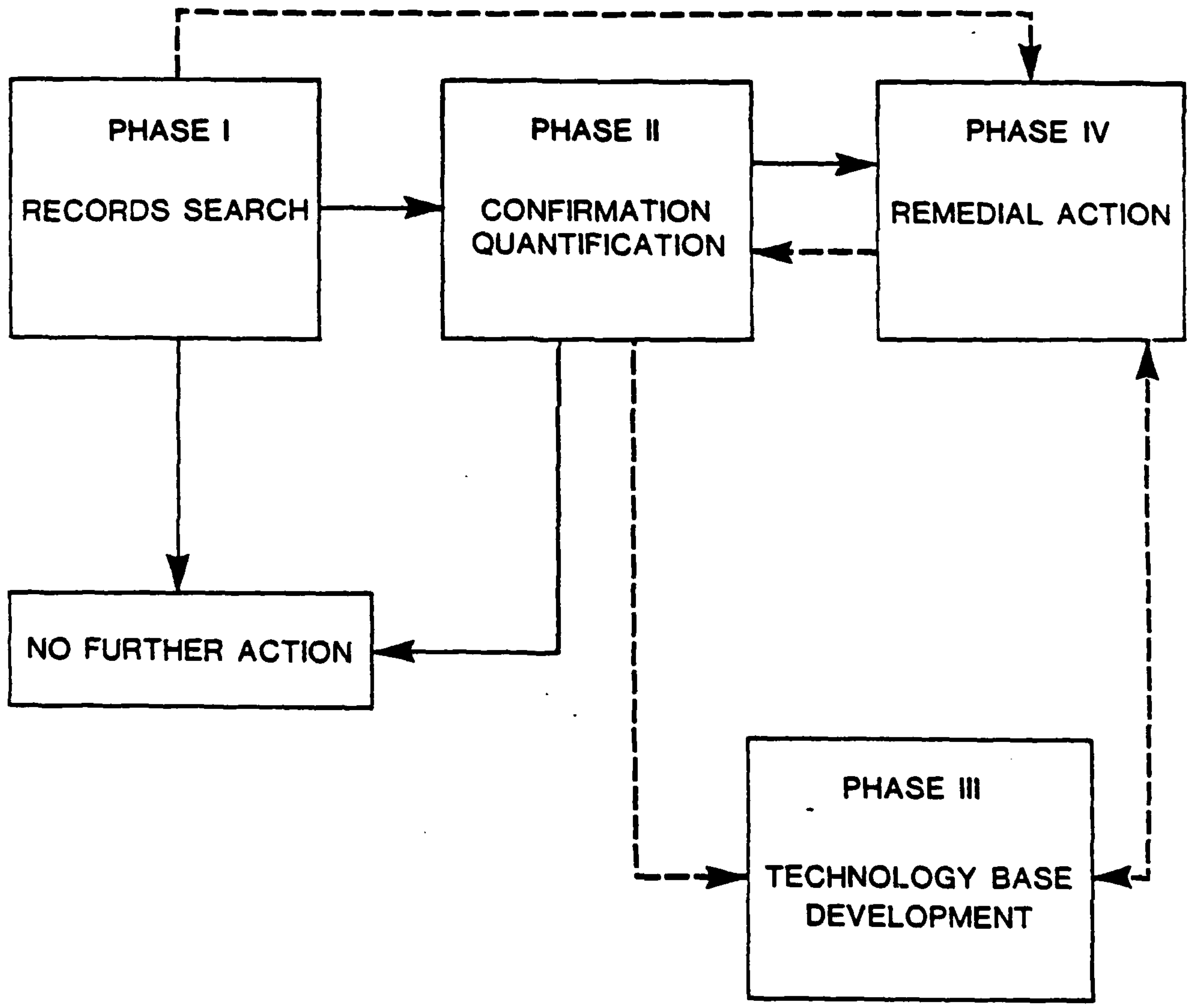
1.2 PURPOSE, AUTHORITY, AND SCOPE OF THE ASSESSMENT

The IRP is a four-phased program, designed as shown in Figure 1.2-1, to ensure that identification, confirmation/quantification, and remedial actions are performed in a timely and cost-effective manner. Each phase is briefly described below:

- Phase I - Installation Assessment/Records Search. Phase I is to identify and prioritize those past disposal sites that may pose a hazard to public health or the environment as a result of contaminant migration to surface or groundwaters or that have an adverse effect by contaminant persistence in the environment. In this phase, it is determined whether a site requires further action to confirm an environmental hazard or whether it may be considered to present no hazard at this time. If a site requires immediate remedial action, such as removal of abandoned drums, the action can proceed directly to Phase IV. The Phase I report is a basic background document for the Phase II study.

- Phase II - Confirmation/Quantification. Phase II is to define and quantify, by preliminary and comprehensive environmental and/or ecological survey, the presence or absence of contamination, the extent of

U.S. AIR FORCE INSTALLATION RESTORATION PROGRAM



SOURCE: HQ AFESC 1985

E.C. JORDAN CO. CONSULTING ENGINEERS	U.S. AIR FORCE INSTALLATION RESTORATION PROGRAM (IRP) ELEMENTS	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 1.2-1

contamination, and waste characterization (when required by the regulatory agency), and to identify sites or locations where remedial action is required in Phase IV. Research requirements identified during this phase will be included in the Phase III effort of the program.

- <u>Phase III - Technology Base Development</u>. Phase III is to develop a sound data base upon which to prepare a comprehensive remedial action plan. This phase includes implementation of research requirements and technology for objective assessment of adverse effects. A Phase III requirement can be identified at any time during the program.

- <u>Phase IV - Operations/Remedial Actions</u>. Phase IV includes the preparation and implementation of the remedial action plan.

To most effectively coordinate the IRP Phase IV, the USAF has entered into an interagency agreement with the U.S. Department of Energy to administer Remedial Action Planning (RAP) Programs through the Oak Ridge National Laboratory (ORNL). The National Guard Bureau (NGB), under the auspices of the Air National Guard (ANG), enlisted the services of, and provided funding to, ORNL for the purpose of conducting the Massachusetts Military Reservation (MMR) IRP. As a component of the overall program, the E.C. Jordan Co. (Jordan) conducted an initial assessment/records search at MMR. This report comprises the Phase I Record Search of the Massachusetts Army National Guard (ARNG), Massachusetts ANG, USAF, and Veterans Administration (VA) facilities located at MMR and contains a summary and evaluation of the information collected during Phase I of the IRP and recommendations for any Phase II action. The Phase I records search of U.S. Coast Guard (USCG) facilities located at MMR is contained in a separate report.

The objective of Phase I was to identify the potential for environmental contamination from past waste disposal practices at MMR and to assess the potential for contaminant migration. Activities performed in the Phase I study included the following:

1. review of site records;
2. interviews with personnel familiar with past generation and disposal activities;
3. inventory of wastes;
4. determination of estimated quantities and locations of current and past hazardous waste treatment, storage, and disposal;
5. definition of the environmental setting at the base;
6. review of past disposal practices and methods;
7. performance of field inspections;
8. an aerial tour of the facilities;

9. gathering of pertinent information from federal, state, and local agencies;

10. assessment of potential for contaminant migration; and

11. development of conclusions and recommendations for any necessary Phase II action.

Jordan performed the on-site portion of the records search during March 1986. The following team of professionals was involved:

Michael A. Keirn, Ph.D.	Senior Scientist and Team Leader, Chemist; 21 yrs professional experience.
Michael E. Murphy	Ecologist; 8 yrs of professional experience.
Susan A. Waite	Chemical engineer; 2 yrs of professional experience.
Theodore W. Taylor	Geologist; 3 yrs of professional experience.

Detailed information on these individuals is presented in Appendix B.

1.3 METHODOLOGY

The methodology utilized in the MMR records search began with a review of past and current industrial/laboratory operations conducted at the base. Information was obtained from available records, such as shop files and real property files, as well as from interviews with past and current base employees from the various operating areas. Interviewees included current and former personnel associated with the mission of MMR and tenant organizations on base. A list of interviewees, by position and approximate years of service, is presented in Appendix C.

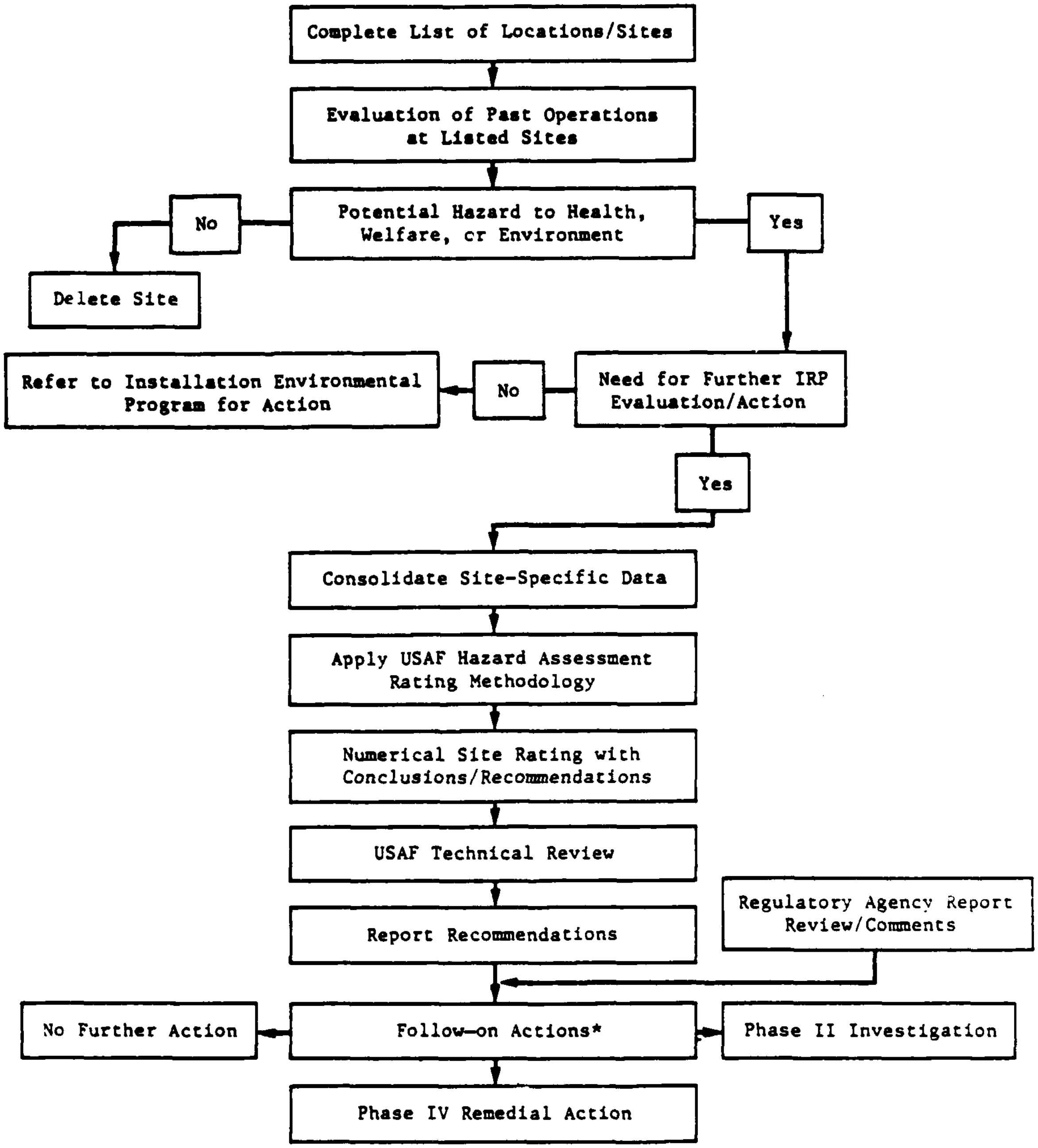
Concurrent with the base interviews, the applicable federal, state, and local agencies were contacted for pertinent base-related environmental data. The outside records centers and agencies contacted and personnel interviewed are also listed in Appendix C.

The next step in the activity review was to determine the past management practices regarding the use, storage, treatment, and disposal of hazardous materials from the various operations on the base. Included in this part of the activities review was the identification of all known past disposal sites and other possible sources of contamination, such as spill areas.

A general ground tour of the identified sites was then made by the Jordan project team to gather site-specific information, including (1) visual evidence of environmental stress, (2) the presence of drainage ditches and systems, and (3) visual inspection for any obvious signs of contamination of leachate migration. A helicopter overflight was made as part of the on-site visit to identify possible sites not apparent from the ground.

Using the process shown in Figure 1.3-1, a decision was then made, based on all of the previous information, regarding the potential for hazardous material contamination at any of the identified sites. If no potential contamination existed, the site was deleted from further consideration. If potential for contamination was identified, the potential for migration of the contaminant was assessed based on site-specific conditions. If no potential for migration existed and if there were no further environmental concerns, the site was deleted. If the potential for contaminant migration was considered significant, the site was evaluated and prioritized using the USAF Hazard Assessment Rating Methodology (HARM). A discussion of the HARM system is presented in Appendix G.

PHASE I INSTALLATION RESTORATION PROGRAM
RECORDS SEARCH FLOWCHART



*Beyond scope of Phase I.

SOURCES: HQ AFESC, 1985.

E.C. JORDAN CO. CONSULTING ENGINEERS	DECISION PROCESS	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 1.3-1

2.0 INSTALLATION DESCRIPTION

2.1 LOCATION, SIZE, AND BOUNDARIES

The MMR is located on the upper portion of Cape Cod in Barnstable County, Massachusetts, approximately 60 miles south of Boston and immediately southeast of the Cape Cod Canal. The general location of MMR is shown of Figure 2.1-1. The towns of Bourne, Falmouth, Sandwich, and Mashpee intersect on MMR property.

MMR occupies approximately 20,000 acres and consists of several major cooperating command units:

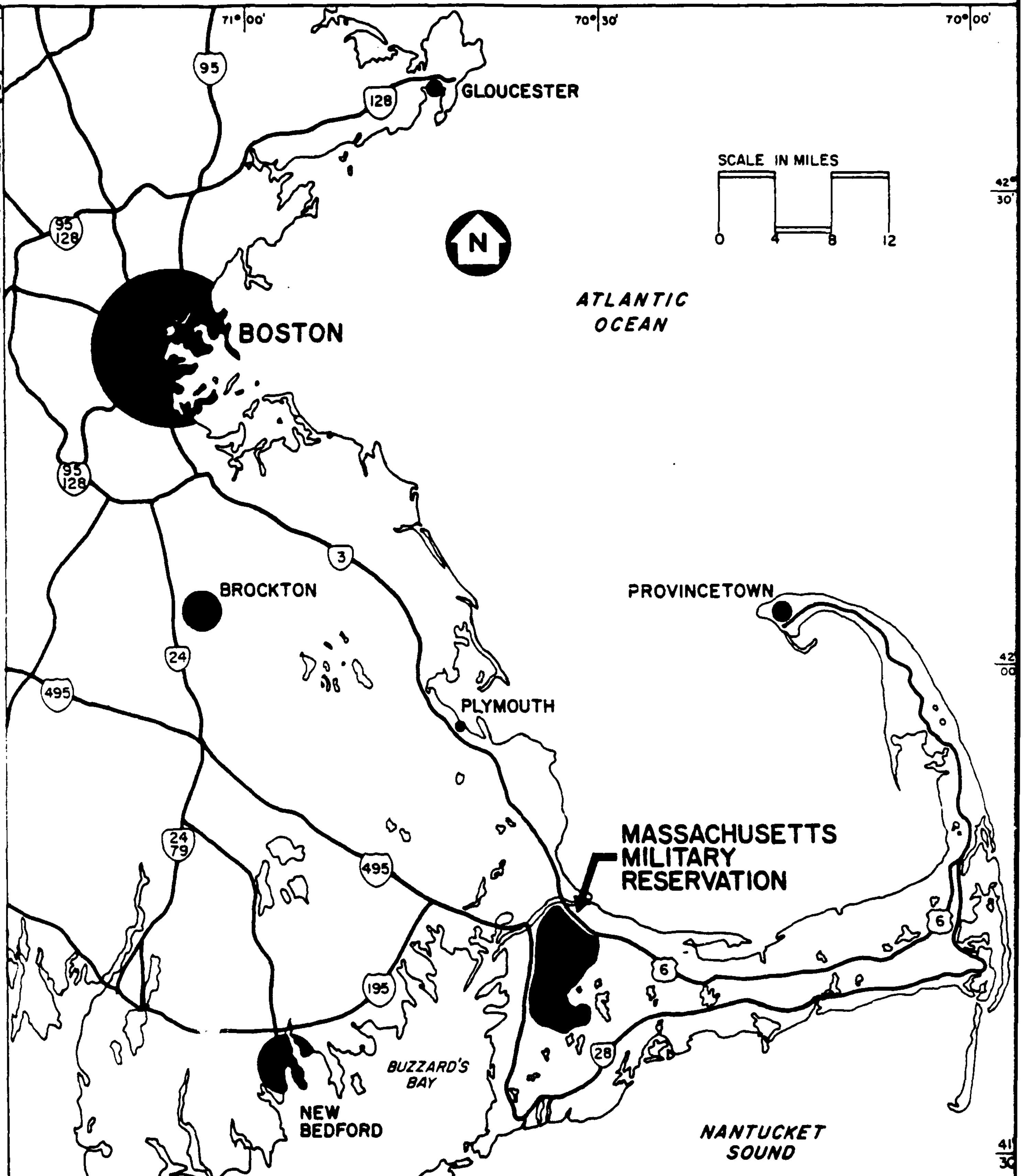
Massachusetts ARNG	(Camp Edwards)
Massachusetts ANG	(Otis-ANG Base)
USAF	[Cape Cod Air Force Station (AFS)]
USCG	[Air Station Cape Cod (ASCC)]
VA	(Massachusetts National Cemetery)

The locations that these units and their major tenants occupy on MMR are shown in Figure 2.1-2. The cooperative command structure is described in Section 2.3.

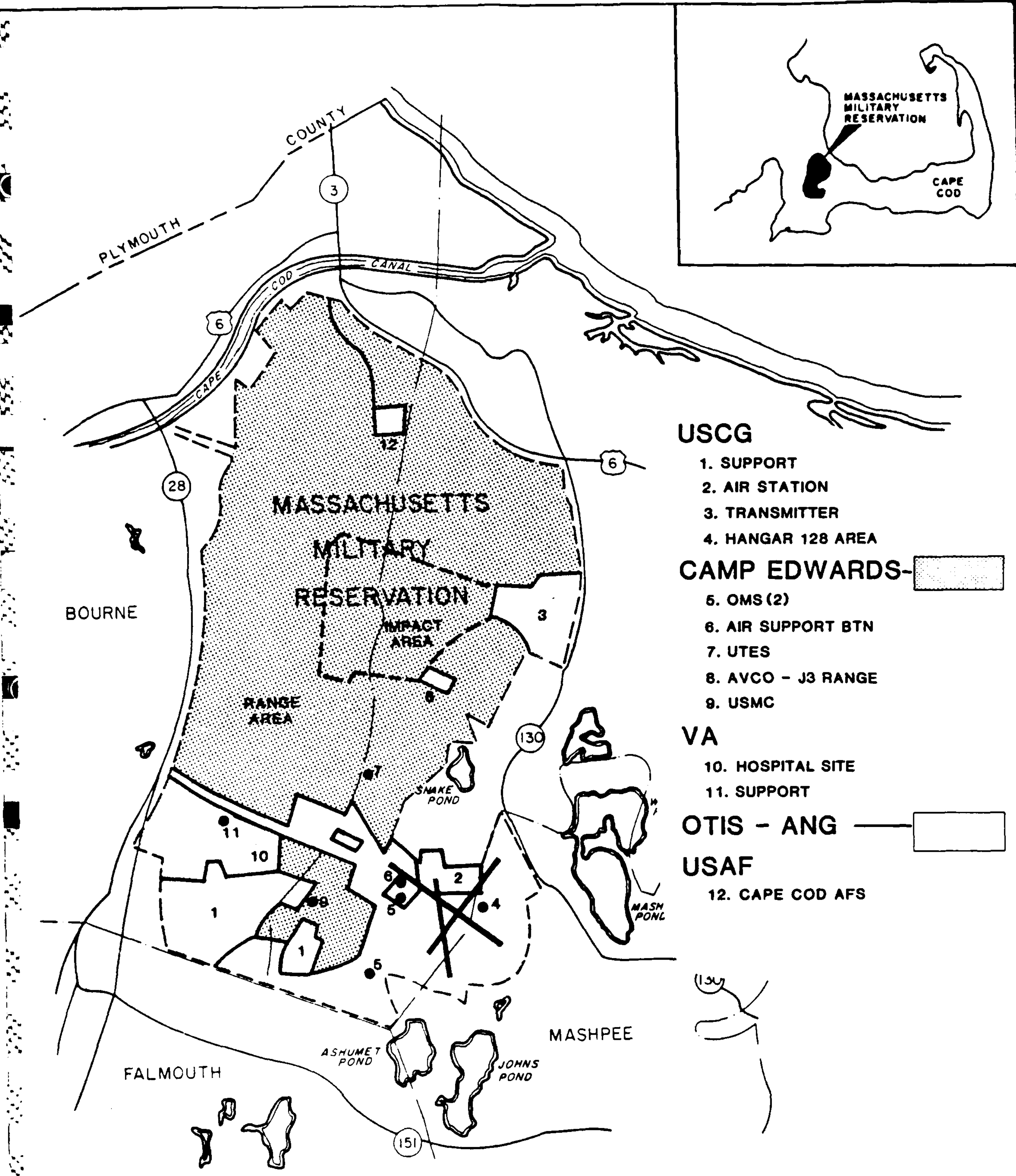
MMR is divided into three major areas: 1) the cantonment area; 2) the range, maneuver, and impact area; and 3) the Massachusetts National Cemetery. The cantonment consists of approximately 5,000 acres and represents the location of most administration and operational facilities, including flight lines, aircraft maintenance, vehicle maintenance, housing, and support facilities. This area is shown in Figure 2.1-3, which generally indicates the location of the facilities belonging to various commands and tenants. The largest area of MMR is the range, maneuver, and impact area, which comprises the northern 70 percent of MMR (14,236 acres). The USCG Transmitter Facility and Cape Cod AFS are located in this portion of the installation. Within the range, maneuver, and impact area, the component areas are as follows:

Training and maneuver areas	11,278 acres
Impact area	2,217 acres
Off-limits areas (easements/ammunition storage)	430 acres
Cape Cod AFS	87 acres
USCG Transmitter Station	224 acres

Cape Cod AFS is commonly known as PAVE-PAWS (an acronym for the Precision Acquisition Vehicle Entry - Phased Array Warning System) housed at the site. The Massachusetts National Cemetery and its support facilities compose the third major area that is located along the western edge of MMR. This area consists of 750 acres under the control of the VA. The general relationship of each of these areas is shown in Figures 2.1-2 and 2.1-3. The total USCG facilities in the range and cantonment areas are 1,407 acres. The USCG facilities are assessed in a separate Records Search Report.



E.C. JORDAN CO. CONSULTING ENGINEERS	GENERAL LOCATION MAP OF MMR	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 2.1-1



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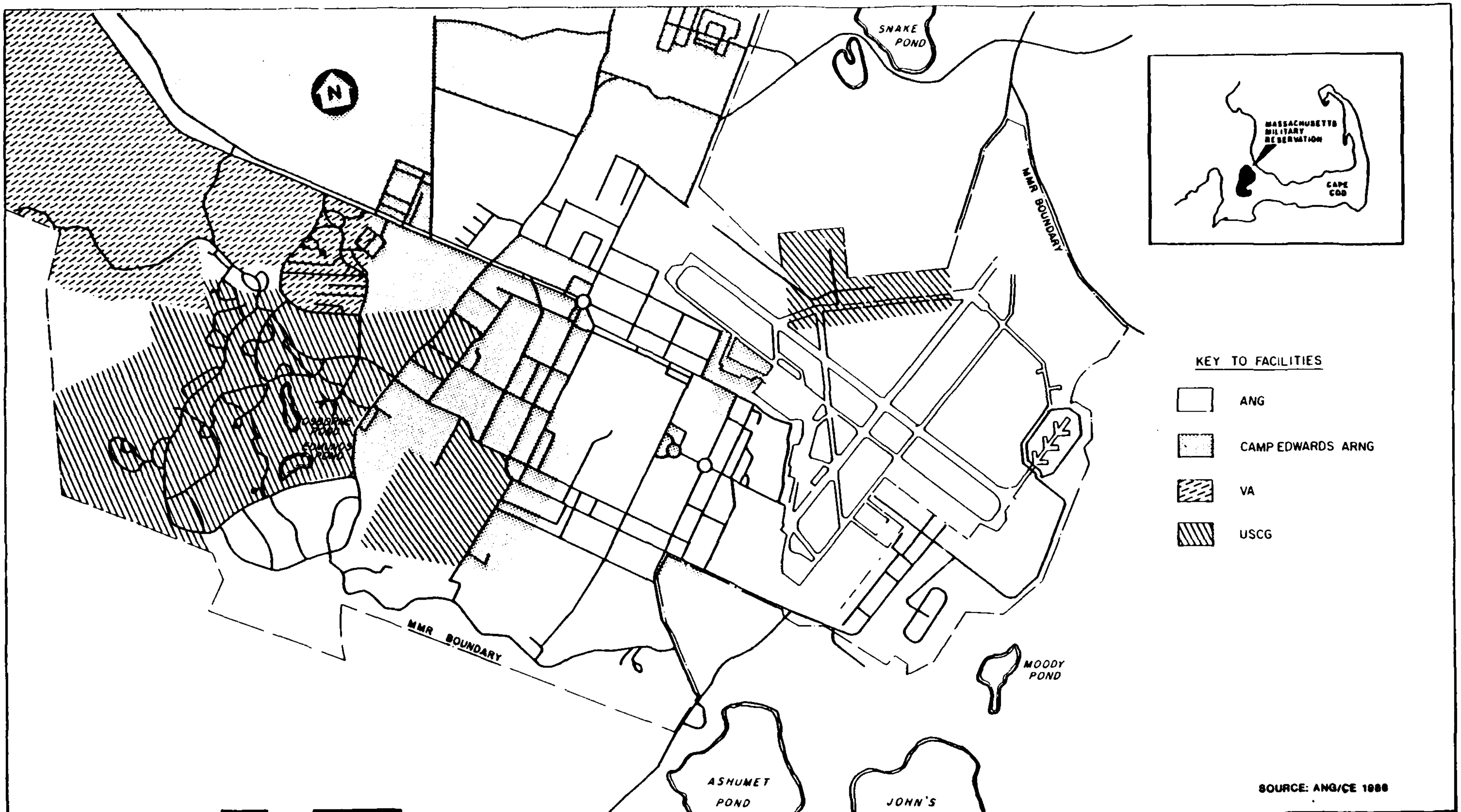
LOCATION OF MAJOR UNITS AT MM

INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

TASK 6

FIGURE 2.1-



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INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

LOCATION OF FACILITIES IN THE CANTONMENT AREA CONTROLLED BY EACH MAJOR COMMAND UNIT

TASK 6

FIGURE 2.1-3

Data for the areal extent of each land use were derived from the USCG and Camp Edwards Master Plans and Environmental Assessment real estate records (USCG 1984, Lyon and Assoc. 1983, and ARNG 1985) and data from Range Control.

2.2 HISTORY

Military use of portions of MMR began as early as 1911. Reportedly, during the period 1911 to 1935, the Massachusetts National Guard periodically camped and conducted maneuvers and weapons training in portions of the Shawme Crowell State Forest. No records exist to document activities during that period. The majority of activity at MMR has occurred since 1935 and includes operations by the U.S. Army, U.S. Navy (USN) and Marine Corps (USMC), the USAF, the USCG, the Massachusetts ARNG and ANG, and the VA as well as smaller tenant organizations. The history of these activities is summarized in this section. The chronological history was developed from information contained in the following sources and from personal interviews:

1. Air Installation Compatible Use Zone (AICUZ), Otis-AFB [102nd Fighter-Interceptor Wing (FIW), 1980].

2. Installation Survey Report, Otis AFB, Massachusetts (4784th Air Base Group, 1972).

3. Naval Aviation History of Otis Field, Subinstallation of Air Station Quonset Point, Rhode Island (Naval Historical Center, 1986).

4. Emergency Expansion Capacity Plan for Camp Edwards, (Lyon and Assoc., 1983).

5. USCG ASCC, Facilities Master Plan (USCG 1984).

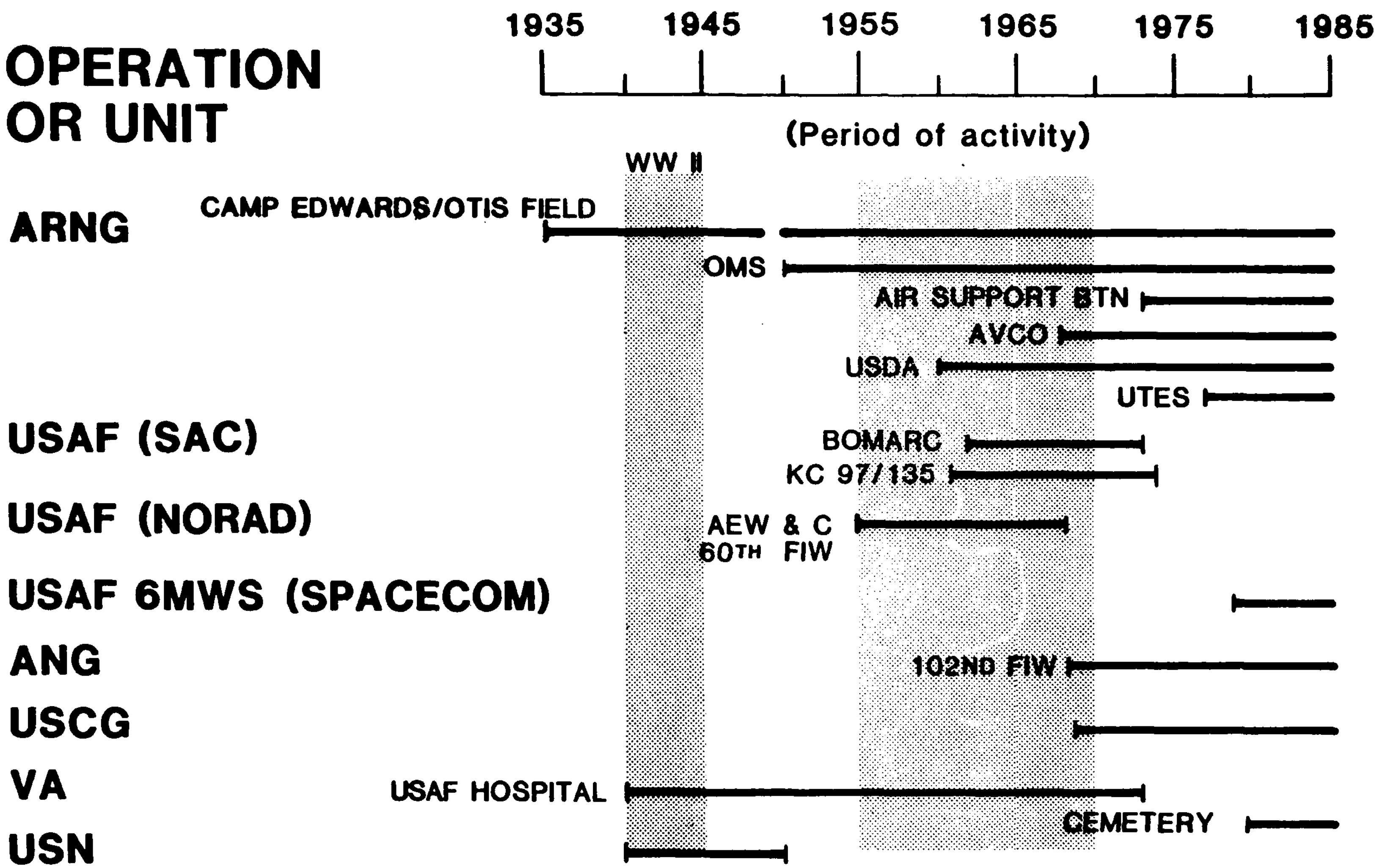
6. 102nd Civil Engineering Squadron (Levitt, 1985).

7. Phase I, Records Search, Otis-ANGB, (Metcalf and Eddy, 1983).

Figure 2.2-1 shows an overview of the operational history for the major units and activities at MMR from 1935 to the present. Current missions and organization for MMR are outlined in Section 2.3.

USCG operations are the subject of a separate Phase I report prepared under the MMR IRP and will not be discussed in detail. However, the USCG timeline is shown in Figure 2.2-1 for comparison.

In general, two different types of operations have dominated military activity at MMR: 1) mechanized army training, maneuvers, and maintenance support and 2) military aircraft operations, maintenance, and support. The intensity and level of activity have varied over the MMR operational history. As shown in Figure 2.2-1, the most intensive army activity occurred during WWII (1940-1944) and during demobilization following the war. The most intensive aircraft operations occurred from 1955 to 1970 when large numbers of surveillance and



SHADED AREAS INDICATE MOST ACTIVE PERIODS

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GENERALIZED CHRONOLOGY OF OPERATIONS AT MMR

INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

TASK 6

FIGURE 2.2-1

air defense aircraft operated from the base. These periods of intensive activity are shaded on Figure 2.2-1.

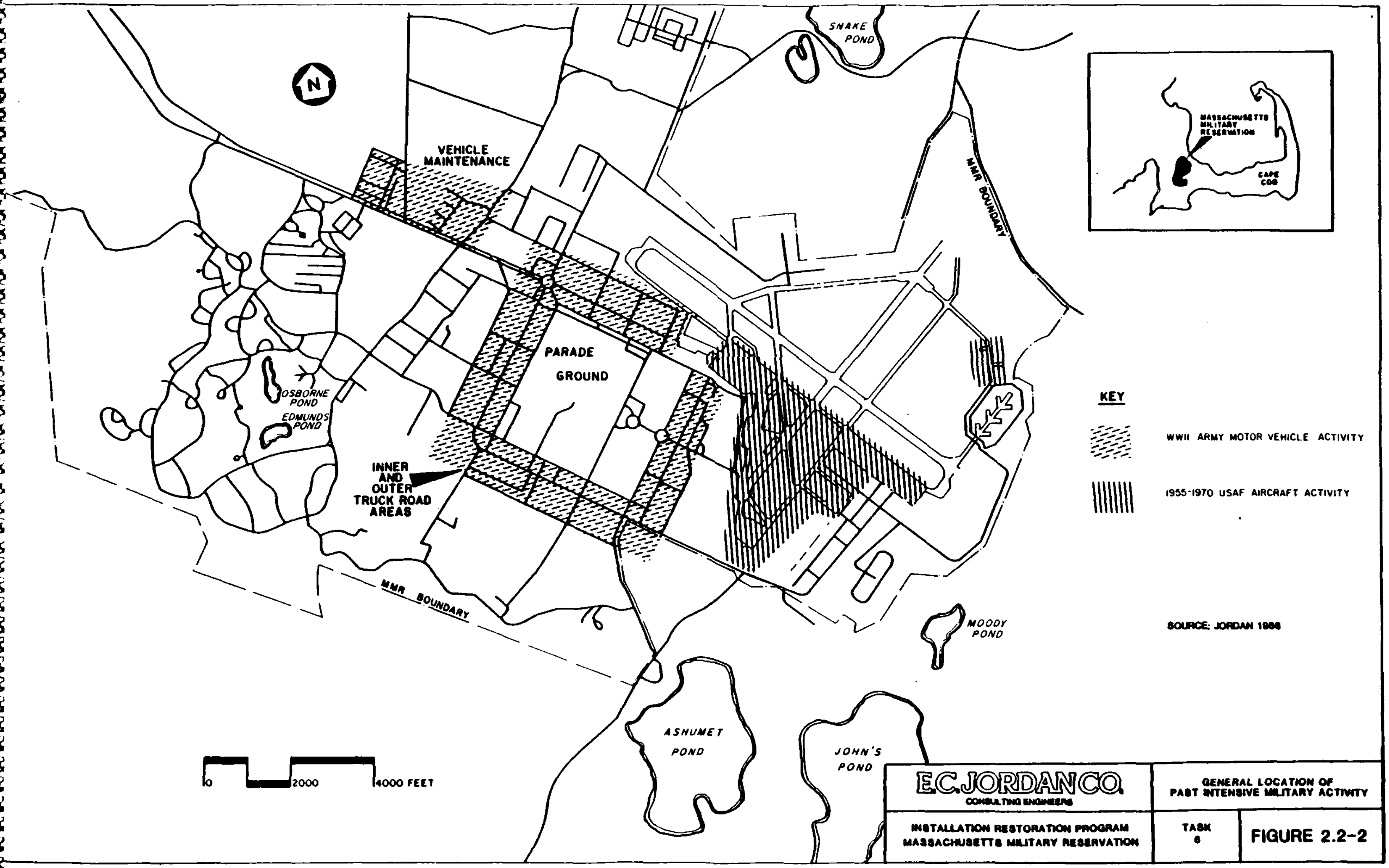
The intensive periods of activity also occurred under separate organizational control and were staged in two separate portions of the cantonment area. The WWII period of activity occurred under U.S. Army control when MMR had been federalized and was known as Camp Edwards. Large-scale motor pool activities and troop billeting occurred in the center of the cantonment, designated the Inner and Outer Truck Road areas (see Figure 2.2-2). These operations were carried out in units surrounding a central parade ground. Air operations at Otis Field during WWII were reportedly of a relatively low level of intensity. The period of most intensive aircraft operations occurred along the expanded flight line areas located in the southeastern portion of the cantonment (see Figure 2.2-2) and was under USAF control. At that time, MMR was known as Otis AFB.

The following paragraphs outline the history of Army, ARNG, ANG, USMC, USAF, and VA operations at MMR that have had the potential to generate hazardous wastes.

MMR was established in 1935 by the Commonwealth of Massachusetts for the purpose of National Guard and army reserve training and was designated as Camp Edwards, named for the Commander of the WWI 26th (YANKEE) Infantry Division. A grass airstrip was built and named Otis Field for 1st Lt. F.J. Otis, a medical doctor and Massachusetts National Guard pilot killed in a 1937 flying accident. A portion of the range and maneuver areas was taken from the Shawme Crowell State Forest. The cantonment area and a portion of the range and maneuver areas were purchased from private sources. The majority of the land forming MMR came from the Coonamesset Sheep Ranch, which was reportedly the largest ranch east of the Mississippi River. Immediately before purchase by the Commonwealth, the area suffered a forest fire that heavily damaged the ecosystem and left the area a dense tangle of scrub oak, pine, and briar.

During the period 1935 to 1940, the Commonwealth of Massachusetts and the federal government constructed 63 buildings and two 500-ft-wide, turfed runways. One runway was 3630 ft long, the other 3890 ft long. The majority of the construction of these initial facilities was performed by the Works Progress Administration (WPA). Principal use of Camp Edwards and Otis Field was by the 101st Observation Squadron of the Massachusetts Army Air Force National Guard.

In 1940 the U.S. Army leased MMR from the Commonwealth under a 99-yr lease and began construction of an expanded facility to accommodate up to 30,000 troops and a 1,722-bed hospital complex. Up to 18,000 personnel were employed during 1941 and 1942 in construction of the troop training facilities. These personnel were grouped into 13 regimental areas located along the North, South, East, and West Truck Roads, which formed a rectangle surrounding a central parade ground. During the first 2 yrs of WWII, the 26th Infantry and a portion of the America Division trained at MMR before embarking for Europe and the South Pacific. In 1941 the 101st Observation Squadron became the first unit to be stationed at MMR. The Otis Field component served as a subinstallation of



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GENERAL LOCATION OF PAST INTENSIVE MILITARY ACTIVITY

INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

TASK 6

FIGURE 2.2-2

Westover Field, Massachusetts, from 1941 to 1944. Several other major units or activities occupied MMR during WWII. The 14th Anti-Submarine Patrol Squadron operated from Otis Field during the period 1941 to 1945. From 1942 to 1945, the Second Batallion, 64th Coastal Artillery Regiment (Anti-aircraft) was stationed at Camp Edwards. Also during this period, the Army Engineering Amphibious Command occupied Camp Edwards and utilized the beaches of Cape Cod, Martha's Vineyard, and Nantucket to train troops for amphibious assault. Later in WWII (1943 - 1945), the East Coast Processing Center was moved to Camp Edwards, and up to 5,000 German POWs were interned at MMR during the final years of the war. At the end of WWII (September - December 1945), Camp Edwards was used as an outprocessing center for U.S. troops. During this period, over 11,000 enlisted men and 210 officers were separated through the post.

In 1944 Otis Field was placed under USN control to provide a base for advanced flight training for carrier-based aircraft pilots. Otis Field was designated as Naval Auxiliary Air Facility (NAAF) Otis Field, an activity of Naval Air Station, Quonset Point, Rhode Island, and was operated by the 26th Carrier Air Support Unit for training Air Group 81. During USN occupancy, the runways were expanded to provide three 7,000-ft runways, and the aircraft parking, dispersal, and taxiway areas were expanded by over 200 percent. In December 1945 NAAF-Otis Field was placed on caretaker status by the USN.

In February 1945 the Military Hospital was activated as one of the Army's largest hospital units. At the close of WWII, this hospital became a major orthopedic rehabilitation center. In support of this activity, Camp Edwards operated numerous athletic fields, tennis and handball courts, a gymnasium, and indoor and outdoor swimming pools. The hospital operated under Army and later USAF control until 1970, when it was deactivated. During 1972 and 1973 the hospital buildings were torn down under USAF contract when Otis AFB was transferred to the Massachusetts ANG. The site of the former hospital has been transferred to VA control.

From the close of WWII until the early 1950's, MMR reverted to a low level of activity. In June 1946 Camp Edwards was deactivated and phased under caretaker status by the Army. From 1946 to 1948, MMR was used primarily for training activities. In 1948 the USAF obtained control of Otis Field for an air defense mission and assignment of a fighter interceptor unit. Flight line and some maintenance and housing facilities were permitted by the Army for USAF use. At this time, runway 05/23 was extended to the northeast to increase its length from 7,000 ft to 8,000 ft.

Camp Edwards was reactivated in 1950 to support the U.S. Army mission during the Korean Conflict. From 1950 to 1952, the Army training activity approached WWII levels. In 1952 the Army again returned Camp Edwards to caretaker status. The USAF selected the facilities required to establish Otis AFB, and these were subsequently transferred from the Department of the Army to the Department of the Air Force under Public Law 155, 82nd Congress and DOD Directive 4165.11, dated November 21, 1953. The action also involved the acquisition and operation of additional facilities and assumption of certain functions, activities, equipment, and real estate that were part of the Camp Edwards operation. These requirements included operation of the following: water pumping and utility distribution systems, sewage disposal system, communication center (telephone exchange), supply facilities, coal yard, structural fire protection for Otis, the hospital, and several commissaries.

The Massachusetts ANG Permanent Field Training Site (PFTS), manned by 35 people, was established in March 1954. Its primary mission was to provide all necessary material except aircraft and personal equipment for ANG units performing 15-day annual field training. Many units came from distant parts of the country to perform their training at Otis AFB, one of five bases in the country with a PFTS. Each year approximately 8,000 troops were supported by the PFTS primarily during the months of July and August. The PFTS was deactivated on April 1, 1973.

In 1955 the 551st Airborne Early Warning and Control Wing (AEW&C) was assigned to Otis AFB. The 45 assigned EC-121 Super Constellation aircraft ("Super Connies") extended land-based radar coverage hundreds of miles to sea, providing protection against a surprise attack along the East Coast. From 1955 to 1970, the AEW&C activity consisted of maintaining 20 aircraft in the air at all times. The year 1955 also marked the arrival of the 60th Fighter-Interceptor Squadron (FIS) of the USAF.

In August 1956 the USAF negotiated a 99-year lease with the Commonwealth of Massachusetts for approximately 19,700 acres, including Otis Field and Camp Edwards. Subsequently, the crosswind runway was extended from 7,000 ft to 9,500 ft, and both runways were considered as primary runways. A new control tower, fire station, hangars, nose docks, and a 1,193-unit family housing area were constructed. The USAF gave the U.S. Army a permit to utilize approximately 14,000 acres east and northeast of Connery Avenue.

In November 1962 when the 26th Air Defense Missile Squadron was activated, Otis became one of the few bases to have both a fighter squadron and Boeing Michigan Aeronautical Research Center (BOMARC) missile activity. The BOMARC activity was terminated on April 30, 1972. The BOMARC was operated under Strategic Air Command (SAC) control by Boeing Corporation.

Since 1968 Otis AFB has acted as host to a number of additional units. The 102nd Tactical Fighter Wing, Massachusetts ANG, arrived at Otis in August 1968 when its facilities at Logan International Airport were vacated. The 4713th Defense Systems Evaluation Squadron was added in 1970 after the 551st AEW&C was deactivated due to a planned phase-out of certain units of the Aerospace Defence Command (ADC). Deactivation of the 60th FIS was completed on May 30, 1971. With the deactivation of the 551st AEW&C Wing, the 4784th Air Base Group assumed the role of host unit in January 1970. In August 1970 the USCG moved from Salem, MA, to Otis AFB and commissioned the USCG ASCC. The activities and history of USCG ASCC are described in a separate Phase I report. In December 1973 the 4784th Air Base Group was deactivated, and the 4789th Air Base Group was formed to act as a caretaker force for the USAF and to operate the base utility systems. Also at this time, the 102nd FIW, Massachusetts ANG, became the airfield manager and Otis AFB became Otis-ANG Bureau (ANGB). In 1973 the U.S. Army began withdrawal of its Camp Edwards Garrison. The Massachusetts ARNG assumed operational control of Camp Edwards in February 1975 to provide inactive duty training and annual training for National Guard units from Massachusetts and Rhode Island and Army reserve units from Maine, New

Hampshire, Vermont, Connecticut, New York, New Jersey, Pennsylvania, West Virginia, and Alabama.

In June 1976 the USAF's 99-year lease was revised, and new leases were signed between the Commonwealth of Massachusetts, the USCG, and the U.S. Army, with approximate land distribution as follows:

	USAF	U.S. Army	USCG
Fee-owned acres	1,253		
Leased acres	2,210	14,705	1,407
Easement acres	395		
Total	3,858	14,705	1,407

During the occupation of Otis under the 99-year lease from the Commonwealth of Massachusetts, the USAF has constantly shared real estate interest with the Commonwealth and surrounding communities. Fifty-one acres were leased to the U.S. Department of Health, Education, and Welfare for construction of three schools operated by the Bourne School System and to a private concern for the operation of a private school. Twenty-six acres were returned to the Commonwealth for construction of the Upper Cape Vocational School. Fifty-four acres were returned to the Commonwealth to enlarge the Massachusetts Route 28 rotary, and 2 acres of land were returned to assist a private landowner in constructing a roadway to his property. Since that time, approximately 1,100 acres have been declared excess to military requirements and are now being utilized for construction of a Veterans National Cemetery, Conservation Commission facilities, and a cemetery for a local community. A summary of leases and agreements in effect are contained in Appendix J. A more complete description of lease arrangements are contained in the Emergency Expansion Capacity Plan for Camp Edwards (Lyon and Assoc., 1983).

Other military activities ongoing at MMR include the 6 Missile Warning Squadron (6MWS), which operates Cape Cod AFS in the northern end of MMR and SAC activity. This latter activity consists of the use of parking area, runways, and an alert housing area in the northeastern quadrant of the cantonment area. SAC operations consist of periodic parking of KC 135 and KC 97 refueling aircraft on alert status at MMR. These aircraft are based out of Griffis AFB and formerly were based from Westover field. This activity has occurred since 1962. The heaviest use of Otis AFB (MMR) for stationing of refueler aircraft on alert occurred during the 1960's. Since the mid-1970's, only minimal use of the alert area "Christmas tree" has been made by SAC.

A Cape Cod AFS was established in 1978 at the eastern site for detection of surface-launched ballistic missiles and acquiring and tracking orbiting satellites. This unit consists of the AN/FPS-115 radar and support facilities and is operated for the USAF Space Command by the 6MWS and the 2165th Communication Squadron. The radar system is more commonly known as PAVE-PAWS.

Three other nonmilitary activities of significance are in operation at MMR. The U.S. Department of Agriculture has operated a Gypsy Moth Research Laboratory at MMR since 1960. AVCO, Inc., a private defense contractor, has operated a weapons and detection systems research and development facility on J-1 and J-3 ranges since 1968. These activities consist of testing of sighting, detection, and armor-piercing warhead testing research dealing primarily with antivehicle weapons. The VA began operations in 1978 to develop the National Cemetery of Massachusetts. The cemetery and support facilities have been operated since 1980.

2.3 ORGANIZATION AND MISSION

2.3.1 ORGANIZATION

The overall organization structure at MMR is unique. MMR consists of an association of independent command units in which no clear host-tenant relationship exists, and responsibilities are shared among the several military and other governmental agencies. The MMR complex is shared by the Massachusetts National Guard (ARNG and ANG), the USAF, the USCG, and the VA with no single chain of command. MMR is managed by an association of governing authorities through the individual unit commanders as shown in Figure 2.3-1. The ANG, because of the location of physical facilities and its responsibility for flight line integrity, handles MMR water supply, wastewater disposal, and solid waste disposal.

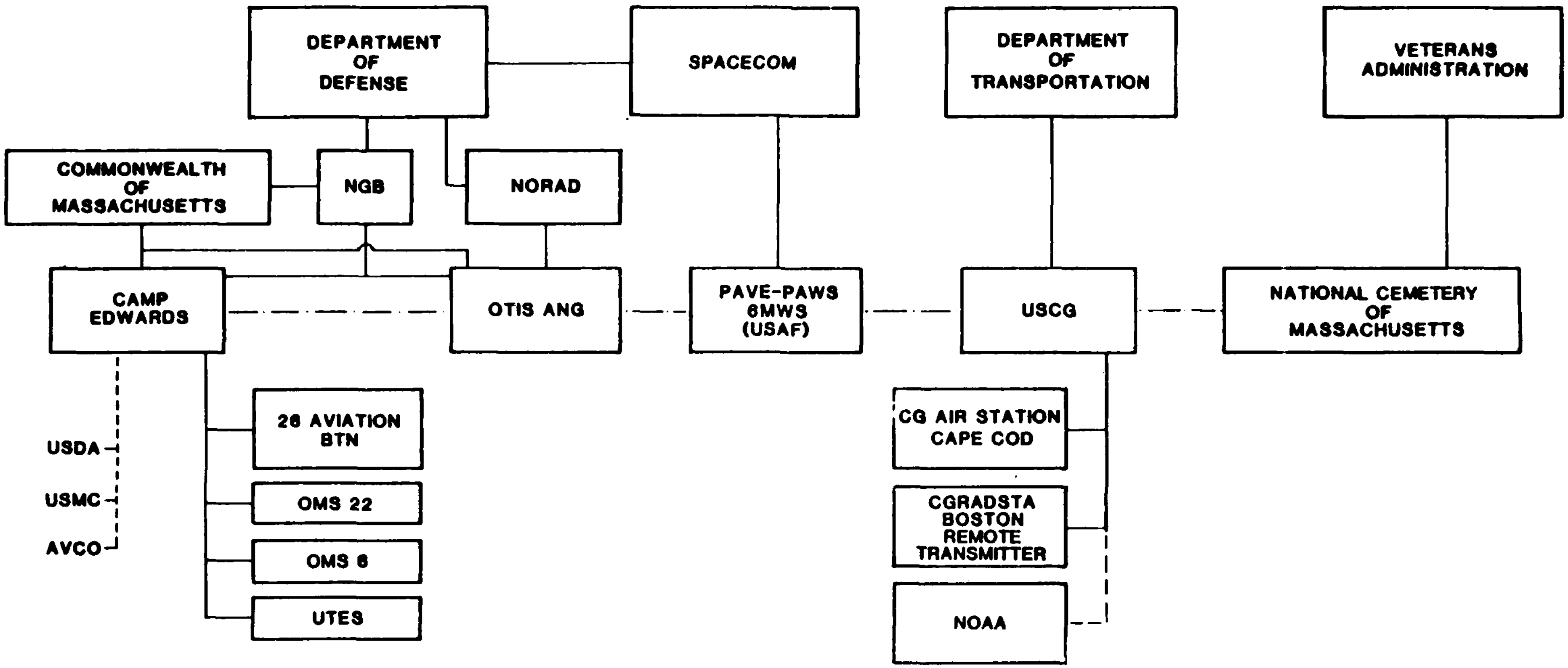
2.3.2 MISSION

The following paragraphs describe the primary missions of the major units and tenants at MMR. The USCG mission is described in a separate Phase I report developed as a component of the MMR-IRP.

102 Fighter Interceptor Wing (FIW)/OTIS ANGB

The primary mission of the 102nd FIW is to provide the Commander and Chief of the North American Air Defense Command (NORAD) with the required number of aircraft and aircrews on a 24 hours/day, 365 days/yr basis to maintain peacetime surveillance and control to ensure air sovereignty of the United States in its assigned sector. In time of federal mobilization, the 102nd FIW will additionally be responsible for the 177th Fighter Interceptor Group, Atlantic City, New Jersey; 125th Fighter Interceptor Group, Jacksonville, Florida; and the 147th Fighter Interceptor Group, Ellington-ANGB, Texas.

Otis-ANGB is also responsible as the airfield manager for operation and maintenance of the flight line and airfield. They equip, administer, train, and furnish personnel to operate the required installation facilities. Within this mission, Otis-ANGB provides administrative and logistical capabilities to support other units co-located at MMR and to support SAC refueler aircraft on alert; which utilize designated runway and flight line areas.



NOAA - NATIONAL OCEANOGRAPHIC AND ATMOSPHERIC ADMINISTRATION
OMS - OPERATIONAL MAINTENANCE SHOP
NORAD - NORTH AMERICAN AIR DEFENSE COMMAND
UTES - UNIT TRAINING EQUIPMENT FACILITY
NGB - NATIONAL GUARD BUREAU
BTN - BATALLION

SOURCE: ARNG 1986

RELATIONSHIP

TENANT - - - - - - -
COMMAND CHAIN ———
COOPERATIVE ORGANIZATION — - — - —

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OVERALL MMR ORGANIZATION CHART

INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

TASK 6

FIGURE 2.3-1

Camp Edwards

The Massachusetts ARNG operates Camp Edwards as a reserve training site for the National Guard Bureau. The Camp currently serves as the primary training site for the Massachusetts and Rhode Island National Guard, as well as the Army Reserve. The Camp's facilities are also used extensively for training by other reserve components from the states of Maine, New Hampshire, Vermont, Connecticut, New York, New Jersey, Pennsylvania, West Virginia, and Alabama. The other reserve components using the training facilities are the Massachusetts ANG, USMC Reserve, U.S. Naval Reserve, and USCG Reserve, as well as the law enforcement agencies that regularly use the small arms ranges.

The USMC (1st Battalion, 25th Marine Regiment, 4th Division) maintains an Inspector Instructor and staff to monitor the Corps reserve training program at Camp Edwards.

AVCO, Inc., a private defense contractor, and the Department of Agriculture (USDA) currently maintain tenant operational activities at Camp Edwards. AVCO, Inc., utilizes the J-1 and J-3 range facilities for military research and development under DOD contract requirements. The USDA maintains an ongoing, laboratory-scale research program for development of biological control of gypsy moth infestation.

In time of federal mobilization, Camp Edwards is activated as a subinstallation of Ft. Devens, Maryland.

6 Missile Warning Squadron (6MWS)/Cape Cod AFS

The mission of Cape Cod AFS is to operate and maintain the USAF AN/FPS-115 radar to provide early warning detection of sea- or surface-launched ballistic missiles for a distance of 3,000 nautical miles in support of NORAD. The 6MWS is a unit of the USAF Space Command with responsibility for operation, facilities, security, administration, and supply. Commander 6MWS serves as the Cape Cod AFS commander. The 2165th Communications Squadron, USAF Communication Command, has direct responsibility for the installation of electronic gear and operates the station communication center.

National Cemetery of Massachusetts/Veterans Administration

The VA operates and maintains the National Cemetery of Massachusetts. This cemetery, located in the western portion of MMR, has been developed for burial of U.S. military veterans.

3.0 ENVIRONMENTAL SETTING

This section describes the environmental conditions at MMR, including specific site data for meteorology, geology, soils, surface hydrology, geohydrology, water quality, and biota. These data subsequently are used in the HARM scoring system to numerically assess the pollutant transport mechanisms and potential receptors at the site. Appendix G describes the factors used in the HARM system.

3.1 METEOROLOGY

Climatological data relevant to MMR are summarized in Table 3.1-1. These data were collected in the cantonment of MMR. The period of record is 25 yrs (October 1942 - April 1944 and November 1948 - December 1971).

MMR is located on the extreme upper (landward) portion of Cape Cod. Complete, long-term, National Oceanic and Atmospheric Administration (NOAA) records exist only for mainland locations; partial and short-term records exist for locations further seaward along the Cape. Because of MMR's location in a transition zone between the mainland and outer Cape, the most relevant records for use in contaminant transport assessment are those existing at MMR. The climate at MMR is categorized as a humid continental climate that is modified by close proximity to the Atlantic Ocean. Prevailing winds are from the northwest in the winter (November - March) and from the southwest in the summer (April - October). Windspeeds range from an average of 9 miles per hour (mph) from July-September to an average of nearly 12 mph in fall and winter (October-March). Short periods of much higher wind velocities (40 to 70 mph) occur periodically as a consequence of tropical and oceanic storms that pass the Cape.

Precipitation is fairly evenly distributed throughout the year with the least rainfall occurring in June. The average monthly precipitation is 3.98 inches per month throughout the year, with a variation from 2.0 to 4.8 inches per month. The annual average rainfall is 47.8 inches. Two meteorological factors used in the HARM evaluation are net precipitation and the 1-yr, 24-hour rainfall event. The net precipitation at MMR is similar to Falmouth, Massachusetts, which is 21 inch/yr (USGS 1984, Metcalf and Eddy 1983). The 1-year, 24-hour rainfall event is approximately 2.7 inches (U.S. Dept. of Commerce, 1961). Infrequent tropical storms passing the Cape may produce 24-hour rainfall events of 5 to 6 inches (U.S. Dept. of Commerce, 1961).

All temperature extremes are reduced due to the influence of the Atlantic Ocean, producing milder winters and cooler summers than inland areas. In February the daily temperature ranges from an average minimum of 23°F to an average maximum of 38°F. In the warmest period of the year, the July average temperature range is from daily lows of 63°F to high temperatures near 78°F. The record high is 99°F, and the recorded low temperature is -10°F.

TABLE 3.1-1

MMR CLIMATOLOGICAL DATA

Month	Temperature (F°) Daily Mean Max.	Daily Mean Min.	Extreme Max.	Extreme Min.	Precipitation (in) Mean	Surface Winds Prevailing Direction	Surface Winds Mean Speed
Jan.	38	24	60	-7	4.8	NW	11
Feb.	38	23	59	-9	4.1	NW	11
Mar.	43	30	68	1	4.3	NW	12
Apr.	53	38	79	18	4.7	SW	11
May	64	47	86	28	3.4	SW	10
Jun.	73	57	97	41	2.0	SW	10
Jul.	78	63	96	47	3.3	SW	9
Aug.	77	62	99	44	4.8	SW	9
Sep.	70	55	89	36	3.9	SW	9
Oct.	62	46	82	22	3.7	SW	12
Nov.	52	37	74	15	4.5	NW	11
Dec.	41	27	65	-10	4.3	NW	12
Annual	57	42	99	-10	47.8	WSW	11

Source = 102nd FIW Weather Office
Period of Record = Oct. 42 - Apr. 44, Nov. 48 - Dec. 71

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3.2 GEOGRAPHY

3.2.1 Physiography

The Cape Cod Peninsula lies in the extreme northern portion of the Coastal Plain Physiographic Province (Hunt, 1967) in Southern New England. The MMR is located on two distinct types of terrain on the Cape Cod Peninsula. The main cantonment area lies on a broad, flat, gently southward-sloping glacial outwash plain. Elevations in this area range from 100 to 140 ft above sea level. To the north and west of the cantonment area, the terrain becomes hummocky with irregular hills and greater relief. This area lies in the southward extent of terminal glacial moraines. The elevations in this area generally range from 100 to 250 ft. The highest elevation reportedly is 306 ft. MSL (U.S. COE 1985). The entire site is dotted with numerous depressions, termed "Kettle Holes," some of which contain water. These are depressions left during glacial recession by melting buried blocks of ice.

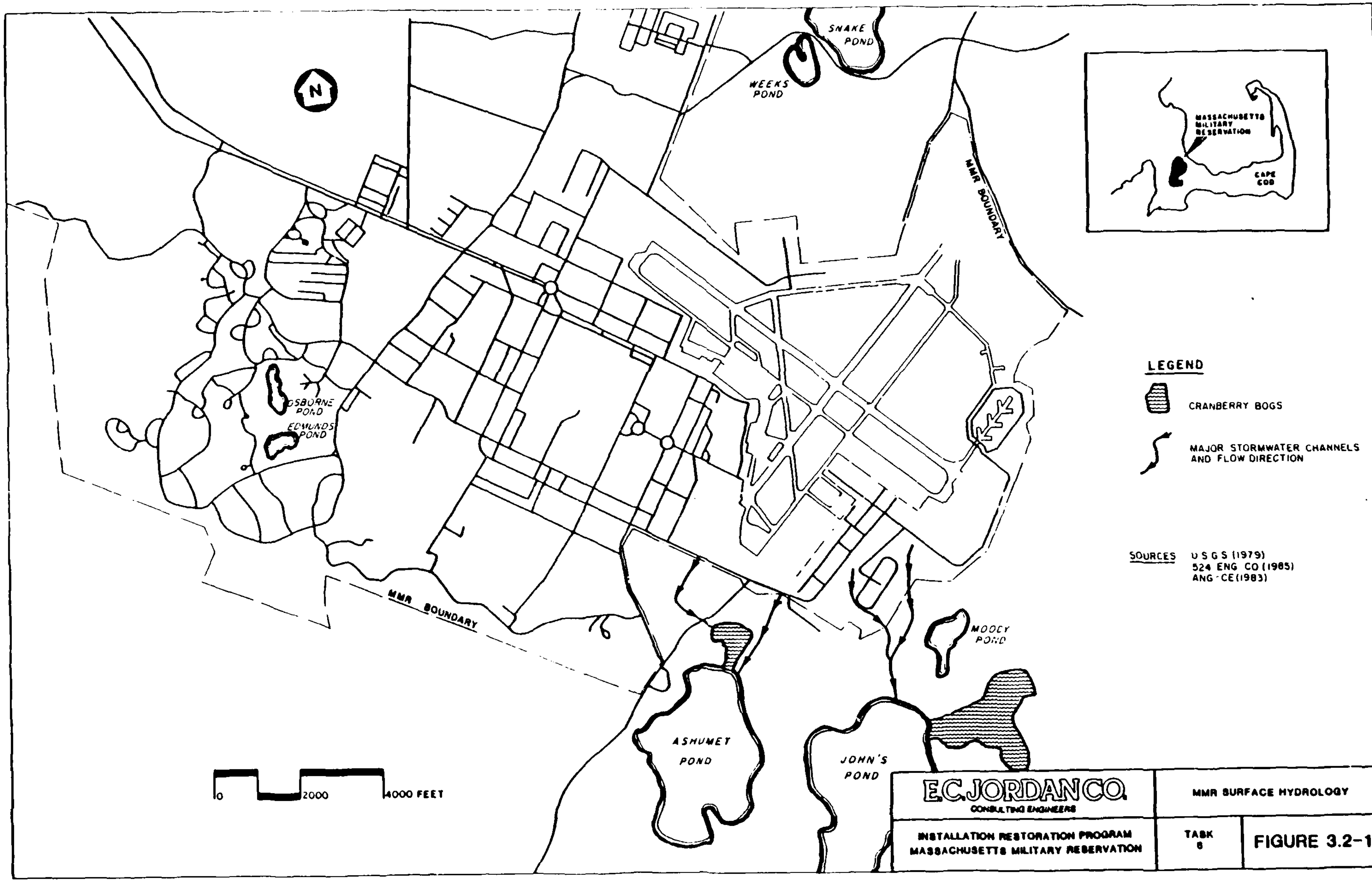
3.2.2 Surface Hydrology

The major surface hydrologic features at MMR are shown in Figure 3.2-1. Surface water runoff at MMR is virtually nonexistent. There are no perennial streams. The highly permeable nature of the sands and gravels underlying the area allow for rapid infiltration of rainfall, which essentially eliminates surface water runoff except on extreme slopes. Intermittent streams are present on MMR in a few of the drainage swales. These intermittent streams begin at the outfall areas of the storm sewer drainage system and are active only during heavy rainfall.

There are two ponds located in the cantonment area of MMR. These are Osborne Pond and Edmunds Pond. Two other unnamed ponds are located at the western boundary of MMR at the Rod and Gun Club. In addition, there are 13 small surface water bodies or wetlands located in the range and maneuver area. These are water-filled kettle holes, each of less than 2 acres extent. These small water bodies receive limited runoff from the steep slopes within the immediate vicinity. Primarily, they exist at locations where kettle hole depressions intersect the water table. Snake Pond and Weeks Pond are located off-base immediately southeast of the range area. Surface topography shows swales leading from the MMR range area toward these ponds. No surface water drainage, however, appears to enter these ponds from MMR.

The storm sewers beneath the flight line area carry runoff from the runways and ramps and also receive wastewater from hangar deck drains and shop drains. The storm drains empty into three open drainage ditches. These ditches lead southward off-base and are components of the watershed of Ashumet Pond and Johns Pond.

Ashumet Pond has no surface outflow and reportedly receives the majority of its water input as groundwater (K-V Associates, 1986). Two storm drainage courses enter the Ashumet Pond watershed. As shown in Figure 3.2.1, a major drainage ditch from the flight line area discharges to the cranberry bog at the north end of the pond. A second drainage course enters immediately east of the cranberry bog. The drainage receives storm water from the hangar area and the



E.C.JORDAN CO. CONSULTING ENGINEERS	MMR SURFACE HYDROLOGY	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 3.2-1

petroleum fuel storage area located in the southern portion of the flight line area.

The third drainage course enters Johns Pond and drains the extreme eastern portion of the flight line and hangar area. Johns Pond appears to receive groundwater flow from Ashumet Pond and discharges via a cranberry bog to the Quashnet River. The Quashnet River flows south into Waquoit Bay.

According to K-V Associates (1986), limited surface water flow occurs in these drainage courses. Sufficient rainfall to develop surface water discharge to Ashumet Pond occurs from one to four times per year.

Storm drains in the USCG housing area of MMR discharge to Osborne and Edmunds Ponds and to local surface depressions.

3.3 GEOLOGY

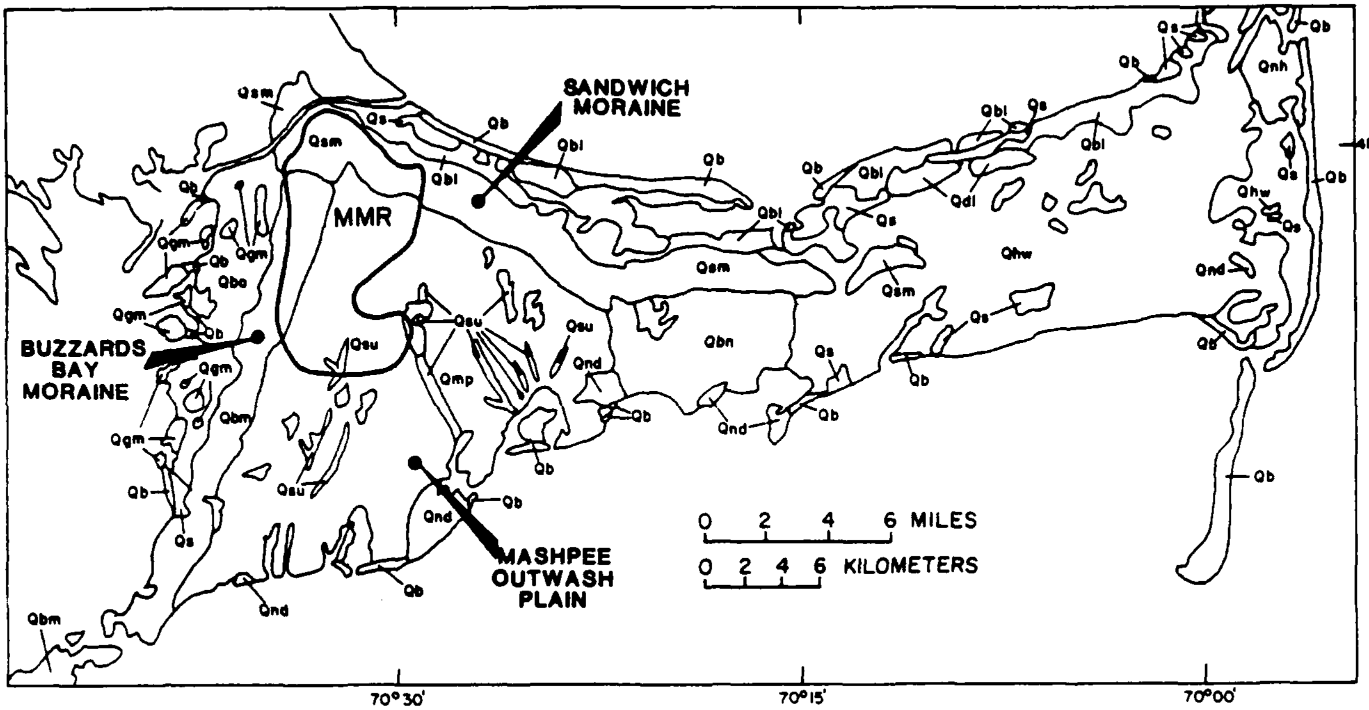
3.1 Geologic Setting

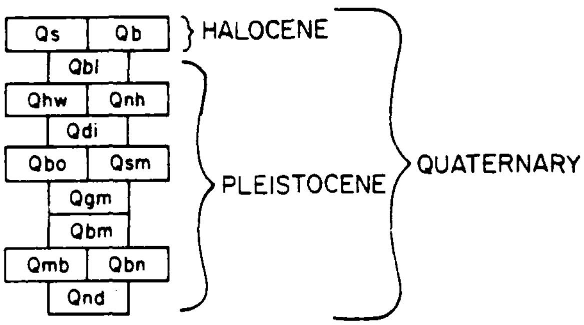
The Cape Cod peninsula, which encompasses the MMR, is characterized by geological features that appear to be a result of the last glacial advance. This period of glacial activity, known as the Wisconsin Glaciation, ended approximately 12,000 yrs ago in Southern New England. The section of ice that covered this area has been named the Laurentide Ice Sheet. Cape Cod was formed from the depositional processes associated with the advance and retreat of the Laurentide Ice Sheet. According to Strahler (1972), glacial deposits generally extend to a depth of 300 to 500 ft below sea level beneath most of Cape Cod, except in the Sandwich-Bourne area, where depths to bedrock are in the range of 150 ft below sea level.

The MMR is characterized by three distinct surficial geologic units. In the northern section of the MMR, the east-west trending Sandwich Moraine (Qsm) is present. In the western section, the dominant geologic feature is the north-south trending Buzzards Bay Moraine (Qbm). These two recessional moraines intersect in the northwest corner of the MMR. To the south and east of the moraines, underlying the cantonment area, is the Masphee Outwash Plain (Qmp). Figure 3.3-1 shows the general locations of these features at MMR. As this figure shows, the cantonment and southeastern portion of the range and maneuver area are located on outwash deposits. The northern and western portions of the range and maneuver area and the VA Cemetery are on moraine formations.

The recessional moraines are an ice contact deposit, formed from boulders, gravel, sand, and silt sloughing off at the ice margin. At MMR it appears that the rate of advance of the ice sheet was matched by the rate of melting. As a result of the stationary ice margin, the moraines were allowed to develop. The moraines are characterized by a highly variable composition. The soils range from silty till to stratified sand and gravel (Oldale, 1976).

The outwash plain deposit was formed as a result of meltwater carrying sand, silt, and gravel away from the ice margin. These fluvial deposits are characterized by a uniformly graded, unconsolidated, stratified sand and gravel with traces of silt. Recent geologic data indicate the presence of lenses of silt





Qb	BEACH and DUNE DEPOSITS
Qs	SWAMP and MARSH DEPOSITS
Qbl	BARNSTABLE LAKE DEPOSITS
Qnh	NAUSET HEIGHTS ICE-CONTACT DEPOSITS
Qhw	HARWICH OUTWASH PLAIN DEPOSITS
Qdi	DENNIS ICE-CONTACT DEPOSITS
Qsm	SANDWICH MORAINE DEPOSITS
Qbo	BUZZARDS BAY OUTWASH DEPOSITS
Qgm	BUZZARDS BAY GROUND MORAINE DEPOSITS
Qbm	BUZZARDS BAY MORAINE DEPOSITS
Qbn	BARNSTABLE OUTWASH PLAIN DEPOSITS
Qmp	MASHPEE PITTED PLAIN DEPOSITS
Qbm	NANTUCKET SOUND ICE-CONTACT DEPOSITS
Qsu	SAND & GRAVEL UNDIFFERENTIATED

SOURCE: OLDALE, U.S.G.S. 1972

E.C. JORDAN CO. CONSULTING ENGINEERS	GENERALIZED GEOLOGIC MAP OF UPPER CAPE COD	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 3.3-1

and peat in subsurface soil in certain areas at the southern boundary of MMR (USGS, 1986).

The outwash plain and the moraine terrain are pitted with numerous depressions called kettles. Kettles were formed from isolated blocks of ice that became covered by outwash deposits. When the ice blocks melted, a depression was formed as sediments caved in to fill the void. Many of these kettles now contain surface water bodies.

Underlying the surficial deposits is a basal till consisting of a fine, silty sand with some clay (Oldale, 1972). The basal till is thought to have been deposited as a result of sediments being ground and smeared along the bedrock surface as the glacial ice sheet advanced.

The bedrock has been mapped as a granodiorite (Oldale and Tuttle, 1964). A general cross section of the southern area and the immediate off-base area downgradient are shown in Figure 3.3-2. This figure illustrates the general relationship of the coarse outwash material that overlies the finer sand and salt and dense till.

3.3.2 Soils

Soils at MMR can be separated into two general zones. These zones correspond to the surficial geology. The soils found in the moraine terrain are of the Plymouth-Canton-Carver association. The Plymouth and Carver soils are excessively drained and are characterized by highly permeable sandy subsoil with a gravelly sand substratum. The Canton soils are well drained and consist of a fine, sandy loam mantle (20 to 30 inches thick) with a gravelly, loamy sand substratum.

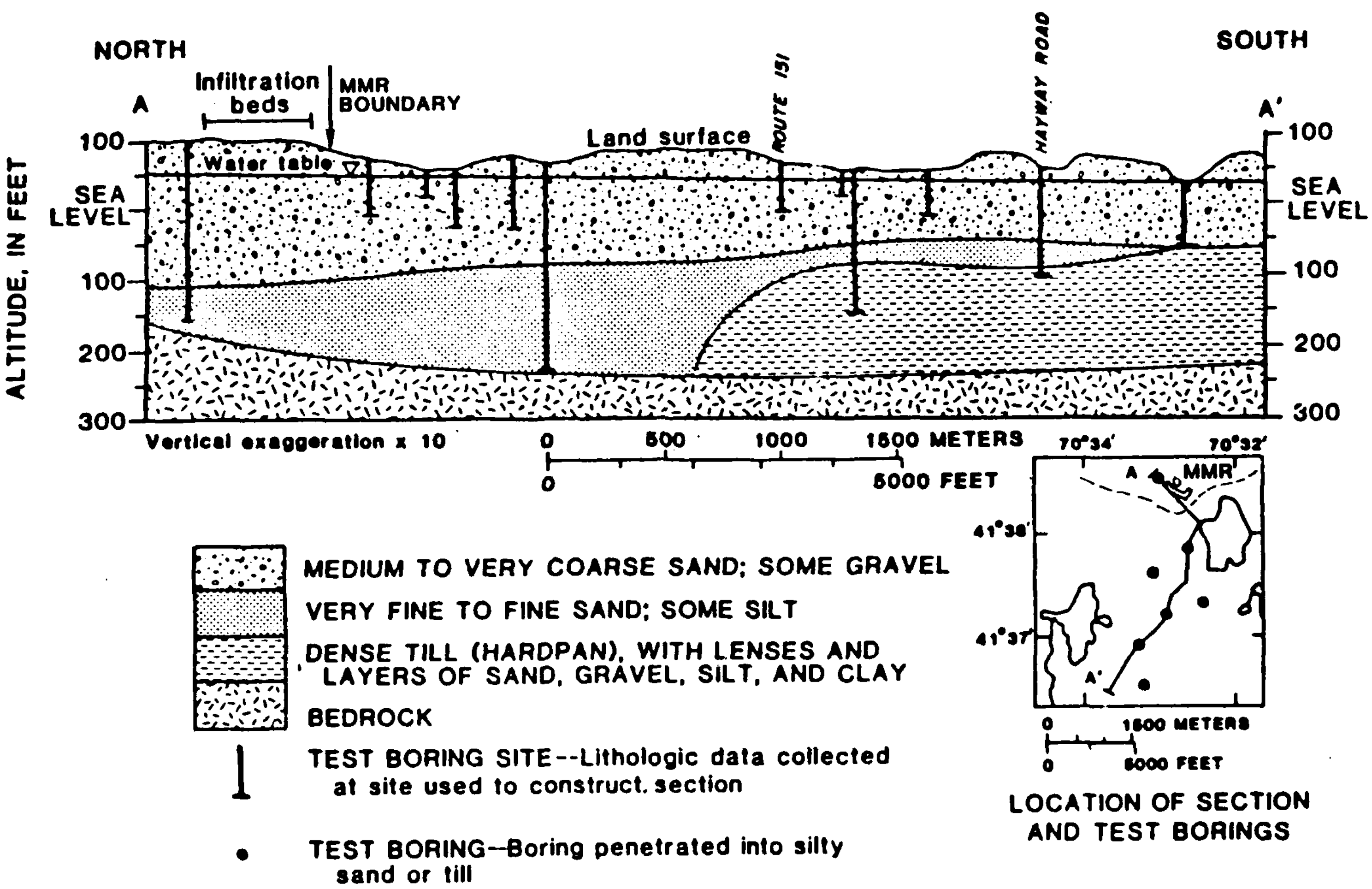
In the outwash terrain, the dominant soil types are of the Agawam or Enfield Series. The Agawam soils are well drained and consist of a sandy loam surface soil and subsoil. Typically, they are free of gravel to a depth of 3 ft. The Enfield soils are well drained and are characterized by a crumbly silt loam surface soil and subsoil to a 2-ft depth. Substratum in both these types is a stratified sand and gravel.

In general, the soils at MMR are Spodosols, characterized by a low cation exchange capacity and a low base saturation level. Soil pH is in the 5.0 to 6.0 range. Figure 3.3-3 and Table 3.3-1 illustrate the soil types and their locations at MMR.

3.3.3 Hydrogeology

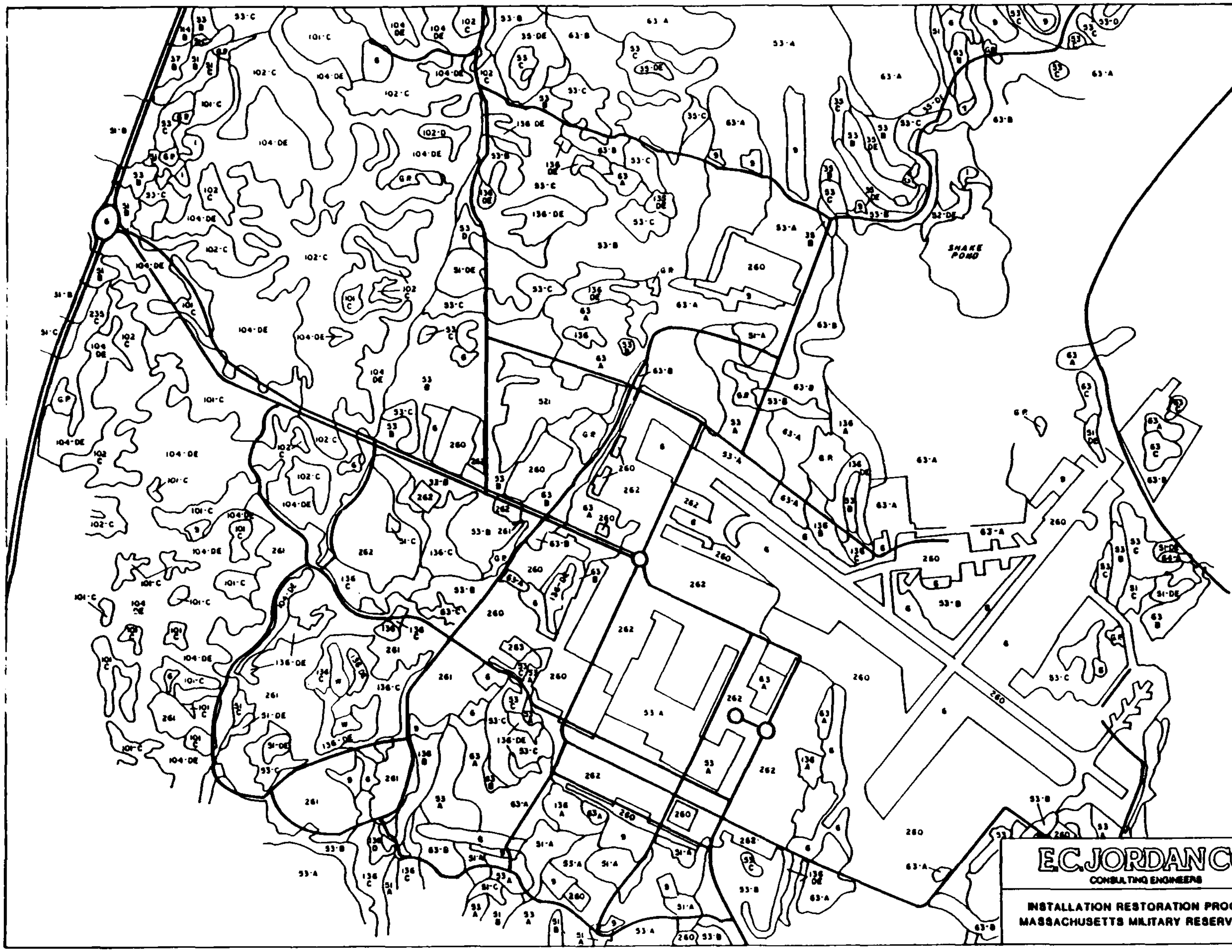
Groundwater Environment

Cape Cod consists of unconsolidated glacial deposits. These deposits constitute an aquifer that serves as the primary source of water for the residents of Cape Cod. According to the U.S. EPA, this aquifer has been designated as a "sole source aquifer." The aquifer is bounded laterally by the Atlantic Ocean, Cape Cod Bay, Cape Cod Canal, and Nantucket Sound. The upper zones of the aquifer beneath the cantonment area are comprised of unconsolidated sand and



SOURCE: LeBlanc 1984

E.C.JORDAN CO. CONSULTING ENGINEERS	GENERALIZED GEOLOGIC CROSS SECTION FROM THE SOUTHERN PORTION OF MMR	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 3.3-2



U.S. SOIL CONSERVATION SERVICE,
BARNSTABLE CO. 1986

E.C. JORDAN CO.
CONSULTING ENGINEERS

MMR CANTONMENT AREA SOILS MAP

INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

TASK 6

FIGURE 3.3-3

TABLE 3.3-1

SOIL TYPES AT MMR
(KEYED TO FIGURE 3.3-3)

Soil Map Symbol	Field Soil Name	Soil Map Symbol	Field Soil Name	Soil Map Symbol	Field Soil Name	Soil Map Symbol	Field Soil Name
1	Freetown and Swansea Muck	51C	Carver Coarse sand, 8 to 15 percent slopes	99	Freetown, ponded	235DE	Plymouth stony loamy sand 15 to 35 percent slopes
6	Udipsamments, smooth	51DE	Carver Coarse sand, 8 to 35 percent slopes	101C	Plymouth-Canton-Carver complex, bouldery, 5 to 15 percent slopes	260	Urban land
7	Freetown coarse sand	53A	Agawam fine sandy loam, 0 to 3 percent slopes	102C	Plymouth-Canton-Carver complex, very bouldery, 5 to 15 percent slopes	261	Carver-Urban land complex, 0 to 5 percent slopes Carver soils 50%
9	Stripped land, sand, and gravel	53B	Agawam fine sandy loam, 3 to 8 percent slopes	103DE	Plymouth-Canton-Carver complex, very bouldery, 15 to 35 slopes	262	Agawam-Udipsamments-Urban complex, 1 to 5 percent slopes Agawam soils - 30% Udipsamments - 30%
10	Stripped land, glacial till	53C	Agawam fine sandy loam, 8 to 15 percent slopes	104DE	Plymouth-Carver-Canton Complex, extremely bouldery, 15 to 35 percent slopes	GP	Pits, gravel
35B	Plymouth loamy sand, 3 to 8 percent slopes	53D	Agawam fine sandy loam, 15 to 35 percent slopes	201C	Canton fine sandy loam, 3 to 8 percent slopes	521	Sanitary landfill
35C	Plymouth loamy sand, 8 to 15 percent slopes	63A	Enfield very fine sandy loam, 0 to 3 percent slopes	201C	Canton-Plymouth-Carver Complex, stony, 5 to 15 percent slopes	W	Water
35DE	Plymouth loamy sand, 15 to 35 percent slopes	63B	Enfield very fine sandy loam 3 to 8 percent slopes	203DE	Plymouth-Carver-Canton Complex, stony, 15 to 35 percent slopes		
37B	Merrimac fine sandy loam, 3 to 8 percent slopes	73A	Hinesburg loamy sand, 0 to 3 percent slopes	235B	Plymouth stony loamy sand, 3 to 8 percent slopes		
51A	Carver coarse sand, 0 to 3 percent slopes	74B	Amostown fine sandy loam, 3 to 8 percent slopes	235C	Plymouth stony loamy sand, 8 to 15 percent slopes		
51B	Carver coarse sand, 3 to 8 percent slopes						

gravel containing trace quantities of silt. These deposits overlie fine to very fine sand and silt. To the north and west in the moraine systems, the aquifer consists of a mixture of ablation till and sand and gravel deposits (Leblanc, 1984).

The groundwater in the vicinity of MMR exists under unconfined or "water table" conditions. The MMR complex lies at the highest elevations in the Upper Cape; therefore, groundwater flows out in all directions from the reservation. Figure 3.3.4, taken from LeBlanc (1984), shows the regional groundwater configurations. Figure 3.3.5 shows the groundwater table configurations beneath the southern portion of the base. These were developed as a component of the ongoing MMR IRP. This area is the portion of MMR in which most previous and current disposal operations have occurred. According to Leblanc (1984), the saturated thickness of the aquifer generally decreases to the south of MMR. Because of its location on the highest elevation in the Upper Cape, MMR is a major recharge area for the aquifer. Groundwater recharging in the western and northern portions of the range and maneuver area provides the water supply for portions of the towns of Bourne and Sandwich. Groundwater recharging in the cantonment area moves south generally toward Mashpee and Falmouth.

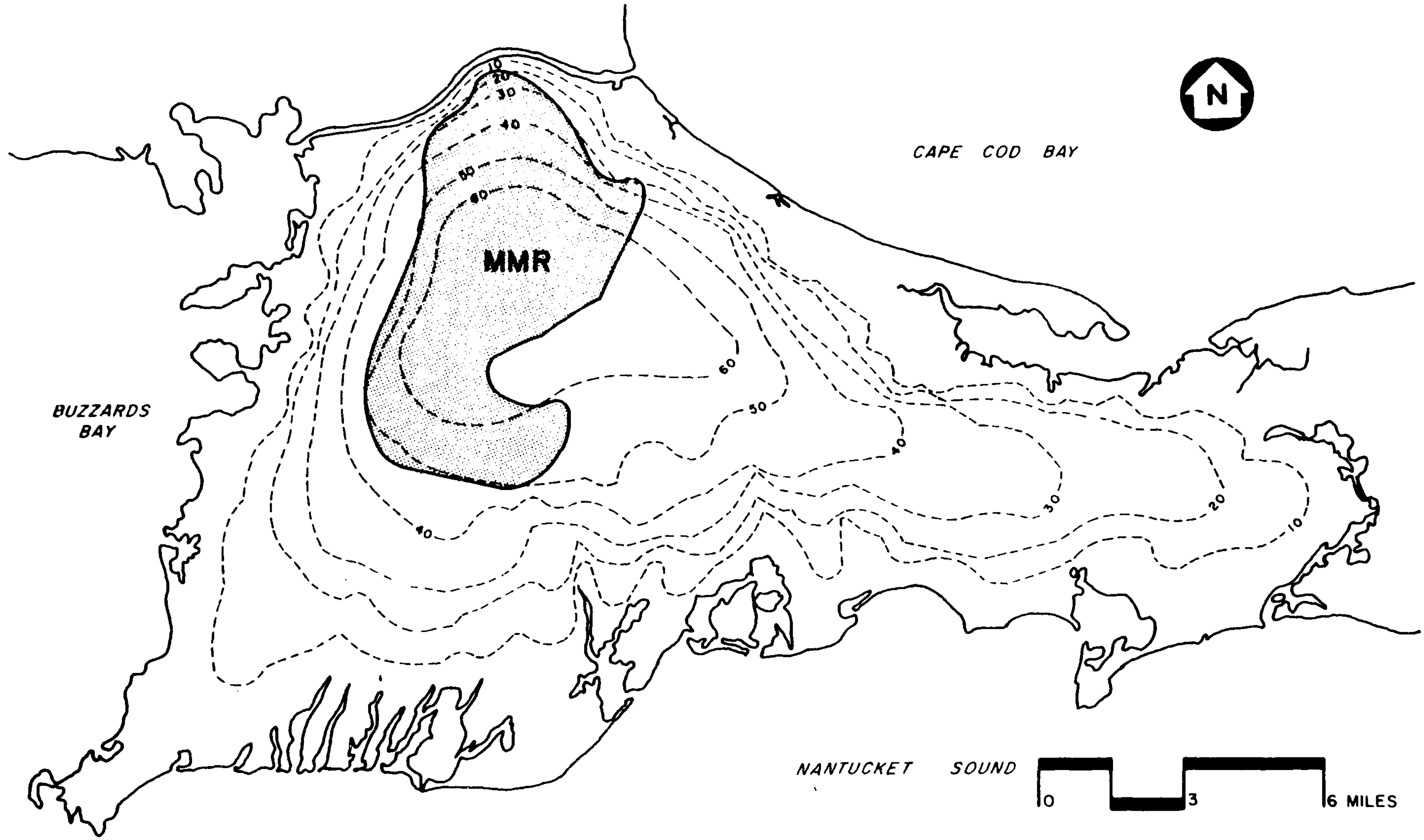
Recharge to the aquifer is from precipitation and inflow from adjacent parts of the aquifer. The average annual recharge is approximately 21 inches, which is roughly half the average annual precipitation (see Section 3.1). Half of the precipitation is lost to evaporation and evapotranspiration. The depth to groundwater is greatest below the moraine areas, while depths to groundwater in excess of 100 ft are common in the range and maneuver areas. In general, the depth to groundwater beneath the cantonment area averages about 50 ft and decreases to the south. Immediately south of MMR, the land surface elevation rapidly drops off and depth to groundwater is 0 to 20 ft below the land surface along a valley in the vicinity of Ashumet Pond.

The unconsolidated sand and gravel deposits have a high permeability due to their coarse texture and sorted deposition. The horizontal hydraulic conductivity, as estimated by Leblanc (1984), is in the range of 200 to 300 feet/day. With an average groundwater gradient of 0.03 percent, the groundwater flow velocity, therefore, probably averages 0.8 to 2.3 feet/day. Vaccaro (1985) has suggested that anisotropic conditions may exist within the aquifer. Such a condition would create differences in groundwater flow rates depending on the direction of flow, with maximum horizontal hydraulic conductivities following the general north-south depositional stratigraphy. Vaccaro indicates a possible east-west hydraulic conductivity at 18 to 21 feet/day and a north-south hydraulic conductivity of 140 to 167 feet/day. Data are limited on this subject, and the extent to which anistrophy exists has not been defined.

The vertical hydraulic conductivity is likely lower than the horizontal because of the layered depositional environment but is likely also relatively high due to the general coarse texture of the upper layers of unconsolidated materials.

Installation Water Wells

Potable water at MMR is produced from groundwater supply wells. The original supply system, installed in 1941, included four gravel-packed, screened, steel

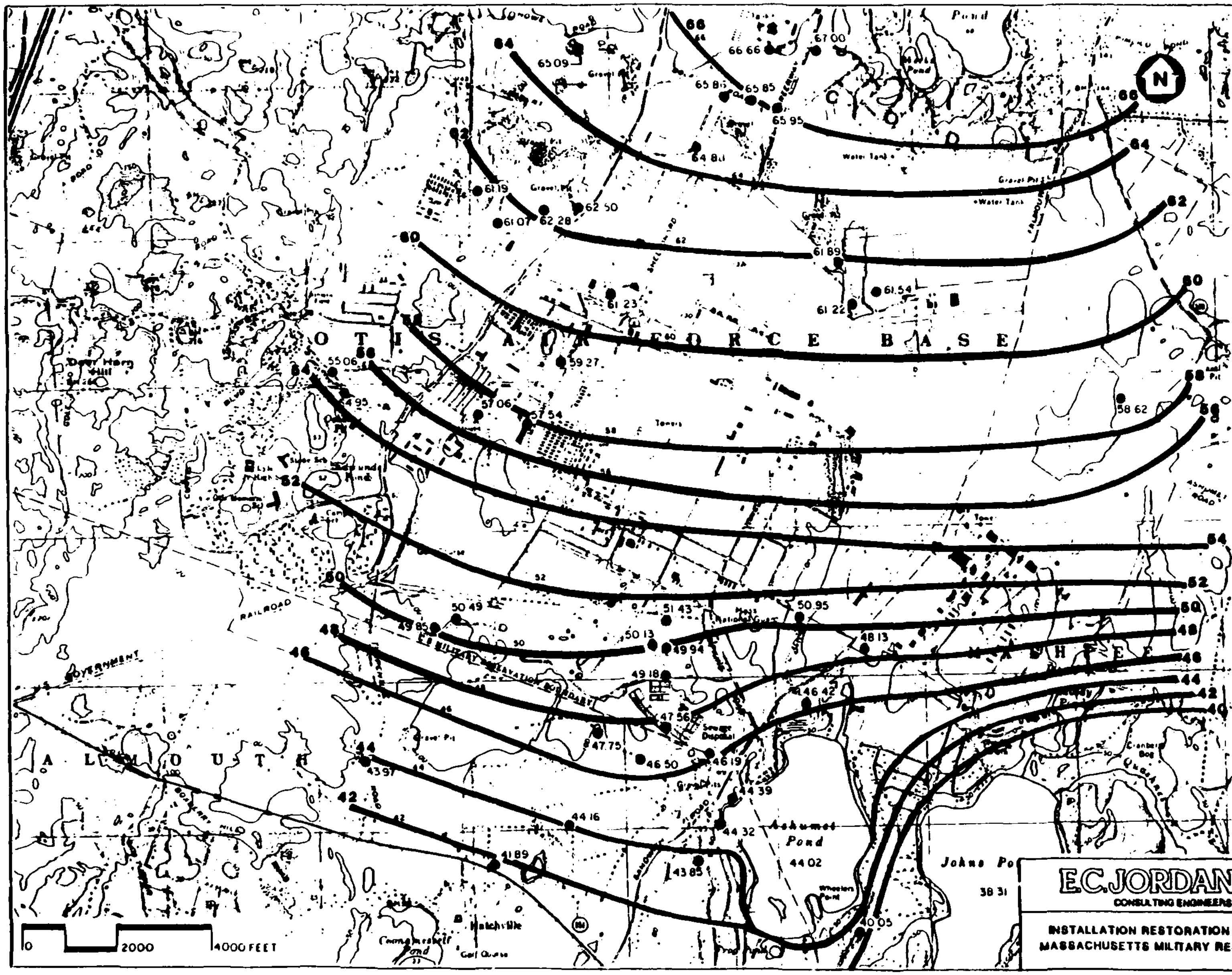


LEGEND

--10-- OBSERVED AVERAGE WATER-TABLE CONTOUR, IN FEET, DATUM IS SEA LEVEL, CONTOUR INTERVAL 10 FEET.

SOURCE: U.S.G.S., 1984

E.C.JORDAN CO. CONSULTING ENGINEERS	REGIONAL GROUNDWATER CONFIGURATION	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 3.3.4



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CONSULTING ENGINEERS

INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

WATER TABLE MAP

MAY 6, 1986

TASK 6

FIGURE 3.3-5

wells (Wells B, E, G, and J) and pumping stations. Of the four original wells, only one (Well J) is presently in use. In addition to these wells, there are water supply wells located at the Coast Guard Transmitter Station, Cape Cod AFS, AVCO, and the VA Cemetery. All of the water supply wells are situated in the unconsolidated sand and gravel unit that contains the aquifer. The location of these wells is shown in Figure 3.3-6. Characteristics of the wells are summarized in Table 3.3-2. The wells range in depth from 40 to 412 ft below ground surface. Water demand at MMR is seasonal with peak demand from June through August when the highest level of training exercises occur. As stated previously, Well J is the only water supply well producing water for the cantonment area. Its maximum capacity is 1,350 gpm. The drawdown to the well at this capacity is approximately 5.7 ft. The capture zone for this well extends 1,000 ft to the east and west of the well, and the zone of influence has been estimated to extend out 1,000 ft in radius from the well location. Some of the water supply wells have been closed due to contamination. The contamination status of the water supply wells is discussed in Section 3.4.2.

3.4 WATER QUALITY

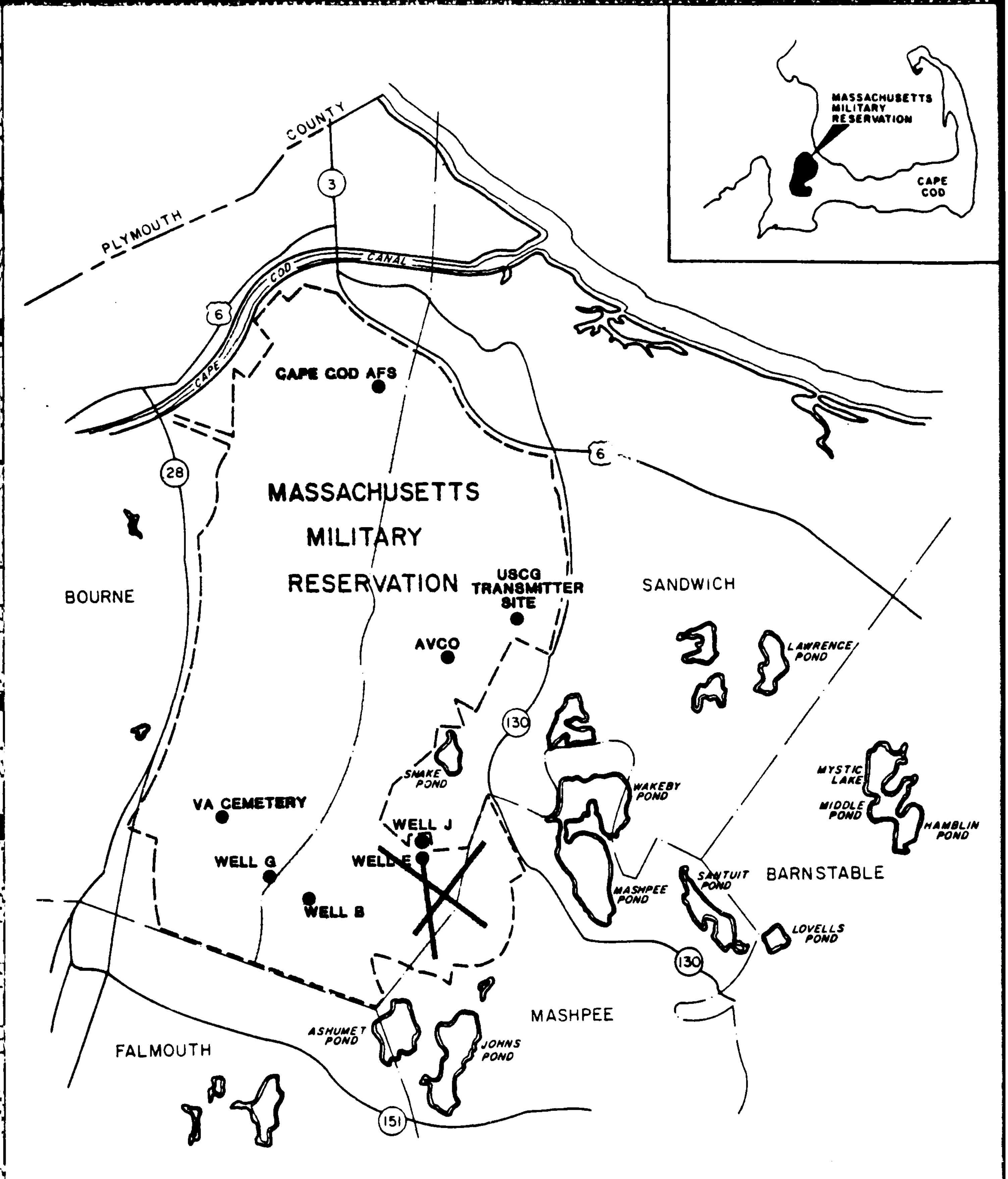
3.4.1 Surface Water Quality

As described in Sections 3.2.1 and 3.2.2, MMR is situated in an area with infrequent surface water runoff due to the highly permeable nature of the soil. There are no perennial streams located on the reservation. Two ponds are located in the western portion of the cantonment area: Edmunds Pond and Osborne Pond. There are several additional depressions in the range, impact, and maneuver area that contain water and have formed ponds, bogs, or small wetland areas. Two unnamed ponds are located at the western edge of MMR at the Rod and Gun Club (see Section 3.2.2).

No comprehensive surface water quality studies have been performed for the surface water of MMR. The surface water quality data base on MMR is limited to a single 1984 sampling of Osborne Pond. The kettle hole ponds on the reservation have been classified as Class B under the Massachusetts Water Quality Standards for Surface Water. Class B surface waters are designated for the use, confirm protection, and propagation of fish, other aquatic life and wildlife and for secondary contact recreation. Class B surface water quality standards for MMR are summarized in Appendix E.

Deep Bottom Pond had been partly dredged for use as an engineering training area. This activity is no longer carried out, and the pond is off-limits for any activities. There is some evidence of minor siltation in Donnely Pond as a result of runoff from a nearby dirt road.

As described in Section 3.2.2, storm drains from the USCG housing area discharge into Osborne Pond and Edmunds Pond. In addition, these ponds receive runoff in limited quantities from the adjacent watershed. The sampling and analysis of Osborne Pond in 1984 were limited to primary and secondary contaminants regulated under the National Primary Drinking Water Regulations and National Secondary Drinking Water Regulations. Maximum contaminant limits for these parameters are presented in Appendix E. The parameters measured included



E.C. JORDAN CO. CONSULTING ENGINEERS	MMR-WATER SUPPLY WELL LOCATIONS	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 3.3-

TABLE 3.3-2

MMR WATER SUPPLY WELLS

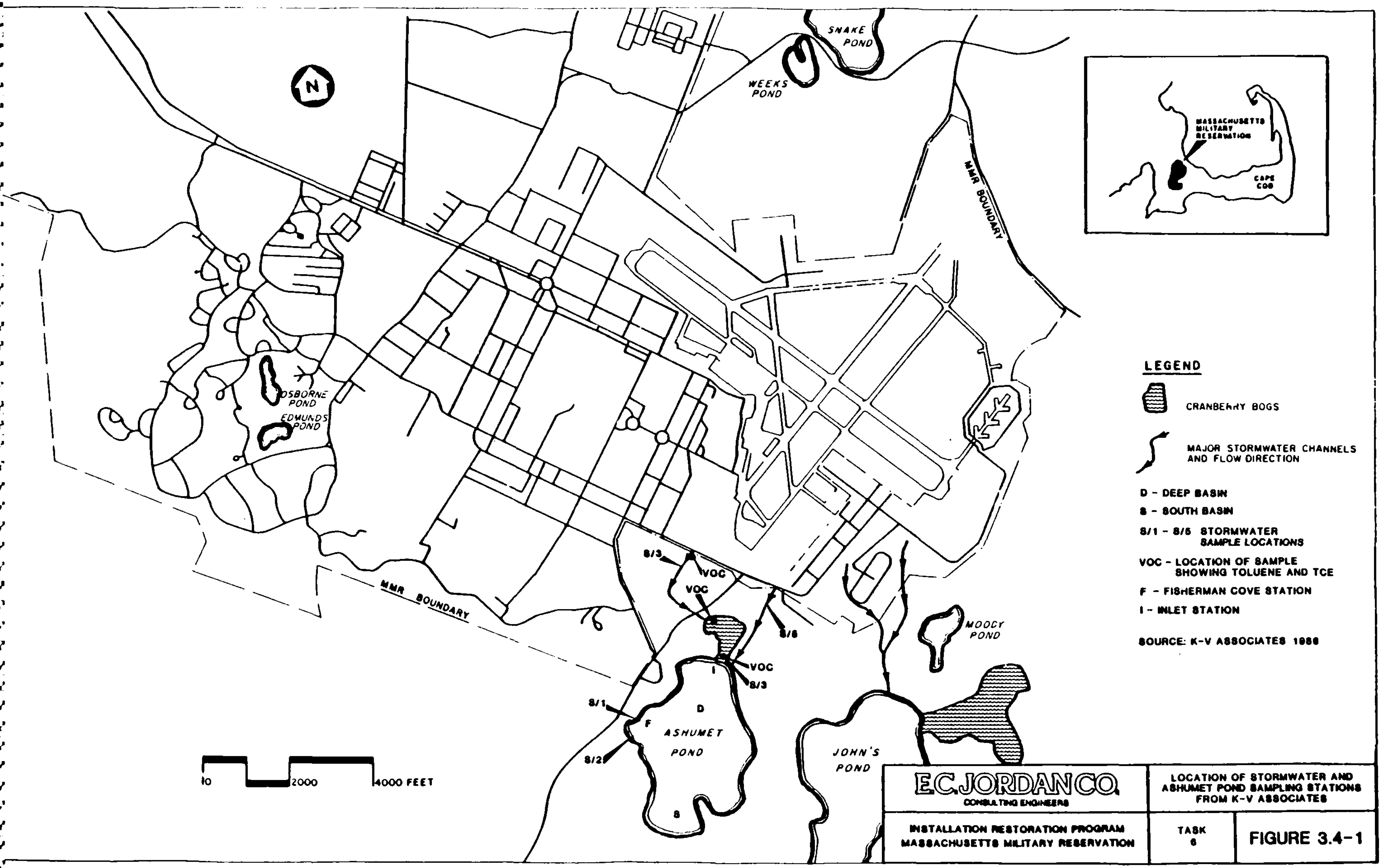
Well I.D.	Depth Below Land Surface (ft)	Diameter I.D.	Screen Type	Screen Length (ft)	Comments
J	86	24	Steel	45	Current base water supply
B	84	24	Steel	45	Abandoned as potable water due to contamination (1962) used for irrigation of USCG; golf course
G	91	24	Steel	45	Shut down due to contamination (15 Nov 1985)
E	117	24	Steel	50	Dismantled to provide runway clearance
USCG Transmitter Station	110	12	--	50	Installed due to contamination found in previous well
Cape Cod AFS	412	20	Stainless Steel	20	
VA Cemetery	200	8	Stainless Steel	50	
AVCO, Inc.	40	--	--	--	
	85	--	--	--	

chloride, color, fluoride, total dissolved solids, sulfate, surfactants, turbidity, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, silver, zinc, and nitrate. None of these exceeded its respective maximum contaminant level (MCL). Nitrate concentration was <0.1 mg/L as nitrogen. No organic compounds, pesticides, or PCBs were measured. Osborne Pond water quality data are tabulated in Appendix F.

A limited study of stormwater runoff water quality was performed in 1985 by K-V Associates to determine nutrient and metals entering the Ashumet Pond watershed from the drainage of the MMR flight line, petroleum fuel storage area, and southeastern portion of the base. Stormwater sampling locations are shown in Figure 3.4-1. Table 3.4-1 shows the composited results of the stormwater sampling. As shown in this table, elevated nitrogen concentrations typical of suburban stormwater (EPA, 1979) were observed in the runoff. Iron, copper, manganese, and zinc were detected in the stormwater. Copper and zinc were observed at concentrations greater than the short-term Federal Water Quality Criteria (EPA, 1980 and 1985) for protection of aquatic life. According to a 1984 Massachusetts Department of Environmental Quality Engineering (DEQE) report (Duerring and Rojko, 1984), Ashumet Pond total hardness ranges from 11 to 26 mg/L as calcium carbonate ($CaCO_3$). This is similar to groundwater in the area (LeBanc, 1984). Based on this hardness level, the Federal Water Quality criterion was 0.002 mg/L for copper and 0.050 mg/L for zinc. Concentrations of copper and zinc in surface runoff (stormwater) at the boat ramp and beach at Fishermans Cove were higher than those from the MMR drainage. The concentration of these materials at both locations are typical of storm runoff from urban and suburban watersheds (EPA, 1979). The impact on Ashumet Pond from these metals would be expected to be mitigated to an extent by dilution. No sampling for metals has been conducted in Ashumet Pond. A single sample from the oil water separator discharge was screened for volatile organics. No volatile organics were detected in this discharge.

Both Ashumet Pond and Johns Pond have been sampled in conjunction with the Massachusetts Lake Classification Program and the Massachusetts Clean Lakes Program (Chapter 628 of the Commonwealth Acts of 1981). Summaries of these results, taken from Duerring and Rojko (1984), are contained in Appendix F. The results of these surveys indicated that Ashumet Pond was classified as mesotrophic/eutrophic. Johns Pond was classified as mesotrophic. Both ponds have been responding to inputs of nitrogen and phosphorus resulting from watershed development. As a result of continued eutrophication of Ashumet Pond, a diagnostic/feasibility study is being conducted under sponsorship of the towns of Mashpee and Falmouth to determine the sources of nitrogen and phosphorus and to develop alternatives for eutrophication control.

Data collected in Ashumet Pond during the summer and fall of 1985 are summarized in Table 3.4-2. Locations of the sampling stations are shown in Figure 3.4-1. According to K-V Associates (1986), Ashumet Pond was classified as an oligotrophic lake in 1969. The nutrient status and relative population sizes of the algae and aquatic plants of a lake are used to determine its trophic state. An oligotrophic lake is generally considered to contain low concentrations of total nitrogen and total phosphorus; sustain relatively low primary productivity be free from algal blooms and nuisance aquatic vegetation and have a very small oxygen demand in the bottom waters after summer and/or winter



E.C. JORDAN CO. CONSULTING ENGINEERS	LOCATION OF STORMWATER AND ASHUMET POND SAMPLING STATIONS FROM K-V ASSOCIATES	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 3.4-1

TABLE 3.4-1

STORMWATER QUALITY IN THE ASHUMET POND WATERSHED

Parameter	Concentrations in Composite Samples (mg/L)			
	Fishermans Cove		Cranberry	Oil Water
	Beach	Boat Ramp	Bog	Separator
Ammonia Nitrogen	0.44	0.90	0.49	0.23
Nitrate Nitrogen	0.43	0.16	0.28	0.10
Total Kjelddl Nitrogen	2.50	2.41	1.74	1.74
Cadmium	<0.010	<0.010	<0.010	<0.010
Chromium	<0.02	<0.02	<0.02	<0.02
Copper	0.02	0.04	0.02	<0.02
Iron	13.8	1.01	2.46	0.56
Lead	<0.01	<0.10	<0.10	<0.10
Manganese	0.20	0.05	0.64	0.04
Zinc	0.07	0.11	0.05	0.07

Source K-V Associates (1986)

TABLE 3.4-2

SUMMARIZED 1985 WATER QUALITY STATUS
OF ASHUMET POND
(SEE FIGURE 3.4-1 FOR STATION LOCATIONS)

	Station Identification (Number of Samples)									
	Deep Basin				South Basin		Cranberry Bog Outlet		Fishermans Cove	
Water Quality	Epilimnion/Metalimnion		Hypolimnion							
Parameter (Units)	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
pH (Standard Units)	6.3(14)	5.5-7.2	5.9(7)	5.5-6.6	6.4(6)	6.1-7.1	5.9(8)	5.1-6.8	6.4(7)	5.9-7.1
Specific Conductance (umho/cm @ 25°C)	89.75(12)	85-110	95.5(6)	85-110	84.2(5)	75-89	85.71(7)	60-95	87.17(6)	79-95
Total Alkalinity (mg/L as $CaCoH_3$)	10.07(14)	7-25	15.0(7)	9-22	9.5(6)	8-11	14.63(8)	7-23	10.0(7)	8-12
Chloride (mg/L)	10.94(14)	10.1-12.0	11.01(7)	9.86-12.2	10.93(6)	10.5-11.5	8.70(8)	5.5-12.0	12.17(7)	10.3-15.0
Total Dissolved Solids (mg/L)	54.14(14)	30-80	53.57(7)	30-68	40.16(6)	13-60	59.75(8)	22-90	48.14(7)	22-78
Total Kjeldahl Nitrogen (mgN/L)	0.74(14)	0.26-1.74	1.10(7)	0.45-1.76	0.58(6)	0.28-.90	1.13(8)	0.44-2.16	0.56(7)	0.05-1.63
Ammonia Nitrogen (mgN/L)	0.25(14)	0.05-0.77	0.63(7)	0.05-1.29	0.16(6)	0.05-0.26	0.35(8)	0.05-0.63	0 30(7)	0.05-1.22
Nitrate Nirtogen (mgN/L)	0.18(13)	0.04-0.36	0.19(6)	0.06-0.60	0.19(6)	0.04-0.38	0.22(8)	0.16-0.31	0.21(7)	0.11-0.33
Total Phosphate (mgp/L)	0.012(14)	0.005-0.028	0.041(7)	0.005-0.133	0.009(6)	0.005-0.017	0.029(8)	0.005-0.053	0.012(7)	0.005-0.023
Dissolved Inorganic Phosphate (mgp/L)	0.009(14)	0.005-0.022	0.038(7)	0.005-0.131	0.006(6)	0.005-0.008	0.026(8)	0.005-0.053	0.01(7)	.005-0.023

Source: K-V Associates (1986)

thermal stratification. A lake that is mesotrophic to eutrophic contains higher levels of nitrogen and phosphorus and, therefore, supports larger populations of algae and aquatic plants. As a consequence, algal blooms and aquatic weed nuisance conditions may occur. The oxygen demand in the bottom waters becomes greater, and low dissolved oxygen concentrations occur after stratification in the bottom water layers. As the level of nutrients increases, a lake shows a trend toward eutrophication. The available data for Ashumet Pond for 1980 and 1985 suggest such a trend, which leads toward water quality degradation. A partial fish kill occurred in Ashumet Pond during the summer of 1985 and again in 1986. This kill has been described in K-V Associates, 1986. Ashumet Pond is located less than 0.5 miles south of MMR and receives the majority of its water input as groundwater. A portion of the recharge that comes from the southeastern sector of MMR includes effluent from the base sewage treatment plant (STP).

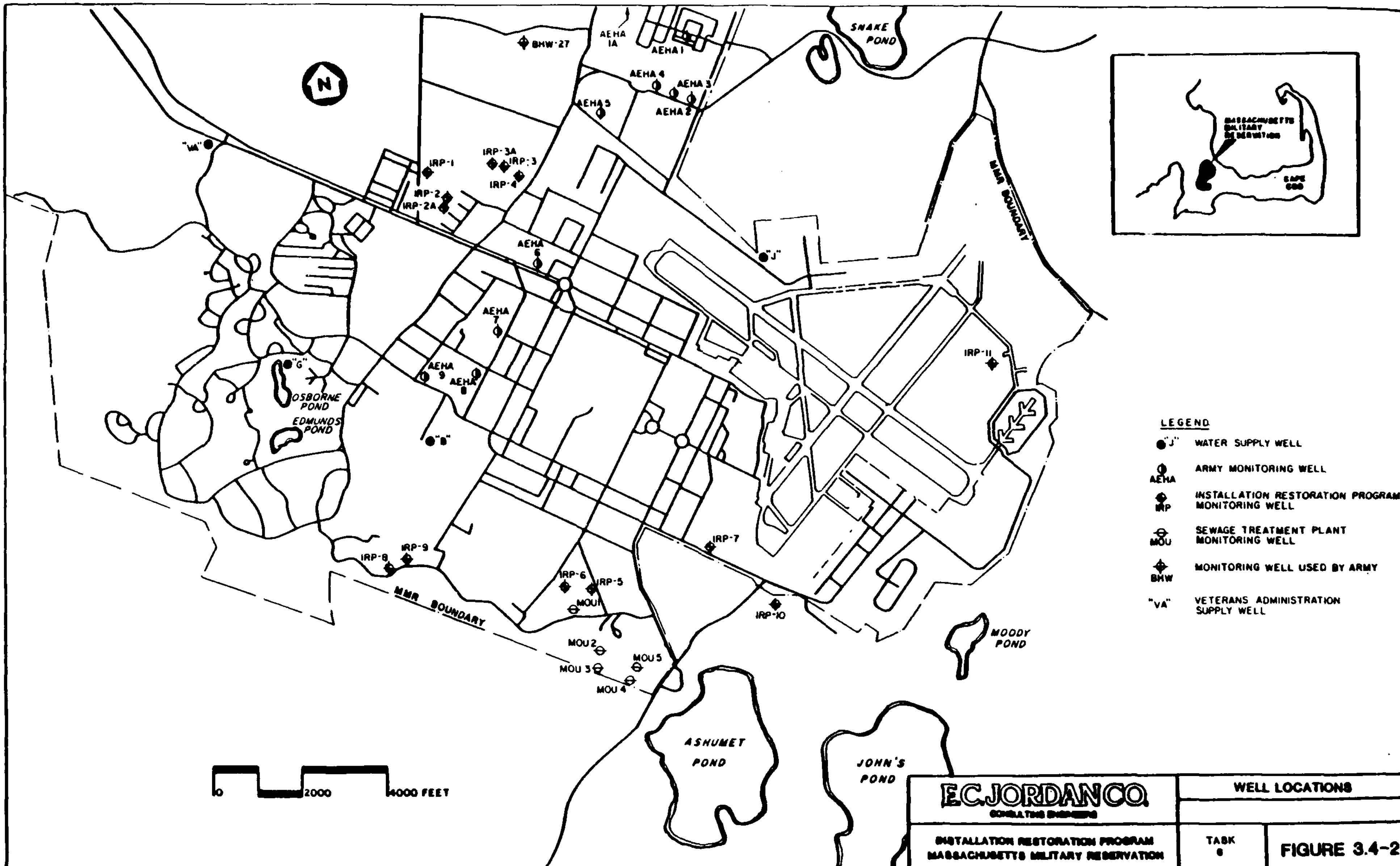
The natural surface water inlets to Ashumet Pond are through a cranberry bog and a swale at the north end of the pond; there is no outlet. Following a heavy rain event, surface water will discharge from MMR storm drainway into the cranberry bog located at the north end of the pond and directly into the pond from the second drainage in the same area as the cranberry bog inlet. The locations of these drainage areas and their hydrologic properties were described in Section 3.2.2. Dissolved volatile priority pollutant organic compounds (VOCs) have been detected in the cranberry bog and the inlet to Ashumet Pond (K-V Associates, 1986). Toluene was observed at up to 93 ug/l and trichloroethylene (TCE) at 9.0 ug/L. Water samples taken at the Ashumet Pond boat landing contained VOC but at concentration levels less than 1 part per billion (ppb) (USGS 1984). The base STP and stormwater drainage systems are discussed in Section 4.0. Because of the potential for impact to Ashumet Pond from MMR, an evaluation of Ashumet Pond is being conducted as a separate task within the MMR IRP program.

3.4.2 Groundwater Quality

3.4.2.1 General

The quality of the groundwater at MMR has been closely monitored during the last 2 yrs. There are presently 28 monitoring wells located on base. These include 12 IRP wells, installed in 1983 as a part of the R.F. Weston Phase II, Stage 1 investigation; five memorandum of understanding (MOU) wells, installed in 1981 to satisfy an agreement with EPA; and 11 U.S. Army Environmental Hygiene Agency (AEHA) monitoring wells, 10 installed in 1985; and BHW-27, an observation well installed in 1940 and included as a monitoring well in the AEHA program. In addition to the monitoring wells, there are eight water supply wells on base. Figure 3.4-2 shows the locations of the wells in the cantonment area. In addition to the four water supply wells shown in Figure 3.4-2, two wells are located at the AVCO facility on J-3 range, one at the USCG Transmitter site, and one at the Cape Cod AFS. An additional water supply well (Well E) has been dismantled.

Water quality data for MMR water supply wells exist for periodic samples collected during the period 1948 to 1982 and have been tabulated in the Otis ANGB Phase I report (Metcalf and Eddy, 1983). No systematic data collection



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INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

WELL LOCATIONS

TASK 6

FIGURE 3.4-2

occurred during 1983 to 1984. In late 1985, however, at the direction of NGB, a systematic monitoring program was implemented at MMR (by Otis ANGB Civil Engineering and Medical Services) to quantify VOCs observed in the base water supply and water distribution system. These results, as well as a single 1985 Occupational and Environmental Health Laboratory (OEHL) analysis, are summarized in Appendix F. Water distribution systems sampling has focused on the water quality at the three Bourne public schools located on MMR.

In addition to the on-base groundwater analysis programs, two major studies are ongoing off-base to the south of MMR. The U.S. Geological Survey (USGS) has been studying the migration of inorganic and organic compounds as related to the land disposal of sewage effluent from the base STP. These results have been reported in LeBlanc (1984). Because of the findings in the LeBlanc report and contamination that caused one Town of Falmouth public water supply well located south of MMR to be abandoned, a program of sampling private wells south of MMR has been implemented by the Boards of Health of Mashpee and Falmouth in conjunction with the Barnstable County Health Department. In addition to the above, during 1985 the Otis ANGB Medical Service conducted a sampling program at more than 200 privately owned wells in the Ashumet Pond area of Falmouth and Mashpee.

Detailed evaluation of these groundwater data, as well as additional sampling and analysis, is ongoing as components of separate MMR IRP tasks. In addition, Barnstable County and MMR are continuing to conduct systematic monitoring and sampling of the base water supply and domestic wells to the south of MMR. The following paragraphs summarize the most important groundwater quality results at MMR.

3.4.2.2 Water Supply Wells

Historical data for the MMR supply wells reported in Metcalf and Eddy did not show violations of Federal Primary or Secondary Drinking Water Standards (these standards are presented in Appendix E). In this historical data base, VOCs were analyzed for Well J and Well G. No VOCs were detected in a single sample from Well J. Well G showed evidence of VOC contamination as, summarized in Table 3.4-3. Well G, a former water supply well, was closed on November 15, 1985, due to contamination by VOCs. VOCs detected in the 1985-1986 program were tetrachloroethylene (PCE), trichloroethylene (TCE), 1,1,1-trichloroethane (TCA), trihalomethanes, trichlorofluoromethane, and dichlorodifluoromethane. PCE was found in concentrations up to 42 µg/L (See Appendix F). No federal drinking water MCL has yet been proposed by EPA for this compound. The concentrations of the other compounds found were below the proposed MCLs. Proposed MCLs for VOCs are tabulated in Appendix E. The recommended maximum contaminant level (RMCL) for PCE has not been promulgated by EPA because recent mammalian toxicity testing for this compound is currently under public review. If the toxicity data are accepted, a final RMCL of 0 µg/L, the current proposed RMCL, may be promulgated. In this event, the MCL may be set in a manner analogous to the testing of the proposed MCL for TCE. Should this occur, an MCL for PCE of 5 µg/L would result.

TABLE 3.4-3

SUMMARY OF VOLATILE ORGANIC COMPOUNDS FOUND IN MONITORING WELL G (6/79 THROUGH 4/82)

Parameter	Concentration Range (μg/L)	Number of Samples
Methylene Chloride	ND	6
1,1-Dichloroethylene	ND	5
1,1-Dichloroethane	ND	4
1,2-Trans-Dichloroethylene	ND	5
Chloroform	0.5-2.3	10
1,2-Dichloroethane	ND	6
1,1,1-Trichloroethane	ND-12.8	12
Carbon Tetrachloride	ND-5.5	10
Dichlorobromomethane	ND-1.0	8
Trichloroethylene	ND-8.0	12
Dibromochloromethane	ND-2.9	8
Bromoform	ND-0.7	7
Tetrachloroethylene	0.9-3.0	8
1,2-Dichloroethylene	ND	2
1,1,2,2-Tetrachloroethylene	ND-3.0	6
Toluene	1.5	1

ND - Not Detected, detection limit not given.
Source: Metcalf and Eddy (1983)

Well J, the present water supply well, showed concentrations of 5 μg/L of TCE on November 18, 1985, and 4.8 μg/L on November 20, 1985. The proposed Federal Drinking Water MCL for TCE is 5 μg/L. In addition, concentrations up to 3.8 μg/L of PCE were detected in Well J. Summarized VOC data for Well J are contained in Appendix F.

Well B was abandoned as a potable water supply in 1962 due to phenolic contamination and has been used solely for irrigation of the golf course since that time.

Among the other water supply wells on the MMR, a recent sampling showed the VA well to be free of organic contamination. In addition, no inorganic contaminants detected exceed federal primary or secondary drinking water standards in that well. Likewise, the water supplies at the AVCO facility and at Cape Cod AFS meet federal drinking water standards. No VOC analyses have been performed at AVCO or Cape Cod AFS. The water quality of the well at the USCG Transmitter Station shows trace amounts (<10.0 μg/L) of TCA. It should be noted that the original well at the Transmitter Station was abandoned due to contamination. At this time the type and amounts of contamination at the abandoned well are undocumented.

3.4.2.3 IRP Monitoring Wells

VOCs were also observed in the IRP monitoring wells installed in the Phase II, Stage I IRP program at MMR by R.F. Weston, Inc. (1984). Figure 3.4-2 shows the location of these wells. Well installation in this program was designed for verification of groundwater quality status at six locations recommended for study by the 1983 Phase I Study (Metcalf and Eddy, 1983) and one additional site identified during the Phase II, Stage I presurvey. These sites are described in Sections 4.0 through 6.0 of the Phase II report and are also components of additional sampling and analysis under other tasks in the current MMR IRP program. Table 3.4-4 is summarized from the Weston (1984) data and indicates VOC contamination of MMR groundwater. In addition to halogenated solvents, methyl isobutyl ketone (MIBK) was detected.

Petroleum, oils, and lubricant (POL)-related contamination was also observed in the IRP monitoring wells (see Table 3.4-4). Oil and grease were detected in well RFW-1 - RFW-9. POL-related VOCs (toluene, xylenes, and ethyl benzene) were also detected, as shown in Table 3.4-4.

Among the AEHA Wells (see Appendix F, Table F-4) sampled in July 1985, AEHA-1 contained concentrations of PCE (16 μg/L) and TCE (8 μg/L). AEHA-6 contained PCE (7 μg/L). Similarly, AEHA-27 (BHW-27) contained concentrations of PCE (23 μg/L). The locations of these wells are topographically downgradient of the former BOMARC site and the current UTES facility (Figure 3.4-2).

Benzene was detected in water from Well J taken July 19, 1985, during AEHA sampling at a concentration of 16 μg/L. This compound has not been detected in any other analysis since or before this time. No other VOCs normally associated with POL (e.g., xylenes, toluene, or ethyl benzene) were detected. No other sampling events have detected this compound in Well J. Therefore, it is probable that the benzene detected was a laboratory or sampling artifact.

TABLE 3.4-4

SUMMARY OF OTIS-ANGB PHASE II STAGE I GROUNDWATER ORGANICS DATA (FROM R.F. WESTON, 1984)
(SEE FIGURE 3.4-2 FOR WELL LOCATIONS)

Parameter	Detection Limit	RFW-1	RFW-2A	RFW-3A	RFW-4	RFW-5	RFW-6	RFW-7	RFW-8	RFW-9	RFW-10	RFW-11
Phenol (mg/L)	0.005	0.007	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Oil & Grease (mg/L)	0.1	1.03	0.15	2.0	0.24	2.29	0.26	2.09	0.16	0.13	ND	ND
GC Hydrocarbon Scan (mg/L)	1	NA	NA	NA	NA	NA	NA	NA	ND	ND	ND	ND
Carbon Tetrachloride (μg/L)	2.0	ND	ND	ND	2.8	NA	NA	NA	NA	NA	NA	NA
Dichlorodifluoromethane (μg/L)	4.0	ND	11	5.0	6.1	NA	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene (μg/L)	3.0	22	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA
Methylene Chloride (μg/L)	2.0	ND	4.2	6.5	2.0	NA	NA	NA	NA	NA	NA	NA
1,2-Trans Dichloroethylene (μg/L)	2.0	7.6	4.2	ND	ND	ND	5.6	ND	ND	ND	NA	NA
Tetrachloroethylene (μg/L)	2.0	ND	3.5	ND	ND	7.1	3.0	ND	ND	ND	NA	NA
1,1,1-Trichloroethane (μg/L)	2.0	ND	ND	ND	9.0	NA	NA	NA	NA	NA	NA	NA
Trichloroethylene (μg/L)	2.0	ND	18	ND	ND	2.4	ND	ND	ND	ND	NA	NA
Ethyl Benzene (μg/L)	2.0	6.4	ND	ND	ND	ND	ND	ND	ND	2.8	59	ND
Trichlorofluoromethane (μg/L)	3.0	ND	ND	ND	3.0	NA	NA	NA	NA	NA	NA	NA
Total Xylenes (μg/L)	4.0	ND	ND	ND	ND	ND	ND	ND	ND	4.6	78	ND
Methyl Ethyl Ketone (μg/L)	10.0	ND	ND	ND	ND	81	ND	ND	ND	ND	ND	ND
Methyl Isobutyl Ketone (μg/L)	4.0	5.3	ND	ND	ND	ND	ND	ND	ND	210	ND	ND

NA - Not Analyzed
ND - Not Detected

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Water samples obtained from the MOU Wells, installed in the vicinity of the STP (see Figure 3.4-2), contain detectable levels of VOC contamination. Most notable are the amounts of PCE in MOU Wells 1, 2, and 4. The concentrations are 10, 16, and 7.1 µg/L, respectively. Also, 13 µg/L of TCE was detected in MOU-2.

LeBlanc (1984) has characterized the groundwater quality, off-base downgradient of the STP. These data indicate a plume of sewage effluent-related compounds in excess of 8,000 ft in length downgradient of MMR. VOC contamination was detected in wells downgradient of the STP. These VOC results are summarized in Appendix F. The USGS is continuing studies of groundwater quality in the area downgradient of MMR. Results of these studies are under review by USGS and are being coordinated with off-post groundwater data being generated as a component of other MMR IRP tasks.

The analyses of private wells that have been conducted to date by Otis ANGB Medical Service and Barnstable County from over 200 households indicate that a total of approximately 40 wells in Falmouth and Mashpee had low detectable levels of VOCs. The principal areas in which groundwater contamination has been detected are located downgradient with respect to groundwater flow from the reservation and include the Ashumet Valley area of Falmouth and the Briarwood, Tri-Town Circle, and Horseshoe Bend Way areas of Mashpee. The principal organic chemicals detected include TCE, PCE, TCA, and 1,1-dichloroethane (DCA). Concentrations detected ranged from not detected (ND), which is generally <1 µg/L (ppb) for VOCs to 125 µg/L. Table 3.4-5 summarizes the results to date from the sampling events in these communities.

In summary, there appear to be detectable levels of VOCs in the groundwater at MMR. In addition, VOC contamination has been documented off-base downgradient of MMR. Phase II, Stage 1 and Stage 2 groundwater characterization programs are ongoing both on-base and off-base in the area of observed VOC contamination as separate tasks within the current MMR IRP program.

3.5 BIOTIC COMMUNITIES

MMR covers an area of approximately 20,000 acres. Eighty percent of MMR remains undeveloped and provides natural habitat for wildlife. The remaining 20 percent of MMR has been developed to support various military needs. No comprehensive ecological surveys of MMR have been carried out; therefore, no comprehensive species list is available.

The forests on MMR occur primarily in the range, impact, and maneuver area and are classified as pine-oak climax forests. The predominant vegetation is pitch pine (*Pinus rigida*) and scrub oak (*Qercus iliafolia*). Other species include white oak (*Quercus alba*), red oak (*Qercus borealis*), and pin oak (*Quercus palustrus*). Understory vegetation includes bracken fern, sweet fern, common greenbriar, blueberry, and other heaths (U.S. Army Corps of Engineers, 1985). The cantonment and flight line consist of open, mowed grassland and lawns.

Common mammals found at MMR include the red fox, grey fox, raccoon, red squirrel, eastern chipmunk, woodchuck, skunk, shorttail weasel, rabbit, and

TABLE 3.4-5

SUMMARY OF ANALYTICAL RESULTS FROM OTIS ANGB MEDICAL SERVICE AND BARNSTABLE COUNTY SAMPLING EVENTS

Community	Date of Sampling Event	Number of Private Wells Sampled	NUMBER OF PRIVATE WELLS WITH TOTAL VOCs DETECTED IN FOLLOWING CONCENTRATIONS			
			ND <1 µg/L	1-5 µg/L	6-50 µg/L	Greater than 50 µg/L
Ashumet Valley, Falmouth	August 1985	200	161	32	6	1
Briarwood, Mashpee	February- March 1986	8	5	0	3	0
Tri-Town Circle/ Horseshoe Bend Way, Mashpee	February- March 1986	28	25	3	0	0

Source: Barnstable County Health Dept. (1986)

whitetail deer. Birds that are common to MMR are ruffed grouse, bob white quail, chickadee, goldfinch, herring gull, osprey, red tail hawk, bluejay, mockingbird, brown thrasher, and robin. There have been sightings of the short-eared owl during winter in some of the open fields (U.S. Army Corps of Engineers, 1985). Scientific names of these species are tabulated in Table 3.5-1. In addition, there are over 100 species of migratory birds that use the Cape as a major stop on the Atlantic Flyway. Because of the small area of aquatic habitat, MMR does not constitute a major waterfowl habitat.

Edmunds Pond and Osborne Pond support fish populations consisting of largemouth bass (Micropterus salmoides), chain pickerel (Esox niger), yellow perch (Perca flavescens), and brown bullhead (Ictalurus nebulosis). Small populations of these fish may exist in some of the other permanent kettle ponds on the reservation.

Wildlife management at MMR consists of a deer hunting season administered each year by the Massachusetts Division of Fisheries and Wildlife. The hunting season is in November. A maximum of 600 permits are issued for any given day of hunting on the reservation. In the 1985 season, a total of 53 deer were taken.

The Massachusetts Natural Heritage Program (MNHP) did an inventory of endangered and threatened wildlife at MMR in the summer of 1984. The results indicated that there are currently no known federal endangered or threatened wildlife species occurring on MMR. There are also currently no known state-listed endangered or threatened species of mammals, reptiles, amphibians, fish, or invertebrates occurring on MMR (MNHP, 1984).

Three species of birds that inhabit the unforested areas and fields around runways and taxiways have been classified by the Massachusetts Division of Fisheries and Wildlife as State Endangered, State Threatened, or Species of Special Concern. These are 1) the Upland Sandpiper (Bartramia longicauda) which is considered State Endangered; 2) the Northern Harrier or Marsh Hawk (Circus cyaneus), which is considered State Threatened; and 3) the Grasshopper Sparrow (Ammodramus savannarum), which is considered a Species of Special Concern. Further studies were conducted, and a subsequent report was written by MNHP in 1985 to develop a management plan for maintaining or enhancing habitat for these three species that is compatible with primary National Guard responsibilities and objectives. This report is currently being reviewed by the National Guard.

The MNHP 1984 survey located two areas on MMR that support rare plants. The first area is the unnamed ponds in the Rod and Gun Club area just northeast of the Route 28 rotary near the MMR main gate (see Figure 3.2-1). In those ponds Umbrella-grass (Guirena-pumila) and Hyssop Hedge-nettle (Stachys- hyssopifolia) were found. The other ponds located on MMR are floristically much less diverse than these ponds and contain no rare species (MNHP, 1985). The second area is a roadside grassy habitat along Greenway Road at the edge of the range area north of the Sandwich gate. Sandplain Flax (Linum intercursum) is found here and is listed as a State Rare Plant.

TABLE 3.5-1

COMMON FAUNA AT MMR

red fox	Volpes fulva
gray fox	Urocyon cinereoargenteus
raccoon	Procyon lotor
red squirrel	Tamiasciurus hudsonicus
eastern chipmunk	Tamias striatus
woodchuck	Marmota monax
skunk	Mephitus mephitus
shorttail weasel	Mustela erminea
cotton rabbit	Silvilagus floridanus
white-tailed deer	Odocoileus virginianus
ruffed grouse	Bonasa umbellus
bobwhite quail	Colinus virginianus
chickadee	Tarus atricatillus
goldfinch	Spinus tristis
herring gull	Larus argentatus
osprey	Pandion haliaetus
red-tailed hawk	Buteo jamaicensis
blue jay	Cyanocitta cristata
mockingbird	Nimus polyglottos
brown thrasher	Toxo stomarufum
robin	Turdus migratorius

Source: Massachusetts Natural Heritage Program (1985)

3.6 ENVIRONMENTAL SETTING SUMMARY

The MMR is situated on upper Cape Cod in the Coastal Plain province. The cantonment area lies on a broad, flat, gently sloping outwash plain. The range, impact, and maneuver area and the areas to the west of MMR lie mainly on the hummocky, morainal terrain. Throughout the MMR numerous kettle holes dot the landscape. The reservation contains two named ponds and several other small water bodies. Surface water runoff is virtually nonexistent due to the high permeability of the soils and the relatively flat topography. In the southern portion of MMR, intermittent streams or drainage swales exist. Flow may be initiated in the drainways during periods of heavy rainfall as a result of discharge from the storm sewer system that drains the flight line area. The intermittant stream courses lead off-base toward Ashumet Pond and Johns Pond.

Surface water quality data are limited. Analysis of water from Osborne Pond has been limited to drinking water parameters. Of those analyzed, none were above the Safe Drinking Water Standards or Class B by the Commonwealth of Massachusetts. Water quality in Ashumet Pond, which is downstream and downgradient of the reservation, shows a trend toward eutrophication that results from the impact of excess nitrogen and phosphorus. In addition, toluene and TCE have been detected in the waters of the cranberry bog located immediately north of Ashumet Pond.

Soils on the MMR are a mixture of sandy to sandy-loam surface soil and subsoil with a substratum of sand and gravel. They are generally very well drained. In the moraine areas many large boulders are present. The soils are highly permeable and would be susceptible to infiltration by contaminants.

A designated sole source aquifer exists under unconfined conditions beneath the MMR. This aquifer occurs in the unconsolidated sand and gravel deposits. This sole source aquifer supplies the Upper Cape. By virtue of its location on the highest elevation of this system, MMR represents a major recharge area. Groundwater flows radially from MMR. The predominant flow direction from the cantonment area is to the south. The water table generally averages 50 ft below the surface beneath the cantonment area. Recharge to the aquifer is from precipitation and inflow from adjacent zones of the aquifer. Discharge is to lakes and ponds, rivers, and the ocean, in addition to being used as potable water supply.

Groundwater quality at MMR has been closely monitored. Several wells show detectable concentrations of VOC predominantly, the solvents PCE and TCE. Trihalomethanes were also detected but in much lesser concentrations on the reservation. In addition to solvents, oil and grease and other petroleum-related hydrocarbons were detected in several of the IRP monitoring wells. Contamination of the groundwater at MMR has, therefore, occurred. Because of the groundwater flow rate of 1 to 2 ft/day, there is potential for the contamination to migrate off the reservation. Organic compounds have been identified to the south of MMR. The extent and sources of the on- and off-base groundwater contamination are currently under study as other components of the MMR IRP.

Average annual rainfall at MMR is approximately 48 inches, and net precipitation (total rainfall minus evaporation) is 21 inches. The 1-yr, 24-hour rainfall event is 2.7 inches. The value of 21 inches/yr for net precipitation indicates a potential for infiltration as well as surface runoff and accounts for the occurrence of permanent surface water feature. The 1-yr, 24-hour rainfall event of 2.7 inches indicates a potential for runoff and erosion. These data indicate that contamination at MMR could migrate by both surface water and groundwater pathways. The high permeability of the soils and the low topographic gradient greatly reduce the potential for surface water contamination migration.

Twenty percent of MMR consists of developed land; the remaining 80 percent remains undeveloped and provides natural habitat for wildlife. Forests on MMR exist in the undeveloped areas and are classified as pine-oak climax forests. There are no perennial streams located on MMR. There are several small kettle hole ponds and two larger ponds (Edmunds and Osborne Ponds). The two larger ponds support populations of warm-water species of fish. Wildlife management at MMR consists of a deer hunting season administered by the Massachusetts Division of Fisheries and Wildlife.

There are currently no known federal endangered or threatened wildlife species occurring on MMR. There are three species of birds that are classified as either State Endangered, State Threatened, or Species of Special Concern by the Massachusetts Division of Fisheries and Wildlife. There are also two areas on MMR that support rare plants.

As a result of the hydrogeological environment and soil characteristics, conditions at MMR are conducive to contaminant migration. Contaminants would primarily migrate vertically through the soils to the groundwater. Contaminant transport by surface water would be very limited due to the surficial permeability. Contaminants entering the groundwater could potentially contaminate the sole source aquifer used by residents of Cape Cod as potable water.

4.0 FINDINGS

To assess hazardous waste management and disposal at the ARNG, ANG, USAF, and VA facilities on MMR, past activities, material useage, waste generation, and disposal methods were reviewed. This section contains a summary of hazardous wastes generated, descriptions of waste disposal methods, identification of waste disposal sites on base, and evaluation of the potential for environmental contamination. Section 4.1 provides a review of MMR activities that have the potential for hazardous waste generation. Section 4.2 describes the disposal sites identified on base and presents an evaluation of the potential for environmental contamination.

Before the Records Search presented in this report, both Phase I and Phase II, Stage 1 programs had been performed on the ANG facilities only at MMR under other contracts. A Phase I Records Search (Metcalf and Eddy, 1983) was performed in 1982. Phase II, Stage I sampling and analysis were performed during 1983 and 1984 at six sites identified in the Records Search (Weston, 1985) and at one additional site identified during Phase II, Stage I presurvey. To deal comprehensively with potential contaminant migration from MMR, the activities review and contamination assessment presented in this section include USAF, ANG, ARNG, and VA activities. Subsequent to the original records search and the conduct of the Phase II field studies for the ANG, a retired base civil engineer identified an additional number of potential disposal sites. Because the records search was performed 4 yrs ago and because of the additional potential sites identified subsequently, a reassessment of ANG activities at the Otis-ANGB facilities was performed. USCG facilities at MMR have been evaluated in a separate Phase I report.

4.1 CURRENT AND PAST ACTIVITY REVIEW

In an effort to identify possible hazardous waste disposal sites, current and past operations and disposal methods were reviewed. During this activity, files and records were reviewed, current and former base employees were interviewed, and possible disposal areas were visited.

MMR operations discussed in this section include past and present operations in which toxic or hazardous materials have been reportedly handled, stored, or disposed. These activities include industrial and laboratory operations in which pesticides, polychlorinated biphenyls PCBs, POL, organic solvents, industrial chemicals, explosive munitions, hypergolic fuels, and radiological materials have been handled.

Because the mission of the base has changed several times over the years, past activities at MMR vary greatly from present ones. When possible, both past and present operations have been discussed in the following sections. Although many present operations generate only small amounts of wastes, present shops and laboratories have been incorporated into these sections. Similar information is often unavailable for past operations.

In general, only those past shops and laboratories that may have generated and disposed of large amounts of hazardous wastes are described. When specific, documented information concerning hazardous waste management was unavailable, common base or military-wide practices carried out during the appropriate time period were considered as the probable methods of generation and disposal for these operations.

Two distinct periods in the history of the base involved the largest-scale industrial activities, requiring specific discussion in Section 4.1.1. The history of MMR is described in Section 2.2. From 1940 to 1946, the Army used the base for training and mobilization of troops. The many motor pools operating on base at the time handled large quantities of wastes. The base was reactivated by the USAF in 1955. Major aircraft and motor vehicle maintenance operations in support of AEW&C and NORAD required the use of large quantities of hazardous materials until approximately 1970. From 1962 to 1973, MMR was also used as a BOMARC air defense missile site. Further description of these activities are included in the sections below. Military activity and, therefore, waste generation rates were higher during these two periods than at present. Since 1970 the major missions and waste generation rates for units at MMR have been similar to the present although the air defense mission and installation management were transferred from the USAF to ANG in 1973. The VA maintenance activity dates from 1980 when the Massachusetts National Cemetery opened. Cape Cod AFS began operations in 1978. Post-1970 waste generation rates in general are lower than for the 1940-1946 and 1955-1970 time periods.

Appendix D contains a master list of shops (with the exception of USCG shops) currently operating at MMR. A summary of waste generation/disposal from past and present industrial and laboratory operations is presented in Tables 4.1-1 and 4.1-2. Industrial and laboratory operations, activities, and waste treatment, storage, and disposal are described in the following paragraphs. Locations of the shops and laboratories are shown in Figures 4.1-1 through 4.1-5. The majority of activity has occurred in the cantonment area and flight line. Limited activity currently occurs at the VA maintenance area and at Cape Cod AFS in the northern portion of the range area.

During the site visit, interviews were conducted with personnel from the industrial shops and laboratories, including the shops that generate the largest amounts of hazardous wastes. Shop interviews focused on hazardous waste materials, waste quantities, and disposal methods. Disposal time frames were prepared for each major hazardous waste generator from information provided by shop personnel, others familiar with shop operations and activities, ANG-102nd FIW Bioenvironmental Engineering Service files, Camp Edwards Directorate of Facilities and Engineering (DFAE) files, and available reports. Information obtained from detailed shop review, including information on current and past shop locations, identification of hazardous waste, waste quantities, and disposal methods, is summarized below and presented in Table 4.1-1 for industrial operations. Disposal time frames are shown for wastes. Table 4.1-1 does not include shops that do not generate hazardous waste. Table 4.1-2 is a presentation of similar data for present and past laboratory operations.

TABLE 4.1-1

NMR INDUSTRIAL OPERATIONS:
WASTE GENERATION

Shop Name	Location (Bldg. No.)	Waste Materials	Waste Quantity (gal/yr)*	1935	1945	1955	1965	1975	1985
USAF and ANG Shops									
I. Vehicle Maintenance Shops									
Current Vehicle Maintenance	754	Waste motor oil	1200				Picked up by RI. DRMO or contract disposal		
		Waste solvents (petroleum distillates, halogenated solvent)	50				Picked up by RI. DRMO or contract disposal		
		Antifreeze (ethylene glycol)	100-150				Picked up by RI. DRMO or contract disposal		
		Paint residues	<55				Picked up by RI. DRMO or contract disposal		
		Battery electrolyte	300				Neutralized and discharged to sanitary sewer		
Former West Truck Road ANG Motor Pool	1532	Waste motor oil	Exact quantities unknown. However, the motor pool serviced 120 motor vehicles			Dumped on-site			
		Waste solvents (petroleum distillates, and halogenated solvents); antifreeze (ethylene glycol); battery acid; waste JP-4, AVGAS, and MOGAS							
Former West Truck Road ANG Motor Pool	1753	Waste motor oil; halogenated and non-halogenated solvents, antifreeze; paint residuals; battery acid; waste JP-4, AVGAS, and MOGAS	Exact quantity unknown. The motor pool serviced about 100 vehicles			Dumped on-site			
Former ANG Motor Pool	2806	Waste motor oil, cleaning solvent, antifreeze, paint residuals, and battery acid	Exact quantity unknown. The motor pool serviced about 90 vehicles				Disposal method unknown		

* Units of waste quantity in gals/yr. except where otherwise noted.

TABLE 4.1-1 Cont'd

NNR INDUSTRIAL OPERATIONS:
WASTE GENERATION

Shop Name	Location (Bldg. No.)	Waste Materials	Waste Quantity (gal/yr)*	Waste Management Practices (1935–1985)
Former USAF Main Motor Pool	4100 Block	Waste motor oil; halogenated and nonhalogenated solvents; antifreeze; paint residuals; battery acid; waste fuels (JP-4, AVGAS, MOGAS)	Exact quantity unknown	Dumped on-site
Former Refueler Maintenance	3461	Waste motor oil; halogenated and non-halogenated solvents; antifreeze; paint residuals; battery acid; waste fuels (JP-4, AVGAS, MOGAS, diesel)	Quantity unknown. The motor pool serviced about 20-25 vehicles	Dumped on-site
Former USAF Civil Eng./Roads	968	Waste motor oil; halogenated and non-halogenated solvents; antifreeze; paint residuals; battery acid; waste fuel (MOGAS, diesel)	Quantity unknown. The motor pool serviced about 300 heavy vehicles	Dumping on-site or picked up by base DPDO
Current ANG Refueler Maintenance Shop	118	Waste motor oil and petroleum distillate solvents	120	Picked up by RI. DRMO or contract disposal
		Battery acid	Variable	Picked up by RI. DRMO or contract disposal
II. Aircraft Maintenance and Support Shops				
CAMS Shops	156/158	Spent Petroleum distillate solvents	1000	Dumping and pick-up by base DPDO; Pick-up by base or RI. DRMO
		Halogenated and non-aalogenated solvents	600	Dumping and pick-up by base DPDO; Pick-up by base or RI. DRMO
		(TCE, PCE, 1,1,1-TCD, dichlorofluoromenthane, trichlorofluoromethane acetone, toluene, MIBK, MEK, methylene chloride)		
		battery electrolyte	2	Neutralized and discharged to storm drain system; Picked up by RI. DRMO
		Used nickel-cadmium and lead acid battery cases	variable quantities	Base DPDO; Picked up by base or RI. DRMO

* Units of waste quantity in gals/yr. except where otherwise noted.

TABLE 4.1-1 Cont'd

MMR INDUSTRIAL OPERATIONS: WASTE GENERATION

Shop Name	Location (Bldg. No.)	Waste Materials	Waste Quantity (gal/yr)*	Waste Management Practices (1935–1985)
		Paint wastes and solvents toluene, MEK, MIBK, Xylenes	150	Dumping and pick-up by base DPDO; Pick-up by base DPDO or RI. DRMO or by contract disposal
		Waste oil and fuel (JP-4 and AVGAS)	6000	Dumping and pick-up by base DPDO; Pick-up by RI. or base DRMO or contract disposal
		Radon tubes	200 tubes/yr.	To base landfill or gravel pit
Vapor Degreaser Unit	156	TCE/PCE	unknown	Evaporate/recycle or discharge to leaching bed
Aerospace Ground Equipment Shop (AGE)	191/192	Cleaning solvent (PD 680 or 140)	1320	To storm drain system; Sent to RI. DRMO
		Gunk (petroleum distillates) MEK and toluene	240	To storm drain system; Sent to RI. DRMO
		Petroleum wastes	1600	Dumping or to RI. DRMO or base DPDO
	3144/3142	Antifreeze	Unknown	To storm drain system
		Cleaning solvent	Unknown	To storm drain system
		Paint thinner	Unknown	To storm drain system
		Waste oil	Unknown	To storm drain system
Engine Run-up Stand	202	Waste JP-4	Variable	Contract disposal
	204	Waste JP-4, waste AVGAS	180	To dry well; Discharged to ground; sent to DPDO on-site or to RI. DRMO
		Waste PD-680	1000-1500	
Engine Rebuild	156	Paint stripper solvents (halogenated and nonhalogenated), waste POL	175 300 1000	To base DPDO or RI. DRMO; Reportedly also to sanitary sewer system
Former Corrosion Shop	3117	Paint and fiberglass residue	Quantity unknown Quantity unknown	Disposal method unknown
Former Nosedocks	163/165	Waste solvents and petroleum	Unknown	Discharged to storm drains

* Units of waste quantity in gals/yr. except where otherwise noted.

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TABLE 4.1-1 Cont'd

MMR INDUSTRIAL OPERATIONS:
WASTE GENERATION

Shop Name	Location (Bldg. No.)	Waste Materials	Waste Quantity (gal/yr)*	Waste Management Practices (1935 – 1945 – 1955 – 1965 – 1975 – 1985)
Hangars 124, 126, 128	124/126/128	Waste oil and fuel, waste solvent	Quantity unknown; these hangars serviced 18-21 aircraft	Disposal method unknown
Battery Shop	163	Battery electrolyte	Quantity unknown	Discharged to ground; Picked up by RI. DRMO
		Battery cases	Quantity unknown	To DPDO
Hangar 192 and 194	192/194	Waste fuels and oil, waste solvents	Quantity unknown	Disposal method unknown
Permanent Field Training Site Hangar (PFTS)	3140	Waste cleaning solvents, paint thinners, waste oils and fuels	1500	Discharged to aquafarm stormwater drainage swale
III. Civil Engineering Shops and Operations				
Civil Engineering shops	971	Waste cutting oil	5	DPDO or contract disposal
		Paint wastes	55	Evaporates or used in process, DPDO or contract disposal
		Waste solvents (methylene chloride, TCE, PCE, 1,1,1-TCA, petroleum distillates, toluene acetone, MEK)	Unknown	Evaporates in Process, DPDO or contract disposal
Roads and grounds	124	Vehicle washing solvent (PD-680) petroleum distillates	110	Discharged to oil/water separator
		Herbicide rinsings	156	Sprayed at the point of application or discharged to sanitary sewer
		Waste oil	200	Picked up by DRMO in RI or on-site
Sewage plant	3212	Hazardous substances that may originate from shops tied into the treatment plant may be present in sludge and wastewater	Unknown	Discharged to ground or placed on sludge drying beds; To base landfill
Heating plant	160	Waste POL	100	Dumped on-site; Contract disposal

* Units of waste quantity in gals/yr. except where otherwise noted.

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TABLE 4.1-1 Cont'd

MMR INDUSTRIAL OPERATIONS:
WASTE GENERATION

Shop Name	Location (Bldg. No.)	Waste Materials	Waste Quantity (gal/yr)*	Waste Management Practices 1935–1985
Camp Edwards Motor Pool	1368	Waste oil	Quantity unknown (135 vehicles maintained)	Contract disposal or DRMO (1975 → 1985)
		Waste solvents and degreasers (halogenated and nonhalogenated)	Quantity unknown	Contract disposal or DRMO (1975 → 1985)
Former WWII regimental motor pools	Truck roads (North) (South) (East) (West)	Waste motor oil, (halogenated and non-halogenated); solvents antifreeze; paint residuals; battery acid; waste MOGAS	Quantity unknown	Dumping on-site or base landfill
II. Aircraft Maintenance and Support Shops				
Helicopter hangar	2816	Waste oils	1500	Sent to DPDO on-site or Ft. Devens DRMO (1975 → 1985)
		Degreasers (trichloroethylene, toluene) (petroleum distillaters)	50	Sent to DPDO on-site or Ft. Devens DRMO (1975 → 1985)
III. Other Present and Former Industrial Operations at MMR				
Defense Property Disposal Office (DPDO)	1532	Waste oil, waste solvents Waste fuels	Unknown	Sent to other DPDO or contract disposal (1955 → 1985)
BOMARC	1400 Block	Waste halogenated solvents	Unknown	Evaporate in process or unknown (1960 → 1975)
		RFNA	Unknown	Neutralization and disposal in acid leaching pit (1960 → 1975)
		UDMH	Unknown	Disposal into hazardous fuel leaching pit (1960 → 1975)
		JP-4	Unknown	Unknown (1960 → 1975)
Former Weapons Shop	3461	Cosmoline, degreasing solvent	Unknown	Unknown (1940 → 1945)
Hospital and Hospital Heating Plant	3700, 3800 Block	Coal ash landfill	Quantity unknown	Discharged to ground (1945 → 1975)
		Solvents, acids, and bases	150	Discharged to sanitary sewer (1945 → 1975)

* Units of waste quantity in gals/yr. except where otherwise noted.

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TABLE 4.1-1 Cont'd

MMR INDUSTRIAL OPERATIONS:
WASTE GENERATION

Shop Name	Location (Bldg. No.)	Waste Materials	Waste Quantity (gal/yr)*	1935	1945	1955	1965	1975	1985
						Waste Management Practices			
Cape Cod AFS		Waste lubricating oils	Variable					Contract disposal	
VA Roads and Grounds Shop		Waste oil petroleum distillate solvents	100-150						Contract disposal
U.S. Navy		AVGAS, waste oils, waste solvents, and painting wastes	Quantity unknown		Disposal method unknown				

* Units of waste quantity in gal/yr except where otherwise noted.

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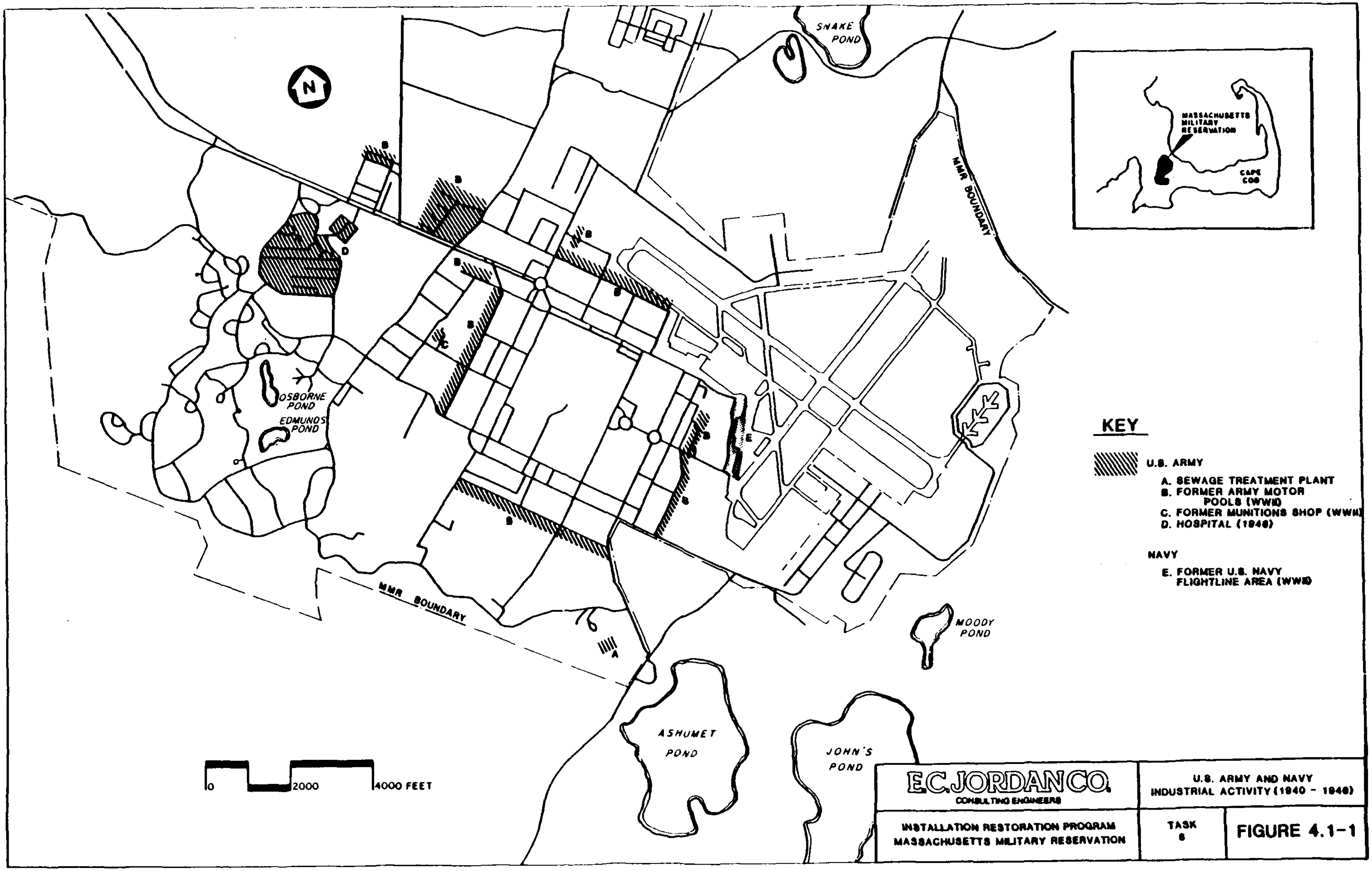
TABLE 4.1-2

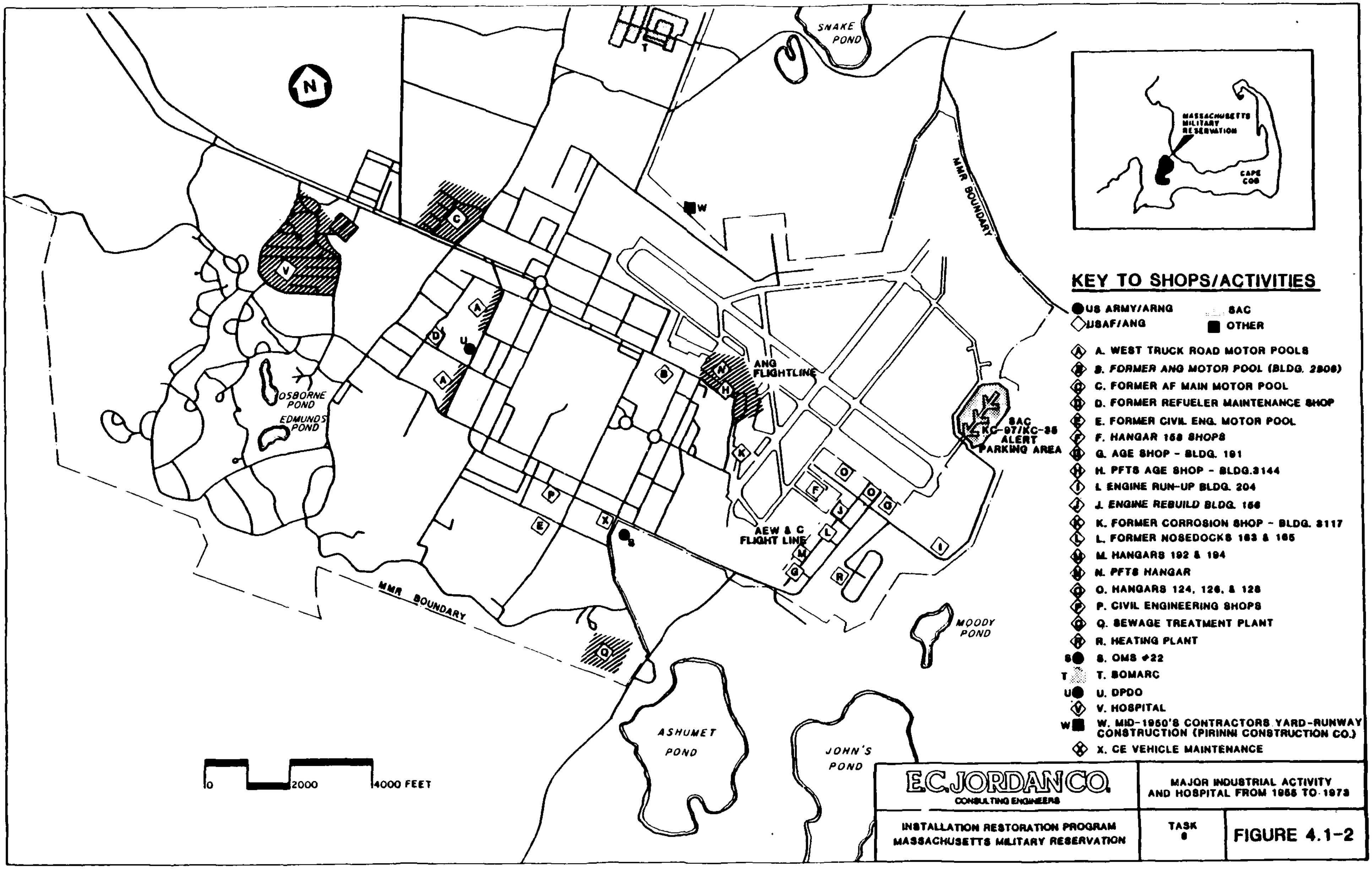
LABORATORY
ACTIVITY WASTE GENERATION

Shop Name	Location (Bldg. No.)	Waste Materials	Waste Quantity (gal/yr)*	1935	1945	Waste Management Practices 1955	1965	1975	1985
Air National Guard and Air Force Labs									
Photo Lab	158	Film developer	3000					To RI. DRMO	
		Film fixer	<200					To sanitary sewer	
		Silver	<120 lb/yr					To RI. DRMO	
Nondestructive Inspection Lab (NDI)	156	Penetrant	55					To contract disposal	
		Emulsifier	55					To contract disposal	
		Developer	10 lb/yr					To contract disposal	
		1,1,1-trichloroethane	12					To contract disposal	
		Inspection oil	<2					To contract disposal	
NDI Lab (Former)	3146	Penetrant, emulsifier, developer Halogenated solvents including TCE	450			To leaching Pit	to sanitary sewer		
Precision Measurement Equipment Lab (PMEL)		120	Isopropanol	0.5		All chemicals evaporate are discharged to the sanitary sewer			
		Methyl ethyl ketone	0.25						
		Trichloroflouroethane	0.25						
		Trichloroethylene	0.25						
ANG Medical Lab	169	Methanol	0.1				Discharged to sanitary sewer		
		Acetone	0.1						
		Sulfuric acid	0.25						
		Acetic acid	0.25						
Other Labs									
USDA Lab	1398	Pesticide residues	0.1 lb/yr			To base landfill			

* Units of waste quantity in gals/yr except where otherwise noted.



E.C. JORDAN CO. CONSULTING ENGINEERS	U.S. ARMY AND NAVY INDUSTRIAL ACTIVITY (1940 - 1946)	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 4.1-1

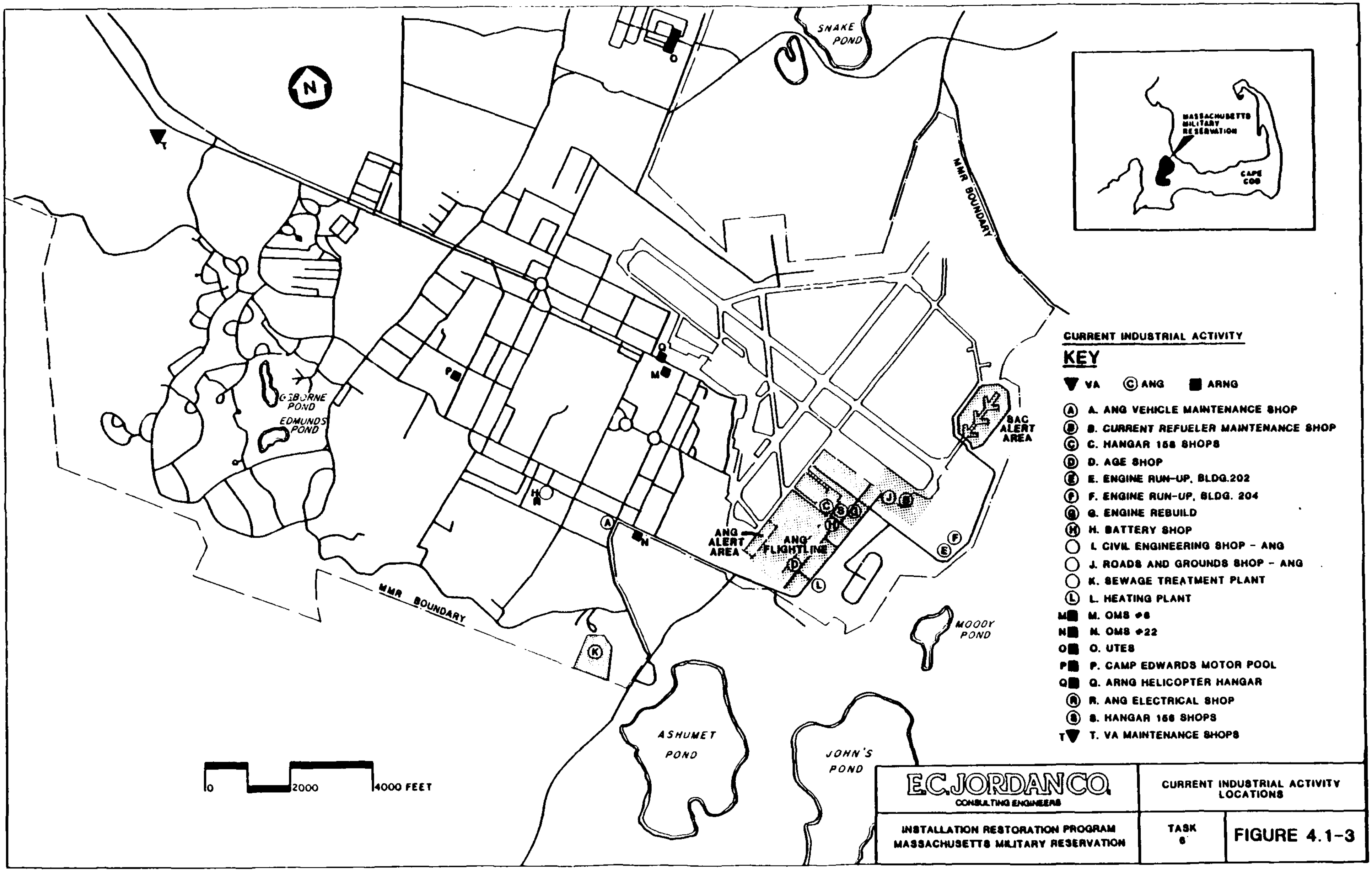


INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

MAJOR INDUSTRIAL ACTIVITY AND HOSPITAL FROM 1955 TO 1973

TASK 6

FIGURE 4.1-2



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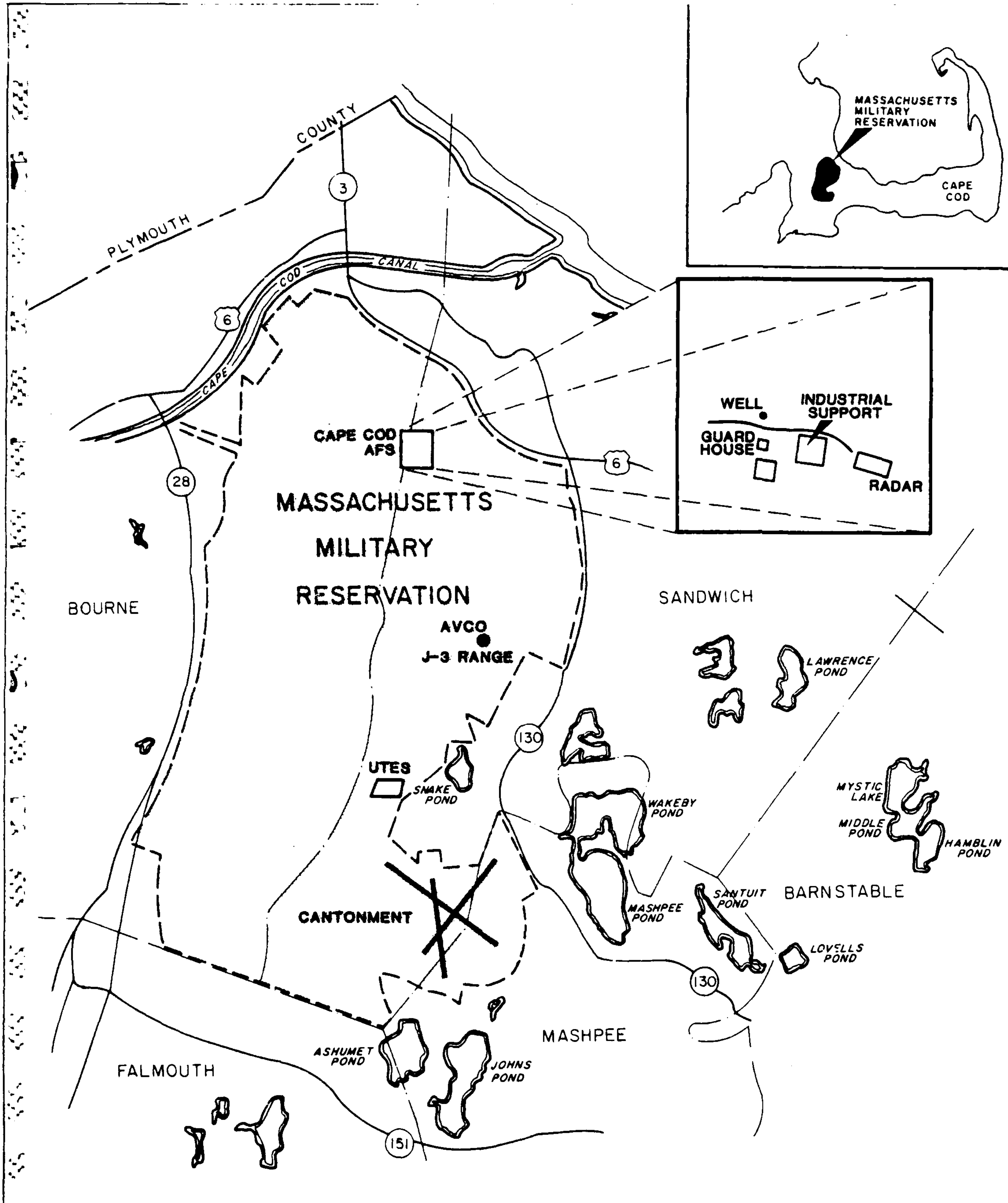
INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

CURRENT INDUSTRIAL ACTIVITY LOCATIONS

TASK 6

FIGURE 4.1-3



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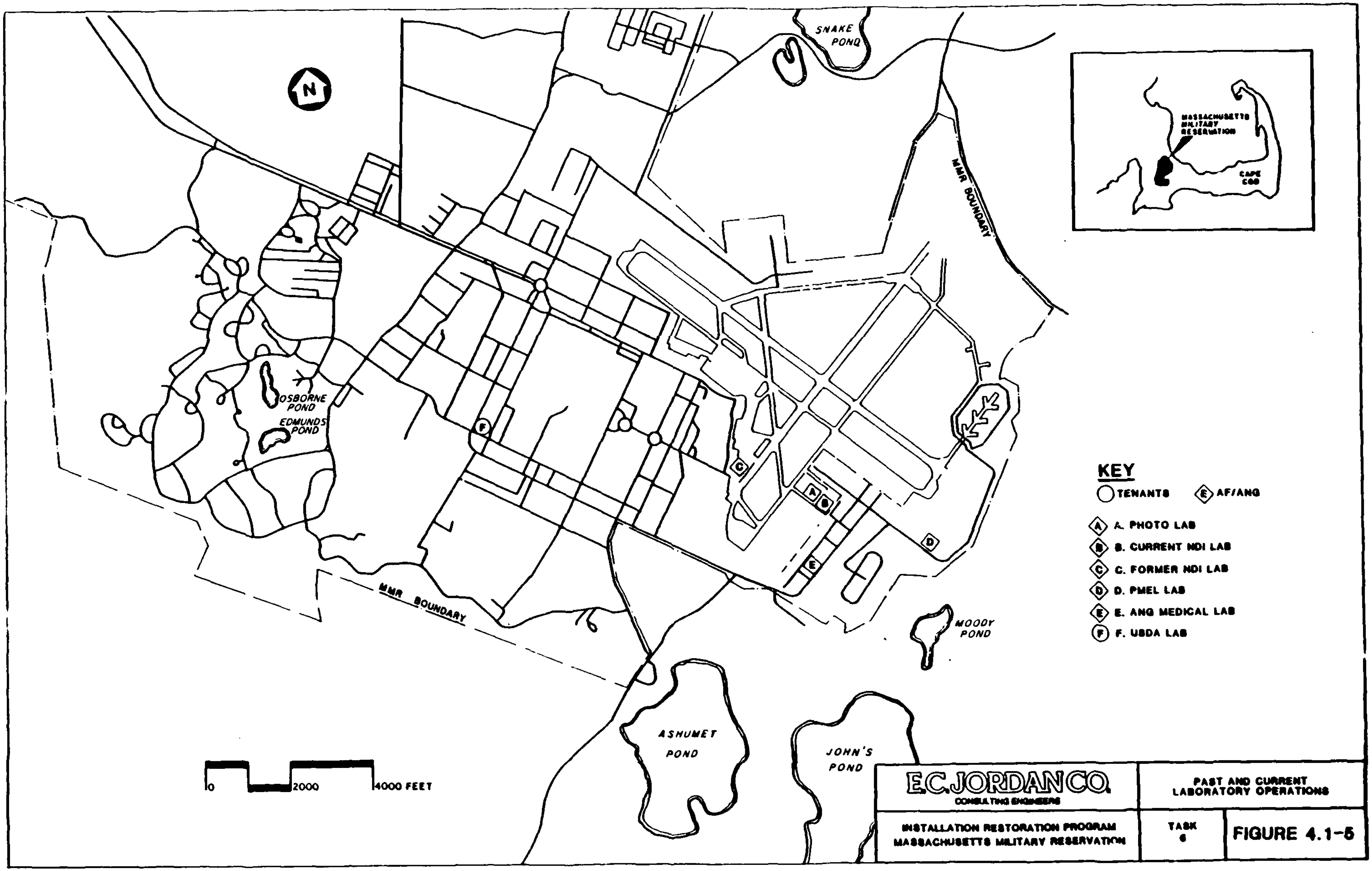
INDUSTRIAL AND RESEARCH & DEVELOPMENT ACTIVITY OUTSIDE THE CANTONMENT

INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

TASK 6

FIGURE 4.1-



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INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

PAST AND CURRENT LABORATORY OPERATIONS

TASK 6

FIGURE 4.1-5

4.1.1 Industrial Operations

4.1.1.1 ANG and Former USAF Shops.

Vehicle Maintenance Shops

Current Vehicle Maintenance Shop. The ANG civil engineering vehicle maintenance shop (Building 754) (Figures 4.1-2 and 4.1-3) opened in 1967. From 1967 to 1974, the shop was under USAF control and was responsible for 600 vehicles; since 1974 the maintenance shop has serviced 215 ANG vehicles. Waste generated on-site includes waste oil (1,200 gal/yr), halogenated and nonhalogenated solvents (50 gal/yr), ethylene glycol antifreeze (100 to 150 gal/yr), paint residues (<55 gal/yr), and waste battery electrolyte (300 gal/yr). Detailed records of the solvent chemicals used at the shop were not recovered. Expectedly, these would have included halogenated degreasers and petroleum distillate solvents in common use during this period. Until March 1985 waste oils, solvents, and paints were stored in a common bowser. Now these wastes are stored in separated containers. Since the shop opened, wastes have been picked up by the Davisville, Rhode Island, Defense Reutilization and Marketing Office (DRMO), formerly called the Defense Property Disposal Office (DPDO); the on-site DRMO; or an outside hazardous waste contractor. Battery electrolyte is neutralized and discharged to the sanitary sewer system. Floor drains in the building are discharged to an oil/water separator. Water from the separator is drained to a ditch on-site. Waste oil is currently stored in a 300-gal underground tank. This tank is pumped out by an outside contractor approximately every 2 months.

On September 29, 1984, a 4,500-gal spill of JP-4 fuel occurred behind the shop. The fuel was directed to a manhole that drains to a ditch nearby. The JP-4 spill was cleaned up immediately. The spilled JP-4 and and 75 cubic yards (cy) of contaminated soil were removed from the site. This spill is discussed in detail in Section 4.2-4.

Before 1967, USAF vehicle maintenance was carried out in Block 4100. This activity is discussed in the following paragraphs.

Former ANG West Truck Road Motor Pools. Formerly, two ANG motor pools were located at existing Army World War II motor pool locations on West Truck Road (see Figure 4.1-2). The first (Building 1753) was operated from 1954 to 1958. During that time the motor pool was responsible for approximately 100 vehicles. Oil changes and routine maintenance were performed on a periodic monthly basis. All waste oil, halogenated and nonhalogenated solvents, and ethylene glycol generated on-site were dumped along the back fence of the site. Cleaning of vehicles with petroleum distillate solvent (6 drums/yr) was performed on-site. Based on the generation rates for the current shop described in the preceding section, as much as 600 gal/yr of waste oil and 20 to 30 gal/yr of solvents were probably disposed of on the ground at this site.

In 1958 the ANG moved to Building 1532. This motor pool was responsible for about 120 vehicles with maintenance schedules similar to those serviced at Building 1753. Waste fluids were also dumped along the back fence of the site, probably at similar rates. In addition, as many as 25,000 gals (total) of JP-4 and aviation gasoline (AVGAS) were reportedly dumped at the two sites. This fuel dumping occurred when refueler trucks required maintenance.

At this location, an underground motor gasoline (MOGAS) tank failed a tank test conducted as part of the ANG fuels management and abandoned tank removal program in 1985 (see Section 4.1.5). Unknown quantities of MOGAS may have leaked into the subsurface.

Former ANG Motor Pool (Building 2806). From 1966 to 1973, Building 2806 (see Figure 4.1-2) served as a motor pool for the ANG. This motor pool maintained 90 vehicles. Wastes generated include waste motor oil, halogenated and nonhalogenated solvents, antifreeze, paint residues, and battery electrolyte. The quantity of waste generated and method of disposal are unknown. Dumping liquid wastes on the ground was common practice during that time period. Quantities of wastes probably were similar to the previous two motor pools, based on the number of vehicles serviced.

Former Air Force Main Motor Pool (Block 4100). From approximately 1954 to 1967, the main USAF motor pool was located at the corner of Connery Avenue and Turpentine Road (Block 4100) (see Figure 4.1-2). This motor pool was responsible for complete maintenance on all USAF vehicles except refuelers. All solvents, waste oils, and waste fuels generated were dumped on-site. The number of vehicles serviced is unknown but would be expected to be 200 to 400, based on the level of USAF activity overall.

Former Refueler Maintenance Shop (Building 3461). Building 3461 served as the USAF refueler maintenance shop and vehicle spray-paint shop from 1955 to approximately 1974. The location of this shop, which serviced 20 to 25 refuelers, is shown in Figure 4.1-2. Waste motor oil, halogenated and nonhalogenated solvents, antifreeze, paint residues, and battery electrolyte were generated. On-site dumping was common practice at the time. Unknown quantities of jet aircraft fuel (JP-4) and AVGAS from refueler trucks also were generated as waste at this location.

During WWII, Building 3461 served as a weapons repair facility for small arms and artillery used at MMR. Reportedly, unpacking of cosmoline-coated new weapons and weapons parts occurred. The degreasing agent(s) used are unknown.

Former USAF Civil Engineering/Roads and Grounds Motor Pool (Building 968). From 1950 to 1973, 300 heavy vehicles were maintained in the area of Building 968 (see Figure 4.1-2). Waste motor oil, halogenated and nonhalogenated solvents, antifreeze, paint residues, and battery electrolyte were generated during maintenance. Since on-site dumping was common practice at that time, it is probable that these wastes were dumped on-site.

Current ANG Refueler Maintenance Shop. The current ANG refueler maintenance shop has been located in Building 118 since 1974 (see Figure 4.1-3). The shop services nine refueler trucks. Wastes generated on-site include waste motor oil and petroleum distillate solvents (120 gal/yr), waste JP-4 (480 gal/yr), and battery electrolytes (variable quantities). These wastes are picked up by the Davisville, Rhode Island, DRMO or an outside contractor.

Aircraft Maintenance Shops

Aircraft maintenance has occurred at MMR since approximately 1940. USN and Army Air Corps operations occurred from 1941 to 1946; USAF, AEW&C, and Air Defense Operations from 1955 to 1970; and ANG operations from 1967 to the present. SAC refueler aircraft regularly used MMR for alert status parking during the 1960's but were not maintained at MMR. Refueler aircraft have used MMR for alert status parking only very infrequently since the early 1970's.

Hangars 156 and 158 CAMS Shops. The Consolidated Aircraft Maintenance (CAM) shops located within Hangars 156 and 158 have provided maintenance to USAF and ANG aircraft since 1955. The following shops, which generate solid and liquid hazardous wastes, are currently located within this area: Corrosion Control, Machine Shop, Sheet Metal Shop, Electrical Shop, Pneuhydraulics Shop, Tire Shop, Communications and Navigations Shop, MA-1 Radar and Weapons System Shops, Survival Shop, Egress Shop, and the Engine Shop.

The Corrosion Control Shop uses polyurethane coatings, paints, paint strippers (containing xylene, toluene, acetone, MEK, MIBK, and methylene chloride), as well as TCA, chlorofluorocarbon degreasers, and petroleum distillate solvents. The majority of these materials are used in process or evaporate. This shop has been located in Hangar 158 since 1942. Liquid solvent wastes are disposed as shown in Table 4.1-1.

The Sheet Metals Shop uses limited quantities of paints, chlorofluorocarbon degreasers, and MEK. These also generally are used in process or evaporate. Liquid wastes from this shop are disposed as shown in Table 4.1-1.

The Electrical Shop repairs aircraft electrical systems and components. Principal wastes from this shop are variable quantities of used nickel-cadmium, lead-acid batteries, and spent electrolyte. Electrolyte was neutralized and discharged to the storm drainage system until 1982. Since 1982 these wastes have been collected by the Davisville, Rhode Island, DRMO for off-site disposal. Used battery cases have been disposed of by reclaiming through either MMR DRMO or the Davisville, Rhode Island, DRMO.

The Pneuhydraulics Shop services the pneumatic and hydraulic systems of aircraft. This shop uses petroleum distillate solvents (petroleum naphtha 360 gal/yr) and limited quantities of hydraulic fluid. This shop utilizes facilities in both Building 156 and 158. In Hangar 156 a sonic cleaner/vapor degreaser is used for parts cleaning. This system employs PCE and o-dichlorobenzene. Approximately 10 gal/yr of each of these are generated as waste. These wastes are disposed as shown in Table 4.1-1. As shown, PCE formerly may have been discharged to a leaching pit adjacent to Hangar 156. This is further discussed in Section 4.2.3.

The Tire Shop is located in Hangar 156 and maintains aircraft wheels and tires. The waste generated from this shop includes recycled petroleum distillate and halogenated solvents, which are disposed as shown in Table 4.1-1.

The Communication and Navigation Shop located in Building 158 maintains the communications and navigations systems of aircraft. This shop uses limited quantities (<10 gal/yr) of halogenated solvents (methylene chloride and TCA) and petroleum distillates. The majority of this evaporates at the point of use.

The MA-1 System Shops service the aircraft radar and weapons fire control systems. These operations are located in Building 158. Limited quantities of dichlorofluoromethane and trichlorofluoromethane are used for parts cleaning. These evaporate in use. Approximately 40 gal/yr of TCA are used in this shop system. The portion of this degreaser that does not evaporate in process is handled as shown in Table 4.1-1.

The Survival and Egress Shops are located in Hangar 158. These shops maintain the personnel parachutes, aircraft drogue chutes, and canopy/seat ejection systems. Limited quantities (<20 gals) of paints and solvents (toluene, MEK, methylene chloride) are used for this activity. These materials in general are used in process or evaporate. Any liquid wastes are disposed as shown in Table 4.1-1. Explosive charges used in the ejection systems and ammunition/rockets for armament are checked in and out through the ammunition storage facility.

The Engine Shop and Fuel System Repair Facility are located in Building 156. These shops repair fuel systems, engine bearings, and other engine components of jet aircraft engines. Waste oil from engines, residual JP-4, and petroleum distillate solvent wastes are generated by this shop and disposed as shown in Table 4.1-1. One to two engines are drained per month. This generates 25 to 30 quarts of engine oil waste. Approximately 20 gals of waste JP-4 is generated in fuel system maintenance. Approximately 55 gal/yr of petroleum distillate fuel calibrating solution are disposed of. Petroleum distillate solvent (PD-680) and waste JP-4 from bearing repair and from fuel line and tank repair are disposed of as shown in Table 4.1-1.

Current approximate total waste generation from these shops includes spent petroleum distillate solvents (860 gal/yr), halogenated solvents, MEK, MIBK, toluene, xylene, acetone solvents and degreasers (500 gal/yr), battery electrolyte (2 gal/yr), used lead and nickel-cadmium batteries, paint wastes (150 gal/yr), and waste oil (5,000 gal/yr). Currently, these wastes are picked up by the Davisville, Rhode Island, DRMO. Past waste disposal practices are shown in Table 4.1-1. Waste generation rates from 1970 to the present are similar.

From 1955 to 1970, these hangars primarily serviced large numbers of EC-121 aircraft. During the period 1955 to 1970, a much higher level of aircraft maintenance activity than at present occurred in support of the USAF AEW&C mission and air defense described in Section 2.2. Approximately 45 EC-121 AEW&C aircraft were stationed at MMR during this period, reportedly except for 2 yrs in which a total of approximately 80 EC-121 aircraft were maintained. In the performance of the overall AEW&C mission, 20 planes were kept in the air at all times, and maintenance occurred on a 24-hour/day, 7-day/week basis. Types of wastes generated would have been similar to those described previously, except that the waste fuel would have been AVGAS from the EC-121s. Maintenance of jet aircraft for the USAF 60th FIW would have generated waste JP-4 and solvents at rates similar to current operations. Records for operations during this period were lost at the time the installation was transferred from USAF to ANG control. Information regarding the EC-121 operations was derived from interviews with former aircraft maintenance personnel and others knowledgeable of the former activity (see Appendix C). The previous Records Search Report (Metcalf and Eddy, 1983), primarily dealt with ANG operations. During the 1950's and 1960's, ANG Flight Operations were located in the former Navy facility on the west side of the runway area (see Figure 4.1-1). The ANG operations also would have generated quantities and types of wastes similar to present rates shown in Table 4.1-1. As indicated in the 1983 Record Search, the ANG wastes during the 1950's and 1960's were dumped into the storm sewer system or disposed of through the Defense Property Disposal Office (DPDO) (now DRMO). The former ANG aircraft maintenance operations are described in the following paragraphs.

EC-121 aircraft maintenance was not described in the 1983 report except for the fuel dump valve testing operation at the northeast corner of the taxiway/runway area (see Section 4.2.4). Interviews with former maintenance personnel indicated that the requirement for rapid maintenance turnaround resulted in solvents and fuels being dumped on the aircraft parking area and nosedocks. Large areas of staining can be seen on the parking area in aerial photographs of the area. The quantities of fuels and waste solvents used and disposed during this period are unknown but are expected to be many times current generation rates. Figure 4.1-6 shows an aerial photograph of the EC-121 maintenance area in 1967. Solvents and AVGAS (which contains lead) so disposed would have evaporated or been washed into the storm drainage system either by rainfall or manually to prevent fire hazards. The relative quantities evaporating or reaching the storm drain system and outfalls are unknown.

During the AEW&C maintenance period, cleaning solvents used on-site included MIBK, MEK, toluene, and large amounts of chlorinated solvents, including TCE and possibly PCE. As a result of fuel dump valve testing, a total of 200 to 1,000 gal/week of AVGAS may have been dumped into storm drains behind Hangar 158. This is in addition to the fuel wastage that occurred at the AVGAS fuel dump site described in Section 4.2.4. Waste oil was reportedly also dumped into storm drains. Storm drains from the EC-121 Maintenance and Parking areas discharge to the four storm drainage channels that lead off-base to the south (see Section 4.2.1).

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OBLIQUE AERIAL PHOTOGRAPH OF
EC-121 PARKING/MAINTENANCE AREA,
20 JUNE, 1967

INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

TASK
6

FIGURE 4.1-6

Radon tubes used in the radar systems of the EC-121 were changed once a year in the hangar. Four to five tubes per plane (total: 200 tubes/yr) were changed. These tubes, however, contained very low radiation levels [10^{-7} to 10^{-9} pico-Curies (pCi)/tube]. These tubes reportedly were disposed of in the base landfill or buried at the gravel pit located on the corner of Herbert and Dolan Roads.

In addition to the these activities, a vapor degreaser was operated in Hangar 156 for the purpose of cleaning engine parts, particularly new parts and whole EC-121 engines preserved in cosmoline. Reportedly, TCE and PCE were used in this operation. The majority of the solvent vapor was recycled and reused. Oily wastes, probably commingled with solvent, were discharged or washed via floor drains to a leaching pit located outside of Hangar 156.

Aerospace Ground Equipment Shops (AGE). Since 1958 Buildings 191 and 192 have served as locations for the USAF and ANG Aerospace Ground Equipment Shops (AGE). Wastes generated include petroleum distillate and halogenated solvents (1,320 gal/yr), other petroleum distillates (240 gal/yr), MEK and toluene (144 gal/yr), and petroleum wastes (1,600 gal/yr). Until 1981 most of the solvents used were dumped on the ground to flow into the storm drain systems that lead south through the coal/ash storage area and the drainage for the petroleum fuel storage area. Relative quantities evaporating and entering the drainage system are unknown. Since 1981 these wastes have been picked up by the Davisville, Rhode Island, DRMO. Petroleum wastes are also sent to the Davisville DRMO.

From 1959 to 1971, Building 3144 was the AGE shop for the ANG PFTS. Antifreeze, cleaning solvents, paint thinners, and waste oils (quantity unknown) were dumped into a drain at the front of the building. This drain discharges to the aquafarm storm drainage system.

Engine Run-up Stand. Since October, 1985, the engine run-up stand has been located at Building 202. After engines have been repaired, they are tested in the run-up area. The only waste currently generated from this operation is waste JP-4 (variable quantity). This is picked up by an outside contractor.

The engine run-up area was located in the area of Building 204 from 1949 to 1985. Before 1954 the run-up area was located within the building, and wastes were washed to a drywell. From 1954 to 1970, engine run-up was located outside on a concrete pad; wastes were washed off the pad and into the ground. Wastes generated during this time included waste fuel (180 gal/yr) and waste PD-680 solvent (1,000 to 1,500 gal/yr).

Engine Rebuild Area. The engine rebuild area (Building 156) includes an engine operations shop, a paint stripping operation, and a wash rack operation. The Non-Destructive Laboratory (NDI), which is also located in this area, is discussed in Section 4.1.2. Wastes generated in the engine rebuild area include paint stripper (175 gal/yr), solvent (halogenated and nonhalogenated) (300 gal/yr), and waste POL (1,000 gal/yr). Paint stripper is disposed of by an outside contractor. Solvent also is disposed of by an outside contractor; however, reportedly, quantities of these materials may be dumped into the sinks and discharged to the sanitary sewer. Waste oil is sent to the Davisville, Rhode Island, DRMO.

Former Corrosion Control Shop. From 1956 to 1972, the Corrosion Control Shop was located in Building 3117. Shop operations included painting and fiberglassing. Wastes generated in this operation were similar to those for the current corrosion control shop. The quantities generated and method of disposal of waste are unknown. Most of the solvents and strippers used probably evaporated in use.

Former Nosedocks. Buildings 163 and 165 served as Nosedock Hangars for routine maintenance of EC-121s from 1955 to 1970. Waste oil solvents and fuel were discharged to storm drainage (South Outer Drainage Basin No. 2), as well as probably being turned into DPDO (now DRMO).

Hangars 124, 126, and 128. From 1955 to 1970, Hangars 124, 126, 128 were used to maintain from 18 to 21 EC-121 aircraft. During maintenance operations waste oil, fuel, and solvent were generated. The method of disposal is unknown. In accordance with common practice, these wastes would have been turned into DPDO (now DRMO) or dumped onto the ground to be washed into the stormwater drainage system. The USCG currently occupies Hangar 128 for maintenance of fixed-wing aircraft. USCG operations at MMR have been described in a separate Phase I Report.

Battery Shop. Since 1975 the ANG has maintained a battery shop in Building 163. Lead acid batteries are stored in the shop. During the first 8 to 10 yrs of operation, acid was drained into a sink that discharged directly to the ground on-site. Now battery acid is collected and sent to the Davisville, Rhode Island, DRMO. Battery cases have been disposed of through the DPDO (now DRMO) in the past.

Former Maintenance Hangars 192 and 194. From 1955 to 1971, Hangars 192 and 194 were used for aircraft maintenance. Waste oils, fuel, and solvents were generated on-site. Method of disposal for these wastes is unknown.

Permanent Field Training Site Hangar (PFTS). Building 3140 was used as the PFTS Hangar from 1958 to 1971. The PFTS hangar was maintained to support ANG training. During this time, solvents, paint thinners, waste oils, JP-4, and AVGAS (up to 1,500 gal/yr total) were discharged to the aquafarm storm drainage system.

Strategic Air Command (SAC). During the period from 1955 to the present, SAC has utilized the "Christmas tree" parking area at the northeast corner of the runway area as an alert parking area for KC-97 and KC-135 refueler aircraft. This activity was constant from 1955 to approximately 1972. Since that time, the alert area has been used only sporadically. No maintenance, fueling, or defueling of SAC aircraft was done at MMR. Because no wastes were stored, generated, or disposed of on-site, this area is not shown on Table 4.1-1.

Civil Engineering Shops and Operations.

Civil Engineering Shops. Since 1958 ANG and USAF Civil Engineering Shops have been located in Building 971. Shops located in Building 971 include the Electrical Shop, the Plumbing Shop, the Sheet Metal Shop, and the Painting/Carpentry Shop. The Plumbing Shop generates waste cutting oil (5 gal/yr), and the Painting and Carpentry Shop generates paint residues and thinners (55 gal/yr). The Electrical Shop uses limited, variable quantities of solvents for parts cleaning. These include petroleum distillates, toluene and MEK, TCA, and SS-25 solvent, which is a mixture of petroleum distillate (50%), PCE (35%), and methylene chloride (15%). Most of this material evaporates or is used in process. Residual wastes reportedly have been disposed of by the DRMO or outside contract.

Roads and Grounds Shop. The current Roads and Grounds Shop began operations in 1973 in Building 124. The shop is responsible for the maintenance of the roads and grounds belonging to the ANG. Wastes generated from operations include petroleum distillate solvent (110 gal/yr), herbicide residues in water (156 gal/yr), and waste oil (200 gal/yr). The petroleum distillate solvent (PD-680) is used in vehicle washing. This washwater is discharged to an oil/water separator that discharges to Reilly Road Drainage Basin. Herbicide residuals and container rinsings are generally applied at the site of use. Limited quantities have been discharged to the sanitary sewer in the past. Waste oil has been sent to the DRMO.

Sewage Treatment Plant. In 1936 a 0.9-million gal/day (mgd) primary wastewater treatment plant was constructed. The plant is located at the southern boundary of the reservation near the Falmouth-Mashpee town line (see Figure 4.1-1). In 1941 a new 3.0-mgd secondary treatment plant was constructed at the same location to replace the primary plant. Renovations, which included the addition of alternative facilities and rehabilitation of eight of the original 24 sand filter beds and two of the original 22 sludge drying beds, were made in 1983. The secondary plant now includes a skimming tank, Imhoff tanks, trickling filters, secondary clarifiers, sand filter beds, and sludge drying beds. The location of these facilities is shown on Figures 4.1-2 and 4.1-3.

Influent to the plant is received from base housing, as well as from various shops, labs, and buildings on the reservation. As shown in Table 4.1-1 and described in the preceding paragraphs, disposal of waste battery electrolyte; limited quantities of paint stripping chemicals (methylene chloride, toluene, acetone); and solvents such as MEK, MIBK, and halogenated compounds may have been dumped into the sanitary sewer system. Particularly, such wastes have been generated from the Engine Rebuild Shop, the Precision Measurement Equipment Lab (PMEL) and the former NDI laboratory (see Section 4.1.2). Effluent from the plant is discharged to sand filters. Sludge is pumped to sludge drying beds. Up until the late 1960's, sludge was removed from the drying beds and piled in a field behind the treatment plant. Sludge is now disposed of in the base landfill. As a result of the low current level of activity at MMR, the plant must recirculate water at a rate of 2,000 gal/min to keep the plant operating effectively.

Table 4.1-1 indicates the period and method of disposal of sludge and sewage effluent from the sewage treatment plant. The effluent has formed a plume of elevated concentrations of nitrogen and phosphorous, low oxidation-reduction potential, and elevated dissolved solids. VOCs have been detected off-base in the area of the plume. This plume has been extensively studied by the USGS (LeBlanc, 1984) and is the subject of ongoing studies by USGS and Phase II studies under the current MMR IRP. The focus of the Phase II studies is to characterize hazardous contaminants in the influent and effluent of the treatment plant and to determine whether VOC contamination observed to the south of MMR can be attributed to the sewage treatment plant or other sources. Groundwater and surface-water quality in the area south of MMR has been described in Section 3.4.

Heating Plant. Since 1956 the central heating plant (Building 160) has generated heat and hot water for most of the buildings on the MMR. Approximately 8,700 tons/yr of bituminous coal are used to fire the three boilers. Fly-ash and bottom-ash are generated from the combustion of this coal. This ash is stored on the ground behind the plant. Coal is also stored in a pile on-site. Metals and polycyclic aromatic hydrocarbons (PAHs) may have leached from these coal and ash piles to the ground. Vegetation stress observed in the vicinity of this coal and ash storage may be a result of the coating of leaves by particulate matter.

Waste oils (150 gal/yr) and solvents (30 gal/yr) are also generated from the process. Until 1978 these wastes were dumped on-site. Since that time, they have been disposed of by an outside contractor.

4.1.1.2 Army and Army National Guard Industrial Operations

Vehicle Maintenance Shops.

Organizational Maintenance Shops (OMS). Two Organizational Maintenance Shops (OMS) operated by the Massachusetts Army National Guard are located at MMR. The location of these shops is shown in Figure 4.1-3.

OMS No. 6. OMS No. 6 (Building 2806) was opened in 1974; since then the shop has been responsible for 140 vehicles. Waste generated at the site includes waste oil (500 gal/yr), solvents (50 gal/yr), and waste battery electrolyte (35 gal/yr). Currently, these wastes are drummed, sent to Building 4600 for storage, and, finally, sent to the Ft. Devens, Maryland, DRMO for disposal. Parts-cleaning solvent is provided and disposed of by an outside contractor. Until 1985 battery acid was neutralized and discharged to the sanitary sewer. Now it is diposed of through Ft. Devens, Maryland, DRMO. Current Product Tank No. 88, an underground tank containing MOGAS, failed a leak test in 1985. Evaluation of a potential leak from this tank is currently being undertaken by DFAE. POL handling, storage, and disposal are described in Section 4.1.5.

OMS No. 22. OMS No. 22 has been located in Building S-2 since 1950. Since then, the maintenance shop has been responsible for maintenance of from 20 vehicles (1950) to 300 vehicles (1986). Wastes generated during the maintenance processes include waste oil (up to 250 gal/yr) and paint thinner (approximately 20 gal/yr), as well as petroleum distillate and halogenated solvents (50 gal/yr). Past disposal practices generally occurring at MMR indicate that some on-site dumping of these wastes probably occurred in the years before 1970. Currently, organic liquid wastes are handled in a manner similar to wastes generated at OMS No. 6. Until 1984 OMS No. 22 wastewater was discharged to an on-site septic system. Waste battery electrolyte (50 gal/yr) generated on-site was neutralized and discharged to the septic system until 1984. Now battery acid is also shipped to the Ft. Devens DRMO. Currently, the shop is connected to the sanitary sewer system.

Current Product Tank 90, which is an underground MOGAS tank at the site, failed a pressure leak test. The tank was installed in 1954. Another underground tank at an unknown location and with unknown contents is located somewhere in the OMS No. 22 site. The location and status of these two tanks are being evaluated as a component of the MMR hazardous waste and underground tank removal program.

Unit Training Equipment Site (UTES). The Unit Training Equipment Site (UTES) maintenance shop began operating in the 4600 Block of MMR in 1976. This is adjacent to the MMR eastern boundary (see Figure 4.1-3). The shop is responsible for the maintenance of 300 to 350 heavy and tracked vehicles. Wastes generated include waste oil (1,000 gal/yr), halogenated and nonhalogenated solvents (50 gal/yr), and battery electrolyte (variable quantities). Waste oil is stored in drums or in an on-site underground tank and then picked up for disposal by the Ft. Devens, Maryland, DRMO. Spillage of waste oil has been documented in the area of the underground tank. Currently, parts cleaning solvent is provided and disposed of by an outside contractor. Since 1981 waste battery electrolyte has been disposed of through the Ft. Devens, Maryland, DRMO; prior to that, acid was neutralized and discharged to the sanitary sewer. Waste generation for UTES is shown in Table 4.1-1.

The 4600 Block at MMR was developed in 1962 as a BOMARC ground-to-air missile site. BOMARC activities are described in a separate paragraph in this section. From the cessation of BOMARC activity in 1973 to the development of UTES, no industrial activity occurred in the 4600 Block. As described in Section 3.4.2, groundwater contamination by PCE has been observed at an AEHA monitoring well located at the southern edge of the site and at two other AEHA wells located near the site. No contamination has been detected in a monitoring well cluster located just off-base to the east of the UTES site.

Building 4600, located at UTES, has been used for Camp Edwards/ARNG hazardous waste storage since 1982. At the time of the site visit, the following materials were stored at the hazardous waste storage facility.

Item	RCRA Code	Quantity (gal)
Cleaning solvent degreaser (waste flammable liquid NOS)	D001	60
Waste battery electrolyte	D002	110
Waste oil	M001	1700
Waste solvent NOS	M003	55
Waste solvent NOS	F004	55
Hazardous waste solid NOS (oil absorbent)	M001	550

Camp Edwards Current Motor Pool. Since 1976 the Camp Edwards motor pool has been located in Building 1368 (see Figure 4.1-3). Waste oils and halogenated and nonhalogenated solvents have been generated on-site. The First Battalion, 25th Marines Motor Pool is co-located with the Camp Edwards Motor Pool. A total of 135 vehicles are currently maintained at this location. This number of vehicles has been relatively constant since 1976. Exact quantities of disposed wastes were unavailable. All wastes are picked up by the Ft. Devens DRMO or disposed off-site by a private hazardous waste contractor.

Former Army WWII Motor Pools. When Camp Edwards was built in 1941, each regiment had its own motor pool that serviced from 130 to 450 vehicles each. These motor pools were located along the North, South, East, and West Outer Truck Roads. Table 4.1-3 shows the units occupying Camp Edwards in 1945 and the total numbers of vehicles maintained. Records do not exist regarding disposal methods. Common practice would have been to either dump vehicle maintenance wastes at each individual motor pool or to place such wastes in the Camp Edwards landfill. Solvents in common use at that time were kerosene and carbon tetrachloride. Waste oil, solvents, paint residues, antifreeze, and MOGAS generated during vehicle maintenance were dumped on-site. These motor pools were in operation until 1946.

Aircraft Maintenance and Support Shops

Current Helicopter Maintenance Hangar. Since 1973 the ARNG 26th Aviation Battalion Helicopter Maintenance Hangar has been located in Building 2816 (see Figure 4.1-3). Thirty-seven helicopters and one fixed-wing aircraft are maintained at the hangar. Wastes generated on-site include waste oils (1500 gal/yr) and solvents (TCE, toluene, petroleum distillates) (50 gal/yr). These wastes are picked up by the Ft. Devens DRMO. In 1980 a 200-gal JP-4 spill occurred at this hangar location (see Section 4.2.4).

Waste POL and solvents are stored at the edge of the concrete/asphalt pad outside the hangar. Limited ground staining suggests spillage of small quantities of waste oil and/or solvents.

4.1.1.3 Other Industrial Operations at MMR.

Defense Property Disposal Office (DPDO)

The base Defense Property Disposal Office (DPDO) operated in Building 1532 from 1956 to 1983 (see Figures 4.1-2 and 4.1-3). Since 1985 the DPDO has been renamed DRMO. During the operations at MMR, the office was termed DPDO. Wastes were transported to the DPDO from shops and labs operating at MMR; potential hazardous wastes consisted primarily of scrap metal, used battery cases, transformers and electrical gear, waste oils, solvents, and fuels. Often the waste substances were commingled. Waste liquids were stored on an unbermed pad in barrels and tank trailers or in underground tanks that were former West Truck Road MOGAS tanks. From the base DPDO, wastes were transported to other DPDOs or to an outside contractor. The amount of wastes handled is unknown.

BOMARC Site

A BOMARC air defense missile system was installed at MMR in 1962. This system was located in the 4600 Block (see Figure 4.1-2) of MMR and consisted of a power plant, a fire station, security and administration buildings, a missile maintenance building, a fueling and defueling facility, fuel and oxidizer storage tanks, a hazardous waste treatment system, and 56 missile hangars. History, mission, and organization of the BOMARC system are described in Section 2.0. The BOMARC facility was operational from 1962 to 1973 and operated as a self-contained, secure area. Waste generation for the BOMARC operation is summarized in Table 4.1-1.

The BOMARC missile was a nuclear-warhead-equipped missile that was powered by both a liquid hypergolic fuel rocket and a ram jet engine. It was designed to act as a ground-to-air missile that would intercept an approaching flight of enemy aircraft. No specific operations records exist for BOMARC at MMR; BOMARC maintenance was managed by SAC.

Industrial operations that generated hazardous waste at this site were the missile guidance system maintenance, fuel and engine system maintenance, and fueling/defueling. Maintenance of the guidance systems would have been expected to use significant quantities of solvents, primarily halogenated hydrocarbons. During the period of BOMARC activity, these would likely have been methylene chloride, TCA, TCE, and possibly PCE. Freon-type solvents (chlorofluoromethanes) might have been used in the last few years of BOMARC activity. Quantities of solvents used and waste disposal methods are unknown. The majority of solvent probably evaporated in use. Waste JP-4 was generated as a result of engine/fuel delivery maintenance and probably as a result of requirements to prevent failure of the system due to aged fuel. The disposal method for waste JP-4 is unknown; however, it is likely that it was turned in to the base DPDO.

A hazardous liquid storage and waste treatment system was in place to handle the highly reactive fuel and oxidizer components of the hypergolic rocket fuel. Separate systems were used to handle the red fuming nitric acid (RFNA) oxidizer and the Aerozine 50 fuel. Aerozine 50 is made up of a 50:50 mixture of unsymmetrical dimethyl hydrazine (UDMH) and hydrazine. RFNA from defueling of rockets for maintenance was discharged to a leaching pit after neutralization in limestone. RFNA decomposes to nitrogen oxides, water, and nitric and nitrous acids (HNO_2 and HNO_3). No major spills or accidents were reported for RFNA handling at MMR. RFNA is extremely toxic and reactive; however, it is nonpersistent in the environment because of its extreme reactivity. UDMH $C_2H_8N_2$ and hydrazine N_2H_4 are also highly reactive and extremely toxic and are strong reducing agents. Because of the nature of the rocket fuel, extremely careful handling precautions would have been in place to prevent spills of either compound and to prevent any mixing of the two materials.

Hydrazine and UDMH are used in industrial and military applications as rocket propellant, in boiler feed water deoxygenation, in fuel cells, and as a blowing agent. The BOMARC missile system used UDMH or a 50:50 mixture of UDMH and hydrazine (called Aerozine 50) as rocket fuel. In the BOMARC the fuel (UDMH or Aerozine 50) was reacted with a strong oxidizing agent, RFNA, to propel the missile. This liquid fuel/oxidizer combination is termed a hypergolic rocket fuel because it reacts spontaneously upon mixing. The purpose of this discussion is to summarize the environmental fate (degradation) of these compounds as handled at the MMR BOMARC site.

Hydrazine, UDMH, and RFNA are highly reactive compounds. Uncontrolled mixing of RFNA with either fuel material results in immediate fire or explosion. In addition, hydrazine and UDMH rapidly and spontaneously react with air by a process called auto-oxidation. Because of the strong reactivity of these chemicals, they are highly toxic, causing severe chemical burns in cases of direct contact with the liquid material and severe irritation of the mucous membranes of the eyes and respiratory tract even at trace concentrations in air. Because of these factors, handling and storage of hypergolic rocket fuels, such as those used in BOMARC, have always been conducted with extreme caution to prevent human exposure, environmental release, or mixing of fuel and oxidizer chemicals. Storage is maintained in specially designed storage vessels and piping that do not react with the fuels or allow them to be exposed to air. Personnel handling the fuel and oxidizers are protected by totally encapsulated suits and self-contained breathing apparatus. Because of the conservative handling precautions, the types of spills normally associated with petroleum-type fuel handling do not occur. Special emergency procedures have always been in place to contain accidental release where hypergolic fuels are handled.

At the MMR BOMARC site, the fueling-defueling operations were conducted under carefully controlled conditions. RFNA, which behaves like nitric acid, was disposed of in a leaching pit by neutralizing by crushed limestone under controlled conditions to produce water and nitrate. Hydrazine and UDMH were pumped into a waste fuel tank and carefully released at a slow rate into a sump to allow complete auto-oxidation to nitrogen gas, nitrogen oxides, and water for hydrazine-nitrogen gas, nitrogen oxides, water, and carbon dioxide for UDMH. The breakdown of hydrazine and UDMH is further discussed below. All of the hydrazine, UDMH, and RFNA storage and transfer were conducted aboveground. The neutralization and auto-oxidation sumps were the only subsurface structures involved in hypergolic fuels handling at MMR.

The normal handling of all BOMARC fuels resulted only in the release of nitrogen gas, water, carbon dioxide, nitrogen oxides, and nitrate. Nitrate in concentrations >10 mg/L as nitrogen can cause adverse health effects. Nitrate released from the RFNA breakdown would be diluted in groundwater to background concentrations before it could have affected any potable water supply wells. Nitrate does not bind to soil and, therefore, would no longer be present at the BOMARC site.

Hydrazine has the chemical formula N_2H_4. It reacts rapidly and spontaneously with the oxygen in air to form nitrogen gas, oxides of nitrogen, and water. The oxides of nitrogen produced by this reaction are also produced by combustion of gasoline and other fuels.

UDMH has the chemical formula $N_2C_2H_8$. It is very similar to hydrazine with the exception that two hydrogen atoms in the hydrazine are replaced by two methyl (CH_3) groups in UDMH. These methyl groups are common to hydrocarbon compounds. UDMH reacts rapidly and spontaneously with the oxygen in air to form nitrogen gas, water, nitrogen oxides, and carbon dioxide. The source of the carbon dioxide is the carbon from the methyl groups. The disposal of UDMH from BOMARC defueling resulted in reaction of UDMH with air in the disposal sump. Nitrogen and carbon dioxide were evolved as gases. The nitrogen oxides formed reacted with water to form small quantities of nitrate. Disposal at a controlled rate would have generally allowed complete reaction of the UDMH.

Only under conditions when not enough air is present to allow complete oxidation are other compounds formed from UDMH. Under conditions where oxygen is limited, small amounts of the compound N-nitrosodimethylamine are formed. This might occur as a result from disposal of the UDMH from a spill. No UDMH spills were reported at MMR, however. Only very small quantities of N-nitrosodimethylamine would have been formed during disposal of UDMH from the BOMARC site. N-nitrosodimethylamine is a priority pollutant and a suspected carcinogen. It is one of the compounds implicated as potential cancer-causing agents in bacon and other meats preserved with nitrites and nitrates. N-nitrosodimethylamine is degraded in the environment by bacteria. None of this material is expected to remain as a result of the former BOMARC activities.

UDMH from rocket defueling was disposed of into a septic system and allowed to auto-oxidize. The quantities of UDMH disposed are unknown. No analyses for N-nitrosodimethylamine have been reported for MMR groundwater. The former UDMH septic system has been filled with earth. No record of materials buried in this system exists.

Former Munitions Shop

From 1941 to 1946, Building 3461, used later for vehicle maintenance (see Section 4.1.1.1), was used as a weapons repair shop. Small arms and artillery components were unpacked and repaired at the site. Cosmoline, a petroleum jelly preservative, was removed from the guns with degreasing solvent. Unknown quantities of the cosmoline and waste solvent may have been dumped on the ground at this location.

Hospital and Hospital Heating Plant

From 1945 to 1972, the U.S. Army and USAF operated a hospital in the 3700 and 3800 Blocks. At one time, the facility had 1500 beds. Reagents and solvents (150 gal/yr) used on-site were discharged to the sanitary sewer system. A coal-fired heating plant provided heat, steam, and hot water for the hospital. Coal was stored in a 40' x 40' pit on-site. Ash from this plant was landfilled at this location. The buildings were demolished in 1972. Construction debris, including large quantities of friable asbestos insulation, was left scattered throughout the area.

Cape Cod AFS

Industrial activities at Cape Cod AFS consist of support for the operation of the AN/FPS-115 radar system. This includes provision of standby electrical power, space heating, steam, and hot and chilled water. Variable quantities of waste lube oil are generated from the bearings of the diesel generators. This constitutes the principal waste generated by Cape Cod AFS. Boiler/condenser water conditioners are used to control slime, scale, and corrosion in the steam, chilled, and hot water system. These chemicals are used in process. Water conditioning chemicals used are non-toxic and biodegradable and are oxygen scavengers, polymer dispersants, and corrosion inhibitors. No zinc or chromates are used. The algicide used in the cooling tower is AQUACIDE 400®, a quaternary amine compound, which is registered and approved by EPA. This compound is produced by AQUA Laboratories, Inc., Amesbury, Massachusetts.

Waste oils are stored on a concrete pad beside the generator room. All solid and liquid industrial waste is containerized and disposed of off-site by a private disposal contractor.

VA Roads and Grounds Shop

The VA has operated a vehicle maintenance shop since 1980 to house and maintain equipment for groundskeeping at the National Cemetery of Massachusetts. Approximately 100 to 150 gal/year of waste POL and petroleum distillate solvent waste are generated. This is stored in a 600-gallon underground tank and disposed of yearly by an off-site oil recylcing contractor. This underground tank has not been tested for leakage. Vehicle maintenance and washing are carried out in three shop bays. Floor drains from these bays discharge to a leaching pit through an oil water separator. Vehicle refueling and pesticide formulation (Section 4.1.3) are carried out on a tarmac surface in the shop/garage area. Spills on this surface would be carried into a storm drain and/or flow to the edge of the tarmac and discharge into a small wetland/pond immediately south of the maintenance yard. Reportedly, no spills have occurred in the five-year history of operations.

U.S. Navy. During the latter part of WWII (1944-1945), the USN operated advanced aircraft carrier flight training from MMR (see Section 2.2). According to the Naval Historical Center (1986), over 160,000 landings and takeoffs were recorded. The locations of USN Aircraft maintenance are shown in Figure 4.1-1. Quantities of wastes and disposal methods for this period are unknown. Wastes would have included AVGAS, waste oils and solvents (both halogenated and nonhalogenated), and painting wastes.

4.1.2 Laboratory Activities

Laboratory operations on MMR are performed by the ANG photo lab, the NDI, the ANG PMEL, the ANG medical lab, and the USDA lab. Laboratory waste generation and disposal methods are summarized in Table 4.1-2. The operations are briefly described in the following paragraphs. The locations of laboratory operations at MMR are shown in Figure 4.1-5. USCG laboratory activity at MMR has been described in a separate Phase I report prepared as a component of the ongoing MMR IRP.

Photo Lab.

Since 1979 the ANG photo lab has been located in Building 158. In addition to developing photographs, the lab collects fixer from the ANG medical clinic, the NDI lab, and photo debriefing. The lab processes this fixer for the removal of silver. The wastes generated include film developer (3,000 gal/yr), film fixer (<200 gal/yr), and silver (<120 lb/yr). Film developer and silver are sent to the Davisville, Rhode Island, DRMO. Film fixer, after being processed for silver removal, is discharged to the sanitary sewer.

Non-Destructive Inspection Lab (NDI).

The NDI lab has been in operation in Building 156 since 1978. The purpose of the lab is to test the structural integrity of aircraft parts. Currently, as part of the testing procedure, waste penetrant (55 gal/yr), emulsifier (55 gal/yr), developer (10 lb/yr), 1,1,1-trichloroethane degreaser (12 gal/yr), and inspection oil (<2 gal/yr) are generated. Currently, these wastes are picked up by an outside contractor.

From 1955 to 1978, the NDI lab was located in Building 3146. At total of 450 gal/yr of waste penetrants; TCE; and other halogenated solvents, emulsifiers, and developers were generated in the testing process at this lab. From 1970 to 1978, these wastes were discharged to the base sanitary sewer system. Before 1970 wastes were discharged to a leaching pit or dry well behind the building; this dry well drained to the aquafarm stormwater drainage system.

Precision Measurement Equipment Lab (PMEL).

Since 1955 the PMEL lab has been located in Building 120. Test equipment is repaired and calibrated at the lab. Solvents used at the site include isopropanol (0.5 gal/yr), MEK (0.2 gal/yr), trichloroflouroethane (0.25 gal/yr), and TCE (0.25 gal/yr). The majority of the solvent evaporates. Limited quantities currently are discharged to the sanitary sewer.

ANG Medical Lab.

Since 1972 the ANG medical lab has been located in Building 169. The lab is responsible for performing the required physical examinations and immunizations for the 102 FIW. Small amounts of methanol, acetic acid, sulfuric acid, and acetone are generated. These wastes are discharged to the sanitary sewer after dilution.

Other Labs

USDA Lab.

Since 1960 the USDA has conducted research in Buildings 286 and 240. From 1963 to 1969, the lab tested insecticides for private companies. Residuals from the pesticides (totaling approximately 0.1 lb/yr) were disposed of at the base landfill. These pesticides, however, reportedly included aldrin, chlordane, DDT, toxaphene, dieldrin, endrin, and heptachlor. The major focus of the USDA laboratory since 1960 has been development of biological control measures for the gypsy moth. Laboratory and bench-scale testing occurs currently. Pesticide chemicals tested are inventoried and controlled by EPA, and unused chemicals as well as soil or materials contaminated by a test material, are returned to the manufacturer or disposed of by an EPA-approved disposal contractor. The USDA laboratory participated in monitoring the Japanese beetle pesticide application and is described in Section 4.1.3.

4.1.3 Pesticide Storage, Handling, and Disposal

ANG and ARNG.

Integrated pesticide and herbicide management programs do not exist at MMR. Since 1983 ANG has contracted to an outside contractor for pest management services. From 1970 to 1983, ANG pesticide storage occurred at Building 1116. Since 1983 this building has been used by Camp Edwards to store small quantities of pesticide. Pesticide wastes for the period 1970 to 1983 were delivered to DPDO for disposal. Prior to that time, pesticide wastes reportedly were disposed of into the landfill. Neither ANG nor ARNG have a large pest management program; therefore, only limited quantities of material likely were landfilled. Recordkeeping for both ARNG and ANG has been sporadic. At the current pesticide shop, mixing of pesticides occurs outside on an unbermed pad. Washwater or spills of pesticide from this source could be washed onto the ground at this location.

Limited herbicide application is done by ARNG and ANG roads and grounds crews. ARNG herbicides are stored and mixed at Building 1116; ANG herbicide mixing, storage, and disposal are conducted at Hangar 124, as described in Section 4.1-1.

Systematic records for pest management prior to 1970 do not exist. In 1963, however, 2,700 acres of the cantonment and runways were treated with dieldrin to prevent the spread of Japanese beetles. This was carried out as a component of a program to control this infestation at airfields in the eastern U.S. (Smith, 1963; USDA, 1962; USDA, 1963). Thirty pounds per acre of 10 percent dieldrin was applied to the cantonment and runways. Application of chlordane was scheduled for the housing area as a part of this program. According to USDA laboratory records (USDA, 1983), this latter application was not carried out.

VA.

Pesticides have been stored at the VA maintenance facility (see Figure 4.1-3) since 1980. These are mixed on the tarmac maintenance area and applied to control inf .tations on the National Cemetery. Reportedly, sevin is applied routinely for gypsy moth control and lindane for tree borers. Pesticide container rinsate formulations and equipment rinse water are sprayed on the application area. The pesticide mixing area is unbermed, however, and spills can flow into the maintenance area storm drainage system, which discharges to a small kettle hole wetland adjacent to the area. Pesticide is stored in the maintenance garage in the hazardous and flammable storage locker. A floor drain in the locker leads to a leaching pit located outside of the building. No spills have been reported; however, the leaching pit and wetland are located less than 300 yards from the VA water supply well.

4.1.4 PCB Handling, Storage, and Disposal

Electric power distribution at MMR, except at Cape Cod AFS, has been under ANG control since 1973. Prior to that time, this activity was under USAF and U.S. Army control. No PCB-containing or contaminated electrical equipment is in place at Cape Cod AFS (TSI, 1981). Material with a PCB content <50 ppm is not regulated under the Toxic Substances Control Act (TSCA). Under TSCA, PCB-contaminated material is defined as material with PCB concentrations between 50 and 500 ppm. PCB-containing equipment is equipment in which oils have a PCB content >500 ppm. No records exist for PCB/electrical equipment handling prior to ANG control. No reports exist of major spills, leaks, or other environmental contamination by PCBs on MMR with the exception of the USCG transmitter station. Potential PCB disposal at this location is described and evaluated as a component of a separate Phase I report prepared under the ongoing MMR IRP.

The electrical distribution system at MMR consists of two main substations, the East Substation (located adjacent to Building 1164) and West Substation (located adjacent to Building 3471). Approximately 450 to 500 transformers, capacitors, and switching apparatus are located at MMR.

A PCB compliance inspection of MMR was performed by EPA in 1984 (EPA, 1985). PCB-containing or contaminated equipment was located at both substations and at the electric service room in Building 3169. The locations of these areas are shown in Figure 4.1-7. A program of transformer oil testing is in place at MMR.

Out-of-service transformers are stored in Building 768 (see Figure 3.1-7). At the time of the EPA inspection, 56 transformers were in storage.

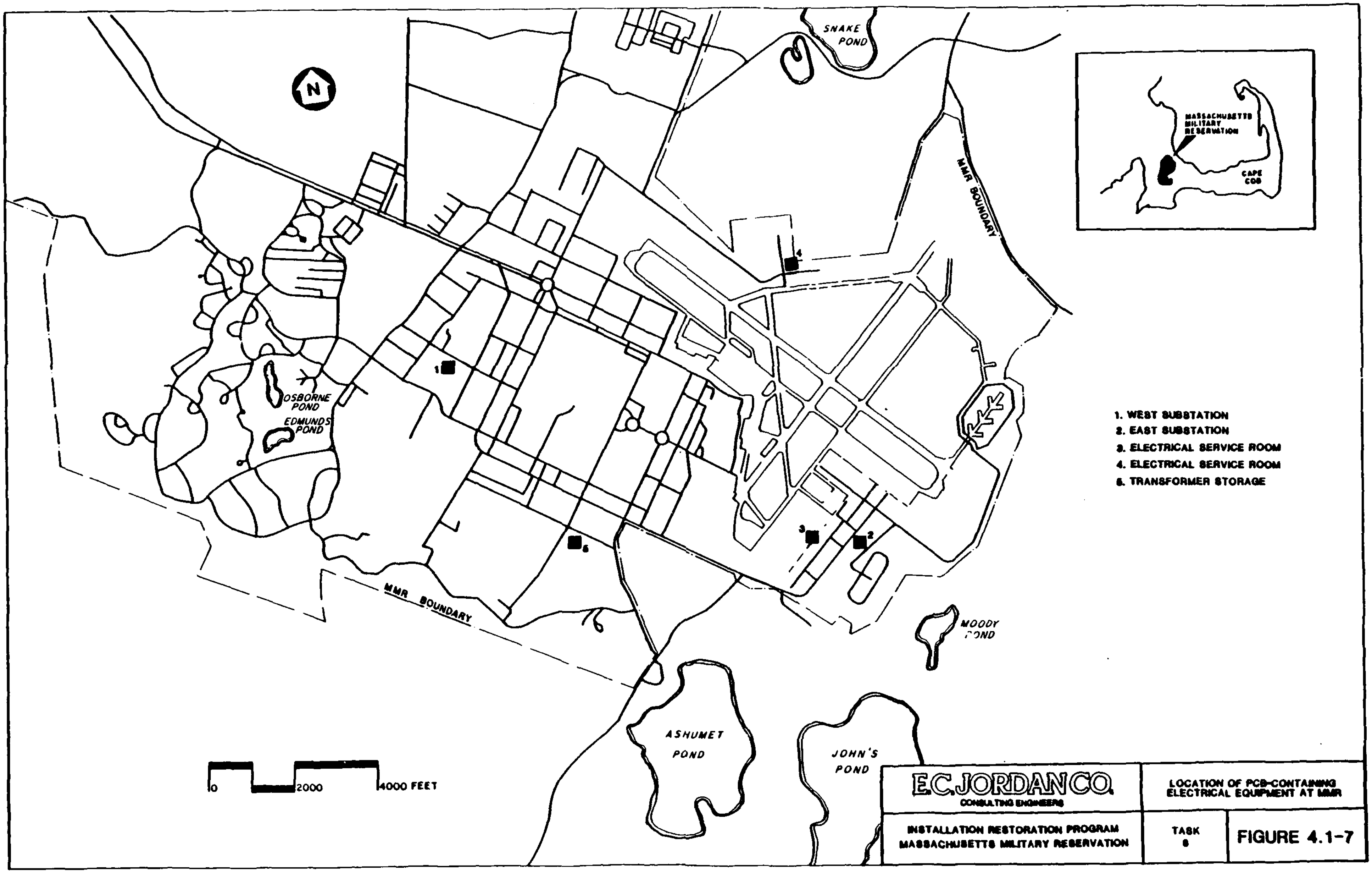
4.1.5 POL Storage, Handling, and Disposal

The types of POL used and stored at MMR include MOGAS, diesel fuel, fuel oil, propane, AVGAS, JP-4, kerosene, hydraulic fluid, and various grades of lubricating oil. The existing POL storage facilities for the ARNG and ANG, respectively, are listed in Tables 4.1-4 and 4.1-5. Abandoned POL storage facilities are listed in Tables 4.1-6 and 4.1-7. Locations of these facilities are shown in Figure 4.1-8.

POL spill management and waste disposal for the ANG are addressed in the Contingency Plan - Spill Prevention Control and Countermeasures (102nd FIW 1985). POL spill management and waste disposal for ARNG are addressed in the "Spill Prevention Control Plan and Installation Spill Contingency Plan," Camp Edwards, June 1985. The major fuel storage area at MMR consists of three aboveground storage tanks. These were identified as the Petroleum Fuel Storage Area in the Phase II, Stage I report prepared by Weston (1985). This area is currently under further Phase II investigation as a component of the current MMR IRP. Two tanks (CPT-15 975,000 gal, CPT-16 602,000 gal) contain JP-4, and the other tank (CPT-17 344,000 gal) contained JP-4 in the past but presently contains fuel oil. Each tank is diked for spill containment. In the past, these tanks were filled via two underground pipeline systems shown in Figure 4.1-9. A 3-inch underground line extends from the Cape Cod Canal at Sandwich to a fuel cutoff station on the reservation. Reportedly, this line was used from 1965 to 1973. Two 10-inch underground lines, used from 1955 to 1965, extend from a railroad fuel pumping station to the fuel cutoff station. The railroad fuel pumping station was identified as a potential contamination site in the former Phase I study (Metcalf and Eddy, 1983) and investigated as a part of the original Phase II, Stage I program (Weston, 1985). The railroad fuel pumping station is under evaluation for further Phase II study under the current MMR IRP. From the fuel cutoff station, two 10-inch pipes, one for JP-4 and one for AVGAS, delivered fuel to the storage tanks. Reportedly, the 10-inch lines from the railroad fuel pumping station were abandoned in 1965. Because of leaks, the 3-inch pipeline from Sandwich was abandoned in 1973 (see Table 4.2-4). All fuel has been transported to the storage tanks by truck since 1973.

Reportedly, after shutdown the 3- and 10-inch lines were left in place and were not drained. At the railroad fuel pumping station, the pipeline headers have been left sticking up from the land surface. The 10-inch lines ran a distance of over 6,000 ft to the pumping station. The 3-inch line was routed down the right-of-way of Greenway Road. This line is approximately seven and a half miles long, based on the distance from the Cape Cod Canal to the fuel cutoff station.

Fuel (JP-4) is distributed from the petrol fuel storage area via underground pipelines to either of two pump stations (Buildings 174 and 123) located on the



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CONSULTING ENGINEERS

INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

LOCATION OF PCB-CONTAINING ELECTRICAL EQUIPMENT AT MMR

TASK 6

FIGURE 4.1-7

TABLE 4.1-3

CAMP EDWARDS
WORLD WAR II MOTOR POOLS

Unit	Location	Block	No. of Vehicles
1. Special Troops	East Truck Rd.	31	168
2. 101st A.C.Ob. Squad	Near Airfield	31	14
3. 101st Medical	East Truck Rd.	3 & 4	198
4. 101st Engineers	East Truck Rd.	5	231
5. 104th Infantry	South Truck Rd.	6 & 7	254
6. 181st Infantry	South Truck Rd.	8 & 9	273
7. 182nd Infantry	South Truck Rd.	10 & 11	254
8. 101st Infantry	West Truck Rd.	12 & 13	273
9. 102nd F.A. Regiment	West Truck Rd.	14 & 15	295
10. 180th F.A. Regiment	West Truck Rd.	16 & 17	369
11. 101st Q.M. Regiment	Connery Ave	35	544
12. C.A.S.C. 5th Ordinance	Near Frank Perkins Rd.	36	75
13. Co.C 84th Q.M./Co. D 54th Q.M.	Turpentine Rd.	19 & 20	265
14. Co's A&B 22nd Q.M.	Turpentine Rd.	19 & 20	202
15. 101st F.A. Regiment	North Truck Rd.	22 & 23	295
16. 102nd C.A.A.A.	Greenway Rd.	21	139
17. 208th C.A.A.A.	North Truck Rd.	24 & 25	362
18. 198th C.A.A.A.	North Truck Rd.	26 & 27	362
19. 68th C.A.A.A. & 36th C.A. Brigade	North Truck Rd.	28 & 29	452
Total		5025	

Notes:

A.C. Ob. Squad = U.S. Army Air Corps Observation Squadron
F.A. = Field Artillery
Q.M. = Quarter Master
C.A.S.C. = Coastal Artillery Supply Corps.
C.A.A.A. = Coastal Artillery Anti-Aircraft
C.A = Coast Artillery

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TABLE 4.1.-4
EXISTING POL STORAGE FACILITIES
CAMP EDWARDS/ARNG
(see Figure 4.1-8 for Tank Locations)

LOCATION	KEY	# OF TANKS	CAPACITY (GAL)	CONTENTS	CONSTRUCTION MATERIAL	INSTALLATION DATE	ABOVE/ UNDERGROUND	OWNER/ OPERATOR	TANK TESTED	TANK DISPOSITION
Bldg 2806	CPT 88	1	10,000	MOGAS	Steel	1968	Under	Comm of Mass/ OMS #6	Yes	Under study
Bldg 52	CPT 89	1	12,500	Diesel	Steel	1979	Under	Comm of Mass/ OMS #22	No	Remain in service
	CPT 90	1	5,000	MOGAS	Steel	1954	Under	Comm of Mass/ OMS #22	Yes	Under study
UTES	CPT 91	1	6,000	MOGAS	Steel	1962	Under	U.S. Govt/ CP Edwards	Yes	Under study
	CPT 92-93	2	5,000	Diesel	Steel	---	Tanker	U.S. Govt/	No	Remain in service
	CPT 94	1	1,200	MOGAS	Steel tank trucks	---	Tank trucks	U.S. Govt/ CP Edwards	No	Remain in service
	CPT 95-99	5	600	Fuel Oil	Steep pods	---	Above	U.S. Govt/ CP Edwards	No	Remain in service
Bldg 3594	CPT 100-101	2	5,000	MOGAS	Steel	1941	Under	U.S. Govt/ CP Edwards	Yes	Under study
	CPT 102-103	2	5,000	Diesel	Steel	1941	Under	U.S. Govt/ CP Edwards	Yes	Under study
Bldg 3693	CPT 104	1	5,000	MOGAS	Steel	1941	Under	U.S. Govt/ CP Edwards	Yes	Under study
	CPT 105	1	5,000	Diesel	Steel	1941	Under	U.S. Govt/ CP Edwards	Yes	Under study
Bldg 1368	CPT 106	1	5,000	Diesel	Steel	1941	Under	U.S. Govt/ CP Edwards	Yes	Under study
	CPT 107-108	2	5,000	MOGAS	Steel	1941/52	Under	U.S. Govt/ CP Edwards	Yes	Under study
Bldg 2816	CPT 109-110	2	1,200	JP-4	Steel tank trucks	---	Tank trucks	Comm of Mass/ AASF	No	Remain in service
	CPT 111	1	1,300	JP-4	Steel tank trucks	---	Tank trucks	Comm of Mass/ AASF	No	Remain in service
	CPT 112	1	5,000	JP-4	Steel tank trucks	---	Tank trucks	Comm of Mass/ AASF	No	Remain in service
	CPT 113	1	1,200	AVGAS	Steel tank trucks	---	Tank trucks	Comm of Mass/ AASF	No	Remain in service

TABLE 4.1.-4 CONT'D.
EXISTING POL STORAGE FACILITIES
CAMP EDWARDS/ARNG
(See Figure 4.1-8 for Tank Locations)

LOCATION	KEY	# OF TANKS	CAPACITY (GAL)	CONTENTS	CONSTRUCTION MATERIAL	INSTALLATION DATE	ABOVE/ UNDERGROUND	OWNER/ OPERATOR	TANK TESTED	TANK DISPOSITION
Bldg 4021	CPT 114	1	10,000	Fuel oil	Steel	1960	Under	U.S. Govt/ CP Edwards	Yes	Under study
Bldg 1820	CPT 115	1	500	Fuel oil	Steel	1970	Under	U.S. Govt/ CP Edwards	Yes	Removed 6-18-85
Bldg 3451	CPT 116	1	2,000	Fuel oil	Steel	1978	Under	U.S. Govt/ CP Edwards	Yes	Under study

NOTE: CPT denotes current product tank

TABLE 4.1-5
EXISTING POL STORAGE FACILITIES/ANG
(see Figure 4.1-8 for Tank Locations)

Tank Location	Capacity (gals.)	Aboveground (AG) Underground (UG)	Former Contents	Current Contents	Date Installed	Date Leak Tested	Future Plans	Location
Current Product Tank								
1	25,000	UG	--	JP-4	1957	--	JP-4	Bldg. 123
2	25,000	UG	--	JP-4	1957	--	JP-4	Bldg. 123
3	25,000	UG	JP-4	Empty	1957	--	JP-4	Bldg. 123
4	25,000	UG	--	JP-4	1956	--	JP-4	Bldg. 123
5	25,000	UG	MOGAS	MOGAS	1960	--	MOGAS	Bldg. 145
6	25,000	UG	AVGAS	AVGAS	1956	--	Deicing	Bldg. 178
7	25,000	UG	AVGAS	AVGAS	1956	--	Deicing	Bldg. 178
8	25,000	UG	AVGAS	AVGAS	1956	--	MOGAS	Bldg. 178
9	25,000	UG	AVGAS	AVGAS	1956	--	MOGAS	Bldg. 178
10	25,000	UG	Diesel	Empty	1956	--	Diesel	Bldg. 178
11	30,000	UG	JP-4	JP-4	1960	--	JP-4	Bldg. 174
12	30,000	UG	JP-4	JP-4	1960	--	JP-4	Bldg. 174
13	50,000	UG	JP-4	JP-4	1960	--	JP-4	Bldg. 174
14	50,000	UG	JP-4	JP-4	1960	--	JP-4	Bldg. 174
15	967,500	AG	JP-4	JP-4	1955	--	JP-4	Bulk Stor.
16	602,000	AG	JP-4	JP-4	1955	--	JP-4	Bulk Stor.
17	344,000	AG	JP-4	Fuel oil	1950	--	Fuel oil	Bulk Stor.
18	25,000	UG	AVGAS	MOGAS	1941	--	Remove	Adj. 3192
19	25,000	UG	AVGAS	MOGAS	1941	--	Remove	Adj. 3192
20	25,000	UG	AVGAS	Deicing fld.	1941	--	Remove	Adj. 3192
21	25,000	UG	AVGAS	Deicing fld.	1941	--	Remove	Adj. 3192
22	25,000	UG	AVGAS	Water	1941	--	Remove	Block 3000
23	25,000	UG	AVGAS	Water	1941	--	Remove	Block 3000
24	25,000	UG	AVGAS	Water	1941	--	Remove	Block 3000
25	25,000	UG	AVGAS	Water	1941	--	Remove	Block 3000
26	25,000	UG	AVGAS	Water	1941	--	Remove	Block 3000
27	25,000	UG	AVGAS	Empty	1941	Apr 1985	Remove	Block 3000
28	10,000	UG	MOGAS	MOGAS	1969	--	MOGAS	Bldg. 754
29	5,000	UG	Diesel	Diesel	1969	--	Diesel	Bldg. 754
30	1,000	UG	MOGAS	MOGAS	1969	--	MOGAS	Bldg. 754
50	1,000	UG	--	Fuel oil	1965	--	Fuel oil	Bldg. 104
51	275	AG	--	Fuel oil	1978	--	Fuel oil	Bldg. 154
52	275	UG	--	Fuel oil	1980	--	Fuel oil	Bldg. 176
53	500	UG	--	Fuel oil	1952	--	Fuel oil	Bldg. 201
54	500	UG	--	Fuel oil	--	--	Fuel oil	Bldg 322
55	275	AG	--	Fuel oil	--	--	Fuel oil	Bldg. 601
56	275	UG	--	Fuel oil	1968	--	Fuel oil	Bldg. 753
57	3,000	UG	--	Fuel oil	1960	--	Fuel oil	Bldg. 769
58	400	UG	--	Fuel oil	1960	--	Fuel oil	Bldg. 769
59	275	AG	--	Fuel oil	1955	--	Fuel oil	Bldg. 3211
60	300	UG	--	Fuel oil	1985	--	Fuel oil	Bldg. 3212
61	275	AG	--	Diesel	--	--	Diesel	Bldg. 104
62	275	AG	--	Diesel	--	--	Diesel	Bldg. 122
63	275	AG	--	Diesel	--	--	Diesel	Bldg. 124
64	275	AG	--	Diesel	--	--	Diesel	Bldg. 130
65	275	AG	--	Diesel	--	--	Diesel	Bldg. 131
66	275	AG	--	Diesel	--	--	Diesel	Bldg. 137
67	550(2 Tanks)	AG	--	Diesel	--	--	Diesel	Bldg. 146

TABLE 4.1-5
EXISTING POL STORAGE FACILITIES/ANG
(see Figure 4.1-8 for Tank Locations)

Tank Location	Capacity (gals.)	Aboveground (AG) Underground (UG)	Former Contents	Current Contents	Date Installed	Date Leak Tested	Future Plans	Location
Current Product Tank								
68	550(2 Tanks)	AG	--	Diesel	--	--	Diesel	Bldg. 160
69	300	AG	--	Diesel	--	--	Diesel	Bldg. 161
70	275	AG	--	Diesel	--	--	Diesel	Bldg. 167
71	--	--	--	Diesel	--	--	Diesel	Bldg. 175
72	275	AG	--	Diesel	--	--	Diesel	Bldg. 186
73	1,000	UG	--	Diesel	--	--	Diesel	Bldg. 191
74	275	AG	--	Diesel	--	--	Diesel	Bldg. 201
75	275	AG	--	Diesel	--	--	Diesel	Bldg. 322
76	275	AG	--	Diesel	--	--	Diesel	Bldg. 601
77	275	AG	--	Diesel	--	--	Diesel	Bldg. 700
78	--	UG	--	Diesel	--	--	Diesel	Bldg. 711
79	--	UG	--	Diesel	--	--	Diesel	Bldg. 770
80	275	UG-AG	--	Diesel	--	--	Diesel	Bldg. 971
81	500	UG	--	Diesel	--	--	Diesel	Bldg. 3002
82	275	AG	--	Diesel	--	--	Diesel	Bldg. 3213
83	300	AG	--	Diesel	--	--	Diesel	Bldg. 3306
84	500	UG	--	Diesel	--	--	Diesel	Bldg. 3309
85	275	AG	--	Diesel	--	--	Diesel	Bldg. 5025
86	275	AG	--	Diesel	--	--	Diesel	Bldg. 7060
87	275	AG	--	Diesel	--	--	Diesel	Bldg. 9003

Adj = Adjacent to
-- = No data

TABLE 4.1-6
ABANDONED TANK INVENTORY
CAMP EDWARDS/ARNG
(see Figure 4.1-8 for Tank Locations)

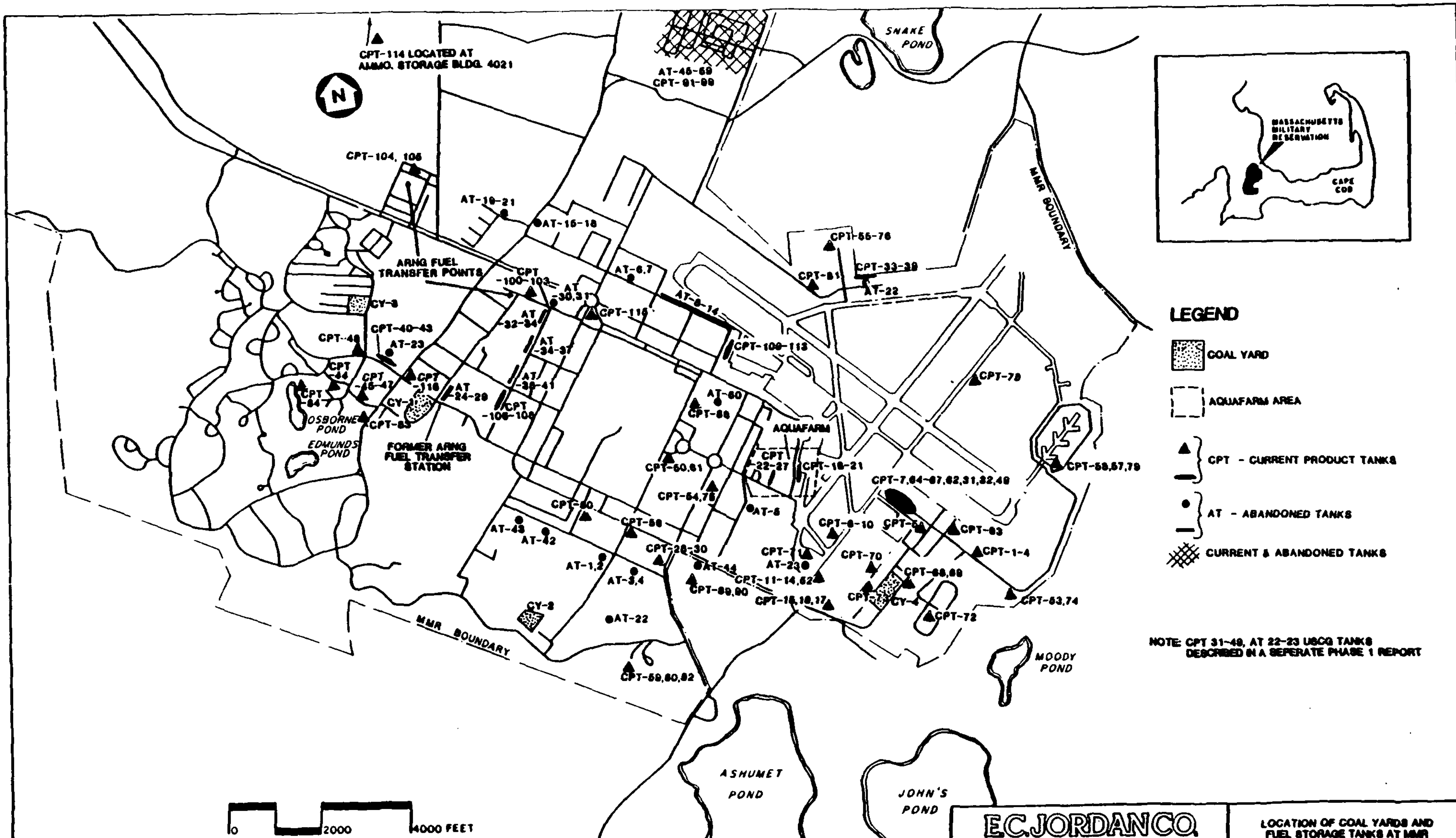
LOCATION	KEY	# OF TANKS	CAPACITY (GAL)	CONSTRUCTION MATERIAL	INSTALLATION DATE	ABOVE/ UNDERGROUND	ORIGINAL CONTENTS	PRESENT CONTENTS (GAL)	OWNER/ OPERATOR	TANK TESTED	TANK DISPOSITION
3400 Area	At 24-29	6	10,000	Steel	1941	Under	MOGAS	7,000	U.S. Govt/ CP Edwards	No	Removal 1985
DPDO Yard	At 30-37	8	5,000	Steel	1941	Under	MOGAS	Empty	U.S. Govt/ DLA	No	Removal 1985
1500 Area	At 38-41	4	5,000	Steel	1941	Under	MOGAS	700	U.S. Govt/ CP Edwards	No	Removal 1985
1100 Area	At 42-43	2	5,000	Steel	1941	Under	MOGAS	10,000	U.S. Govt/ CP Edwards	No	Removal 1985
Bldg S2	At 44	1	500	Steel	1960	Under	Fuel oil	Empty	Comm of Mass/ OMS #22	No	Removal 1985
UTES	At 45	1	475,000	Steel	1960	Above	Fuel oil	Empty	U.S. Govt/ CP Edwards	No	Mothball
	At 46	1	5,000	Steel	1960	Above	Propane	2,000	U.S. Govt/ CP Edwards	No	Removal 1985
	At 47	1	25,000	Steel	1960	Under	Fuel oil	25,000	U.S. Govt/ CP Edwards	No	Removal 1985
	At 48	1	4,000	Steel	1960	Under	Fuel oil	300	U.S. Govt/ CP Edwards	No	Removal 1985
	At 49-50	2	10,000	Stainless steel	1930	Under	JP-4	20,000	U.S. Govt/ CP Edwards	Feb 85	Removal 1986
	At 51	1	5,000	Stainless steel	1960	Under	JP-4	5,000	U.S. Govt/ CP Edwards	No	Removal 1986
Bldg 2806	At 60	1	350	Steel	1972	Under	Waste oil	Empty	Comm of Mass/ OMS #6	Feb 85	Removal 1986

At = Abandoned Tank.

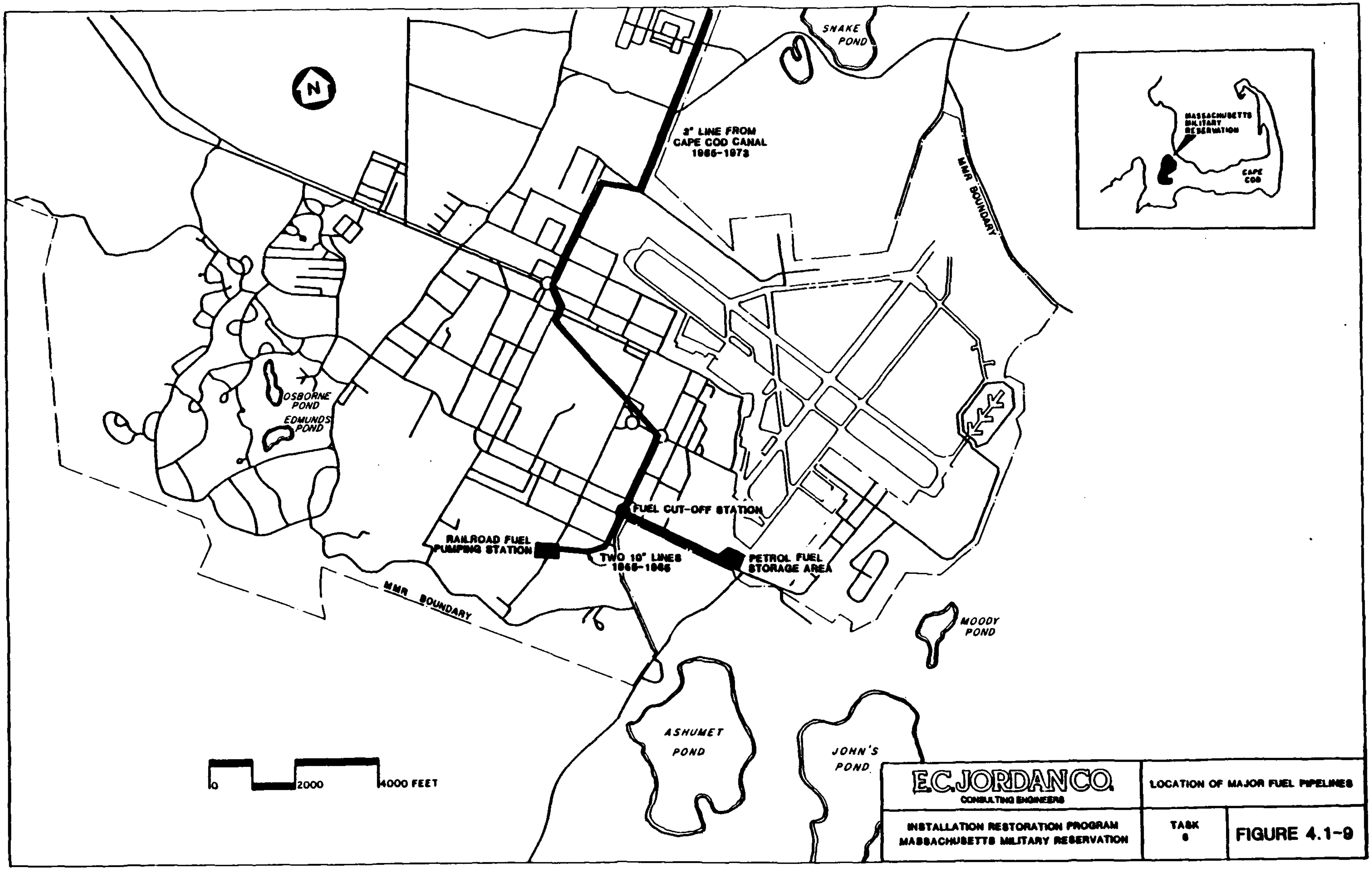
TABLE 4.1-7
ABANDONED TANK INVENTORY/ANG
(see Figure 4.1-8 for Tank Locations)

Tank Location	Capacity (gals.)	Aboveground AG Underground UG	Former Contents	Current Contents	Date Installed	Date Leak Tested	Tank Owner/ Operator	Future Plans	Remarks
Abandoned Tank									
AT-1	5,000	UG	[illegible]AS	Empty	1941	--	ANG	Remove	
2	5,000	UG	M[illegible]AS	Empty	1941	--	ANG	Remove	
3	5,000	UG	MOGAS	Empty	1941	--	ANG	Remove	
4	5,000	UG	MOGAS	Water	1941	--	ANG	Remove	
5	5,000	UG	MOGAS	MOGAS (3')	1941	--	ANG	Remove	
6	5,000	UG	MOGAS	Empty	1941	--	ANG	Remove	
7	5,000	UG	MOGAS	Empty	1941	--	ANG	Remove	
8	5,000	UG	MOGAS	Water	1941	--	ANG	Remove	
9	5,000	UG	MOGAS	Rocks	1941	--	ANG	Remove	
10	5,000	UG	MOGAS	Empty	1941	--	ANG	Remove	
11	500	UG	MOGAS	Water	1941	--	ANG	Remove	
12	12,000	UG	MOGAS	Empty	1941	--	ANG	Remove	
13	5,000	UG	MOGAS	Empty	1941	--	ANG	Remove	
14	5,000	UG	MOGAS	Water	1941	--	ANG	Remove	
15	5,000	UG	MOGAS	Water	1941	--	ANG	Remove	
16	5,000	UG	MOGAS	Water	1941	--	ANG	Remove	
17	5,000	UG	MOGAS	MOGSA (1")	1941	--	ANG	Remove	
18	5,000	UG	MOGAS	Empty	1941	--	ANG	Remove	
19	5,000	UG	MOGAS	Empty	1941	--	ANG	Remove	
20	5,000	UG	MOGAS	Water	1941	--	ANG	Remove	
21	12,000	UG	MOGAS	Empty	1959	--	ANG	Remove	

AT = Abandoned Tank.



E.C.JORDAN CO. CONSULTING ENGINEERS	LOCATION OF COAL YARDS AND FUEL STORAGE TANKS AT MMR	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 4.1-8



E.C.JORDAN CO.
CONSULTING ENGINEERS

INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

LOCATION OF MAJOR FUEL PIPELINES

TASK 6

FIGURE 4.1-9

flight line. From the late 1950's through the early 1970's, AVGAS was distributed to a pumphouse (Building 178), also referred to as the "Constellation Fueling Area." This line was abandoned after the EC-121 aircraft operations ceased. These pumphouses have underground storage tanks and are capable of defueling as well as fueling aircraft and refueler trucks.

Fuel storage for the WWII Otis Field Army Air Corps and USN is located in the 3100 Block. This area has been called the "aquafarm" because AVGAS was transferred from underground storage tanks to refueler trucks by pumping water into the tanks and displacing the fuel (see Figure 4.1-10). When a storage tank was out of service, it was kept full of water. To refill, fuel was pumped into the tank from a tank truck and the water displaced through a drain to the stormwater drainage system. For every gallon of fuel delivered to the flight line, one gallon of wastewater contaminated by AVGAS was discharged to the storm drainage system. This is discussed further in Section 4.2.

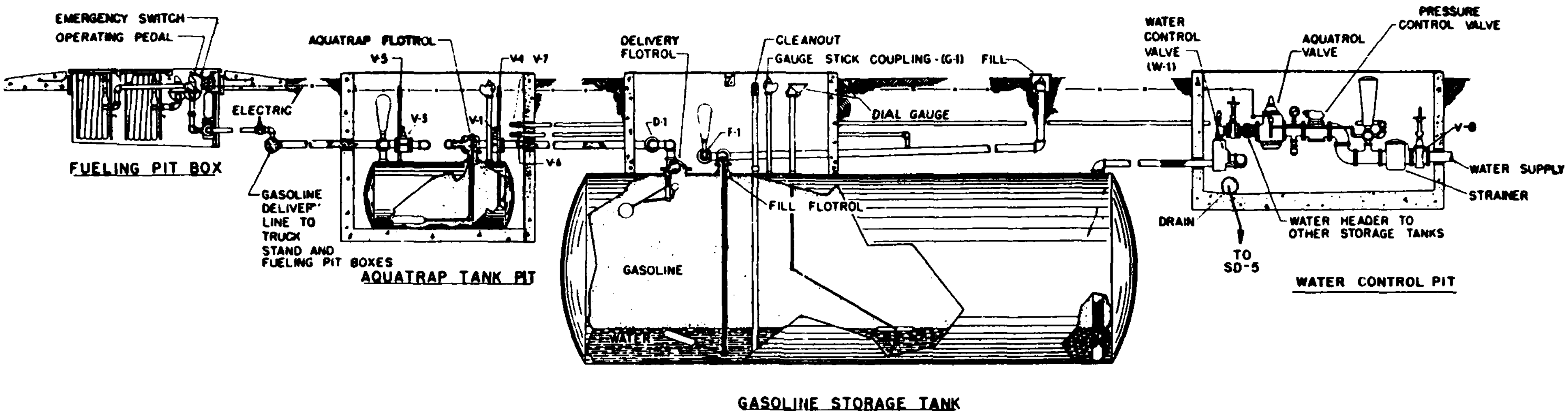
The aquafarm consists of two separate fuel storage areas, one on each side of the stormwater drainage. The location of the aquafarm areas is shown in Figure 4.1-8. Each area has five 25,000-gal underground tanks. This was the major fuel storage area for AVGAS and JP-4 until the early 1950's when the aboveground tanks at the current petroleum fuel storage area were installed (1950-1955). The aquafarm was used on a regular basis until the early 1960's when its use became secondary to the current fuel storage area. During the 1960's, use of the west side of the aquafarm was discontinued. Reportedly, these tanks (CPT 22-27) (Table 4.1-5) contain water or are empty. Tanks on the east side (CPT 18-21) (Table 4.1-5) now contain MOGAS, ethylene glycol deicing fluid, and water.

Other present and former fuel transfer areas are located on MMR. These are the railroad fuel pumping station, former MOGAS fuel storage and transfer point, and several existing fuel transfer points.

The railroad fuel pumping station located on the southern end of the base was the point at which fuel was transferred from 10,000-gal railcars to an underground pipeline that carried AVGAS or JP-4 to the aboveground tanks in the petroleum fuel storage area. This station was utilized from 1955 to 1965. During its peak use, as many as 15 railcars per day would be defueled at this location. Fuel trucks (8,000 gal) would also refuel at this location. At peak use, as many as 30 trucks a day may have refueled at this location. As indicated in the preceding paragraphs, this site is currently under study as a component of the ongoing MMR IRP.

The former ARNG MOGAS fuel storage and transfer point is located at the 3400 Block along Lee Road (see Figure 4.1-8). Six 10,000-gal underground tanks were installed here in 1941. This facility was used to refuel vehicles used on Camp Edwards. These six tanks were removed in 1985. These tanks were found to be in good condition with no evidence of leakage.

The ARNG currently operates two fuel transfer points for the purpose of refueling vehicles used during training activities in the range area. The refueling takes place at the 3500 and 3600 Blocks (see Figure 4.1-8). At the 3500 Block, fuel transfer is usually between the larger tankers (10,000 gal) to the



E.C. JORDAN CO. CONSULTING ENGINEERS	CROSS SECTION OF UNDERGROUND TANK SYSTEM AT AQUAFARM
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6

FIGURE 4.1-10

smaller tank trucks (5,000 gal or less). At the 3600 Block, fuel transfer is between the smaller tankers and the vehicles used in the range (trucks, jeeps, etc.). Approximately 400,000 gal/yr of fuel is transferred for use in the range.

Current POL storage tanks are checked for leakage. A few tanks have been pressure tested (see Tables 4.1-4 through 4.1-7). If the tanks failed the test, either the tank was removed or the potential for leakage is now under further study.

POL storage for heat and standby power generation at Cape Cod AFS is closely monitored. Tanks are checked on a daily basis, and computed fuel usage based on plant operations is compared with storage levels on a weekly and monthly basis. Reportedly, no POL leakage has occurred at Cape Cod AFS. A total of over 100,000 gal of diesel fuel is maintained in storage at this location.

Waste POL at MMR includes lube oil, petroleum-based solvents, hydraulic fluids, and contaminated fuel. The generation and disposal of waste POL are described in Section 4.1.1. POL that is stored in on-site bowsers has been removed from MMR through the DRMO or by an authorized waste disposal firm or is stored in an underground tank (CPT-27) until removed. Waste POL from ARNG is stored in the Camp Edwards hazardous waste storage area at UTES (Block 4600) for removal by an outside contractor. In the past, a portion of the waste POL was applied to dirt roads in the range for dust control or dumped on the ground. Contaminated or waste fuel was used approximately until 1973 for the fire-fighter training exercises. (Fire-fighter training is discussed in Section 4.2.) Sludge from the cleaning of fuel storage tanks is air-dried and taken to the sanitary landfill for disposal. Until the 1960's, dried POL sludge reportedly was disposed of on the sludge drying beds at the base sewage treatment plant.

4.1.6 Coal and Coal Ash Storage Yards

MMR has had four major coal storage areas (shown in Figure 4.1-8) during its operational history. Coal was used widely for space heating from 1940 to 1957. Currently, coal is used for centralized hot water and steam generation in the cantonment area. The earliest coal storage yard is shown as CY-1 at the southwest portion of the cantonment area. This area was operated by the Army. Coal was unloaded from railroad cars and stored for distribution to individual heating plants. Coal was stored at this location from 1940 to 1957.

From 1957 to 1984, coal was stored at a former USAF and ANG coal storage yard located at CY-2. This area is located near the base sewage treatment plant. Coal was brought to this location by rail and placed on a concrete pad. Runoff from the coal pile was channeled into a storm drain that discharges at the southeast corner of the pad. Some runoff flowed toward the northwest corner of the pad.

Coal and coal ash were also stored at CY-3, the former hospital heating plant. Coal was stored on a concrete pad at the hospital and in hopper bins. Coal ash was disposed in a pit located at the hospital steam plant. This pit was cleaned out every 1 to 2 months, and ash was taken to the base landfill.

In 1955 the current coal-fired steam plant was constructed on Grandville Road, site CY-4. Coal is stockpiled in the yard south of the plant. In 1978 a concrete pad was laid down as a storage area. Operations at this plant produced bottom-ash, fly-ash, and since 1978, soot. These products are temporarily landfilled behind the plant. The ash and soot are periodically taken to the base landfill. In addition to the ash and soot, waste gasoline (used for cleaning) was dumped behind the plant in an area that now serves as a soot collection pit. Reportedly, approximately 100 gal/yr of MOGAS (from 1955 to 1982) were disposed of behind the plant. Since 1982 approximately 80 gal/yr of petroleum distillate cleaning solvents have been used.

4.1.7 Radioactive Materials Handling, Storage, and Disposal

Current activities that deal with radioactivity at MMR have been limited to generation of ionizing radiation by medical Xray, radar, and transmitter systems on the ground and on aircraft. From 1955 to 1970, radon tubes were used in surveillance aircraft electronic systems. With the advent of solid state circuity, these tubes were phased out. From 1955 to 1970, approximately 200 tubes/yr were removed from aircraft. Some of these tubes were disposed of at the base landfill. Reportedly, other tubes have been buried in the gravel pit at the northwest corner of Herbert and Turpentine Roads (see Figure 4.1-2).

Radiation levels in these tubes range from 10^{-7} to 10^{-9} pCi. No excess radiation or migration of radionuclides in excess of background would be expected from this disposal. Current USAF practice is to dispose of such tubes by placing them in their original boxes and placing them in a landfill.

4.1.8 Explosive/Reactive Materials Handling Storage and Disposal

Both the ARNG and ANG handle ordnance as a consequence of troop training and the air defense missions of MMR. In addition, a defense contractor, AVCO, Inc., of Wilmington, Massachusetts, has operated a research and development facility (AVCO J-3 Range) since 1968 in the range area of MMR for the purpose of ordnance and weapons guidance testing.

Since the mid-1950's, USAF and ANG air defense munitions have been stored and repaired in the ammunition storage area located on Easton Road immediately east of the aircraft maintenance facilities and the steam plant. Ammunition for interceptor armament (20-mm cannon and 50-caliber machine gun), as well as air-to-air missiles (AIM-4), are stored in bunkers (Buildings 183-185, 187, 188). No disposal of explosives or energetic fuels (solid-fuel missile propellant) is carried out at MMR. The aircraft ammunition/missile storage and handling mission has been consistent for the period 1955-1986.

The troop training mission at MMR has had large fluctuations in activity level since 1935, as described in Section 2.2. During WWII, munitions storage was carried out in bunkers located in the present USCG housing area. Currently, issue of ammunition for small arms and artillery training is carried out through Ft. Devens, Massachusetts. An ammunition supply point and magazine storage has been located in the east side of the range area along Pew Road approximately 1 mile north of Connery Avenue. A total of 50 live-fire ranges are located at MMR. These are summarized in Table 4.1-8. All live fire is

TABLE 4.1-8

MMR LIVE FIRE RANGE IDENTIFICATION

Range Identification Letter	Number Points on Range	Type of Range	Number of Ranges
B, C & D	116	5.56 & 7.62 mm rifle	3
E & E-1	54	As above, plus machine gun	2
K & M	51	Pistol .38 & .45 cal.	2
A	4	Machine gun .50 cal.	1
CRT-1	--	Helicopter minigun	1
F	10	Tank table I, II, III	1
O & Q	8	Light machine gun 5.56 & 7.62 mm	2
N	1	Individual reaction course	1
S	20	3.5 Rocket launcher	1
I	8	M 79 grenade launcher	1
L, R & P	--	Attack course: squad/platoon	3
G	5	shotgun	1
E-2	--	Engineer demolition (heavy) 40-lb maximum charge	1
E-3	--	Engineer demolition (light) 10-lb maximum charge	1
CRT-1	--	Known distance range, 200, 300, 500 yard	1
CRT-1	3	M 31 trainer	1
GP-2	--	Emergency mission position	1
See Note #1	--	105/155 mm fire	17
See Note #2	--	Mortar, ground mounted 4.2 & 81 mm	4
See Note #3	--	Mortar, track mounted 4.2 & 81 mm	2
See Note #4	--	DOD test ranges	

Note #1 Ranges: GP-3 thru GP-12, GP-14, GP-16, GP-17, GP-18, GP-20, GP-22 & GP-24
Note #2 Ranges: MP-1, MP-2, NP-4 & MP-5
Note #3 Ranges: MP-3 & MP-4
Note #4 Ranges: J-1, J-2 & J-3

Source:

Lyon Associates, Inc., 1980.

directed into the 2,217-acre impact area shown in Figure 2.1-2. All issued ammunition is either used or turned in for storage and returned to Ft. Devens, with the exception of propellant bags used with the 4.2-inch and 81-mm mortars and 155-mm guns. Small quantities of unused single- and double-based propellant are burned at each range after the completion of each exercise. Open burning of single- and double-based propellant and explosive disposal by burning or detonation are standard military procedures carried out under strict safety protocols for disposal of unserviceable ordinance, bulk explosives, single- and double-based propellant, and solid energetic fuels. These materials are classified as reactive under RCRA and cannot be disposed of by landfilling or burial.

An AEHA study (Newell, 1985) at 40 U.S. Army Explosives ordnance demolition facilities has indicated that open burning of propellant generally does not result in residues of metals in quantities that can migrate into the groundwater and constitute a leachate hazard. Reactive residues (explosives and unburned propellants) were also found to be below 1,000 ppm in over 95 percent of cases studied. Newell, however, indicated that the potential for contamination was greatest in acidic, permeable soils such as those that occur at MMR. Residues from burning of propellant bags would consist of lead, traces of nitrocellulose, and traces of 2,4-dinitrotoluene (2,4-DNT). Nitrocellulose is the principal ingredient in smokeless powder propellant, and 2,4-DNT is added at approximately 10 percent concentration to control propellant burn rate. 2,4-DNT is a priority-pollutant, semivolatile organic chemical and is a suspected carcinogen. Soils at propellant-burning facilities, therefore, frequently contain low levels of nitrocellulose, 2,4-DNT, and lead. These concentrations typically remaining are not sufficient to cause detectable groundwater contamination beyond the immediate area of the burning pad even where large quantities are burned for long periods of time, based on numerous Phase II environmental survey results carried out under the U.S. Army IRP. Testing for residues of single- and double-based propellants in soils has not been conducted at the range area of MMR; however, because of the relatively small quantities burned and the numerous areas used for burning, it is unlikely that detectable residues would be present.

AVCO, Inc., tests detection, sighting, and guidance systems associated with antiarmor ordnance and tests armor-piercing ordnance prototypes on J-1 and J-3 ranges. The majority of testing is classified; however, no solvent or reactive material disposal reportedly is conducted by AVCO at MMR.

4.2 WASTE DISPOSAL METHODS AND DISPOSAL SITES IDENTIFICATION, EVALUATION, AND HAZARD ASSESSMENT

In general, the most significant potential for generation of waste at MMR has been the result of past fuels management, aircraft maintenance, and vehicle maintenance in the cantonment area and the flight line.

As described in the current and past activity review (Section 4.1), various methods have been used for disposal of wastes generated by MMR activities. In general, operational wastes have included halogenated solvents, aromatic solvents and ketones, petroleum distillate solvents, waste POL, waste POL mixed with solvents, lead-acid and Ni-Cad batteries, and spent electrolyte generated as a result of aircraft and vehicle maintenance and electronics parts cleaning. The majority of these liquid wastes have been contained and disposed of off-base through the base DPDO; off-base DRMO, or a hazardous waste contractor. However, in the past, quantities of waste were also reportedly disposed of at the base landfill, at the point of generation, to the sanitary sewage system, and to the stormwater drainage system.

Large quantities of wastes may have been disposed of at the base landfill. The MMR landfill has been evaluated as a component of previous Phase I and Phase II programs (Metcalf and Eddy, 1983; Weston, 1985) and is a component of ongoing Phase II study within current MMR IRP program. Dumping of wastes at the point of generation occurred in the earlier periods of operations, especially with regard to vehicle maintenance and the intensive AEW&C aircraft maintenance. Also, even where waste has been contained for off-site disposal, an estimated 10 to 25 percent of the waste material was spilled in the past as a result of housekeeping practices. These disposal methods/spillage estimates have been derived primarily based on interviews with present and former base personnel and are in agreement with general practices carried out by the military and by industry during the 1940's through late 1970's for similar operations.

In accordance with general waste handling and disposal practices prior to the late 1970's, large quantities of waste materials generated at fuel management and aircraft and vehicle maintenance activities may have been discharged into the stormwater drainage system. This was partially a result of the intensity of effort reportedly required to support the AEW&C mission during the 1960's. As described in Section 4.1, certain shops discharged waste solvent into the sanitary sewage system. Until 1985 most used battery electrolyte was also so disposed.

Expectedly, the majority of volatile fuel components and solvents disposed to the concrete and tarmac surfaces would volatilize rather than enter the soil. The distribution of these wastes between the soil and air compartments would be variable and highly dependent on temperature, precipitation, and wind velocity, as well as on whether the spill or disposal was washed into a drainage system or off the hard-surfaced area. Data from Section 4.1 indicate that the stormwater drainage system potentially received large quantities of industrial waste.

The Phase I study of Otis-ANGB (Metcalf & Eddy, 1983) identified fuels management, solvent disposal, and disposal to the base landfill as the major operations with potential for contamination. Based on their review, six sites were recommended for Phase II, Stage 1 study. Phase II study was initiated at these locations by the R.F. Weston Co. (Weston, 1985). A seventh site, the Petroleum Fuel Storage Area, was added to that program. The sites for which Phase II, Stage 1 studies were performed and the probable waste disposed at these sites are the following:

1. Current fire-training area (CFTA), waste POL and solvents

2. Former fire-training area/former NDI laboratory (FFTA/NDI), waste POL and solvents

3. Base landfill, waste POL, solvents, metals, and other industrial chemicals

4. AVGAS Fuel Test Dump Site (AFTDS), waste AVGAS

5. Railyard Fuel Pumping Stations (RFPS), waste POL

6. Petroleum Fuel Storage Area (PFSA), waste POL

Based on review of the Phase II, Stage 1 report, further Phase II investigation has been initiated for three of the sites as components of the current MMR IRP, and further investigation is recommended at the remaining three sites. These recommendations were based on assessment of the Phase II, Stage 1 data and preliminary evaluation of the information obtained during the current Phase I reevaluation of each site.

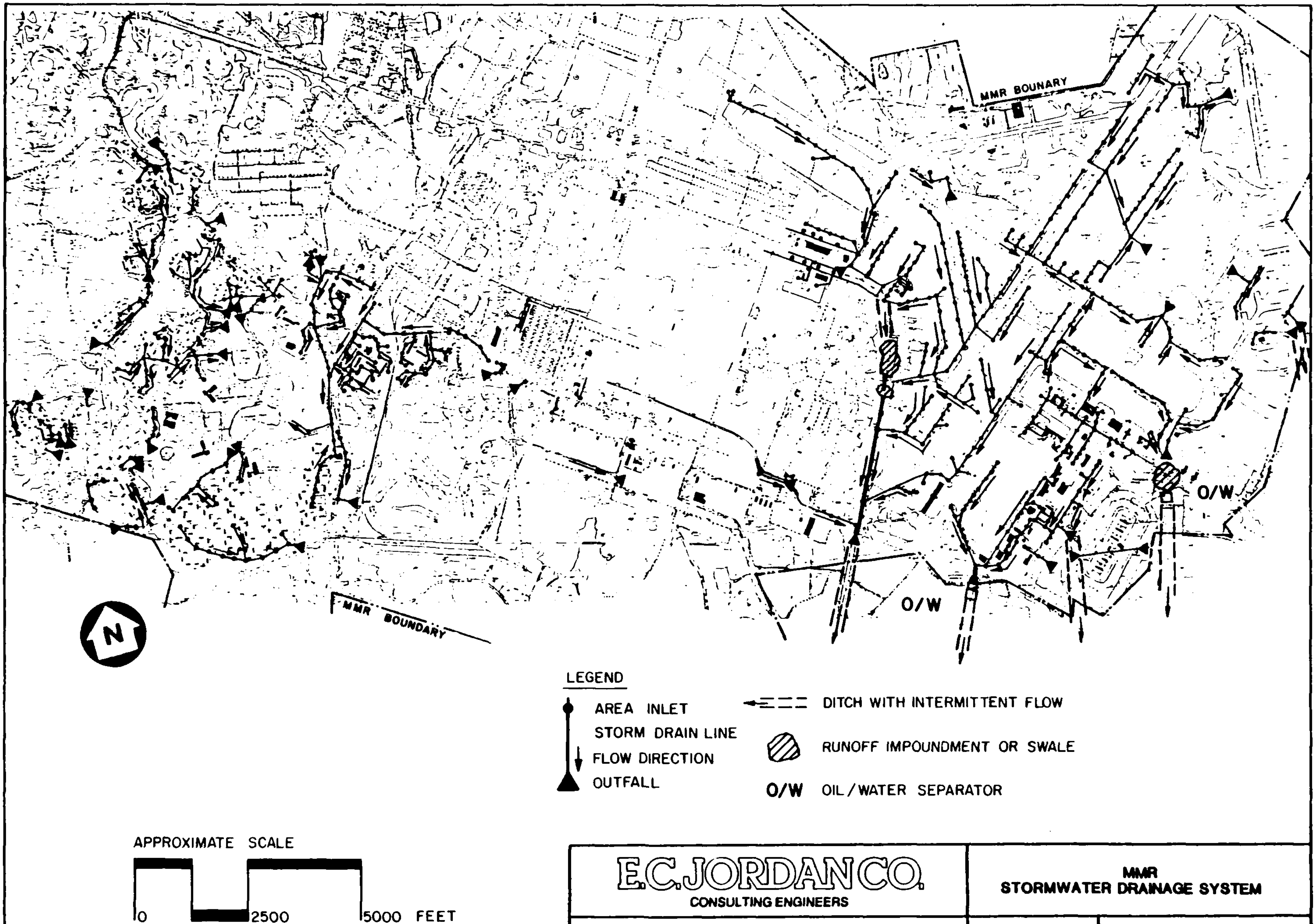
In this section, disposal sites located on ARNG, ANG, and VA facilities at MMR, including the sites identified previously, are described, and their potential for environmental contamination and contaminant migration is evaluated. Conclusions and recommendations regarding these sites are summarized in Sections 5.0 and 6.0.

4.2.1 Stormwater Drainage System

Stormwater drainage in the cantonment and flight line/runway areas at MMR is conveyed via two storm drain systems. The layout of these systems is shown in Figure 4.2-1. The westernmost system conveys runoff primarily from the USCG housing area and USCG shops. As described in a separate Phase I report prepared as a component of the ongoing MMR IRP, this system has little potential for receiving contamination by hazardous substances. This system conveys street and parking lot runoff primarily to internal drainage outfalls where infiltration occurs. The eastern stormwater drainage system is much more extensive than the western. This system drains extensive concrete and tarmac runway aircraft parking, hangar, and maintenance areas.

Because of the extensive impervious area drained, large quantities of water are discharged from each of the storm sewers into four ditches that lead south off MMR. These are shown in Figure 4.2-1. As described in Section 3.2.1, rain events totaling 1-inch in 1 to 2 hours are sufficient to cause flow in the unlined ditches in spite of the high permeability of MMR soils. Reportedly, approximately four times per year, sufficient discharge occurs to convey storm water flow off-base to Ashumet Pond.

Large-scale industrial operations (primarily aircraft maintenance and fueling) have been carried out since the 1940's on the area drained by the eastern stormwater drainage system. In the current and past activity review (Section 4.1), sources of potential contamination were identified as either discharging to the storm drainage system or being washed into this system due to disposal on the impermeable surfaces channel. As a result, the locations where storm drain outfalls discharge to the unlined ditches have been identified as potential disposal sites for evaluation of contamination and contaminant migration.



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MMR
STORMWATER DRAINAGE SYSTEM

INSTALLATION RESTORATION PROGRAM
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TASK
6

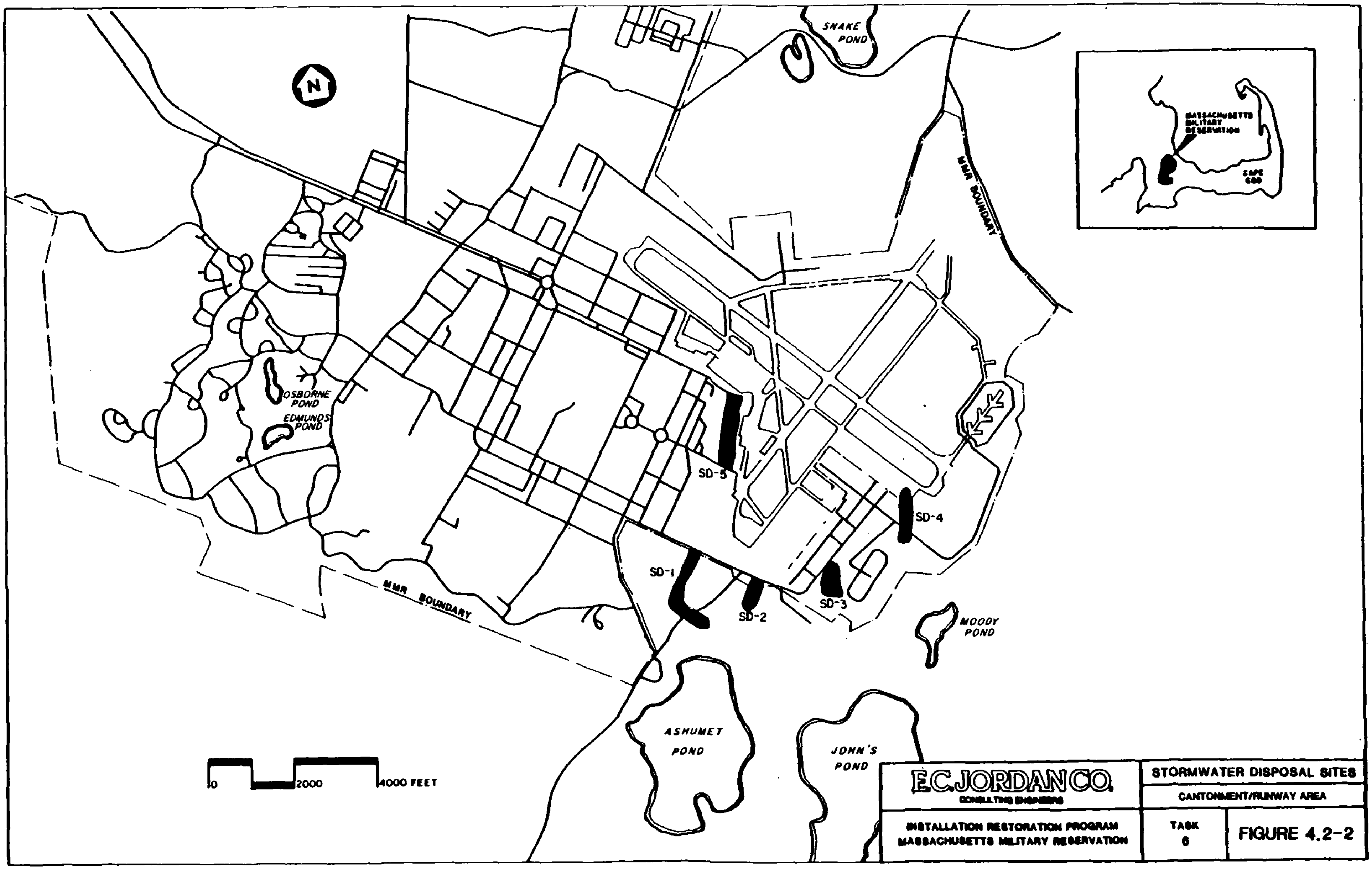
FIGURE 4.2-1

Contaminant migration would be expected both as a result of infiltration and as a result of surface water transport. Based on the large drainage areas discharging at each major outfall, a strong driving force would be present to move contaminants through the vadose zone and into the groundwater. The vadose zone in the area of the stormwater drainage is approximately 50 ft thick (see Section 3.3). Infiltration would also occur under the storm sewers due to leaks. Surface water transport of both dissolved and particulate contaminants would occur during significant rain events. Contaminants carried either as dissolved material or as a separate phase (e.g., in an oil phase distinct from the aqueous phase) would be conveyed with the stormwater to the point of infiltration. These materials would either infiltrate or partition to the ditch substrate. Particulate in runoff and particulate eroded from the ditches would be transported via storm events. Contaminants sorbed to these particulates would be gradually transported downstream as a result of periodic runoff events.

Five stormwater drainage system disposal sites that potentially received industrial wastes containing hazardous chemicals were identified at MMR. Figure 4.2-2 shows the location of these sites.

Stormwater Drainage Disposal Site No. 1 (SD-1).

This area is the drainage ditch beginning at an outfall located at the south side of South Outer Road (South Outer Road Drainage Basin No. 1). The drainage channel is constructed of rip-rap blocks loosely fitted together and conveys stormwater southward off-base to the cranberry bogs located north of Ashumet Pond. The drainage ditch receives water from a 48-inch and two 72-inch storm drains. The smaller line drains portions of the parade ground north of OMS 22 and Air National Guard/Civil Engineering (ANG/CE) shops area. The two 72-inch lines convey stormwater from the western portion of the former EC-121 parking and fueling area, the alert hangar area, and portions of the southern runway area. In addition, during large rain events, overflow from the aquafarm drainage swale and impoundment (SD-5 on Figure 4.2-2) is conveyed to SD-1. During the period 1955 to 1970, maintenance activity on the EC-121 parking area, as well as periodic fuel spills indicated in the past activity review (Sections 4.1.1 and 4.1.5) and described in Sections 4.2.3 and 4.2.4, may have resulted in contamination of the soils of the ditch by AVGAS and JP-4 fuel components and solvents (lead, oil and grease, straight-chain hydrocarbons, aromatic hydrocarbons, and halogenated and nonhalogenated solvents). The aquafarm drainage swale and impoundment also has received contamination as described below (see discussion of SD-5). Because of the permeability of the soils, the quantities of contaminated water migrating from the SD-5 area into the storm sewer to be transported to SD-1 are unknown. Contaminants from SD-5 would include TCE; other halogenated and nonhalogenated components; and fuel residues, including lead from AVGAS and JP-4. Aircraft and runway deicing fluid also would expectedly be washed into the storm drainage system. Diluted with water, ethylene glycol is readily biodegradable and would not persist as a contaminant. In its application as a deicing agent, the ethylene glycol would not be contaminated with metals. (Used ethylene glycol antifreeze used in engine cooling applications is contaminated by metal corrosion products from the cooling system.)



E.C.JORDAN CO. CONSULTING ENGINEERS	STORMWATER DISPOSAL SITES CANTONMENT/RUNWAY AREA	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 4.2-2

The 72-inch storm sewer lines that outfall at SD-1 traverse the filled area of the FFTA identified in the previous record search (MetCalf and Eddy, 1983). This area was investigated during the former Phase II, Stage 1 study (Weston, 1985). Soil from one test pit showed nearly 7000 µg/g of lead and 1600 µg/g of oil and grease. Test pits in the FFTA area through which the storm sewer line traverses contained evidence of burned trash. Reportedly, the area was used for burning of base domestic refuse for a short time prior to installation of the sewer line and to regrading. Contaminants in the soils surrounding the sewer line can be conveyed either along the bedding of the line because of the more permeable nature of the disturbed soils along the route of the line to undisturbed soil or via the sewer by infiltration through leaks in the line.

TCE, TCA, DCE and other solvent-related compounds have been detected in groundwater south of MMR, downgradient of site SD-1. Toluene and TCE were detected in the cranberry bog located at the north end of Ashumet Pond. Toluene is used as a solvent but is also one of the major aromatic constituents of both AVGAS and JP-4. Groundwater flow direction and the contamination status in the off-base area south of SD-1 are described in Section 3.0. The off-base contaminant plume is being studied under other Phase II and Phase IV-A components of the ongoing MMR IRP. Initially, contamination reaching the outfall would have been discharged to the ground at that point. Because of the permeable nature of the soils and the large quantities of water infiltrating at the ditch, significant potential for migration via groundwater exists. Secondly, even though the ditch is lined with rocks, transport of dissolved contaminants and transport of sorbed contaminants on particulates would be expected.

The probable persistence at MMR of the potential contaminants from the aircraft maintenance and fuel spills is described in Sections 4.2.3 (chemical spill and disposal sites) and 4.2.4 (fuel spill sites). Halogenated solvents (TCA, TCE, methylene chloride, and PCE), nonhalogenated solvents (MEK, MIBK, toluene, acetone), and POL-related contaminants (benezene, toluene, xylenes, napthylene, C-6 to C-24 alkanes oil and grease, as well as lead) would have potentially entered SD-1. Because of the nature of the majority of the spillages onto an impervious surface, the quantities of the volatile components actually reaching SD-1 are impossible to estimate. Volatilization versus transport to SD-1 would depend on

- air temperature and wind conditions,
- size of spill,
- subsequent rainfall,
- distance to the sewer line. and
- any spill wash.

The period when contamination potential was highest was 1955 through 1970. Fuel spills washed to the stormwater system during that period were reported in interviews, as was aircraft maintenance in the drainage area.

Potential for contamination exists at site SD-1 and potential for migration off-site via groundwater and surface water exists. In addition, indirect evidence exists for migration due to observed groundwater and surface water contamination downgradient. The contamination cannot, however, be linked to any particular site based on the present data base. Site SD-1 was ranked using the HARM process (see Appendix G). A summary of the HARM rating for this site ranking is presented in Section 4.2.7. Conclusions and recommendations regarding this site are given in Sections 5.0 and 6.0.

Stormwater Drainage Disposal Site No. 2 (SD-2).

This site, the South Outer Road Drainage Basin No.2 (see Figure 4.2-2), located just south of the PFSA, serves as a drainage channel for two 42-inch outfalls from the CAM ramp (formerly the EC-121 ramp), the hangar nosedocks, and other support buildings along the east edge of the main aircraft parking area. This area is shown in the photograph in Figure 4.1-6, taken in 1967. Evidence indicates that up to 500,000 gal of petroleum distillate solvent (PD-680) could have been flushed into storm drains on the ramp during the period of EC-121 maintenance activity (1955-1969). Based on interviews with personnel present during this period, an estimate of up to 80 gal/day of PD-680 were used to wash oil, grease, hydraulic fluid, and fuel off the ramp into storm drains. Over the 14-yr period, an additional 20 gal/day were used to wash aircraft prior to engine run-ups. Run-ups were needed for engine maintenance. In addition, 3,000 gal of AVGAS were flushed into the storm drains from hangar 165 from 1967 to 1968 due to fuel dump valves accidentally opening inside the nosedock. Sources indicate that unknown quantities of TCE were used and dumped into storm drains during maintenance in the period 1955-1969. The materials potentially entering SD-2 are similar to those described previously for site SD-1. Relatively larger quantities of AVGAS and JP-4 would have entered the storm sewers leading to SD-2 because of the proximity of the fuels pump house, Building 174, to the drain line. Section 4.2.4 describes the major fuel spills that occurred in the EC-121/CAMS ramp area. The most intense activity primarily took place prior to the installation of the oil-water separator in the drainage channel in 1968. The stormwater drainage channel leads directly to Ashumet Pond. As described in Section 3.3, stormwater from drainage SD-2 flows south down a deep swale or gully and enters the north end of Ashumet Pond. A single storm event sample from the oil-water separator in 1985 did not contain detectable VOCs. A layer of what appears to be weathered petroleum exists off-base in a portion of the channel between MMR and Ashumet Pond. This suggests probable discharge of POL from the SD-2 storm water drainage system.

Another source of contamination, based on historical data from the Bioenvironmental Engineering Service files, has been the AGE Shop (Building 191). A report indicates that from 1955 to 1980, 110 gal/month of PD-680, 20 gal/month of gunk (both petroleum distillate solvents), and 12 gal/month of methyl ethyl ketone (MEK) were discarded into the SD-2 storm drain system (see Table 4.1-1). At Building 191, a 375-gal waste solvent holding tank was emptied annually. The amount of waste reportedly generated in a year, however, was approximately four times the tank capacity.

Potential for contamination exists at site SD-2. The quantities of wastes entering this system were greatest during the period 1955 - 1970, based on the level of aircraft maintenance activity during the AEW&C mission compared with the fighter interceptor missions (1973 - present). As indicated by the industrial activity review, contamination of the stormwater drainage system since approximately 1980 probably has been limited to minor fuel spills that are collected in the oil-water separator.

Potential exists for contaminant migration both by surface water transport or via groundwater after infiltration in the unlined ditch. The probable mechanisms for transport have been described previously. This site has potential for contaminant migration off-base and, therefore, was ranked using the HARM process (see Appendix G). The HARM rating is summarized in Section 4.2.7. Conclusions and recommendations regarding site SD-2 are summarized in Sections 5.0 and 6.0.

Stormwater Drainage Disposal Site No. 3 (SD-3).

This area, located southeast of the coal-fired steam plant, receives outfall from storm drains located along Grandville Road and runoff from the coal pile, coal ash (fly-ash and bottom-ash), and soot disposal areas. The ditch draining these areas was lined with fly-ash and soot particulates. Runoff in this drainage flows toward Johns Pond.

Stormwater draining into this drainage ditch does not drain areas where large quantities of POL or solvents were handled (see Figure 4.2-1). The major concern at this location is migration of contaminants from the coal pile and ash landfills. Airborne transport of the coal dust and ash has coated vegetation in the area.

Coal, coal-ash, fly-ash, and soot are not presently classified as hazardous wastes; however, these materials may contain significant quantities of metals that indicate the possibility of heavy metal contamination in runoff. Table 4.2.1 presents the concentrations of metals detected by EPA in fly-ash. These values are all well below the maximum allowable concentrations established by EPA as criteria for establishing hazardous wastes based on leachate toxicity. Note that no testing was performed on bottom-ash, coal, or soot. Although metals contained in ash are unlikely to be leached and enter the surface water or groundwater or dissolved species, limited transport could occur as a result of movement of particulates during major storm events. From 1955 - 1978, approximately 180 gal/yr of petroleum distillate solvents were dumped on the ground at this site.

Coal contains sulfur, iron, other metals, phenols, and PAHs. Coal pile runoff typically is acidic and contains significant quantities of iron. Typical coal pile runoff is shown in Table 4.2-2. The organics present in coal pile runoff PAHs are complex molecules and, therefore, are partitioned to soil rather than being transported as dissolved organics. The coal pile has been at the current location near SD-3 since only 1984. As a result, only limited quantities of either potentially toxic metals or organic contaminants would have likely entered SD-3. Transport of the organic materials would be via particulate transport in surface water runoff. Metals could be transported either by surface water transport or by groundwater after infiltrating the unlined ditch.

Potential exists at SD-3 for contamination due to coal- and ash-related particulate materials. Because of the short history of coal storage at this site and the relative insolubility of the metals of the ash, contaminant quantities at this site were considered small. Potential, however, exists for transport via particulate movement during storm events. This site, therefore, was rated

TABLE 4.2-1

LEACHABLE METAL CONCENTRATIONS FROM
FLY ASH USING THE EP TOXICITY TEST

Metal	Leachate Concentration (mg/L)	Allowable Leachate Level (mg/L)
Arsenic	0.01	5.0
Barium	1.00	100.0
Cadmium	0.05	1.0
Chromium	0.05	5.0
Lead	0.02	5.0
Mercury	0.001	0.2
Selenium	0.01	1.0
Silver	0.01	5.0

Source: May 19, 1980, Federal Register, page 3322. Allowable level based on 100 times the primary drinking water MCL in accordance with RCRA.

TABLE 4.2-2

CONSTITUENTS OF COAL PILE LEACHATE

Compound	Concentration Range (μg/L)
Polycyclic Aromatic Hydrocarbons (PAHs)	
Ethylacenapthene	
Phenanthrene	ND-195
Naphthalene	ND-33
Acenaphthene	ND-15
Fluorene	ND-14
Anthracene	ND-0.6
Fluoranthene	ND-67
Pyrene	ND-4
Chrysene	ND-25
Benzo (a) anthacene	ND-2
Benzo (k) fluoranthene	ND-0.6
Benzo (a) pyrene	ND-0.6
Benzanthracene	ND-29
Benzopyrene	ND-30
Anthraquinone	ND-0.7
2-Chloronapthalene	ND-14
Benzidine	ND-14
Benzo (ghi) perylene	ND-44
Inorganic Compounds	mg/L
Iron	0.17-93,000
Ferrous iron	139-850
Sulfate	401-21,920
Zinc	0.8-26.0
Copper	0.08-6.1
Chromium	0-15.7
Manganese	0.69-72.0
Free silica	10.1
Cyanide	0-0.001
Nitrate	0.31
Antimony	4.6
Arsenic	15.7
Cadmium	0.002
Lead	0.06
Nickel	3.1
Selenium	19.9
Mercury	0-0.001
Chloride	0.27

TABLE 4.2-2 CONT'D

CONSTITUENTS OF COAL PILE LEACHATE

Compound	Concentration Range (mg/L)
Other Parameters	
TOC	280
COD	1,436
BOD	0.38
TSS	1551
TDS	720-44,050
Acidity	375-8250
pH	2.1-6.78

Notes:

1) Concentration ranges for polyaromatic hydrocarbons are expressed in µg/L. Each range was compiled using data generated form two laboratory studies. The first study simulated the coal pile leaching process for four different types of coal; four series of samples were analyzed for each type. The second study simulated the same process for coal tar from six different geographical areas of the U.S.; one sample was analyzed for each area. Concentrations are for coal leachate with no dilution from outside sources.

2) Concentration ranges for inorganic compounds and other parameters are expressed in mg/L. pH is expressed in the negative logarithm of hydrogen ion concentration. Each range was compiled using three separate data bases: 1) data from a coal pile leachate survey conducted by the EPA for mine operating coal plants; 2) monitoring of a coal pile at Cornell University in Ithaca, New York, for 17 days; and 3) a simulation of the coal pile leaching process for coal from six different regions; two or three samples were analyzed for each area.

3) Where only a single value is reported from the above sources, only one number is presented in the table.

Sources:

Anderson et al., Coal Pile Leachate - Quality and Quality Characteristics, 1976.

Stahl et al., Characterization of Organic Compounds in Simulated Rainfall Runoffs for Model Coal Pile, 1984.

Wachter et al., Water Pollutants from Coal Storage Areas, 1978.

using the HARM system (see Appendix G). The HARM ratings are summarized in Section 4.2.7. Conclusions an' commendations regarding site SD-3 are presented in Sections 6.0 and 7.0.

Stormwater Drainage Disposal Site No. 4 (SD-4).

This area, the Reilly Road Storm Drainage Basin, is located just off Reilly Road. To the north of Reilly Road, stormwater discharges into a drainage ditch and impoundment approximately 200 to 300 feet long and 10 to 20 ft wide (see Figure 4.2-2). This ditch slopes gently to the south and is unlined. From here overflow is channeled beneath Reilly Road to an oil-water separator (installed in 1968) via concrete culverts and a concrete impoundment. The oil-water separator discharges into a natural, unlined drainage ditch. During periods of low to medium rainfall, water and particulate residue, as well as contaminants washed into the storm drain, would discharge into the drainage ditch north of Reilly Road and infiltrate. Contaminants disposed into the storm drains would also infiltrate at this point. During periods of heavy rainfall, such materials would likely be carried off-base down the drainage ditch via the surface water flow. The drainage ditch eventually discharges to Johns Pond.

As indicated in Section 4.1, solvents were disposed into the storm sewers in this area. The aircraft wash rack located in Hangar 158 flushed petroleum distillate solvents (PD680) into the hangar deck drains, which connect to storm drains. Up to 15 planes per day required washing. Each washing required approximately 20 gal of PD-680. Over the 14-yr time period of activity, an estimated 500,000 to 1.4 million gal reportedly have been flushed into the stormwater drainage system. A corrosion prevention compound, made up of ethanolamine and ethylene glycol, was periodically sprayed onto the aircraft and flushed into the storm drains. This material, however, is readily biodegradable. Maintenance support shops located at Hangar 158 used halogenated solvents in day-to-day operations; reportedly, portions of the waste solvent were dumped into hangar deck drains.

This stormwater drainage system also receives drainage from Hangars 128, 126, and 124 and from the runways and ramps that serve those hangars. Reportedly, unknown quantities of solvents, including toluene and TCE, were flushed into storm drains at Hangar 128. From 1955 to 1970, this area was used to maintain 18 tp 21 aircraft. From 1973 to the present, Hangar 124 has been used as the ANG/CE Roads and Grounds Shop. Hangar 128 has been used since 1978 by the USCG for aircraft maintenance. USCG activities at Hangar 128 were reviewed in a separate Phase I report prepared as a component of the ongoing MMR IRP. Quantities of wastes disposed either into floor drains or to the stormwater system from the hangars during the period 1955 to 1970 are unknown. Floor drains at these locations are tied into the storm drainage system. In addition, the deck joints in Hangars 124, 126, and 128 are open, and some spilled materials probably infiltrated into the subsurface. Reportedly, periodic heating of wing tanks of aircraft housed in Hangar 128 caused numerous spills of AVGAS to the hangar deck from 1978 to present. A portion of this material probably washed to the SD-4 stormwater system.

A 600 to 800-gal AVGAS spill occurred in 1978 just outside Hangar 128. This fuel was flushed into storm drains. A JP-4 pumping station (Building 123), located near SD-4, has had periodic spills that were washed into this drainage basin.

As a result of activities, primarily during the period 1955 to 1970, potential exists for contamination of storm drainage SD-4 by TCE and other halogenated and nonhalogenated solvents, as well JP-4 and AVGAS fuel components. These fuel components would include benzene, toluene, xylenes, alkane hydrocarbons, and lead. Total quantities entering drainage SD-4 are unknown. Potential quantities are assumed to be large, however. The relative proportion of volatile components reaching the outfall area also are a function of the environmental and discharge factors described previously.

Potential exists for contaminant migration from site SD-4 via both surface water and groundwater mechanisms described previously. This site was rated using the HARM process (see Appendix G). The HARM rating is summarized in Section 4.2.7. Conclusions and recommendations regarding this site are summarized in Sections 5.0 and 6.0.

Stormwater Drainage Disposal Site No. 5 (SD-5).

Four storm drain systems (12-, 24-, 42-, and 60-inch diameters) discharge into the swale located behind the former NDI laboratory (Building 3146). This area is termed the Aquafarm Drainage Swale. These storm drains convey runoff from large portions of the runway, vehicle maintenance shop OMS 6 (ARNG), the 26th Aviation Support Batallion Hangar (Building 2816), and the presently unused west hangar ramp area.

Stormwater runoff from the runways and ramps and liquids discarded into hangar floor drains have contributed to the discharge into the area since the 1940's. Also, this site serves as an impoundment for discharge from the two aquafarm fuel transfer systems described in Section 4.1.5. Up until 1962, the area contained standing water. Since that time, no standing water has been evident. Overflow from this area flows into stormwater drainage disposal site No. 1 (SD-1) (see previous discussion of site SD-1).

The aquafarm system discharged aircraft fuel-contaminated water into the impoundment area. Each time the fuel tanks were filled, the displaced water was dumped into this area. During the period from 1948 to 1955, these fueling systems were used extensively. Based on the level of fueling activity, up to 15 tp 20 million gal/yr of such water may have been discharged to SD-5 via the use of the aquafarm systems.

The major aromatic constituents of AVGAS, MOGAS, and JP-4 are benzene, toluene, xylene (BTX), and ethyl benzene, which are soluble to some extent. The approximate solubility of the these compounds in water at 20°F are as follows:

benzene . . .	1800 mg/L	xylene	180 mg/L
toluene . . .	500 mg/L	ethyl benzene . . .	150 mg/L

During the operation of refilling and subsequent fueling, it is likely that these compounds dissolved in the water discharged into the impounding basin. In addition, fuel droplets entrained in the water and fuel product floating on the water potentially were also discharged.

Prior to 1955, AVGAS was the primary fuel stored at the aquafarm. From 1955 to 1970, the aquafarm received limited use as a backup to the main fueling hydrant system. Dissolved tetraethyl lead would have been a constituent of the water discharged. Since 1970 only the MOGAS system has been in use.

The initial Records Search Report (Metcalf and Eddy, 1983) identified the former NDI Lab (Building 3146) as having potential for contamination and contaminant migration. This laboratory was reported to have operated from 1955 to 1978 and received a HARM score of 62 based on the disposal of liquid wastes into a sump/septic tank. These wastes included TCE, other halogenated solvents, penetrants, emulsifiers, and spent film developer. A quantity of 450 gal/yr was estimated for the 15-yr operations history. These wastes were discharged into a dry well septic tank from 1955 to 1970. After 1970 (1970 - 1978) these wastes were disposed into the sanitary sewer system.

Based on the HARM rating by Metcalf and Eddy (1983), Phase II, Stage 1 investigations (Weston, 1985) were carried out at this location. In the Weston report, the NDI lab was designated as Site 6. Test pits were dug in the drainage swale behind the septic tanks and a single well installed topographically downgradient approximately 0.5 miles (2700 ft) from the site. This well was screened below the water table to a depth of 60 ft. In addition to these efforts, samples of the liquid and the sludge from the septic tanks were collected. Samples of soil from test pits within the drainage swale contained detectable total organic halogens (TOX) (0.46 and 0.64 µg/g) and elevated lead (110 µg/g at Pit 21), as well as oil and grease (139 and 313 µg/g). Oil and grease (2.09 mg/L) were detected in the downgradient well during one sampling round. The sludge and supernatant samples from the septic tank contained high levels of oil and grease, organic halogens, and lead. Specific volatile and extractable organic compounds and other metals were not quantified.

The Corrosion Control Shop (Building 3117) operated from 1956 to 1972 and discharged up to 250 gal/yr of MEK, paint thinner, toluene, and zinc chromate solutions into the aquafarm drainage swale.

The PFTS area (Buildings 3144 and 3140) operated from 1956 to 1971 and dumped up to 1500 gal/yr of halogenated solvents, waste POL, ethylene glycol, and fuel into the aquafarm drainage swale. Up to 1,000 gal/yr of AVGAS and JP-4 were dumped in the swale area from 1958 to 1959 to drain refueler tracks prior to fuel delivery maintenance.

Based on the numerous sources of wastes discharged to the swale (SD-5), the quantities involved, and the intermittent large stormwater water flows in the drainage swale, potential contamination and related migration exist. Site SD-5 was ranked using the HARM rating system (see Appendix G). The aquafarm drainage swale SD-5 includes the former NDI laboratory, the stormwater system, the Corrosion Control Shop, the PFTS area, and the aquafarm discharge.

The HARM ratings for SD-5 are summarized in Section 4.2.7. Conclusions and recommendations regarding this site are summarized in Sections 5.0 and 6.0.

4.2.2 Landfills

During the initial records search of ANG facilities in 1983 (Metcalf and Eddy, 1983), a single landfill was identified. This landfill, the main base landfill, was operated from 1944 to the present. Based on the activities review and assessment, this landfill was ranked using the HARM system and recommendations were made for Phase II, Stage 1 studies. Phase II, Stage 1 studies were implemented at this location, termed Site 3, by the R.F. Weston Co. (Weston, 1985). The main landfill was reevaluated as a component of this records search. In addition, based on evaluation of the findings and conclusions of the initial Phase II, Stage 1 studies at this location, further Phase II studies have been implemented.

During the current records search, a total of seven landfills were identified on the Camp Edwards/ARNG, ANG, VA, and USAF facilities at MMR. These landfill locations are shown on Figure 4.2.3. In addition, three debris and rubble landfills were identified on areas under USCG control. These latter three fills were evaluated as components of a separate Phase I report generated under the ongoing MMR IRP.

Landfill No. 1 (Site LF-1)

Landfill No. 1 is the main sanitary landfill for MMR. It has been in operation since 1944. The site (shown on Figure 4.2-3) is bounded by Turpentine Road and Frank Perkins Road to the east and west and Herbert Road and Connery Road to the north and south, respectively, and covers an area of approximately 100 acres.

Disposal at the landfill has occurred in five distinct cells. Figure 4.2.4 shows the locations of these cells and indicates the years in which they were closed. Waste burial is currently accomplished by excavating long, v-shaped trenches in the surface substrate. The trenches generally are 20 to 30 ft deep, 20 to 25 ft wide, and several hundred feet long. Waste is dumped into these trenches and covered with sand and gravel; historical disposal has generally been similar. Most of the trenches can be identified from the air by the presence of long parallel mounds.

During the period between the late 1940's and 1980, the landfill was not restricted and was reportedly used by the Army; USAF; USN; USCG; ARNG; ANG; USDA Experiment Station, Virginia; and, to some extent, the surrounding municipalities. Wastes believed to have been disposed of in the base landfill include general refuse, fuel tank sludges, herbicides, solvents, transformer oil, fire extinguisher fluids, blank small arms ammunition, paints, paint thinners, batteries, barrels of contaminated fuel (JP-4 and AVGAS), waste oil, possibly ordnance, asbestos, and radar tubes (radioactivity 10^{-7} to 10^{-9} pci), DDT powder, other pesticides, hospital wastes, sewage sludge, and coal ash. The quantities of these wastes or where they were placed within the landfill is not known. The activities review (Section 4.1) substantiates that significant disposal to the landfill took place. A review of a 1941 Topographic survey

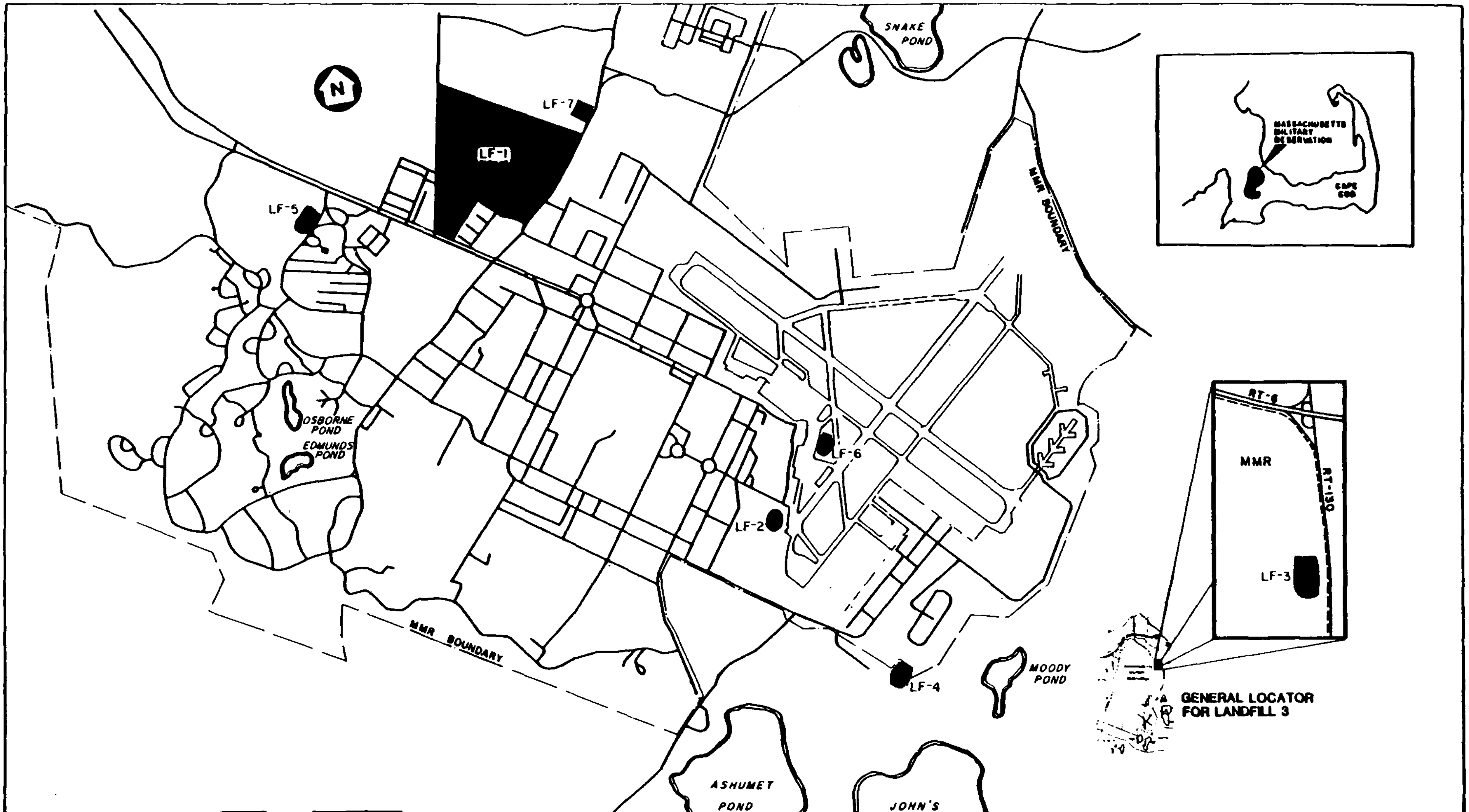


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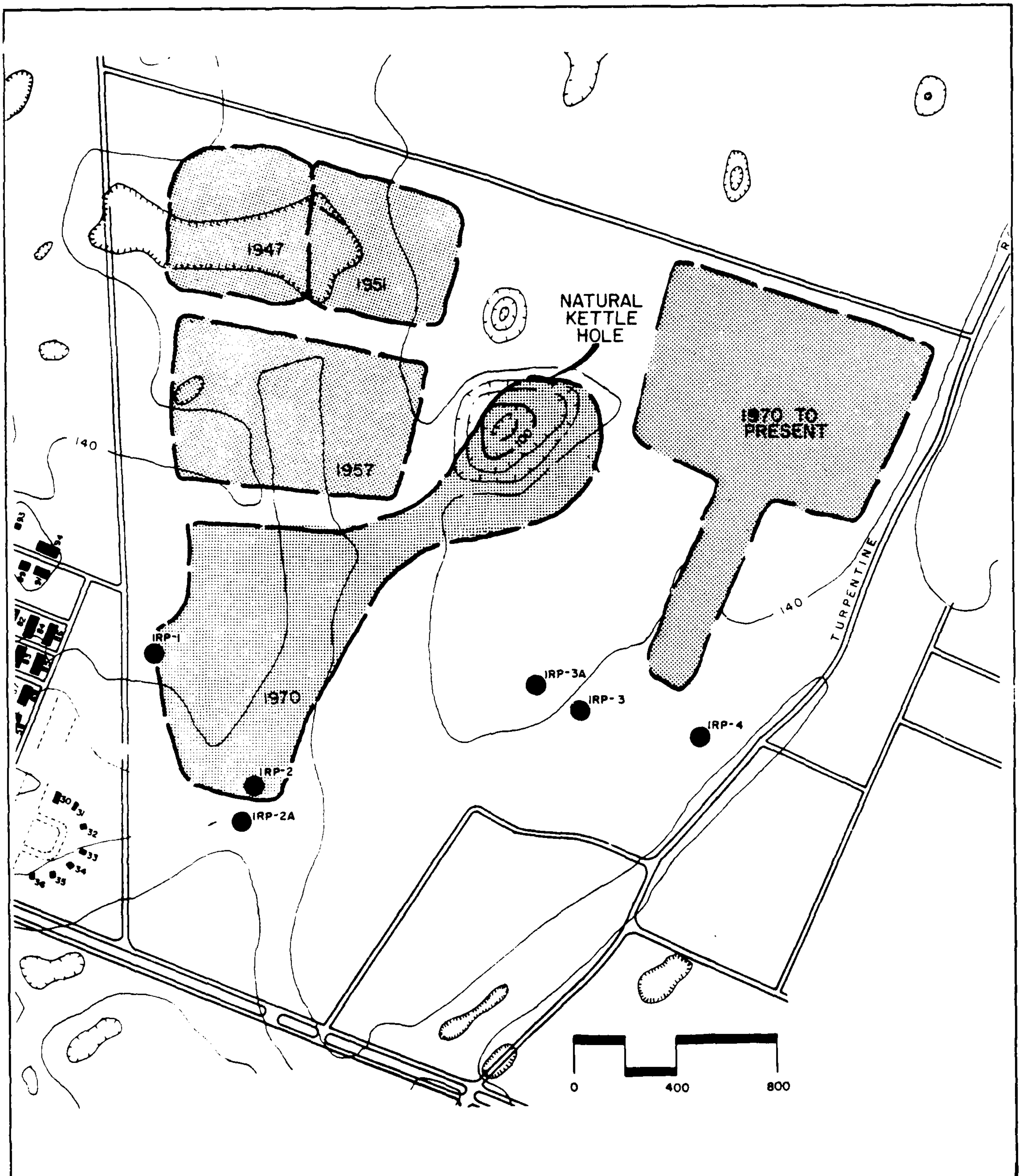
FIGURE 4.2-3



E.C. JORDAN CO. CONSULTING ENGINEERS	CELL LOCATIONS AT THE BASE LANDFILL(LF-1)	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 4.2-4

(C.T. Main Inc., 1941) and historical aerial photographs of the site show a large natural kettle hole (shown in Figure -.2-4), which is no longer present. Prior to 1957, the kettle was used as a gravel pit and between 1957 and 1970 was filled with wastes. Reportedly, numerous drums of waste were deposited into the kettle hole. Prior to being quarried for gravel, the kettle hole was 60 ft deep in the center and 500 ft in diameter.

A large amount of waste has been placed in the kettle hole, and the bottom of this refuse is within 15 ft of the groundwater surface, which is located approximately 75 ft below the ground surface. The exact relationship of the bottom of the fill to the water table at this location is unknown. Potential exists, therefore, for direct contact between the aquifer and the bottom of the fill during periods of extremely high water table.

Since 1984 ANG has carefully regulated disposal into this landfill as a component of the MMR hazardous waste management plan. The 1983-1984 Phase II, Stage 1 investigation of this site (Weston, 1985) included the excavation of nine test pits (approximately 10 ft deep) and the installation of monitoring wells located west, south, and east of the landfill. These well locations are shown in Figure 4.2-4. Groundwater samples were collected for laboratory chemical analysis. The results of these analyses showed levels of 1,4-dichlorobenzene (2.0 to 22 µg/L), 1,2-trans-dichloroethylene (7.7 µg/L), ethyl benzene (6.4 µg/L), difluoromethane (5.9 to 11 µg/L), TCE (18 µg/L), carbon tetrachloride (2.8 µg/L), PCE (3.5 µg/L), TCA (9.0 µg/L), and trichlorofluoromethane (3.0 µg/L) present in groundwater. In addition, Water Supply Well G, located approximately 1 mile downgradient of the landfill, was closed because of the presence of contamination by VOCs, primarily TCE and PCE. Groundwater quality for the IRP monitoring wells and Well G are summarized in Section 3.4.

Based on the above data, direct evidence of contamination exists at LF-1. Based on the depth of fill in the kettle, the permeable nature of the subsurface, and the lack of an impermeable cap on the landfill cells, potential exists for contaminant migration. Evidence exists for such migration in the downgradient IRP monitoring wells. LF-1 was rated using the HARM rating system. These ratings are summarized in Section 4.2.7. Conclusions and recommendations regarding this site are summarized in Sections 5.0 and 6.0.

Landfill No. 2 (Site LF-2)

Landfill No. 2 is located west of Runway 5 and south of the aquafarm (see Figure 4.2-3). This area may have been the original landfill at the base, although this could not be confirmed. Test pits were installed in the area of LF-2 during the Phase II, Stage 1 study of a former FFTA by Weston (1985). Burned refuse was identified in these pits, suggesting the use of the area as a landfill.

Subsequent to the 1940's, the area of LF-2 was filled in and graded. This location has been discussed in Section 4.2.1 as a component of the storm drainage SD-1. During the 1940's, industrial liquid wastes were generally disposed at the point of use (see Section 4.1.1). Waste fuels, waste oils, and solvents were possibly dumped into this area during WWII, however. In addition, domestic refuse was burned and buried. This landfill was closed in 1944 and possibly was used for refuse disposal by Camp Edwards prior to USN occupation of the flight line area. This site was used subsequently as a FFTA in succeeding years. The assessment of this site is summarized in Section 4.2.5. Based on potential contamination from the landfilling activities and the use of the site as a FFTA, the site was assessed as FTA-1.

Landfill No. 3 (Site LF-3)

Landfill No. 3 is located in the northeast corner of the range area adjacent to the MMR boundary and contains rubble, trash, refuse, empty tar buckets, and tires. This landfill is on base property in an area unrestricted from public access. It can be accessed by the public from old Route 130. No evidence of drums of liquids or other hazardous wastes were observed at this location. No evidence of disposal at this location by MMR operations exists. Due to the lack of restricted access, however, hazardous wastes from sources unrelated to MMR could have been disposed at this location. Potential, therefore, exists for contamination. Based on the permeability of the soils at MMR, potential exists for contamination migration, although a relatively thick vadose zone exists in the northern range area (possibly >100 ft). The thick vadose zone would mitigate the spread of contaminants from the site into the groundwater. Because of the unrestricted access to this location by the general public, this site has been referred to the base environmental programs to prevent disposal at this location from non-MMR sources. This site was ranked using the HARM rating system (see Appendix G). These ratings are summarized in Section 4.2.7. Conclusions regarding this site are summarized in Sections 5.0 and 6.0.

Landfill No. 4 (Site LF-4)

Landfill No. 4 (LF-4) is located off-base near Johns Pond (see Figure 4.2.3). This area was a site where contractors dumped wastes from concrete and paving operations. During the site reconnaissance, approximately 18 to 20 rusted 55-gal drums of undetermined contents were observed. Some of these still contained residue. Asphalt debris, empty tar buckets, and general refuse were also observed in the area of the dump site. Due to the presence of drums, the site has a potential for hazardous waste contamination. As shown in Figure 4.2.3, the site is adjacent to MMR. Access, however, is unrestricted, and the largest portion of debris is domestic material such as unserviceable household goods, refuse, construction debris, and asphalt. The origin of the drums is unknown. These drums cannot be identified or clearly linked to MMR. Empty drums attributed to MMR have been located in an area adjacent to the Johns Pond dump. Because of circumstantial evidence for MMR disposal, this site is considered in the Task 6 assessment. This site is located adjacent to a trailer park and near a subdivision that is served by private well water supplies. Potential exists for contamination and migration of contaminants in the permeable substrate. Because of the possibility that hazardous wastes from MMR activities or MMR contractor activities were disposed at this location in the past, this site was rated using the HARM system (see Appendix G). The HARM rankings for this site are summarized in Section 4.2.7. Conclusions and recommendations regarding this site are presented in Sections 5.0 and 6.0.

Landfill No. 5 (Site LF-5)

Landfill No. 5 is located in the vicinity of the VA cemetery (see Figure 4.2-3). It was observed to be a debris and rubble (concrete) fill area. No evidence, visual or reported, of hazardous substances being disposed of at the site exists. No apparent potential exists for contamination at this location; therefore, site LF-5 was eliminated from further consideration using the decision tree process.

Landfill No. 6 (Site LF-6)

Landfill No. 6 is a former USN landfill, once located just west of runway 5 (see Figure 4.2-3). Information on this site was limited. Reportedly, it was used as a debris and rubble fill area during USN expansion of the taxiway area. No evidence of hazardous waste disposal exists, based on this reported use. No potential exists for contamination from LF-6; therefore, this site was dropped from further consideration using the decision tree process.

Landfill No. 7 (Site LF-7)

Landfill No. 7, located in a gravel pit north of the present sanitary landfill (see Figure 4.2-3), is an area were radon tubes were reported to be buried. The radon tubes were removed from EC-121 aircraft radar sets as described in Section 4.1. The number buried is unknown. These tubes contained very low levels of radioactive material (10^{-7} to 10^{-9} PCI). This level of radioactivity is near background level. Present USAF disposal methods for such tubes is to package the tube in its original box for shielding and to dispose of the tubes into a sanitary landfill. Reportedly, radiological assessment of tube burials at other USAF sites, performed as components of the overall USAF IRP, has not indicated significant radiological contaminant migration or human health hazards associated with such sites. Because of the extreme permeability of MMR soils and the high level of EC-121 aircraft maintenance activity, the number of tubes disposed may be large. The hazard from the radiological materials, however, would be expected to be small. Limited potential for contamination and contaminant migration exists at LF-7. This site was rated using the HARM rating system. These ratings are summarized in Section 4.2.7. Conclusions and recommendations regarding this site are presented in Sections 6.0 and 7.0.

4.2.3 Chemical Spill and Disposal Sites

A total of 18 locations at MMR have been identified as chemical spill and disposal sites. Spills and disposal of wastes from industrial operations have often occurred at the sites of waste generation. Specific information regarding such chemical disposal has been discussed in Section 4.1. Releases of chemicals that were disposed of in a manner such that they entered the stormwater drainage system upon release were described in Section 4.2.1. Similarly, chemicals potentially released when disposed into landfills have been described in Section 4.2.2. Potential releases of toxic and hazardous chemicals specifically as a result of spills of fuels (MOGAS, AVGAS, JP-4, diesel fuel, or heating oil), as a result of fire-fighter training exercises or as a result of coal storage are also described in separate sections (Sections 4.2.4, 4.2.5 and 4.2.6, respectively).

As indicated in the activity review, major industrial operations that had potential for disposal of toxic or hazardous chemicals were motor vehicle maintenance, aircraft maintenance, electronic parts cleaning, and the BOMARC missile maintenance. The major quantities of wastes generated have included halogenated solvents (including TCE, PCE, TCA, methylene chloride, and chlorofluorocarbons); nonhalogenated solvents, paint strippers, and thinners, (including toluene, MEK, acetone, and petroleum distillates); ethylene glycol antifreeze; waste POL (frequently commingled with the other compounds); waste battery electrolyte; paint residues, and the specific hypergolic fuel components of the BOMARC system (RFNA and Aerozine-50).

As indicated in Section 4.1, with the exception of the one-time application of pesticide to prevent Japanese beetle infestation of the runway areas in 1983, no integrated pest management program has been in place at MMR. Pest control operations are evaluated in this section.

Explosive ordnance issue and disposal are controlled off-base as indicated in Section 4.1. The only significant ongoing disposal of reactive materials at MMR is the open burning of bags of propellant issued for firing 155-mm howitzers, as well as 81-mm and 4.2-inch mortars. Propellant burning is assessed as chemical disposal.

Based on the past activity review, chemical spill and disposal sites were identified where significant potential exists for past disposal of waste chemicals rather than collection and return to the base DPDO (now DRMO) or for off-site contract disposal. Chemical spill and disposal operations associated with USCG activity have been presented in a separate Phase I report prepared as a component of the ongoing MMR IRP.

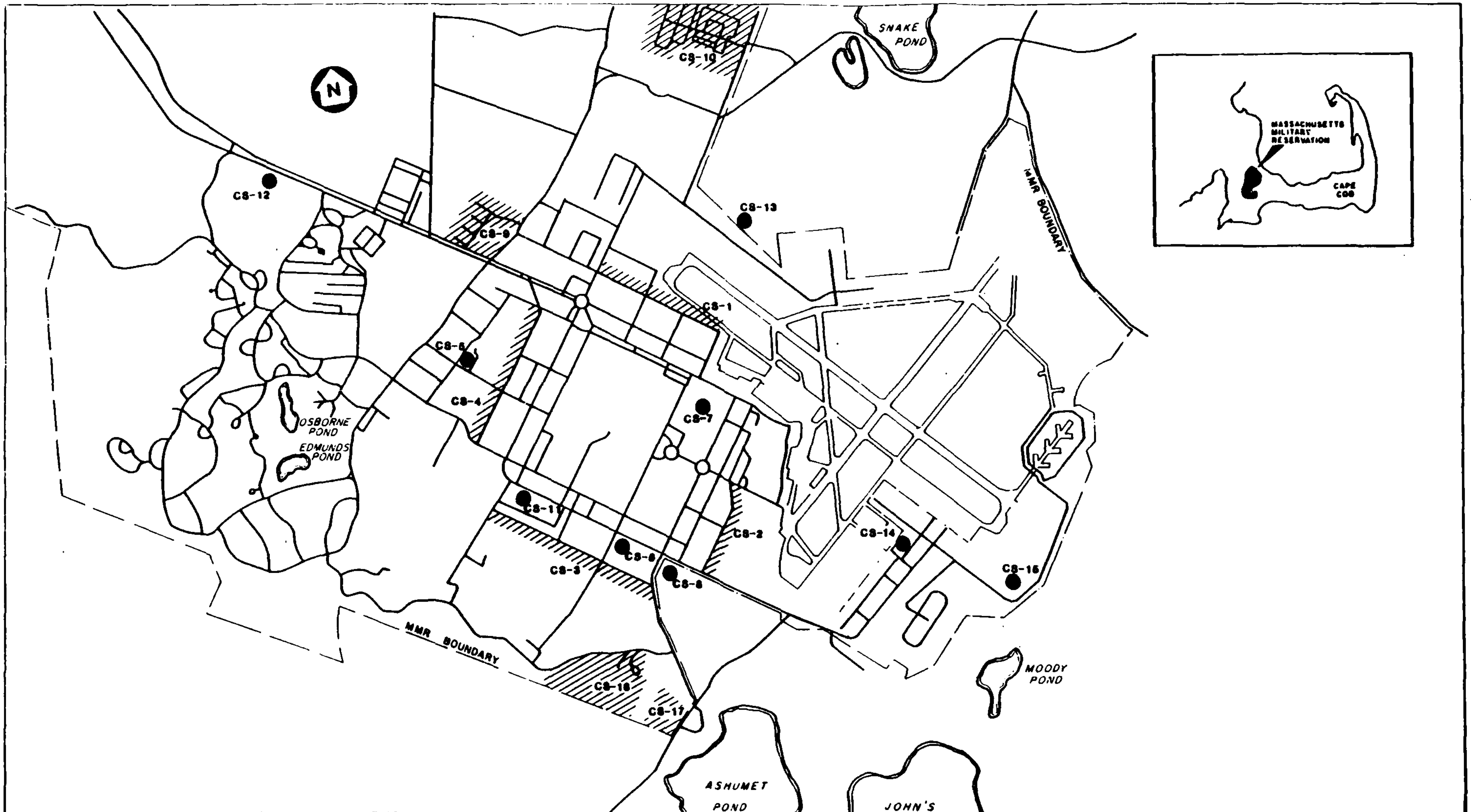
Chemical spill/disposal sites are evaluated in ANG, Camp Edwards/ARNG, USAF, and VA activities in the following paragraphs. The locations of these sites are shown in Figure 4.2-5, and their histories are summarized in Table 4.2-3.

Former Regimental Motor Pools (Sites CS-1, CS-2, CS-3, CS-4)

Army regimental motor pools located on the Outer Truck Roads from 1940 to 1946 generated waste oils, solvents, antifreeze, battery electrolyte, and waste fuels. Unknown quantities of these wastes were reportedly dumped at the sites (see Table 4.1-1). These sites are located in the following areas: North Truck Road (CS-1), East Truck Road (CS-2), South Truck Road (CS-3), and West Truck Road (CS-4), as shown in Figure 4.2-5.

In addition to wastes disposed of from 1940 to 1946, areas along West Truck Road (CS-4) continued to receive wastes until as late as 1973. These areas served as USAF motor pools from 1955 to 1973. These motor pools generated wastes similar to those generated during the earlier Army period. Wastes were dumped along the back fences of each motor pool. As many as 25,000 gal of waste AVGAS and JP-4 were also reportedly dumped at these sites. Use of CS-1 and CS-2 was discontinued after 1946.

In addition to use of the West Truck Road Motor Pool Area (CS-4) until 1973 for vehicle maintenance, the base DPDO storage yard was located on the tarmac in



E.C.JORDAN CO. CONSULTING ENGINEERS	CAMP EDWARDS/AIR FORCE CHEMICAL SPILL/DISPOSAL SITES	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 4.2-5

TABLE 4.2-3

MMR CHEMICAL SPILL/DISPOSAL SITES
(See Figure 4.2-5 for Site Locations)

Site Description	Site Designation	Estimated Dates of Disposal	Waste Description
North Truck Road Motor Pool	CS-1	1941-1946	Waste solvents, fuel, oil, antifreeze, paint, and battery acid.
East Truck Road Motor Pool	CS-2	1941-1946	Waste solvents, fuel, oil, antifreeze, paint, and battery acid.
South Truck Road Motor Pool	CS-3	1941-1973	Waste solvents, fuel, oil, antifreeze, paint, and battery acid.
West Truck Road Motor Pool and Former DPDO Yard	CS-4	1941-1973 (Motor Pool) 1956-1983 (DPDO)	Waste solvents, fuel, oil, antifreeze, paint, and battery acid.
Former Refueler Maintenance Shop Weapons Repair Facility (Bldg. 3437)	CS-5	1941-1967	Waste solvents, fuel, oil, antifreeze, paint, and battery acid.
Current ANG Maintenance Shop (Bldg. 754)	CS-6	1967-present	Waste oil, solvents, and battery acid.
OMS-6 (Bldg. 2806)	CS-7	1966-present	Waste solvents, fuel, oil, antifreeze, paint, and battery acid.
OMS-22 (S-2)	CS-8	1950-present	Waste solvents, fuel, oil, antifreeze, paint, and battery acid.
Former Main USAF Motor Pool (4100 block)	CS-9	1941-1967	Waste solvents, fuel, oil, antifreeze, paint, and battery acid.
UTES/BOMARC (4600 block)	CS-10	1962-1973 1978-present	Waste oil, solvents, UDMH, RFNA, and hydrazine.

TABLE 4.2-3

CHEMICAL SPILL/DISPOSAL SITES (Continued)

Site Description	Site Designation	Estimated Dates of Disposal	Waste Description
ARNG/ANG Pest Control Shop (Bldg. 1131)	CS-11	1970-present	Pesticide residues.
VA Cemetery Roads and Grounds Shop	CS-12	1980-present	Pesticide residues and spills of POL and solvents.
Former Contractors Yard near Well "J"	CS-13	1954-1984	Waste oil and hardened paint.
Building 156 Leach Pit	CS-14	1955-1969	TCE and PCE.
Former Engine Run-up Area	CS-15	1954-present	Waste petroleum distillate solvents and fuels.
Sewage Treatment Plant and Sludge Disposal Area	CS-16	1936-present	Solvents or any other hazardous substance introduced at any point of the sanitary sewer system.
Sludge Disposal Area	CS-17	1936-present	Residual metals or chemicals partitioning on the biological solids POL tank sludges.
Propellant Burning Areas	CS-18	1936-present	Propellant bag burning in range area trace levels of lead and 2,4-dimitro toluene.

the vicinity of Building 1532 from 1956 to 1983. Wastes were transported to DPDO from all shops and labs operating at MMR during the this period. Potentially hazardous wastes with potential for leakage or spillage were transformers and electrical equipment, waste oils, solvents, and waste fuels. Often waste substances were commingled. Waste liquids were stored in an unbermed area in barrels or tank trailers or were deposited in underground tanks. These tanks formerly had been used as MOGAS tanks during the period 1941 - 1946.

The South Truck Road site (CS-3) was also a waste disposal site from 1950 to as late as 1973. During this time, the area was the ANG/CE motor pool. Waste oil, solvents, antifreeze, paint, and battery acid may have been dumped on-site.

As summarized previously and described in Section 4.1, large quantities of waste solvents oils and fuels were potentially disposed at each of these motor pool locations. Commingled with these materials would be metals such as lead (from AVGAS and MOGAS prior to the mid-70's) and other metals that are contained in waste antifreeze and motor oils as corrosion and engine wear products. Depending upon spill rates, weather conditions, and individual solvent properties, some of the solvents would have volatilized. Many of the wastes, however, would have been expected to infiltrate soils on-site.

Persistence of the halogenated and nonhalogenated VOCs in the soils at MMR has not been documented. Metals, particularly lead, would be expected to be more persistent than the organics. Based on the use of persistence factors presented in the HARM methodology (see Appendix G), potential exists for contamination at sites CS-1 through CS-4. As a result of the permeable nature of the substrate, potential exists for migration from each site. The presence of a vadose zone approximately 50 ft thick (see Section 3.3) underlying this portion of MMR could mitigate the potential for contaminants reaching the groundwater because of irreversible sorption or microbial transformation. Soils at MMR are nutrient poor, low in organic content, and highly permeable. Potential, therefore, exists for percolation through the vadose zone and subsequent migration in groundwater.

Sites CS-1 - CS-4 were rated using the HARM process (see Appendix G). The HARM ratings for each site are summarized in Section 4.2.7. Conclusions and recommendations with respect to each site are presented in Sections 5.0 and 6.0.

Former Refueler Maintenance Shop (Site CS-5)

The area around Building 3437 was also a chemical disposal site. The site is designated as CS-5. From 1941 to 1946, the Army used this area as a weapons repair shop. Weapons were repaired and unpacked. Cosmolene was removed from new weapons with a degreasing solvent (possibly gasoline or kerosene). Both cosmolene and solvent may have been dumped on-site. From 1955 to 1967, the USAF used the area as a refueler maintenance shop and spray paint shop. Waste oil, solvents, paints, battery acid, and antifreeze were dumped on-site. Also, refueler truck tanks reportedly were emptied in this area prior to fuel filter and pumping system maintenance. These tanks reportedly contained 50 to 1,000 gal at the time of emptying.

Waste disposal at CS-5 was similar to CS-1 through CS-4 during the 1940's. Reportedly, this practice was continued in the period 1955 - 1967. Potential exists at this site for contamination and contaminant migration as described in the preceding paragraphs. This site was ranked using the HARM process (see Appendix G). The HARM rankings are summarized in Section 4.2.7. Conclusions and recommendations regarding this site are presented in Sections 6.0 and 7.0.

Current ANG Vehicle Maintenance Shop (Site CS-6)

Waste solvents and oils have been generated since 1967 at the current ANG motor pool (CS-6) located in Building 754. With the exception of spills wasted to floor drains, all wastes from this area have been collected and disposed of off-site through either the base DPDO (now DRMO) or an outside contractor. Floor drains at this facility are connected to an oil-water separator that discharges to a ditch adjacent to the site. Limited quantities of waste materials disposed of through these floor drains would, therefore, be discharged to the ground at this outfall. Depending upon discharge rates, weather conditions, and chemical properties, some of these waste materials may have volatilized. However, many of the wastes would have been expected to infiltrate soils in the ditch.

Potential exists for small quantities of wastes to periodically enter the drainage ditch via the floor drains and infiltrate. Based on this factor and the long history of operations at this location, potential for contamination exists. Potential also exists for migration of contaminants entering the ditch. This site was ranked using the HARM process (see Appendix G). The HARM ratings for this site are summarized in Section 4.2.7. Conclusions and recommendations regarding this site are presented in Sections 5.0 and 6.0.

Operational Motor Pools OMS-6 and OMS-22 (Sites CS-7 and CS-8)

As described in Section 4.1.1, the ARNG operated two organizational motor pools at MMR. The first, OMS-6, has operated since 1966 at Building 2806. This site was identified as CS-7. OMS-22 has operated at Building S-2 since 1955. This site has been identified as Site CS-8.

Reportedly, at OMS-6 all vehicle maintenance wastes have been contained and either sent to the base DRMO or taken to the Camp Edwards hazardous waste storage area for off-site disposal by a hazardous waste contractor. Used battery electrolyte was discharged to the sanitary sewer system prior to 1985. The base sewage treatment is described in Section 4.1 and has been assessed as Site CS-14 below. Based on these waste disposal practices, no potential for contamination exists at this location, and Site CS-6 was dropped from further consideration using the decision tree process. Current Product Tank No. 88, located at OMS-6, was tested and potentially leaks. This tank has been evaluated in Section 4.2.4.

OMS-22 has operated at Building S-2 since 1950. Since at least 1970, all vehicle maintenance wastes, with the exception of used battery electrolyte, have been disposed of off-site through either DRMO or via a hazardous waste contractor. Until 1985 electrolyte was discharged to an on-site septic system. No records exists regarding pre-1970 waste disposal practices. Based on practices generally in place at military and civilian vehicle maintenance shops, wastes were likely either taken to the base landfill or dumped on the ground at OMS-22. The relative quantities so disposed are unknown. Up to 250 gal/year of waste oil (commingled with solvents), 20 gal/year of paint thinner, and 50 gal/year of waste solvents probably were generated (see Section 4.1.1). Depending upon discharge rates, weather conditions, and chemical properties, some of the waste solvents probably volatilized. However, much of the waste discharged probably infiltrated soils on-site. Potential for contamination exists, therefore, at CS-8. Because of the environmental characteristics of the soils described earlier, the persistence and potential for transport of the potential contaminants at MMR are unknown. However, potential for residual contamination of the surface soils and vadose zone exists. Site CS-8 was ranked using the HARM process (see Appendix G). The HARM ratings are summarized in Section 4.2.7. Conclusions and recommendations regarding site CS-8 are presented in Sections 5.0 and 6.0.

Former USAF Main Motor Pool (Site CS-9)

As described in Section 4.1, the USAF operated a motor pool for servicing of USAF vehicles at the 4100 Block of MMR from 1954 to 1967. This site has been identified as Site CS-9. During the 1940's (1941 - 1946) this area was used by the U.S. Army as a motor pool/vehicle maintenance area. Reportedly, vehicle maintenance wastes during both periods were disposed of on the ground at this site. Wastes would have included waste oil (commingled with solvents), waste halogenated and nonhalogenated solvents, paint residues, waste battery electrolyte, and used antifreeze. Refueler trucks reportedly were not maintained at this site. These were maintained at Site CS-5, described previously. The quantities of waste fuel, therefore, would have been limited to small quantities of MOGAS from maintained vehicles.

Based on the dates of operation of this location, potential for contamination and contaminant migration are similar to other vehicle maintenance sites described previously. This site was ranked using the HARM system (see Appendix G). The HARM ratings are summarized in Section 4.2.7. Conclusions and recommendations regarding this site are presented in Sections 5.0 and 6.0.

UTES/BOMARC (Site CS-10)

The 4600 Block of MMR was developed in 1962 as the site for a BOMARC missile installation housing 56 missiles. Missile maintenance activities were carried out at this location from 1962 to 1973. No industrial operations occurred at this site from 1973 to 1978. During this time, portions of the missile hangar area were used as horse stables. The UTES was established in 1978 in Building 4601. In 1982 the Camp Edwards hazardous waste storage area was established in Building 4600 at this location. A tank-washing facility was built immediately west of the missile hangar area to provide for washing of tracked vehicles and heavy trucks. Because of the nature of BOMARC operations and because of reported spillage of waste POL and solvents during transfer at UTES, the 4600 Block was identified as a chemical spill and disposal site (CS-10).

As described in Section 4.1.1.3, the BOMARC operations were a self-contained unit, and many operational details are classified. Operations potentially generating hazardous wastes were missile guidance, fuel, and motor systems. It is likely that halogenated solvents were used during electronic-parts cleaning related to the missile guidance systems. The method of waste disposal of this material is unknown; however, a large proportion of the solvents expectedly would have evaporated in use. As described in Section 4.1.1, solvents such as methylene chloride, TCE, PCE, and TCA were in common use as electronic-parts cleaners during the 1960's. Monitoring wells installed by AEHA and located immediately downgradient and to the south and west of the BOMARC/UTES site contain low concentration of VOCs, primarily PCE (see Section 3.4.2).

Waste JP-4 was generated as a result of engine/fuel delivery maintenance and probably as a result of requirements to prevent failure of the engine due to aged fuel. The disposal method for waste JP-4 is unknown.

A hazardous liquid storage and waste treatment system was in place to handle the highly reactive fuel and oxidizer components of the hypergolic rocket fuel. Separate systems were used to handle the RFNA oxidizer and the Aerozine-50 fuel. RFNA from defueling of rockets for maintenance was discharged to a leaching pit after neutralization in limestone. RFNA decomposes to nitrogen oxides, water, and nitric and nitrous acids (HNO_2 and HNO_3). No major spills or accidents were reported for RFNA handling at MMR. RFNA is extremely toxic and reactive; however, it is nonpersistent in the environment because of its extreme reactivity.

The components of Aerozine-50, UDMH and hydrazine are also highly reactive and extremely toxic and are strong reducing agents. Because of the nature of the rocket fuel, extremely careful handling precautions as described in Section 4.1 would have been in place to prevent spills of either compound and to prevent any mixing of the two materials. Hydrazine decomposes to nitrogen gas and water. UDMH rapidly and spontaneously decomposes by auto-oxidation in the environment, primarily to water, carbon dioxide, and nitrogen gas. However, under certain environmental conditions, UDMH reacts to form N-nitrosdimethylamine, a priority pollutant. UDMH from rocket defueling was disposed of into a septic system and allowed to autooxidize. The quantities of UDMH disposed are unknown. No N-nitrosdimethylamine has been detected in MMR groundwater. The former UDMH septic system has been filled with earth. No records of material buried in this system exist.

Wastes from UTES vehicle maintenance reportedly have been either disposed of since 1978 through DPDO, DRMO, or a hazardous waste contractor. Reportedly, however, transfer operations from point of use to hazardous waste storage containers have resulted in 10 to 25 percent of the waste oils, fuel (diesel and MOGAS), and solvents being spilled on the ground. Depending upon spill rates, weather conditions, and chemical properties, some of the solvents and fuels probably volatilized. Many of the wastes, however, may have infiltrated the soils at the site. During a 1982 compliance inspection by Massachusetts DEQE, oil-stained soil was observed behind Buildings 4641 and 4601 and at the tank-washing area (DEQE 1982). Subsequent to this inspection, the stained soil was removed and replaced by clean fill.

Because of the former missile operations and housekeeping practices, potential for contamination exists at Site CS-10. Indirect evidence of contaminant migration exists based on data from the AEHA monitoring wells. This site was ranked using the HARM process (see Appendix G). The HARM rankings for this site are summarized in Section 4.2.7. Conclusions and recommendations regarding this site are presented in Sections 5.0 and 6.0.

ARNG/ANG Pest Control Shop (Site CS-11)

The former ANG and current ARNG pest control storage and mixing area is located in Building 1161. Since 1970 limited quantities of pesticides and herbicide have been mixed on an unbermed asphalt pad located on the east side of the building. Discharged rinsings or pesticide spills would be washed to the edge of the pad and infiltrate into the underlying soils. No major spills have been reported at this location; however, potential for pesticide contamination exists. The types of pesticide formerly stored at this location are undocumented.

Potential for contamination exists at this site. Because of the permeable nature of the soils at MMR, potential exists for contaminant migration. As described above, the presence of a thick vadose zone below Site CS-11 could limit migration of pesticide residues to the water table. Current pesticides used would likely degrade rather than migrate in the soil environment. The low nutrient and organic content of MMR subsurface soils would not be favorable for microbial degradation. Pesticides used in the past are undocumented. Persistent pesticides may have been mixed at this location. This site was, therefore, ranked using the HARM process. HARM ratings for this site are summarized in Section 4.2.7. Conclusions and recommendations for Site CS-11 are presented in Sections 5.0 and 6.0.

VA Cemetery Roads Grounds Shop (Site CS-12)

The VA Roads and Grounds Shop has been in operation since 1980 to maintain the National Cemetery of Massachusetts. All roads and grounds equipment is housed and maintained at the shop location. In addition, pesticide and herbicides for use at the cemetery are mixed on the tarmac at this location. Operations at this shop are described in Sections 4.1.1 and 4.1.3. All waste POL, paint residues, and solvents are disposed of off-site by a disposal contractor. Pesticide and herbicide formulations are applied to the cemetery grounds. Containers are rinsed and the rinseate sprayed at the point of application or used as dilutent for subsequent mixing operations, as appropriate.

Vehicle maintenance and washing takes place in three bays within the maintenance building. Floor drains from these bays, as well as from the flammable and toxic materials storage area, are discharged through an oil-water separator manhole and into a leaching pit. Spills of material on the maintenance floors, therefore, can be washed to disposal in the subsurface at this site.

Spills of POL or pesticides occurring on the tarmac can enter a localized storm drainage system or flow across the tarmac. The storm drainage system flows into a small kettle hole wetland located at the downgradient side of the tarmac. The leaching pit and the kettle hole are located within 300 yards of the VA water supply well.

No significant spills of chemicals or pesticides have reportedly occurred during the 5-yr history of operations. Because of the nature of the drainage system, however, potential for contamination exists in the event of a spill. Contaminant migration would be expected based on the permeable nature of the soils at this location and driving force provided by stormwater runoff. This site was ranked using the HARM process (see Appendix G). The HARM ranking for this site is summarized in Section 4.2.7. Conclusions and recommendations regarding Site CS-12 are presented in Sections 5.0 and 6.0.

Former Contractors Yard (Site CS-13)

A former contractors yard (CS-13), located off-base, approximately 1,000 ft from water supply well J, also served as a site for reported chemical disposal. Drums of hardened paint, waste oil, and an unknown oily substance were present at the site from about 1954 to 1984. In 1984 these drums (approximately 110) were removed by the Massachusetts DEQE. At the time of removal, many of the drums were found to have bullet holes, suggesting the drums may have been bearing contents prior to removal.

Material in the drums was never completely characterized, and the majority of the contents reportedly had leaked to the ground prior to removal. The origin of the drums is unknown. Potentially, however, they were disposeded in the early 1950's during paving contractor maintenance activity. The site of these drums is a borrow pit; therefore, strong potential exists for infiltration of contaminants disposed to the soil at location CS-13. The site is near and upgradient of the only currently operating base water supply well. Low concentrations of VOCs have been detected in Well J (See Section 3.4.2).

Based on the potential for residual contamination from leaking drums at this location and the potential for migration to Well J, this site was ranked using the HARM system. The HARM ratings for this site are summarized in Section 4.2.7. Conclusions and recommendatons regarding this off-base site are presented in Sections 5.0 and 6.0.

Vapor Degreaser Leaching Pit (Site CS-14)

CS-14, located at Building 156, is a leaching pit that receives discharge from a room that housed a vaporization degreaser from 1955 to 1969. This room, located on the west side of the building, has a single scupper drain that leads to the leach pit. Operations in Building 156 are described in Section 4.1.1. This room served primarily as an area where new engines and engine parts were degreased to remove cosmolene. Reportedly TCE and PCE were used in this operation. Wastes were allowed to drain out of the degreaser to the scupper drain. Quantities of waste are unknown, but due to the level of activity during this period (1955-1969), it is likely that significant amounts of solvent were discharged to the leach pit. Since the early 1970's the room has been used by the tire shop for degreasing activities. Waste solvents are now pumped out and stored in 55-gal drums for disposal.

Depending upon the discharge rates and weather conditions, some of these solvents may have volatilized. However, the potential for contamination of the subsurface soils by halogenated solvents exists at CS-14. Based on the permeability of the subsurface soils, potential exists for contaminant migration. This site was ranked using the HARM process. HARM ratings for this site are summarized in Section 4.2.7. Conclusions and recommendations regarding this site are presented in Sections 5.0 and 6.0.

Engine Run-up Area (Site CS-15)

The engine run-up area was located in the area of Building 204 from 1949 to 1985. Currently, this operations is carried out at Building 202. Before 1954 the run-up area was located within the building, and wastes were washed to a drywell. From 1954 to 1970, engine run-up was located outside on a concrete pad; wastes were washed off the pad and into the ground. Wastes generated during this time included waste JP-4 and AVGAS (180 gal/yr) and waste petroleum distillate (PD-680) (1,000 to 1,500 gal/yr). Currently, wastes generated from this operation are disposed of off-site by a hazardous waste contractor.

Potential exists for contamination as a result of fuel components (aromatic hydrocarbons, alkanes, and lead from AVGAS) and petroleum distillate solvents that were discharged to the dry well or washed to the ground at the edge of the pad. The relative quantities of these materials that volatilize or would be microbiologically degraded in MMR soil are unknown. Because of the permeable nature of the soils at MMR, potential exists for contaminant migration. Site CS-15 was ranked using the HARM process (See Appendix G). Rankings for CS-15 are summarized in Section 4.2.7. Conclusions and recommendations regarding this site are presented in Sections 5.0 and 6.0.

The Base Sewage Treatment Plant and Sludge Disposal Area (Sites CS-16 and CS-17)

The base sewage treatment plant discharges to sand filters along the southern boundary of the reservation. The most intensive level of activity and, therefore, the greatest volume of discharge occurred prior to 1970. Since then the flow has dropped off to the point that currently 2.8 mgd is recirculated to maintain treatment efficiency. Very little wastewater data are available prior to 1978. As shown in Table 4.1-1, in the past, waste electrolyte, solvents, and paint thinners were discharged from various operations at MMR to the sanitary sewer. Photo developer and medical dispensary waste (small quantities) continue to be discharged to the sanitary sewer. The possibility exists that solvents, thinners, and other organic chemicals continue to be disposed of through drains that lead to the sanitary sewer. Because of the presence of contamination downgradient of the plant, the influent and effluent are being studied as a component of ongoing MMR IRP Phase II activities.

The former sewage sludge storage area is located to the southeast of the sewage treatment plant. This area received dried sludge from 1941 to the mid 1960's. Since that time, sludge has been taken to the base landfill after drying. It is not known how much sludge was stored at this site. However, records indicate that as much as 200 cy/month may have been placed in the area. This sludge was made available for people on the base for use as soil conditioner. There are still numerous piles of sludge, now grown over with vegetation, in this area. There are no data available on the past or present composition of this sludge.

Metals coming into the STP and organic chemicals that partition strongly to organic matter would be found in the raw sludge. The current sludge drying beds are also being studied as a component of MMR IRP Phase II activities.

Reportedly in the past (prior to the 1960's), tank bottom sludge from the petroleum fuel storage area tanks, consisting of JP-4, heating oil, and AVGAS weathering products, was placed in the sludge drying beds. Biological degradation of the organic portion of the sludge has probably occurred based on the rich microbial flora content and nutrient availability from the sludge. Residual lead from AVGAS and battery electrolyte, as well as other metals from paints and chromium from chromate cleaners potentially occur in the sludge. The mobility of these metals from the organic-rich sludge piles to soil has not been documented.

Potential exists for contamination due to former and possibly currently treated sewage effluent and from the current and former sludge. Indirect evidence exists for migration of VOCs in the sewage effluent (See Section 3.4). Potential exists for migration of metals from the former sludge piles and cement sludge drying beds. Sites CS-16 and CS-17 were ranked using the HARM group (See Appendix G). Summaries of the HARM ratings are presented in Section 4.2.7. Conclusions and recommendations regarding these sites are presented in Sections 5.0 and 6.0.

Propellant-Burning Sites (Site CS-18)

As described in Section 4.1.8, bags of common propellant for 155-mm howitzer and 4.2-inch and 81-mm mortars cannot be returned to the issue point. Unused propellant is burned at the 15 artillery firing points from which these weapons are fired. Unknown quantities have been burned at MMR since the 1940's. Trace concentrations of lead, used in the propellant bag strings, would remain as residual after burning. Depending on the rate and completeness of burning, traces of propellant (single double-base solid propellants) and 2,4-dinitrotoluene (used in propellant formulations to control burn rate) could be dispersed into the surface soil. As indicated in Section 4.1.8, no residual explosion/fire hazard would be expected from the burning operation. 2,4-DNT is present in propellant at approximately 10 percent concentration and is flammable. Traces of this priority pollutant potentially would remain unburned in the surface soils. Potential for contamination, therefore, exists at these locations. Because of the permeable nature of MMR soils, potential for migration exists for lead and 2,4-DNT contamination from the burning areas. Concentrations of 2,4-DNT expected at individual sites would be small. In general, lead from propellant-burning operations is not leachable. Because of the permeable nature of MMR soils and probable low cation-exchange capacity, lead mobility is unknown. These sites were marked as a group using the HARM system (See Appendix G). Ratings for this activity are summarized in Section 4.2.7. Conclusions and recommendations regarding propellant burning are presented in Sections 5.0 and 6.0. These sites are not shown in Figure 4.2.5.

4.2.4 Fuel Spill Sites

Fuel spills have occurred at various locations throughout MMR since the 1940's in conjunction with aircraft fueling/defueling, motor vehicle fueling, and fuels handling and storage. According to the base fire department, there were 142 reported spills in 1983, 237 reported spills in 1984, and 191 reported spills in 1985. The majority of these spills have occurred at airfield or motor pool areas. Most spills are due to overfilling of vehicles or aircraft. The total number of spills that have occurred historically at MMR has not been systematically documented. Major spills that have been reported by interviewed personnel are assessed in this section. MMR activities that may have resulted in fuel release have been discussed in Sections 4.1.1 and 4.1.5. Motor fuels in use at MMR have been MOGAS, diesel, AVGAS, and JP-4.

The major known fuel spills identified in this records search are listed in Table 4.2.4 and their locations shown in Figures 4.2.6 and 4.2.7. Spills that have occurred on the runways or aprons generally have been washed into the storm drainage system. These spills have been evaluated in conjunction with the storm drainage sites in Section 4.2.1. Likewise, fuel dumping in conjunction with disposal of waste solvents and other materials is evaluated with chemical disposal sites in Section 4.2.3. Fuels disposal for fire-fighter training is evaluated in Section 4.2.5.

Fuels management was also identified as having significant potential for contamination in the 1983 Phase I report on Otis-ANGB (Metcalf and Eddy, 1983). Two sites were identified in this report as having significant potential for contamination, the AFTDS and the RFPS. A third fuels management site, the PFSA, was identified subsequent to the original Phase I report. These sites were studied as components of the Phase II, Stage 1 program performed in 1983-1984 (Weston, 1985). These sites were reassessed during the current records search. Based on evaluation of preliminary records search information and the Weston (1985) data, recommendations were made for further Phase II studies at each of these sites as components of the ongoing MMR IRP.

Fuels used at MMR are mixtures composed of straight and branched chain aliphatic hydrocarbons and aromatic hydrocarbons. In addition, AVGAS and MOGAS (used prior to the mid-1970's) contain tetraethyl lead as an additive. Major aromatic constituents of fuels include the VOCs BTX and ethyl benzene. Table 4.2-5 presents a summary of the constituents in a typical unleaded MOGAS and in JP-4. The aromatic and aliphatic components in spilled fuels may volatilize or be microbiologically degraded under aerobic conditions. The soil environment at MMR is likely to be low in nutrient and organic content and highly permeable, based on the soil types present. Under these conditions, fuel spilled on the ground would infiltrate rapidly. The capacity for the soil to absorb the hydrocarbons and prevent migration is probably limited. Hydrocarbons would be expected to distribute into the vadose zone. As a consequence of this, volatilization rate would be limited and also dependent on the spill rate and weather conditions during the spill. The low nutrient content (especially nitrogen) expected for MMR soils, especially subsoils, would likely limit microbial degradation. Fuel constituents potentially could be persistent in MMR soils. In the HARM system (See Appendix G), fuel constituents (aromatic hydrocarbons) and straight chain hydrocarbons are rated as highly persistent.

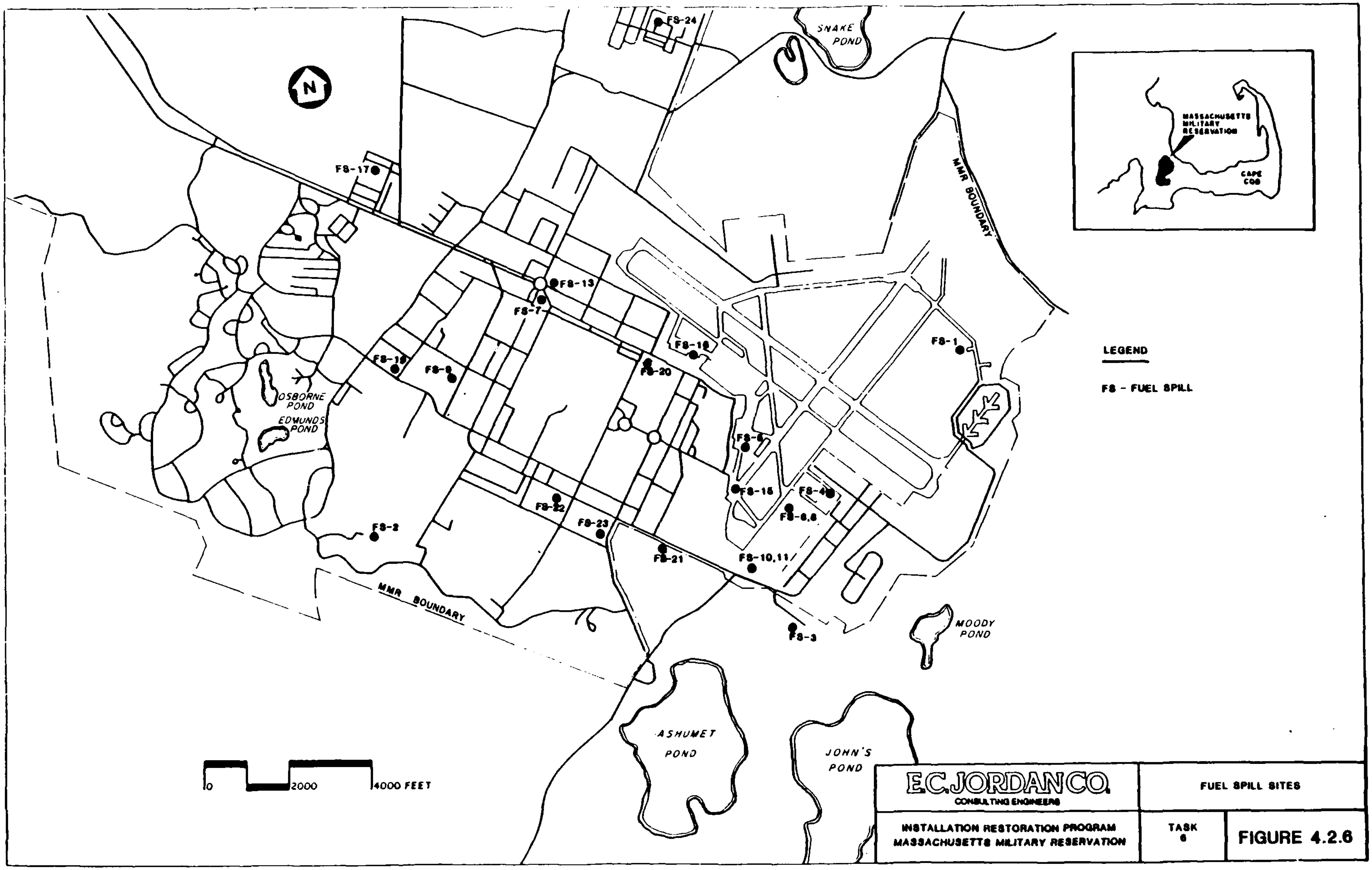
TABLE 4.2-4
SUMMARY OF FUEL SPILL LOCATIONS

SITE #	LOCATION (FIGURE NO.)	DESCRIPTION	COMMAND UNIT	DATE	FUEL TYPE	TOTAL AMOUNT (GAL)	COMMENTS
FS-1	4.2-6	AVGAS Fuel Valve Test Dump Site	Former USAF	1955-1969	AVGAS	Greater than 1 million	Testing of fuel dump valves on *EC-121 Aircraft*.
FS-2	4.2-6	Railroad Fuel Pumping Site	Former USAF	1955-1965	JP-4, AVGAS	110,000	Resulted from refueling operations.
FS-3	4.2-6	John's Pond Road	Former USAF	Approx. 1955-62	JP-4, AVGAS	Approx. 44,000	Dumping of fuel prior to maintaining the refuelers.
FS-4	4.2-6	Current Product Tanks 100, 101	ANG	1956-Present	AVGAS	21,000*	Tank under study.
FS-5	4.2-6	Near aquafarm (apron)	Former USAF	Early 60's	AVGAS	15,000	Three (3) refuelers burned; washed to storm drains.
FS-6	4.2-6	Airfield (apron)	Former USAF	Early 60's	AVGAS	15,000	Constellation spill; washed to storm drain.
FS-7	4.2-6	Current Product Tank 115	ARNG	1970-1985	#-2 Fuel oil	11,000	Tank removed 6-18-85.
FS-8	4.2-6	Airfield (apron)	Former USAF	Early 60's	AVGAS	8,000	Constellation spill and fire; washed to storm drain.
FS-9	4.2-6	Current Product Tank 108	ARNG	1952-Present	MOGAS	3,800	Tank under study.
FS-10	4.2-6	Fuel storage area	Former USAF	Early 60's	JP-4	Approx. 2,000	Leak in pumphouse (Bldg. 170).
FS-11	4.2-6	Fuel storage area	Former USAF	Early 60's	JP-4	Approx. 2,000	Tank 21 overflow.
FS-12	4.2-7	3" Underground fuel line	Private contractor	1972	JP-4	Approx. 2,000	Leak in pipeline in range.
FS-13	4.2.6	3" Underground fuel line	Private contractor	1972	JP-4	Approx. 2,000	Leak in pipeline in contonment area.
FS-14	4.2-7	Range (E-3)	ARNG	1985	MOGAS	1,200	Soil has been excavated.
FS-15	4.2-6	Runway #5	Former USAF	Early 60's	AVGAS	200	Plane crash.
FS-16	4.2-6	Army Helicopter Maintenance Bldg. 2816	ARNG	1982	JP-4	200	Spillage washed off tarmack onto surrounding soil. Refer to Sec. 4.2.3 for more information.
FS-17	4.2-6	Former WWII motor pool/ fuel transfer point	ARNG	?-Present	MOGAS	unknown	Unknown amount of spillage during refueling operations.
FS-18	4.2-6	Fuel transfer point	ARNG	?-Present	MOGAS	unknown	Unknown amount of spillage during refueling operations.

TABLE 4.2-4 CONT'D.

SITE #	LOCATION (FIGURE NO.)	DESCRIPTION	COMMAND UNIT	DATE	FUEL TYPE	TOTAL AMOUNT (GAL)	COMMENTS
FS-19	4.2-6	Former MOGAS/fuel storage and transfer point	ARNG	?-1985	MOGAS	unknown	Unknown amount of spillage during refueling operations. Six 10,000-gal underground tanks were removed in 1985 and found in good condition.
FS-20	4.2-6	Current Product Tank 88	ARNG	1968-Present	MOGAS	108,000*	Tank under study.
FS-21	4.2-6	Current Product Tank 90	ARNG	1954-Present	MOGAS	21,000*	Tank under study.
FS-22	4.2-6	Air National Guard Motor Pool	ANG	Sept. 1984	JP-4	5,000	5,000-gal refueler truck spill. Cleaned up immediately.
FS-23	4.2-6	South Truck Road	Former USAF	1965	JP-4	Approx. 1,000	Leak in 8" underground line.
FS-24	4.2-6	BOMARC	ARNG	1985	Diesel fuel	Approx. 500	Spill during tank decommissioning. Cleaned up immediately.

*Tanks are assumed to leak for tank life and at the rate they leaked upon testing for estimation of total spill volume. Leakage of tanks at MMR has been generally due to problems with fill pipe connections; actual spill volume would, therefore, be much less than estimated. The figures, therefore, represent "worst case" estimates. More-probable quantities leaked would range from 1 to 15 percent of the estimate presented above.



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FUEL SPILL SITES

INSTALLATION RESTORATION PROGRAM
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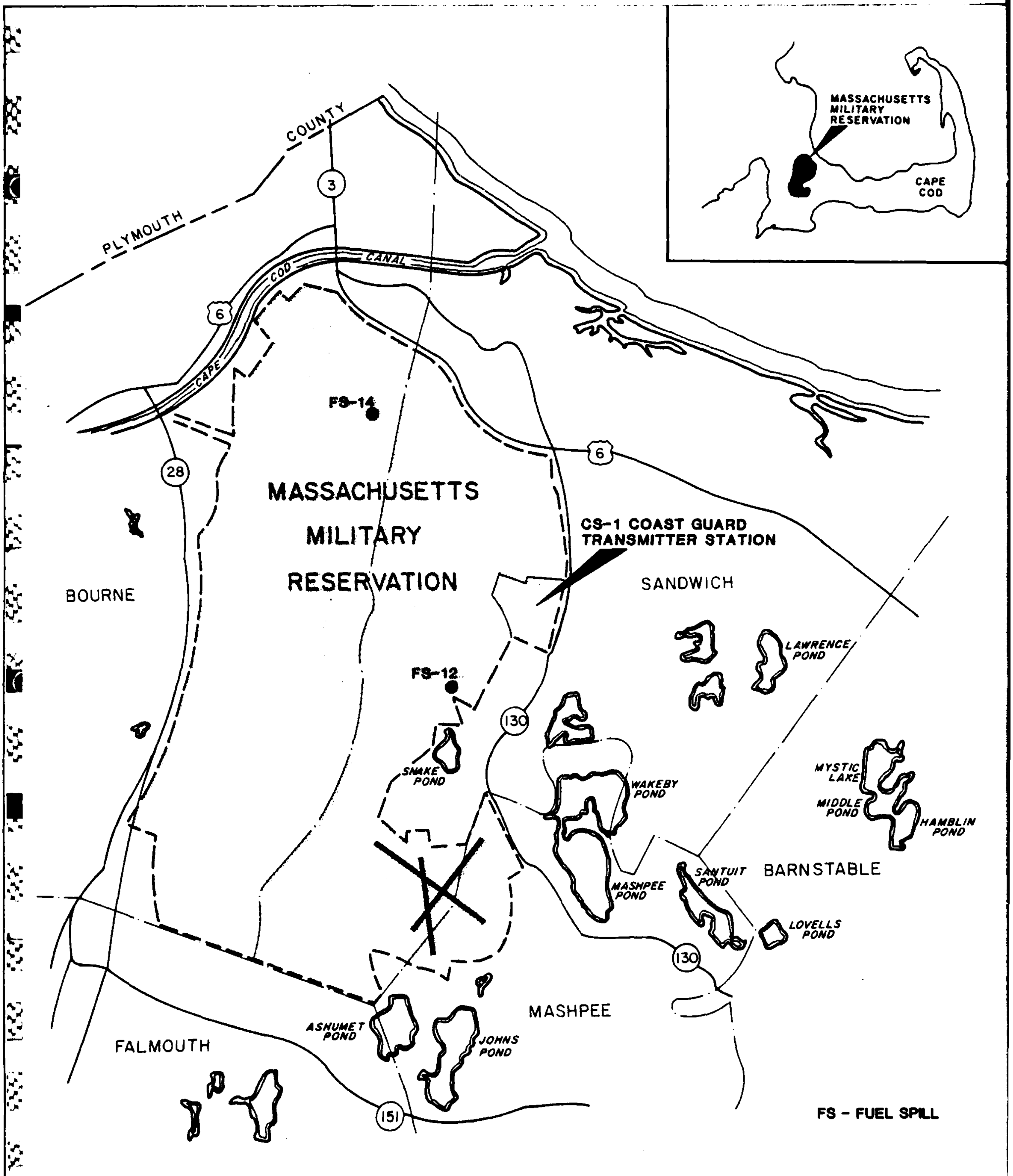
TASK 6

FIGURE 4.2.6



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INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 4.2.7

TABLE 4.2-5

COMPARISON OF GASOLINE AND JET FUEL COMPOSITION

	Unleaded Gasoline[1]		JP-4[2]	
Constituent	Composition in Product (Percent)	Maximum Solubilization Concentration in Water (mg/L)	Composition in Product (Percent)	Maximum Solubilization Concentration in Water (mg/L)
Benzene	1.9	58.7	0.36	13.4
Toluene	4.7	33.4	0.85	9.8
Xylenes	6.0	22.3	Not given	Not given
Ethyl benzene	0.4	4.3	Not given	Not given
1,2,4-Trimethylbenzene	3.2	1.1	Not given	Not given
Napthylene	Not given	Not given	0.27	Not given
Total aromatic compounds	28.4	Not given	Not given	36,400
Total aliphatic hydrocarbons	71.6	Not given	Not given	Not given

Sources:

1 Brookman, Flanagan, and Kebe, 1985.
2 Huges et al., 1985.

Notes:

Constituency and solubility taken from laboratory studies.

The major potential fuel spills, (those spills which total over an estimated 25,000 gal) as shown in Table 4.2-4 are highlighted below. Also highlighted below is the Petroleum Fuels Storage Area (PFSA) the major fuel storage are the the flight line. Although this area has had no spills documented as greater than 25,000 gallons, large quantities of fuel have been handled for a long period, and downgradient POL-related contamination has been observed. Fuels management priorities have been described in Section 4.1.5.

- <u>AVGAS Fuel Valve Test Dump Area (FS-1)</u>. From 1955 to 1969, testing was performed on the fuel dump valves on the EC-121 constellation aircraft. The location of the test area is in an old borrow pit east of the runways (see Figure 4.2-6). Estimates range from 200 to 1000 gal of AVGAS dumped at each test. It is estimated that during the 14 yrs of testing, between 1 and 6 million gal of AVGAS were dumped at this site. The quantity of AVGAS that has infiltrated the soil depends on numerous factors, including spill rate, weather conditions (especially temperature), and the moisture content of the soil. Because of these factors, the actual quantity that may have volatilized and the quantity infiltrating cannot be estimated. This site was identified in the 1983 record search and studied in the original Phase II stage 1 program. (Metcalf and Eddy, 1983 and Weston, 1985, respectively). Based on evaluations of the available Phase II data, further Phase II studies are being recommended at this location as a component of the ongoing MMR IRP.

- <u>Railroad Fuel Pumping Site (FS-2)</u>. From 1955 to 1965, fuel was transferred from 10,000-gal railroad tank cars or 8,000-gal fuel trucks to pipes that transported JP-4 or AVGAS to the current fuel storage area. Each time a fuel truck or tank car was defueled, 1 to 2 gal were reportedly spilled on the ground. It is estimated that as many as 110,000 gal of fuel may have been spilled at this site during the 10 yrs of operation. The amount of fuel that has infiltrated the soil depends on the surface nature, spill rate, and weather conditions during the spill. The range of the volume to infiltrate the soil could be mean actual volume spilled or as low as a few percent of the volume spilled. For further information on the operations of this site, refer to Section 4.1.5. This site was identified in the 1983 record search and studied in the original Phase II, Stage 1 program (Metcalf and Eddy, 1983 and Weston, 1985, respectively). Based on evaluations of the reassessment of this site and the original Phase II data, further Phase II studies are being recommended as a component of the ongoing MMR IRP.

- <u>John's Pond Road (FS-3)</u>. During the period from 1955 to 1962, Johns Pond Road was used to drain refueler trucks prior to maintenance. Each time a refueler was drained, approximately 40 gal of fuel was reportedly allowed to flow out of the tank and onto the road. During the period of use, approximately three trucks per week reportedly used the road for this purpose. Based on this use, it has been estimated that approximately 44,000 gal of fuel were allowed to drain onto Johns Pond Road. The amount of fuel that has infiltrated the soil depends on the surface nature, spill rate, and weather conditions during the spill. The range of the volume to infiltrate the soil could be mean actual volume spilled or as low as a few percent of the volume spilled. This site is located off the present boundary of MMR.

- Current Product Tank 88 (FS-20). Current product tank 88 has been used since 1968 at OMS-6. Based on an observed potential leakage rate of 2.5 L/hour, this tank may have lost up to 108,000 gal over the 18-yr life of the tank. Verification of leak and the source of the leak (tank, fittings, or filler pipe) are under study. It is probable, however, that the leak, if present, is located in the filler pipe, and the quantity lost, an order of magnitude lower than the estimate.

  Some of the underground fuel storage tanks have been tested for leaks (see Section 4.1.5). The only tank that showed evidence of leakage after being removed was CPT-115. CPT-115 had a small leak around the fill pipe connection. Some current product tanks have been leak tested and are still being studied to verify if there is, in fact, a problem. Tanks removed during the abandoned tanks removal program generally are free from corrosion even after 40 yrs of burial. This is due to the well drained nature of MMR soils. It is likely, therefore, that most tank leakage is confined to fittings and filler pipe leaks.

- Petroleum Fuel Storage Area (PFSA) (FS-10, FS-11). The petroleum fuel storage area was studied as a component of the former Phase II, Stage 1 investigation (Weston 1985). The PFSA consists of three aboveground storage tanks ranging in size from approximately 500,000 gal to 1.2 million gal and 12 underground storage tanks, four tanks that hold 500,000 gal each and eight tanks that hold 25,000 gal each. Three pipelines from the storage area to the flight line have been in operation, one for AVGAS and two for JP-4. From the PFSA, the two pipelines carrying JP-4 are still in use. The one that carried AVGAS has been shut down because the need for AVGAS is minimal at present.

  All aboveground and underground storage tanks at the PFSA are on a tank maintenance program. Every 5 yrs tanks are drained, cleaned, and inspected. During the years when large quantities of AVGAS were used at the base, tank cleanings generated tank bottom sludge. These lead-laden sludges were generated in volumes of 3 to 5 cy per tank per 5-yr cleaning. The sludges were either placed in the sludge drying beds at the sewage treatment plant or left in the corner of the diked containment areas around the tanks. The diked containment areas are unlined. No major leaks have been detected in these tanks.

  Spills of small and large quantities of AVGAS and JP-4 have occurred at these sites or in the transfer system during the 35 yrs of operation but detailed records of those spills do not exist and, therefore, no estimates of total quantities spilled can be made. The spills identified in the aircraft fuels handled by installation personnel are presented in Table 4.2-5.

The Phase II, Stage 1 investigation of this site included the installation of one monitoring well (IRP 10), located 500 ft south of the PFSA, and the collection of one groundwater sample for laboratory analysis. The results of these analyses showed concentrations of toluene (2.8 μg/L), ethyl benzene (59 μg/L), and total xylene (78 μg/L) present in the groundwater. These potentially are fuel-derived VOCs.

Due to the presence of volatile organic compounds present in groundwater anticipated as emanating from beneath the PFSA, additional investigation (Phase II, Stage 2) was recommended as a component of the current MMR IRP.

The vadose zone underlying the cantonment area of MMR is estimated to be approximately 50 ft thick. As oil moves downward through the soil, a small amount attaches itself to each particle of soil contacted and remains behind the main body of oil. Where the spill is small relative to the surface area available for contact in the zone of migration, the body of oil is exhausted on the way down until the degree to which it saturates the soil reaches a relatively low point called the "immobile" or "residual" saturation. At this point, the oil essentially stops moving. If the condition develops before the oil reaches the water table, the danger of further contamination is greatly reduced. Subsequent rainfall, percolating through the soil, however, will carry dissolved components downward. This situation, however, creates less risk of significant pollution than if the main body of oil reaches the water table.

Based on methods presented in a 1972 American Petroleum Institute publication (API, 1972) regarding migration of petroleum products in soil and groundwater, an estimate of over 4,000-gal spill volume for gasoline or kerosene (similar to AVGAS and JP-4) on a 10-ft-square soil area would be required to allow free oil to reach the water table at a depth of 50 ft. The exact volume required to reach the groundwater depends on the periodicity and rate of spillage and on the nature of the soil. The quantity required to penetrate the water table may be lower than the estimate because of the extreme permeability and low organic content of MMR soils. Soluble components from the spill, however, (Table 4.2-5) would be carried to the water table.

Each of the spills of greater than a few hundred gallons has potential for contaminant migration of the soluble components (BTX). Each of the spills tabulated in Table 4.2-4, except for FS-15 and FS-16, has potential for at least limited contaminant migration. Spill FS-24 and FS-22 were cleaned up immediately after spillage, and visibly contaminated soil was removed.

Sites FS-15, FS-16, FS-22, and FS-24 were, therefore, dropped from further consideration, using the decision tree process. Fuel spill sites FS-5, FS-6, FS-8, FS-10, FS-11, and FS-23 are assessed in conjunction with other storm drainage or chemical spill sites. Fuel spill sites FS-1 through FS-4, FS-7, FS-9, FS-12 through FS-14, and FS-17 through FS-21 were ranked using the HARM process (See Appendix G). HARM ratings are summarized for these sites in Section 4.2.7. Conclusions and recommendations regarding these sites are presented in Sections 5.0 and 6.0.

4.2.5 Fire-fighter Training Areas

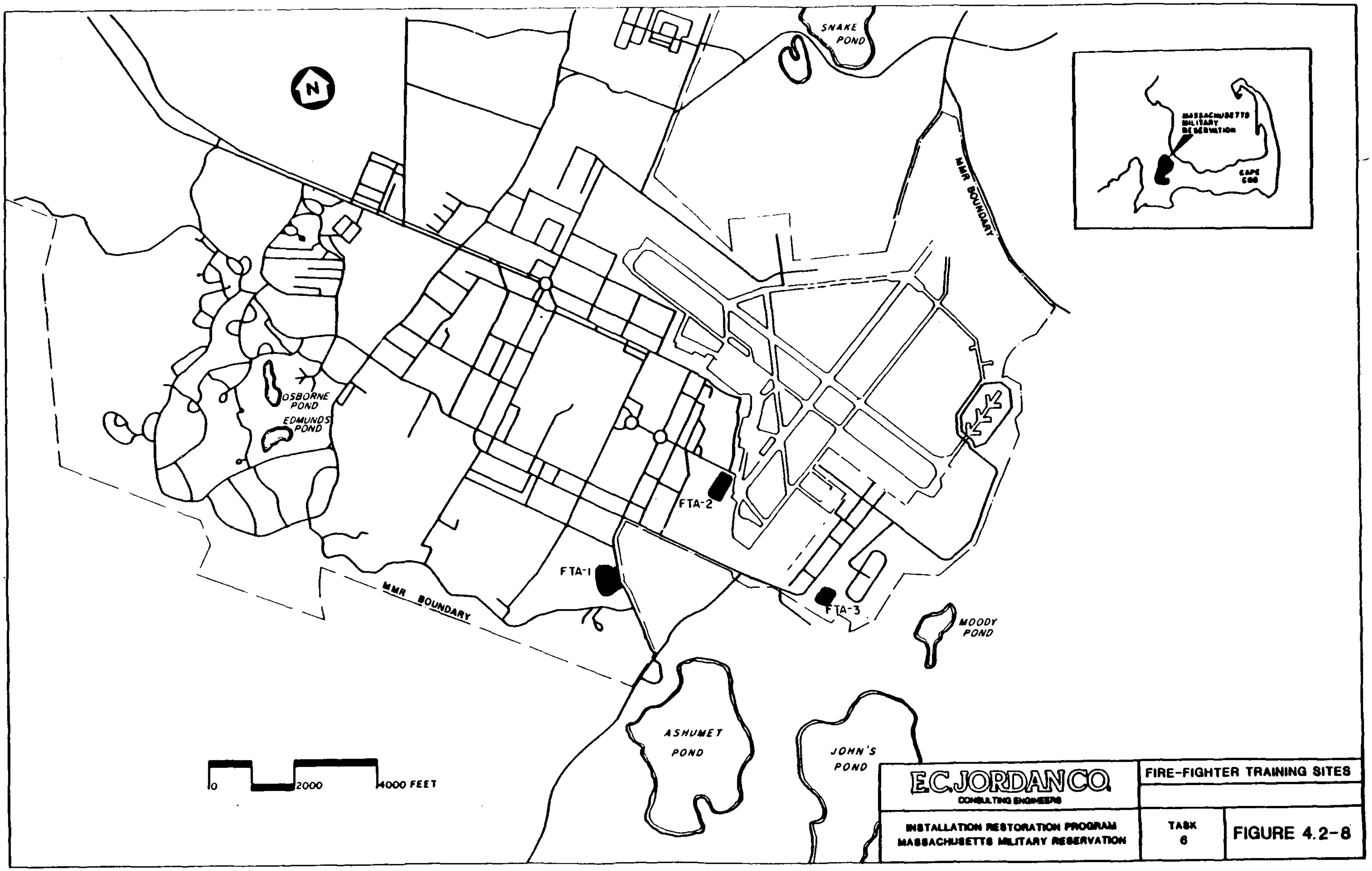
Three fire-fighter training areas were identified at MMR. Figure 4.2-8 shows the location of these sites. Two of these sites, FTA-1 and FTA-2, were identified in the initial Otis-ANGB Records Search (Metcalf and Eddy, 1983) and studied as components of the 1983-1984 Phase II, Stage 1 study (Weston, 1985). These sites were reassessed during the current records search. Records search information and the data from the existing Phase II study were evaluated and further Phase II study recommended at the current and former fire-fighter training areas as components of separate Phase II studies under the ongoing MMR IRP.

Current Fire Training Area (Site FTA-1)

The CFTA was used between 1958 and November 1985 for fire-training sessions by the MMR fire department. Three large and three small impoundments were used in this area for fire training. All but one of these areas are unlined and used concrete blocks placed around the edge to contain the flammable liquids. The one large area that is lined with concrete has soil berms around the edge to contain the flammable liquids. Prior to closing the site in 1985 because of air emission permit difficulties, six to eight fire-training exercises per year were conducted at the site. Fire training has historically occurred at MMR on a quarterly basis with a frequency of 12 to 16 fires per year. It is not known when this frequency ended and the current schedule began. The flammable materials burned at this site included JP-4, AVGAS, MOGAS, diesel fuels, waste oils, solvents, paint thinners, transformer oils, and spent hydraulic fluids. These waste flammable liquids were generated on the flight line and were initially transported to the site in drums but later by tank truck.

Drums were stacked on the eastern portion of the site, and, reportedly, leaks were common. Trucked flammable liquids were stored in an underground storage tank(s) and an aboveground storage tank. There are conflicting reports as to the number of underground storage tanks. One tank has been removed, and no others have been detected, although an additional tank is thought to be present by some interviewed personnel.

Training and/or waste deposition occurred in two ways: either in large volumes in the large areas for large fire trucks or in small volumes as part of small fire-truck training in the small impoundments. The large-volume training exercises involved volumes of flammable wastes of between 300 and 500 gal per training session, and the small volume training sessions involved between 50 and 100 gal. It has been estimated that approximately 70 percent of the material ignited was burned and approximately 30 percent either volatilized into the atmosphere or infiltrated into the soil. Standard operating procedure would be to leave the material to sit overnight to volatilize and seep into the soil and then to burn off what remained the following day to eliminate any fire hazard. For the total period of operation, a volume in excess of 50,000 gal may have been spilled for the purpose of fire training, and of this total, a volume of approximately 15,000 gal (30%) either volatilized into



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TASK 6

FIGURE 4.2-8

the atmosphere or infiltrated into the soil, based on estimates by base personnel.

The Phase II, Stage 1 investigation of this site included the excavation of nine test pits (approximately 10 ft deep) and the installation of two monitoring wells located immediately adjacent to the CFTA to the southeast and the southwest. Ten soil samples and two groundwater samples were collected for laboratory analysis. The results of the soil analyses showed concentrations of oil and grease and organic halogens. Samples were not analyzed for specific volatile and semivolatile organic compounds. Total organic halogen levels in soils of 0.11 µg/g and 0.35 µg/g were detected. Results of laboratory analysis of groundwater samples showed tetrachloroethylene (3.0 to 7.1 µg/L), 1,2, trans-dichloroethylene (5.6 µg/L), trichloroethylene (2.4 µg/L), total halogens (209 µg/L), and oil and grease (2,290 µg/L).

Based on the material disposed of at FTA-1, potential for contamination exists. This is confirmed by the limited test pit sampling results. Evidence also exists for contaminant migration based on contaminants found in the IRP monitoring wells. This site was ranked using the HARM process (see Appendix G). HARM ratings for this site are summarized in Section 4.2.7. Conclusions and recommendations regarding this site are presented in Sections 5.0 and 6.0.

Former Fire-Training Area (Site FTA-2)

A single FFTA located west of the runway/hangar area along a former drainage swale that has now been filled in was identified tentatively by the Records Search (Metcalf and Eddy, 1983). Currently, runway drainage is conveyed by underground storm drains from north to south through the area. The presence and location of this FFTA was confirmed by examination of historical aerial photographs. The former records search report indicated the use of the FFTA from approximately 1948 to 1958. A HARM score of 76 was given to this site in the former report based on burning of up to 3,000 gal/yr of waste POL commingled with solvents. The examination of sequential historical aerial photography in the current record search indicates that the FFTA was located immediately north of the drainage swale and was used from 1950 to 1956. The site may have been used for burning up to 7,000 gal/yr of AVGAS, JP-4, and waste oils, commingled with solvents. Contaminants would include residual POL, including BTX that was not burned; lead from AVGAS; and small quantities of other metals commingled with waste oil, as well as chlorinated hydrocarbons solvents/degreasers. (During the period used, these would include carbon tetrachloride, TCE, PCE.) Use of this FFTA was discontinued in 1956 because of the interference of smoke with air operations (landings and take-offs).

The Phase I, Stage 1 performed by Weston (Weston, 1985) addressed the 1948-1956 FFTA as Site 2 within a zone that included the former NDI lab. The Phase II, Stage 1 investigation of this area included the excavation of 11 test pits in the area where the FFTA was suspected to be buried. This turned out to be the actual area as confirmed by the aerial photographs. The test pits encountered depths of up to 10 ft of burned municipal refuse. As indicated in Section 4.1.1, this area may have been used as a landfill for a short period of time while the area was being filled in. In addition to the test pits, one well was installed 1,600 ft southwest of this site. This is the same monitoring well installed for study of the former NDI Lab IRP-7. Two soil samples were collected from the test pits and a groundwater sample collected from the monitoring well for laboratory chemical analysis. The results of the chemical analysis showed high levels of lead (6,880 μg/g) and oil and grease (1,660 μg/g) in the soil sample taken from test pit TP-26. The groundwater sample had low levels of oil and grease (2.09 μg/L).

Based on the site history, test pit sampling and analysis, and the presence of evidence of former landfilling, potential exists for contamination at FTA-2. Indirect evidence for contamination migration (detectable petroleum hydrocarbons) exists. This site was, therefore, ranked using the HARM process (see Appendix G). The rankings for FTA-2 are summarized in Section 4.2.7. Conclusions and recommendations regarding this site are presented in Sections 5.0 and 6.0.

Former Fire-fighter Training Area 1956-1958 (Site FTA-3)

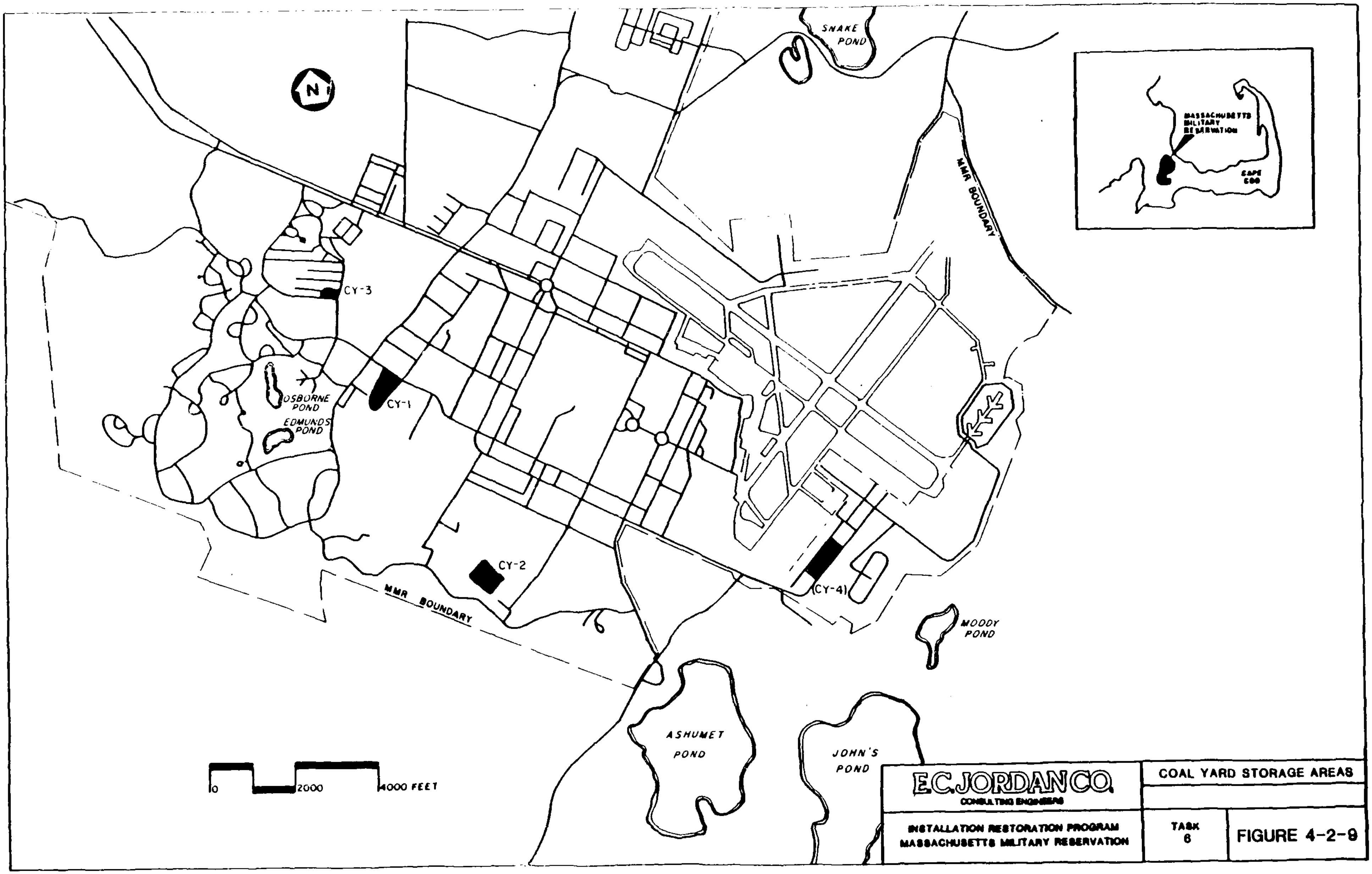
The FTA was moved from FTA-2 to a location southeast of the current coal storage yard from 1956 to 1958. This latter location was not identified in the first records search. In 1958 fire-training operations were moved from this site to the current FTA located north of the base sewage treatment plant because the site was close to trailer parks developing immediately off-base. Materials and quantities burned at this second former FTA are assumed to be similar to those burned from 1958 to 1969 at the current FTA.

Reportedly, training was done quarterly in an unlined gravel pit. Based on use of FTA-1, an estimated 12,000 gal (6,000/yr) were burned on the ground at this site. Potential for contamination exists at FTA-3. FTA-3 is located near the southern boundary of MMR. Because of the permeable nature of the soils at MMR, potential for contaminant migration exists. Site FTA-3 was ranked using the HARM process (see Appendix G). The ratings for this site are summarized in Section 4.2.7. Conclusions and recommendations regarding this site are presented in Sections 5.0 and 6.0.

4.2.6 Coal Yards and Coal Ash Disposal Areas

As indicated in Section 4.1.6, coal was used extensively for space heating at MMR from 1940 to 1957 and for steam and standby power generation from 1957 to the present. Coal ash, bottom ash, and fly ash were generated in large quantities. In addition, soot has been produced since 1978 at the central steam plant. During the records search, four coal storage areas were identified. At two of the areas, coal ash disposal also took place. Figure 4.2-9 shows the location of these sites.

The properties of coal pile leachate and ash leachate were described in Section 4.2.1 as a component of the runoff in stormwater drainage system SD-3, which receives runoff from the current coal pile and ash landfill at the central steam and power generation plant. As indicated in Tables 4.2-1 and 4.2-2, metals in coal ash do not generally leach readily. Coal, however, does



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MASSACHUSETTS MILITARY RESERVATION

COAL YARD STORAGE AREAS

TASK 6

FIGURE 4-2-9

contain leachable metals, sulfur, acidity, and low concentrations of polycyclic aromatic organic compounds (PAHs). Uncontrolled coal pile runoff or leachate, therefore, potentially contains hazardous substances and provides potential for contamination.

Coal Yard No. 1 (Site CY-1)

Coal Yard No. 1 is a former Army coal storage area. Coal was stockpiled at this location on the ground surface from 1940 to 1957. Leachate from the coal piles would have percolated into the ground.

In 1962 water supply Well B was closed due to contamination by phenolic compounds. Phenols could be a transformation product or PAH from coal pile leachate. Although coal is not classified as a hazardous substance, there is a possibility of organic compounds acidity and of metals leaching into the groundwater. For this reason, the potential for contamination exists. Due to the highly permeable soils present at the site, the possibility for contaminant migration exists. Site CY-1 was ranked using the HARM system (see Appendix G). HARM ratings for this site are summarized in Section 4.2.7. Conclusions and recommendations regarding this site are presented in Sections 5.0 and 6.0.

Coal Yard No. 2 (Site CY-2)

Coal Yard No. 2 is a former USAF and ANG coal storage area. Coal was stockpiled here from 1957 to 1984. Most of the coal was piled on a concrete pad. During the site visit, a layer of coal was observed on the ground surface to the north of the pad. Runoff from the coal pile was channeled into two areas. Runoff from the center of the pad was channeled into a storm drain that discharged onto the ground at the northwest corner of the pad. Runoff from the remainder of the pad appeared to be directed off the south edge of the pad.

Potential for contamination and contaminant migration exists at CY-2 because of the possibility that coal pile leachate was discharged to the permeable soils present at this site. Site CY-2 was ranked using the HARM process (see Appendix G). HARM ratings for this site are summarized in Section 4.2.7. Conclusions and recommendations regarding this site are presented in Sections 5.0 and 6.0.

Coal Yard No. 3 and Ash Disposal Area (Site CY-3)

Coal Yard No. 3 is the former coal storage area located at the former hospital. This area is now on the portion of MMR under VA control. Coal was stockpiled on an unbermed concrete pad and transferred into hopper bins. Coal ash was temporarily stored in a gravel pit prior to being taken to the base landfill. This area is located next to the former hospital steam plant and was used from 1946 to 1972. Runoff containing leachate from the coal pile flowed from the pad to the surrounding soil. Organic compounds, acidity, and/or metals may have leached from the pile. Potentially, leachate from the coal pile would have infiltrated into the subsurface soils. The potential, therefore, for contamination and contaminant migration exists at CY-3. Site CY-3 was rated using the HARM process (see Appendix G). HARM rankings for this site are summarized in Section 4.2.7. Conclusions and recommendations regarding site CY-3 are presented in Sections 5.0 and 6.0.

Coal Yard No. 4 and Ash Disposal Area (Site CY-4)

Coal Yard No. 4 (CY-4) is located at the current steam plant. From 1955 to 1978, coal was stockpiled on the ground. A concrete pad was installed in 1978 for coal storage. From 1955 to the present, coal ash and fly ash have been disposed of in an area to the south of the plant prior to transfer to the base landfill. The potential for contamination and contaminant migration from this location is assessed in Section 4.2.1, stormwater drainage disposal areas. Site CY-4 is addressed as a component of SD-3 because runoff or infiltration from CY-4 enters drainage channel SD-3.

4.2.7 Hazard Assessment Evaluation

The review of past operation and maintenance functions and past waste management practices at ANG, Camp Edwards/ARNG, USAF, and VA facilities at MMR has resulted in the identification of 61 sites that were initially considered areas of concern, with potential for contamination and migration of contaminants. These sites, described in Sections 4.2.1 through 4.2.6, were evaluated using the decision process presented in Figure 1.3-1 (in Section 1.3). Eight of these sites were assessed in conjunction with other sites and were not ranked. Seven sites found to have no potential for contamination were deleted from further consideration. Five sites among the 61 were found to warrant review of operational procedures in conjunction with the base environmental programs.

Forty-six sites were found to have potential for contamination and migration of contaminants using the decision process described in Section 1.3. The decision process logic used for each area of initial concern is presented in Table 4.2-6. The sites that were found to have potential for contamination or contaminant migration were evaluated using the HARM system. The HARM system includes consideration of potential receptor characteristics and waste management practices. The details of the rating procedures are presented in Appendix G; results of the assessment are summarized in Table 4.2-7.

The HARM system is designed to indicate the relative need for remedial action. The information presented in Table 4.2-7 is intended for assigning priorities for further evaluation of the disposal areas (Section 5.0--Conclusions, and Section 6.0--Recommendations). The rating forms for the individual waste disposal sites are presented in Appendix H. Table 4.2-8 presents a listing of the sites ranked that are located in the portion of MMR controlled by the ANG, ARNG, and VA. No sites were identified on USAF facilities at Cape Cod AFS. The Phase I assessment of USCG facilities at MMR has been presented in a separate report as a component of the ongoing MMR IRP.

TABLE 4.2-6

SUMMARY OF DECISION PROCESS LOGIC FOR AREAS OF INITIAL ENVIRONMENTAL CONCERN AT ANG, CAMP EDWARDS/ARNG, USAF, AND VA FACILITIES AT MMR

Site	Designation	Command Unit	Potential for Contamination	Potential for Contaminant Migration	Potential for Other Environmental Concern	Refer to base Environmental Programs for Future Action	HARM Rating
Storm Drainage Site No. 1	SD-1	ANG	Yes	Yes	No	No	Yes
Storm Drainage Site No. 2	SD-2	ANG	Yes	Yes	No	No	Yes
Storm Drainage Site No. 3	SD-3	ANG	Yes	Yes	Yes	Yes	Yes
Storm Drainage Site No. 4	SD-4	ANG	Yes	Yes	No	No	Yes
Storm Drainage Site No. 5	SD-5	ANG	Yes	Yes	No	No	Yes
Landfill No. 1	LF-1	ANG	Yes	Yes	No	No	Yes
Landfill No. 2	LF-2	ANG	Assessed in conjunction with Site FTA-2				
Landfill No. 3	LF-3	ARNG	Yes	Yes	Yes	Yes	Yes
Landfill No. 4	LF-4	ANG	Yes	Yes	No	No	Yes
Landfill No. 5	LF-5	VA	No	No	No	No	No
Landfill No. 6	LF-6	ANG	No	No	No	No	No
Landfill No. 7	LF-7	ARNG	Yes	Yes	No	No	Yes
Chemical Spill/Disposal Site No. 1	CS-1	ANG	Yes	Yes	No	No	Yes
Chemical Spill/Disposal Site No. 2	CS-2	ANG	Yes	Yes	No	No	Yes
Chemical Spill/Disposal Site No. 3	CS-3	ARNG	Yes	Yes	No	No	Yes
Chemical Spill/Disposal Site No. 4	CS-4	ARNG	Yes	Yes	No	No	Yes
Chemical Spill/Disposal Site No. 5	CS-5	ARNG	Yes	Yes	No	No	Yes
Chemical Spill/Disposal Site No. 6	CS-6	ANG	Yes	Yes	No	No	Yes
Chemical Spill/Disposal Site No. 7	CS-7	ARNG	No	No	No	No	No
Chemical Spill/Disposal Site No. 8	CS-8	ARNG	Yes	Yes	No	No	Yes
Chemical Spill/Disposal Site No. 9	CS-9	ANG	Yes	Yes	No	No	Yes
Chemical Spill/Disposal Site No. 10	CS-10	ARNG	Yes	Yes	No	No	Yes
Chemical Spill/Disposal Site No. 11	CS-11	ARNG	Yes	Yes	No	No	Yes
Chemical Spill/Disposal Site No. 12	CS-12	VA	Yes	Yes	Yes	Yes	Yes
Chemical Spill/Disposal Site No. 13	CS-13	off base/ANG	Yes	Yes	Yes	Yes	Yes
Chemical Spill/Disposal Site No. 14	CS-14	ANG	Yes	Yes	No	No	Yes
Chemical Spill/Disposal Site No. 15	CS-15	ANG	Yes	Yes	No	No	Yes
Chemical Spill/Disposal Site No. 16	CS-16	ANG	Yes	Yes	No	No	Yes
Chemical Spill/Disposal Site No. 17	CS-17	ANG	Yes	Yes	No	No	Yes
Chemical Spill/Disposal Site No. 18	CS-18	ARNG	Yes	Yes	Yes	Yes	Yes
Fuel Spill Site No. 1	FS-1	ANG	Yes	Yes	No	No	Yes
Fuel Spill Site No. 2	FS-2	ANG	Yes	Yes	No	No	Yes
Fuel Spill Site No. 3	FS-3	ANG	Yes	Yes	No	No	Yes
Fuel Spill Site No. 4	FS-4	ANG	Yes	Yes	No	No	Yes
Fuel Spill Site No. 5	FS-5	ANG	Assessed in conjunction with stormwater drainage site SD-5				
Fuel Spill Site No. 6	FS-6	ANG	Assessed in conjunction with stormwater drainage site SD-2				
Fuel Spill Site No. 7	FS-7	ARNG	Yes	Yes	No	No	Yes
Fuel Spill Site No. 8	FS-8	ANG	Assessed in conjunction with stormwater drainage site SD-2				
Fuel Spill Site No. 9	FS-9	ARNG	Yes	Yes	No	No	Yes
Fuel Spill Site No. 10	FS-10	ANG	Assessed in conjunction with stormwater drainage site SD-2				
Fuel Spill Site No. 11	FS-11	ANG	Assessed in conjunction with stormwater drainage site SD-2				
Fuel Spill Site No. 12	FS-12	ANG	Yes	Yes	No	No	Yes
Fuel Spill Site No. 13	FS-13	ANG	Yes	Yes	No	No	Yes
Fuel Spill Site No. 14	FS-14	ARNG	Yes	Yes	No	No	Yes
Fuel Spill Site No. 15	FS-15	ANG	Yes	No	No	No	No
Fuel Spill Site No. 16	FS-16	ARNG	Yes	No	No	No	No
Fuel Spill Site No. 17	FS-17	ARNG	Yes	Yes	No	No	Yes

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TABLE 4.2-6 CONT'D

SUMMARY OF DECISION PROCESS LOGIC FOR AREAS OF INITIAL ENVIRONMENTAL CONCERN
AT ANG, CAMP EDWARDS/ARNG, USAF, AND VA FACILITIES AT MMR

Site	Designation	Command Unit	Potential for Contamination	Potential for Contaminant Migration	Potential for Other Environmental Concern	Refer to base Environmental Programs for Future Action	HARM Rating
Fuel Spill Site No. 18	FS-18	ARNG	Yes	Yes	No	No	Yes
Fuel Spill Site No. 19	FS-19	ARNG	Yes	Yes	No	No	Yes
Fuel Spill Site No. 20	FS-20	ARNG	Yes	Yes	No	No	Yes
Fuel Spill Site No. 21	FS-21	ARNG	Yes	Yes	No	No	Yes
Fuel Spill Site No. 22	FS-22	ANG	Yes	No	No	No	No
Fuel Spill Site No. 23	FS-23	ANG	Assessed in conjunction with chemical spill/disposal site CS-3				
Fuel Spill Site No. 24	FS-24	ARNG	Yes	No	No	No	No
Fire Fighter Training Area No. 1	FTA-1	ANG	Yes	Yes	No	No	Yes
Fire Fighter Training Area No. 2	FTA-2	ANG	Yes	Yes	No	No	Yes
Fire Fighter Training Area No. 3	FTA-3	ANG	Yes	Yes	No	No	Yes
Coal Yard No. 1	CY-1	ARNG	Yes	Yes	No	No	Yes
Coal Yard No. 2	CY-2	ANG	Yes	Yes	No	No	Yes
Coal Yard No. 3 and Ash Disposal Area	CY-3	VA	Yes	Yes	No	No	Yes
Coal Yard No. 4 and Ash Disposal Area	CY-4	ANG	Assessed in conjunction with site SD-3				

* Refer to Figure 1.3-1 for the decision process.
† Other environmental concerns include environmental problems that are not within the scope of this study (e.g., air pollution, occupation safety problems).
** NA = Not applicable.

TABLE 4.2-7

SUMMARY OF HARM SCORES FOR POTENTIAL CONTAMINATION SOURCES
AT ANG, CAMP EDWARDS/ARNG, USAF, AND VA FACILITIES ON MMR

Site	Report Designation	Command Unit	Receptor Subscore	Waste Characteristics Subscore	Pathway Subscore	Waste Management Factor	Overall Total Score
Storm Drainage Site 1	SD-1	ANG	75.6	56.0	61.0	1.0	64.2
Storm Drainage Site 2	SD-2	ANG	78.9	56.0	80.0	1.0	71.6
Storm Drainage Site 3	SD-3	ANG	81.1	40.0	61.1	1.0	60.7
Storm Drainage Site 4	SD-4	ANG	73.3	100.0	53.7	1.0	75.7
Storm Drainage Site 5	SD-5	ANG	68.3	80.0	80.0	1.0	76.1
Landfill No. 1	LF-1	ANG	70.0	100.0	100.0	1.0	90.0
Landfill No. 3	LF-3	ARNG	76.7	30.0	38.9	1.0	48.5
Landfill No. 4	LF-4	off-base	83.3	80.0	54.4	1.0	72.5
Landfill No. 7	LF-7	ARNG	62.2	10.0	43.9	1.0	38.7
Chemical Spill/Disposal Site No. 1	CS-1	ANG	57.2	56.0	43.9	1.0	52.4
Chemical Spill/Disposal Site No. 2	CS-2	ANG	75.6	70.0	53.7	1.0	66.4
Chemical Spill/Disposal Site No. 3	CS-3	ARNG	81.1	70.0	50.9	1.0	67.3
Chemical Spill/Disposal Site No. 4	CS-4	ARNG	75.0	80.0	46.0	1.0	67.1
Chemical Spill/Disposal Site No. 5	CS-5	ARNG	72.2	70.0	46.3	1.0	62.8
Chemical Spill/Disposal Site No. 6	CS-6	ANG	73.2	16.0	50.9	0.95	44.4
Chemical Spill/Disposal Site No. 8	CS-8	ARNG	78.9	70.0	50.9	1.0	66.6
Chemical Spill/Disposal Site No. 9	CS-9	ANG	64.4	80.0	44.0	1.0	62.8
Chemical Spill/Disposal Site No. 10	CS-10	ARNG	77.8	100.0	80.0	1.0	85.9
Chemical Spill/Disposal Site No. 11	CS-11	ARNG	77.8	40.0	43.8	1.0	53.9
Chemical Spill/Disposal Site No. 12	CS-12	VA	75.6	60.0	53.7	1.0	63.1
Chemical Spill/Disposal Site No. 13	CS-13	off-base	75.0	100.0	80.0	0.95	80.8
Chemical Spill/Disposal Site No. 14	CS-14	ANG	77.7	70.0	43.8	1.0	63.8
Chemical Spill/Disposal Site No. 15	CS-15	ANG	73.3	80.0	58.8	1.0	70.2
Chemical Spill/Disposal Site No. 16	CS-16	ANG	81.1	60.0	80.0	1.0	73.7
Chemical Spill/Disposal Site No. 17	CS-17	ANG	78.9	30.0	50.9	1.0	53.2
Chemical Spill/Disposal Site No. 18	CS-18	ARNG	67.8	15.0	53.7	1.0	45.5
Fuel Spill Site No. 1	FS-1	ANG	76.7	80.0	80.0	1.0	78.9
Fuel Spill Site No. 2	FS-2	ANG	62.2	80.0	100.0	1.0	80.7
Fuel Spill Site No. 3	FS-3	ANG	81.1	64.0	53.7	1.0	66.2
Fuel Spill Site No. 4	FS-4	ANG	68.3	56.0	43.9	1.0	56.1
Fuel Spill Site No. 7	FS-7	ARNG	68.3	56.0	43.9	1.0	56.1
Fuel Spill Site No. 9	FS-9	ARNG	74.4	40.0	43.9	1.0	52.8
Fuel Spill Site No. 12	FS-12	ARNG	78.9	40.0	43.9	1.0	54.3
Fuel Spill Site No. 13	FS-13	ANG	68.3	64.0	43.8	1.0	58.7
Fuel Spill Site No. 14	FS-14	ARNG	57.2	64.0	43.9	0.95	55.0
Fuel Spill Site No. 17	FS-17	ARNG	70.0	50.0	45.6	1.0	55.2
Fuel Spill Site No. 18	FS-18	ARNG	68.3	40.0	46.3	1.0	51.5
Fuel Spill Site No. 19	FS-19	ARNG	72.2	56.0	80.0	0.95	69.4
Fuel Spill Site No. 20	FS-20	ARNG	70.6	56.0	43.9	1.0	56.8
Fuel Spill Site No. 21	FS-21	ARNG	78.9	56.0	50.9	1.0	61.9
Current Fire Fighter Training Area	FTA-1	ANG	78.9	100.0	100.0	1.0	92.6
Former Fire Fighter Training Area	FTA-2	ANG	67.8	100.0	80.0	1.0	82.6
Former Fire Fighter Training Area	FTA-3	ANG	81.1	70.0	43.9	1.0	64.9
Coal Yard No. 1	CY-1	ARNG	75.0	40.0	43.8	1.0	52.9
Coal Yard No. 2	CY-2	ANG	71.1	40.0	53.7	1.0	54.9
Coal Yard No. 3 and Ash Disposal Area	CY-3	VA	72.2	40.0	46.2	1.0	52.8

TABLE 4.2-8

SUMMARY OF SITE RANKINGS FOR
ANG, CAMP EDWARDS/ARNG, USAF, VA, AND OFF-BASE DISPOSAL SITES

I. OVERALL SUMMARY

	Total	ANG	Camp Edwards/ARNG	USAF	VA	Off-Base
Sites Evaluated	61	34	21	0	3	3
Sites Ranked	46	22	19	0	2	3
Sites Referred to Base Environmental Programs	5	1	2	0	1	0

II. RANKED HARM SCORES

AIR NATIONAL GUARD

Site Designation	Site Description	Harm Ranking
FTA-1	Current Fire-Fighter Training Area	92.9
LF-1	Main Base Landfill	90.0
FTA-2	Former Fire-Fighter Training Area (1948-1956)	82.6
FS-2	Railroad Fuel Pumping Site	80.7
FS-1	Avgas Fuel Valve Test Dump Site	78.9
SD-5	Aquafarm Drainage Swale	76.1
SD-4	Hangar 158, Aircraft Maintenance Drainage Ditch	75.1
CS-16	Sewage Treatment Plant	73.7
SD-2	Runway/Aircraft Maintenance Drainage Ditch	71.6
CS-15	Former Engine Run-up Area	70.2
CS-2	East Truck Road Motor Pool	66.4
FTA-3	Former Fire-Fighter Training Area (1956-1958)	64.9
SD-1	Runway/Aircraft Maintenance Drainage Ditch	64.2
CS-14	Bldg. 156 Vapor Degreaser Leaching Pit	63.8
CS-9	Former Main USAF Motor Pool	62.8
SD-3	Coal/Ash Runoff Drainage Ditch	60.7
FS-13	Leak in Fuel Line in Cantonment Area	58.7
FS-4	Current Product Tanks 100, 101	56.1
CY-2	Former USAF/ANG Coal Yard	54.9
CS-17	Former Sewage Sludge Disposal Area	53.2
CS-1	North Truck Road Motor Pool	52.4
CS-6	Current ANG Motor Pool	44.4

CAMP EDWARDS/ARNG

Site Designation	Site Description	Harm Ranking
CS-10	UTES/BOMARC	85.9
FS-19	Former MOGAS/Fuel Storage Point	69.4
CS-3	South Truck Road Motor Pool	67.3
CS-4	West Truck Road Motor Pool	67.1
CS-8	OMS #22	66.6
CS-5	Former Refueler Maintenance Shop	62.8
FS-21	Current Product Tank 90	61.9
FS-20	Current Product Tank 88	56.8
FS-7	Current Product Tank 115	56.1
FS-17	Former WWII Motor Pool/Transfer Point	55.6
FS-14	Spill in Range (E-3)	55.0
FS-12	Leak in Fuel Line in Range	54.3
CS-11	Pesticide Shop	53.9
CY-1	Former Army Coal Yard	52.9
FS-9	Current Product Tank 108	52.8
FS-18	Fuel Transfer Point	51.5
LF-3	Northern Range Area Dump	48.5
CS-18	Propellant-Burning Trenches	45.5
LF-7	Radar Tube Burial Site	38.7

VETERANS ADMINISTRATION

Site Designation	Site Description	Harm Ranking
CS-12	VA Road and Ground Shop	63.1
CY-3	Former Hospital Coal Yard and Ash Disposal	52.8

OFF-BASE

Site Designation	Site Description	Harm Ranking
CS-13	Former Contractors Yard Near Well J	80.8
LF-4	Johns Pond Dump	72.5
FS-3	Johns Pond Road Fuel Dump Site	66.2

5.0 CONCLUSIONS

The goal of the IRP Phase I study is to identify sites where there is potential for environmental contamination resulting from past waste disposal practices and to assess the potential for contaminant migration from these sites. The conclusions are based on the evaluation of information collected from the project team's field inspection; review of records and files; examination of historical aerial photographs; and interviews with base personnel, past employees, and state and local government employees. Sixty-one potential contamination sources were identified on ANG, Camp Edwards/ARNG, USAF, and VA facilities at MMR. These sites are identified and their evaluation summarized in Table 5.0-1. Locations of these sites are shown in Figures 5.0-1 through 5.0-7. Forty-six of the 61 sites were determined to have a potential for contamination and contaminant migration.

Three sites located off-base adjacent to MMR were identified as having potential for contamination and contaminant migration. Based on the site reconnaissance and interviews, hazardous waste disposal, potentially including waste from MMR, may have occurred into the identified sites. Because of the locations of these sites adjacent to documented groundwater contamination and to on- and off-base human receptors, these sites have been included in the overall assessment program. The rationale for inclusion of these sites are summarized below. See Table 5.0-1 for site identification.

- Landfill No. 4 Johns Pond Dump. This site is located adjacent to the southern boundary of MMR. Eighteen to 20 unidentifiable barrels were found at this site. Access to the dump is unrestricted. Other material (e.g., empty asphalt buckets and expansion joint debris) has been found in the area of the dump. In the area north of Ashumet pond and near the dump, six empty barrels traceable to MMR were found. The dump is located immediately adjacent to a trailer park and private residences that utilize groundwater for potable supply. To completely address the sources of off-base contamination, residual contamination in this dump should be identified.

- Chemical Spill Disposal Site CS-13 - Former Contractor's Yard Near MMR Well J. As described in Section 4.2, drum removal has been completed at this off-base site. Because of its location approximately 1,000 ft from the only operating supply well at MMR (Well J) and documentation of trace level VOC contamination in Well J, residual contamination in the surface or subsurface soil in this former drum disposal area should be identified.

- Fuel Spill Site No. 3 - Johns Pond Road. Refueler trucks reportedly were emptied along this road in the late 1950's. Potential exists for residual contamination due to lead in AVGAS and MOGAS and possibly for organic chemicals from the residual fuel. Because this disposal area is located in the vicinity of the trailer park and private residences in the area upgradient of documented off-base groundwater contamination, residual contamination at this location should be identified to completely evaluate sources contributing to off-base groundwater contamination.

TABLE 5.0-1 CONT'D
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES
ON MMR

Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
FTA-2	Former Fire-fighter Training Area (See Figure 5.0-6)	1948-1956	POL, solvents, metals, hydraulic fluid, transformer oil. Direct evidence of contamination. Indirect evidence of contaminant migration. Received a HARM rating of 82.6. Phase II studies recommended.
FTA-3	Former Fire-fighter Training Area (See Figure 5.0-6)	1956-1958	POL, solvents, metals, hydraulic fluid, transformer oils. Potential for contamination; potential for contaminant migration. Received a HARM rating of 64.9. Phase II studies recommended.
CY-1	Former U.S. Army Coal Storage Yard (See Figure 5.0-7)	1940-1957	Coal pile leachate. Organics, metals, acidity, sulfur. Potential for contamination; potential for contaminant migration. Received a HARM rating of 52.9. No Phase II studies recommended.
CY-2	Former USAF and ANG Coal Storage Yard (See Figure 5.0-7)	1957-1984	Coal pile leachate. Organics, metals, acidity, sulfur. Potential for contamination; potential for contaminant migration. Received a HARM rating of 53.2. Phase II studies recommended.
CY-3	Former Hospital Coal Storage Yard and Ash Disposal Area (See Figure 5.0-7)	1946-1972	Coal pile leachate. Organics, metals, acidity, sulfur. Potential for contamination; potential for contaminant migration. Received a HARM rating of 45.5. No Phase II studies recommended.
CY-4	Current Coal Storage Yard and Ash Disposal Area (See Figure 5.0-7)	1955-present	Coal pile leachate. Organics, metals, acidity, sulfur. Assessed in conjunction with SD-3.

TABLE 5.0-1 CONT'D
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES
ON MMR

Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
FS-18	Fuel Transfer Point (See Figure 5.0-4)	?-present	MOGAS (VOCs, hydrocarbons, lead). Potential for contamination; potential for contaminant migration. Received a HARM rating of 51.5. Limited Phase II studies recommended.
FS-19	Former MOGAS/Fuel Storage (See Figure 5.0-4)	?-1985	MOGAS (VOCs, hydrocarbons, lead). Potential for contamination; potential for contaminant migration. Received a HARM rating of 69.4. Phase II studies recommended.
FS-20	Current Product Tank #88 (See Figure 5.0-4)	1968-Present	MOGAS (VOCs, hydrocarbons, lead). Potential for contamination; potential for contaminant migration. Received a HARM rating of 56.8. Phase II studies recommended.
FS-21	Current Product Tank #90 (See Figure 5.0-4)	1954-Present	MOGAS (VOCs, hydrocarbons, lead). Potential for contamination; potential for contaminant migration. Received a HARM rating of 61.9. Phase II studies recommended.
FS-22	ANG Motor Pool (See Figure 5.0-4)	Sept. 1984	JP-4 (VOCs, hydrocarbons). Potential for contamination. No potential for contaminant migration. Site not ranked. No Phase II action recommended.
FS-23	South Truck Road (See Figure 5.0-4)	1965	JP-4 (VOCs, hydrocarbons) Site is included with assessment of CS-3. Not separately ranked.
FS-24	BOMARC Area (See Figure 5.0-4)	1985	Diesel fuel (VOCs, hydrocarbons). Potential for contamination. No potential for contaminant migration. Site not ranked. No Phase II action recommended.
FTA-1	Current Fire-fighter Training Area (See Figure 5.0-6)	1958-1985	POL, solvents, metals, transformer fluids, hydraulic fluids. Direct evidence of contamination. Direct evidence of contaminant migration. Received a HARM rating of 92.6. Phase II studies are ongoing at this site.

TABLE 5.0-1 CONT'D
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES
ON MMR

Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
FS-9	Current Product Tank 108 (See Figure 5.0-4)	1952-present	MOGAS (VOCs, lead, hydrocarbons). Potential for contamination; potential for contaminant migration. Received a HARM rating of 52.8. Referred to Base Environmental Programs. Limited Phase II studies are recommended.
FS-10	Fuel Storage Area (See Figure 5.0-4)	Early 1960's	JP-4 (VOCs, hydrocarbons). Site is included with assessment of SD-2. Not separately ranked.
FS-11	Fuel Storage Area (See Figure 5.0-4)	Early 1960's	JP-4 (VOCs, hydrocarbons). Site is included with assessment of SD-2. Not separately ranked.
FS-12	Leak in Fuel Line in Range (See Figure 5.0-5)	1972	JP-4 (VOCs, hydrocarbons). Potential for contamination; potential for contaminant migration. Received a HARM rating of 54.3. Phase II studies recommended.
FS-13	Leak in Fuel Line in Cantonment Area (See Figure 5.0-4)	1972	JP-4 (VOCs, hydrocarbons). Potential for contamination; potential for contaminant migration. Received a HARM rating of 58.7. Phase II studies recommended.
FS-14	Fuel Spill in Range (E-3) (See Figure 5.0-5)	1985	MOGAS (VOCs, lead, hydrocarbons). Potential for contamination; potential for contaminant migration. Contaminated soil excavated. Received a HARM rating of 55.0. Limited Phase II studies recommended.
FS-15	Runway #5 Spill (See Figure 5.0-4)	Early 1960's	AVGAS (VOCs, lead, hydrocarbons). Potential for contamination. No potential for contaminant migration. Site not ranked. No Phase II recommendations.
FS-16	Army Helicopter Maintenance (Bldg 2816) (See Figure 5.0-4)	1982	JP-4 (VOCs, hydrocarbons). Potential for contamination. No potential for contaminant migration. Site not ranked. No Phase II recommendations.
FS-17	WWII Motor Pool/Transfer Point (See Figure 5.0-4)	?-present	MOGAS (VOCs, lead, hydrocarbons). Potential for contamination; potential for contaminant migration. Received a HARM rating of 55.2. Phase II studies recommended.

TABLE 5.0-1 CONT'D
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES
ON MMR

Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
CS-18	Propellant-Burning Trenches (See Figure 5.0-3)	1940's to present	Lead, 2,4-DNT. Potential for contamination; potential for contaminant migration. Received a HARM rating of 45.5. No Phase II studies recommended. Recommended to Base Environmental Programs.
FS-1	AVGAS Fuel Valve Test Dump Site (See Figure 5.0-4)	1955-1959	Fuel components (VOC, lead, hydrocarbons). Potential for contamination; potential for contaminant migration. Received a HARM rating of 78.9. Phase II studies have been recommended for this site.
FS-2	Railroad Fuel Pumping Site (See Figure 5.0-4)	1955-1965	Fuel components (VOC, lead, hydrocarbons). Potential for contamination. Evidence of contaminant migration. Received a HARM rating of 80.7. Phase II studies have been recommended for this site.
FS-3	Johns Pond Road Fuel Dumping-off-base site (See Figure 5.0-4)	1955-1962	Fuel components (VOC, lead, hydrocarbons). Potential for contamination; potential for contaminant migration. Site is off base. Received a HARM rating of 66.2. Phase II studies have been recommended for this site.
FS-4	Current Product Tanks 100, 101 (See Figure 5.0-4)	1956-present	AVGAS leak (VOC, lead, hydrocarbons). Potential for contamination; potential for contaminant migration. Received a HARM rating of 56.1. Limited Phase II studies recommended.
FS-5	Aircraft Parking Apron near Aquafarm (See Figure 5.0-4)	Early 1960's	AVGAS (lead, VOCs, hydrocarbons). Site is included with assessment of SD-5; not separately ranked.
FS-6	Airfield Apron (See Figure 5.0-4)	Early 1960's	AVGAS (lead, VOCs, hydrocarbons). Site is included with assessment of SD-2. Not separately ranked.
FS-7	Current Product Tank 115 (See Figure 5.0-4)	1970-1985	Fuel oil (VOC, hydrocarbons) Potential for contamination; potential for contaminant migration. Received a HARM rating of 56.1. Limited Phase II studies are recommended.
FS-8	Airfield Apron (See Figure 5.0-4)	Early 1960's	AVGAS (lead, VOCs, hydrocarbons). Site is included with assessment of SD-2. Not separately ranked.

TABLE 5.0-1 CONT'D
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES
ON MMR

Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
CS-10	UTES/BOMARC Site (See Figure 5.0-3)	1962-1973 (BOMARC) 1978-present (UTES)	Spills or waste fuels, oil, solvents, battery electrolytes. Waste electronic parts cleaner (halogenated solvents), UDMH degradation products. Potential for contamination. Indirect evidence of contamination migration. Received a HARM rating of 85.9. Phase II studies recommended.
CS-11	ARNG Pesticide Shop (Former ANG Pesticide Shop) (See Figure 5.0-3)	1970-present	Pesticide residues. Potential for contamination. Potential for contaminant migration. Received a HARM rating of 53.9. Limited Phase II studies recommended.
CS-12	VA Roads and Grounds Shop (See Figure 5.0-3)	1980-present	Spills of waste POL and solvents. Spills of pesticide. Potential for contamination; potential for contaminant migration. Received a HARM rating of 63.1. Referred to Base Environmental Programs. No Phase II studies recommended.
CS-13	Former Contractors Yard near Well J-off-base site (See Figure 5.0-3)	1954-1984	Leaking drums with unknown substances. Potential for contamination. Indirect evidence for contaminant migration. Received a HARM rating of 80.8. Phase II studies recommended.
CS-14	Bldg. 156 Vapor Degreaser Leaching Pit (See Figure 5.0-3)	1955-1969	PCE and TCE. Potential for contamination; potential for contaminant migration. Received a HARM rating of 63.8. Phase II studies recommended.
CS-15	Former Engine Run-up Area (See Figure 5.0-3)	1949-present	Waste fuel and petroleum distillate solvents. Potential for contamination; potential for contaminant migration. Received a HARM rating of 70.2. Phase II studies recommended.
CS-16	Sewage Treatment Plant (See Figure 5.0-3)	1936-present	Metals, VOCs. Potential for contamination; potential for contaminant migration. Received a HARM rating of 73.3. Phase II studies at this site are currently ongoing.
CS-17	Former Sewage Sludge Disposal Area (See Figure 5.0-3)	1941-1960	Metals. Potential for contamination; potential for contaminant migration. Received a HARM rating of 53.2. Phase II studies at this site are currently ongoing.

TABLE 5.0-1 CONT'D
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES ON MMR

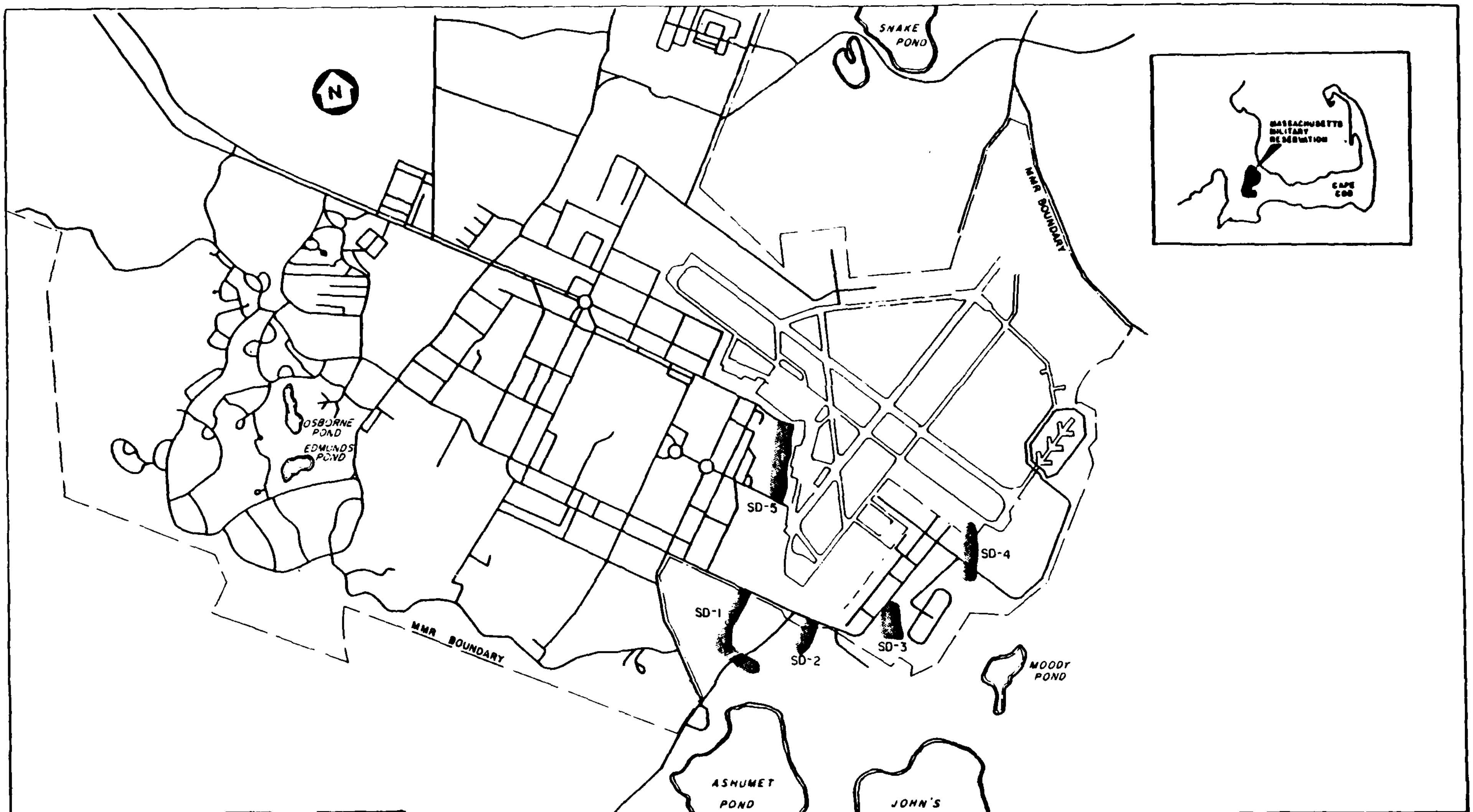
Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
CS-3	South Truck Road Motor Pool (See Figure 5.0-3)	1941-1973	Waste solvents, fuels and oils, antifreeze, paint and battery electrolyte (metals including lead). Potential for contamination; potential for contaminant migration. Received a HARM rating of 67.3. Phase II studies recommended.
CS-4	West Truck Road Motor Pool and Former DPDO Yard (See Figure 5.0-3)	1941-1983	Waste solvents, fuels and oils, antifreeze, paint, industrial chemicals, battery electrolytes (lead), battery cases, scrap metals, transformers. Potential for contamination; potential for contaminant migration. Received a HARM rating of 67.1. Phase II studies recommended.
CS-5	Former Refueler Maintenance Shop/Weapons Repair Facility (See Figure 5.0-3)	1941-1967	Waste solvents, fuels and oils, antifreeze, paints, battery electrolytes (lead). Potential for contamination; potential for contaminant migration. Received a HARM rating of 62.8. Phase II studies recommended.
CS-6	Current ANG Motor Pool/ Vehicle Maintenance Shop (See Figure 5.0-3)	1967-present	Waste solvent and oil spills. Washed to floor drains and to drainage ditch. Limited potential for contamination. Potential for contaminant migration. Received a HARM rating of 44.4. No Phase II studies recommended.
CS-7	OMS-6 (See Figure 5.0-3)	1966-present	Waste solvents and oil waste, battery electrolytes. Organic wastes contained and disposed of off-site. Used electrolyte disposed of to sanitary sewer system. No potential for contamination; no potential for contaminant migration. No HARM rating. No Phase II studies recommended.
CS-8	OMS-22 (See Figure 5.0-3)	1950-present	Waste solvents and oil, waste battery electrolyte. Prior to 1970 wastes may have been disposed of at this site. Potential for contamination; potential for contaminant migration. Received a HARM rating of 66.6. Phase II studies recommended.
CS-9	Former Main USAF Motor Pool (See Figure 5.0-3)	1941-1946 U.S. Army; 1955-1967 USAF	Waste solvents, oil and fuel, waste battery electrolytes. Potential for contamination; potential for migration. Received a HARM rating of 62.8. Phase II studies recommended.

TABLE 5.0-1 CONT'D
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES
ON MMR

Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
LF-3	Northern Range Area Dump (See Figure 5.0-2)	Unknown to present	Access unrestricted to general public. Possible non-MMR disposal of hazardous wastes. Potential for contamination; potential for contaminant migration. Received a HARM rating of 48.5. No Phase II monitoring recommended. Referred to base environmental programs for future action.
LF-4	John's Pond Dump - Off Base Site (See Figure 5.0-2)	Unknown to present	Access unrestricted. Drums of unknown origin (18-20) were observed at this location. Potential for contamination; potential for migration. Received a HARM rating of 72.5. Phase II studies recommended.
LF-5	Landfill No. 5; Rubble landfill at VA Hospital (See Figure 5.0-2)	Unknown	Rubble landfill. No potential for contamination. No potential for contaminant migration. No HARM rating. No Phase II studies recommended.
LF-6	Former U.S. Navy Construction Landfill (See Figure 5.0-2)	1940's	Rubble landfill. No potential for contamination. No potential for contaminant migration. No HARM rating. No Phase II studies recommended.
LF-7	Radar Tube Burial Site (See Figure 5.0-2)	1955-1970	Low level radioactivity (10^{-7} - 10^{-9} pCi). Potential for contamination; potential for contaminant migration. Received a HARM rating of 38.7. No Phase II studies recommended.
CS-1	North Truck Road Motor Pool (See Figure 5.0-3)	1941-1946	Waste solvents, fuels and oils, antifreeze, paint and battery electrolyte (metals including lead). Potential for contamination; potential for contaminant migration. Received a HARM rating of 52.4. No Phase II studies recommended unless studies of more recent motor pools indicate residual contamination.
CS-2	East Truck Road Motor Pool (See Figure 5.0-3)	1941-1946	Waste solvents, fuels and oils, antifreeze, paint and battery electrolyte (metals including lead). Potential for contamination; potential for contaminant migration. Received a HARM rating of 66.4. No Phase II studies recommended unless studies of more recent motor pools indicate residual contamination.

TABLE 5.0-1
SUMMARY OF POTENTIAL CONTAMINATION AT FACILITIES
ON MMR

Report Designation	Site Description and Location Figure	Dates of Operation or Occurrence	Conclusions
SD-1	Runway/Aircraft Maintenance Storm Drainage Ditch (Figure 5.0-1)	1955-1970 (major activity) 1970-present (less activity)	Solvents, fuel components including lead discharged from stormwater outfall. Potential for contamination; potential for migration. Received a HARM rating of 64.2. Phase II studies recommended.
SD-2	Runway/Aircraft Maintenance Storm Drainage Ditch (See Figure 5.0-1)	1955-1970 (major activity) 1970-present (less activity)	Solvents, fuel components including lead discharged from stormwater outfall. Weathered POL sludge found in ditch downgradient. Potential for contamination; potential for migration. Received a HARM rating of 71.6. Phase II studies recommended.
SD-3	Coal and Ash Pile Runoff Storm Drainage Ditch (See Figure 5.0-1)	1956-present (ash) 1984-present (coal)	Ash particulates, coal pile runoff. Potential for contamination; potential for migration. Received a HARM rating of 60.7. Limited Phase II studies recommended. Referred to base environmental programs.
SD-4	Hangar 158, Aircraft Maintenance, Storm Drainage Ditch (See Figure 5.0-1)	1955-1970 (major activity) 1970-present (less activity)	Solvents, fuel spills, fuel components including lead washed to floor drains and storm drainage system. Potential for contamination; potential for migration. Received a HARM rating of 75.7. Phase II studies recommended.
SD-5	Aquafarm Drainage Swale (See Figure 5.0-1)	1940-present	TCE, other halogenated solvents, nonhalogenated solvents, JP-4, MOGAS, and AVGAS. Received discharges from former NDI lab 1955-1978. Potential for contamination; potential for migration. Indirect evidence of contaminant migration. Received a HARM rating of 76.1. Phase II studies recommended.
LF-1	Main Base Landfill (See Figure 5.0-2)	1944-present	Solvents, fuels, waste oil, ordnance, pesticides, other refuse. Potential for contamination. Contaminant migration observed. Received a HARM rating of 90.0. Phase II studies are ongoing.
LF-2	Probable Former Sanitary Landfill (See Figure 5.0-2)	1940-1944	Possible solvents, POL, paints, domestic refuse. Site is assessed in conjunction with Site FTA-2 below.



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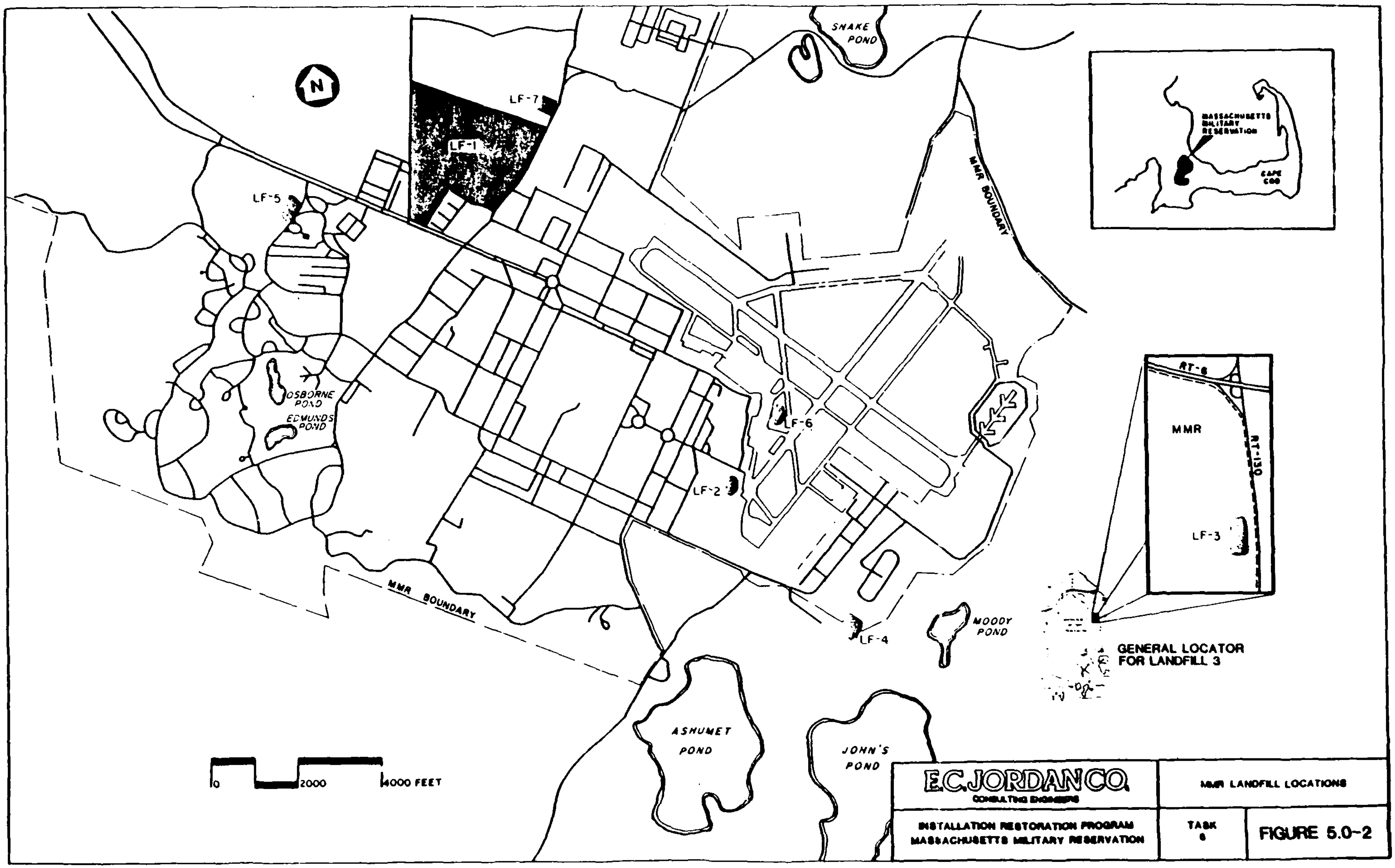
INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

STORMWATER DISPOSAL SITES

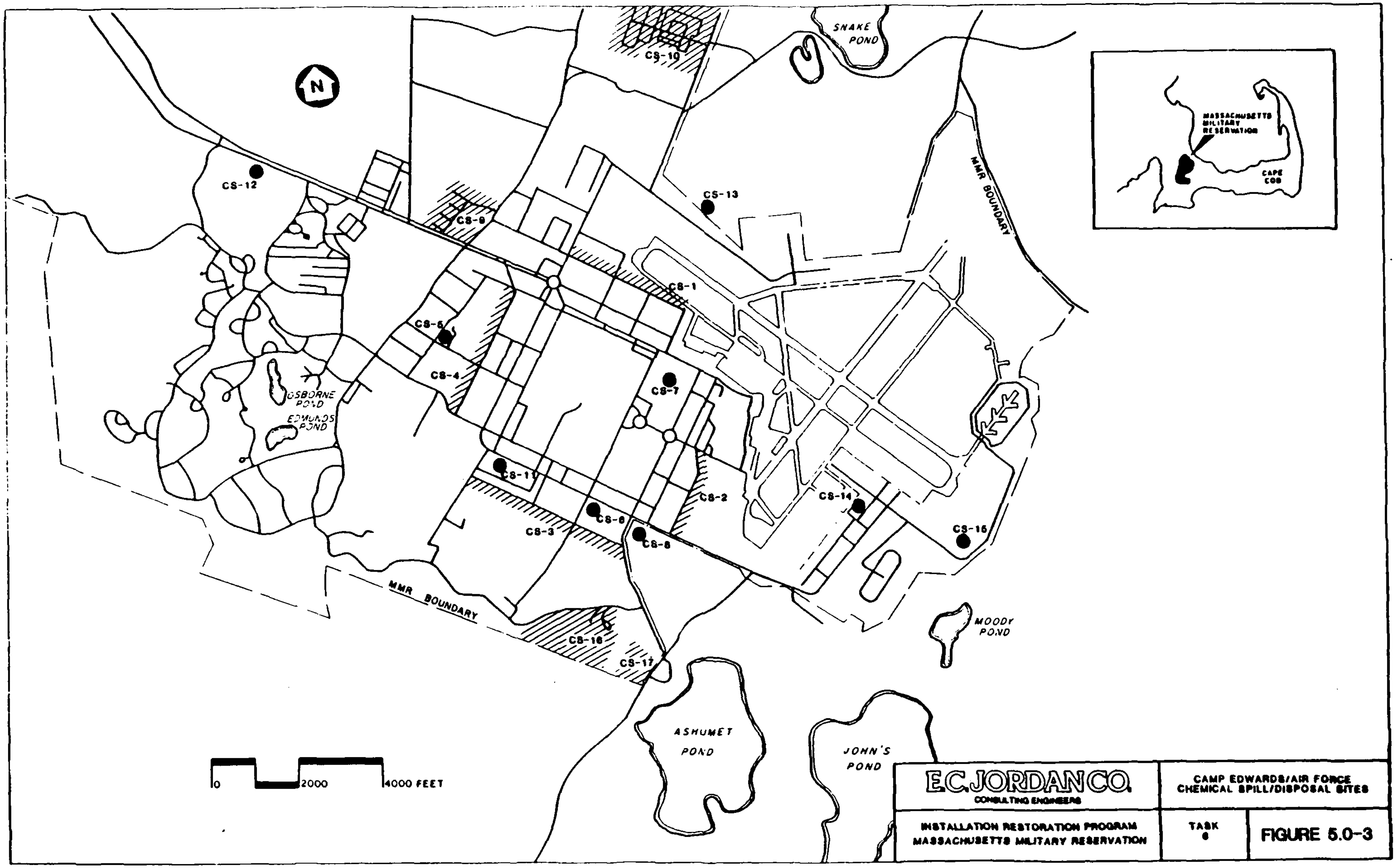
CANTONMENT/RUNWAY AREA

TASK 6

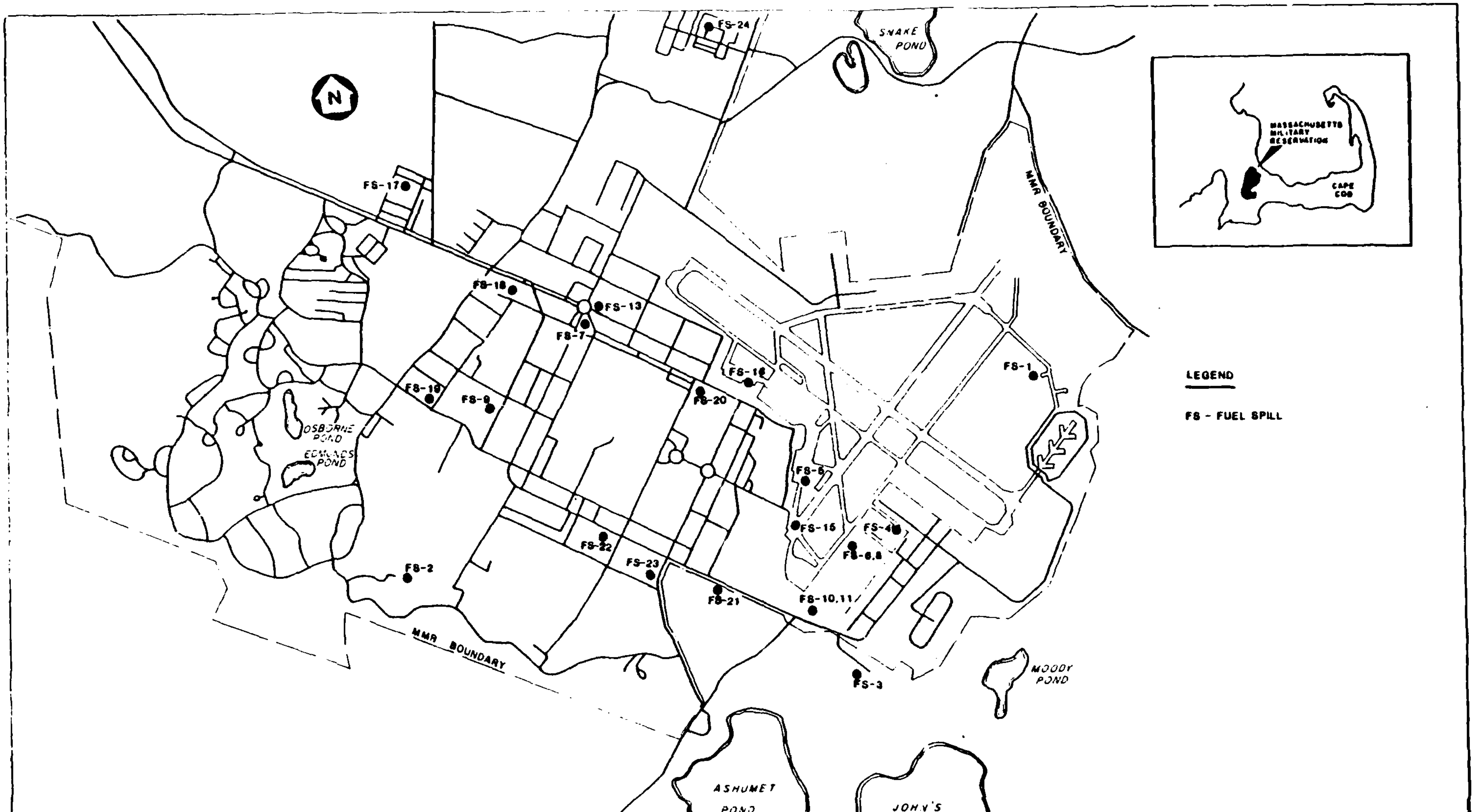
FIGURE 5.0-1



E.C.JORDAN CO. CONSULTING ENGINEERS	MMR LANDFILL LOCATIONS	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 5.0-2



E.C.JORDAN CO. CONSULTING ENGINEERS	CAMP EDWARDS/AIR FORCE CHEMICAL SPILL/DISPOSAL SITES	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 5.0-3



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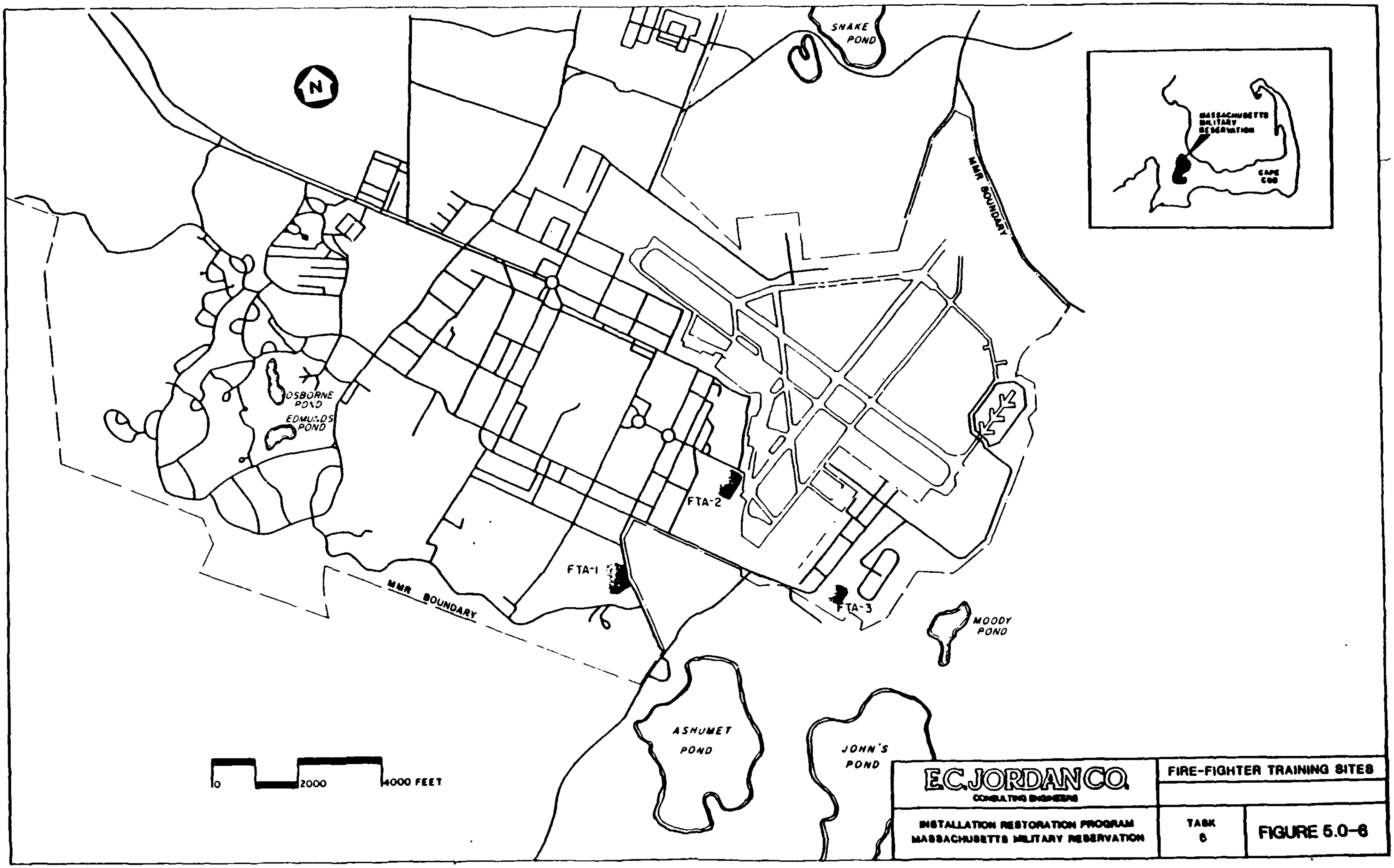
FUEL SPILL SITES

TASK 6

FIGURE 5.0-4



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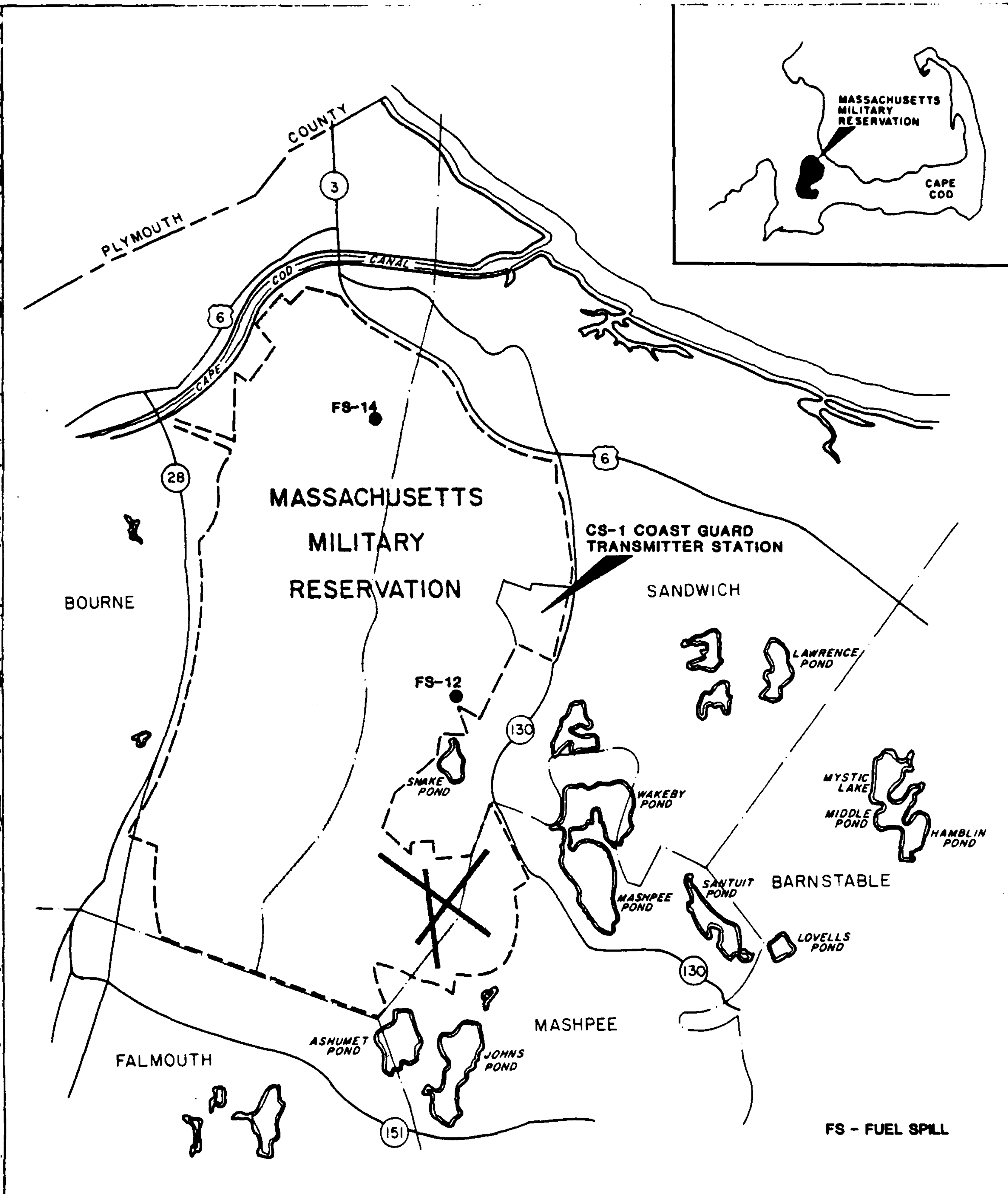
MASSACHUSETTS MILITARY RESERVATION

FIRE-FIGHTER TRAINING SITES

TASK 6

FIGURE 5.0-6



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FUEL SPILL SITES

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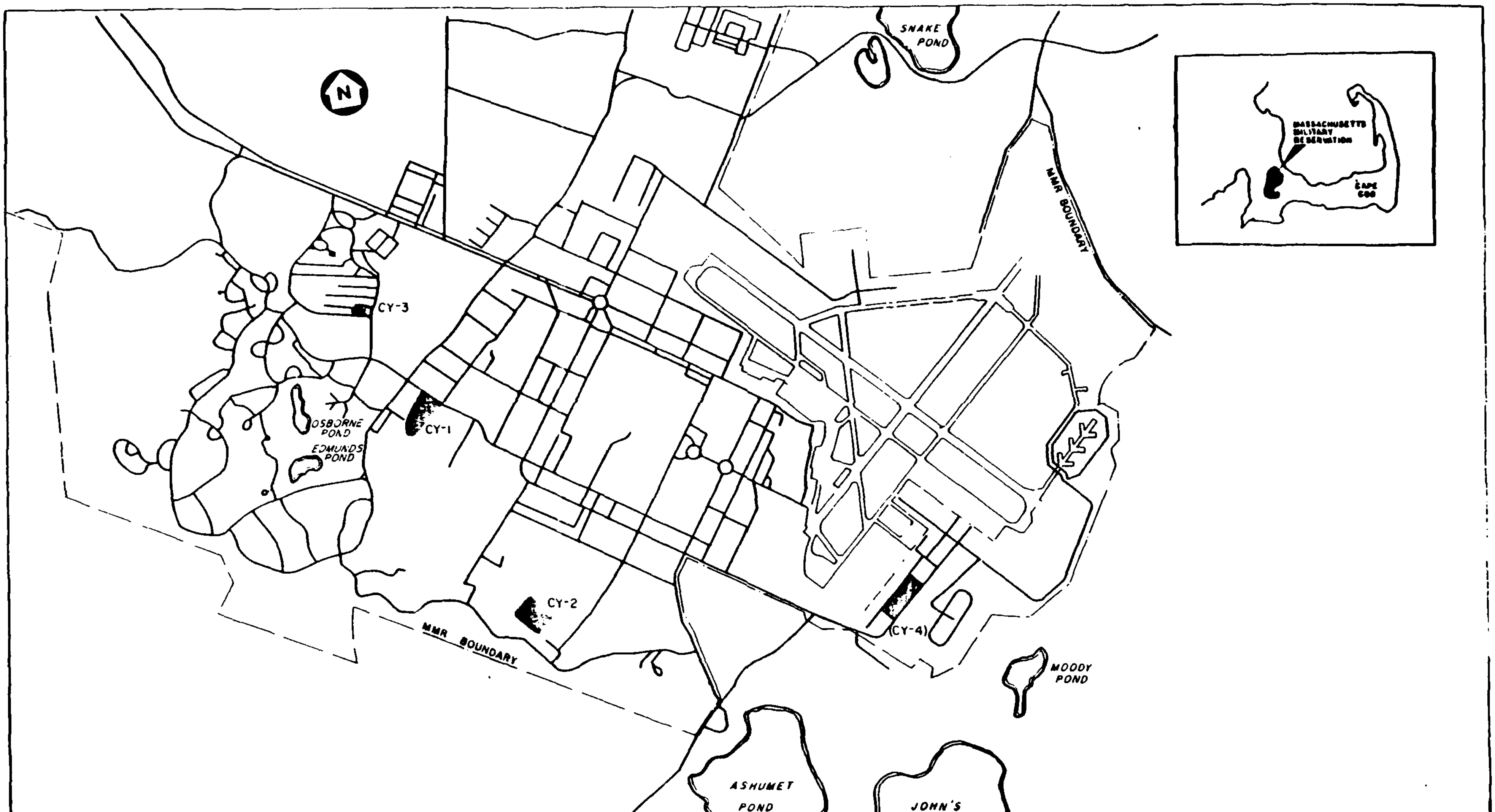
TASK 6

FIGURE 5.0-5



E.C. JORDAN CO. CONSULTING ENGINEERS	COAL YARD STORAGE AREAS	
INSTALLATION RESTORATION PROGRAM MASSACHUSETTS MILITARY RESERVATION	TASK 6	FIGURE 5.0-7

Because these sites are off-base, access is unrestricted. Because of their proximity to MMR, MMR activities could potentially be one contributor to any contamination occurring at each site. However, any contamination from hazardous materials, if present, could have come from non-MMR sources. If residual contamination is identified at any of the three sites, all responsible parties will need to be identified by MMR, DOD, state and federal agencies, and local health agencies to assign and enforce responsibility for any required remediation.

Because of the large number of sites assessed at MMR, this section is presented in Matrix Tables and in graphical form for ease of interpretation. Detailed descriptions of each site and factors considered in the evaluation and ranking were presented in Section 4.2. Conclusions regarding the sites located on the facilities of each command unit (ANG, Camp Edwards/ARNG, and VA) that have potential for contaminant migration and received HARM ratings are summarized in Tables 5.0-2 through 5.0-4. The site locations are shown for each command unit and the off-base sites in Figures 5.0-8 through 5.0-10. No disposal sites were identified on the USAF facilities at Cape Cod AFS. HARM methodology is presented in Appendix G; individual HARM rating forms for each site are presented in Appendix H.

TABLE 5.0-2

SUMMARY OF CONCLUSIONS REGARDING CAMP EDWARDS/ARNG RANKED DISPOSAL SITES (Keyed to Figure 5.0-8)

Site Designation	Site Description	Site Type	Potential for Contamination	Potential for Migration	Referred To Base Environmental Program	Harm Ranking	Recommended For Phase II Action
CS - 10	UTES/BOMARC	Chemical spill/disposal site	Yes	Yes	No	85.9	Phase II studies recommended
FS - 19	Former MOGAS/Fuel Storage Point	Fuel spill/disposal site	Yes	Yes	No	69.4	Phase II studies recommended
CS - 3	South Truck Road Motor Pool	Chemical spill/disposal site	Yes	Yes	No	67.3	Phase II studies recommended
CS - 4	West Truck Road Motor Pool	Chemical spill/disposal site	Yes	Yes	No	67.1	Phase II studies recommended
CS - 8	OMS #22	Chemical spill/disposal site	Yes	Yes	No	66.6	Phase II studies recommended
CS - 5	Former Refueler Maintenance Shop	Chemical spill/disposal site	Yes	Yes	No	62.8	Phase II studies recommended
FS - 21	Current Product Tank 90	Fuel spill/disposal site	Yes	Yes	No	61.9	Phase II studies recommended
FS - 20	Current Product Tank 88	Fuel spill/disposal site	Yes	Yes	No	56.8	Phase II studies recommended
FS - 7	Current Product Tank 115	Fuel spill/disposal site	Yes	Yes	No	56.1	Limited Phase II studies recommended
FS - 17	Former WWII Motor Pool Transfer Pt.	Fuel spill/disposal site	Yes	Yes	No	55.2	Phase II studies recommended
FS - 14	Spill in Range (F-3)	Fuel spill/disposal site	Yes	Yes	No	55.0	Limited Phase II studies recommended
FS - 12	Leak in Fuel Line in Range	Fuel spill/disposal site	Yes	Yes	No	54.3	Phase II studies recommended
CS - 11	Pesticide Shop	Chemical spill/disposal site	Yes	Yes	No	53.9	Limited Phase II studies recommended
CY - 1	Former Army Coal Yard	Coal storage yard	Yes	Yes	No	52.9	No Phase II studies recommended
FS - 9	Current Product Tank 108	Fuel spill/disposal site	Yes	Yes	No	52.8	Limited Phase II studies recommended
FS - 18	Fuel Transfer Point	Fuel spill/disposal site	Yes	Yes	No	51.5	Limited Phase II studies recommended
LF - 3	Northern Range Area Dump	Landfill	Yes	Yes	Yes	48.5	No Phase II studies recommended
CS - 18	Propellant Burning Trenches	Chemical spill/disposal site	Yes	Yes	Yes	45.5	No Phase II studies recommended
LF - 7	Radar Tube Burial Site	Landfill	Yes	Yes	No	38.7	No Phase II studies recommended

TABLE 5.0-3

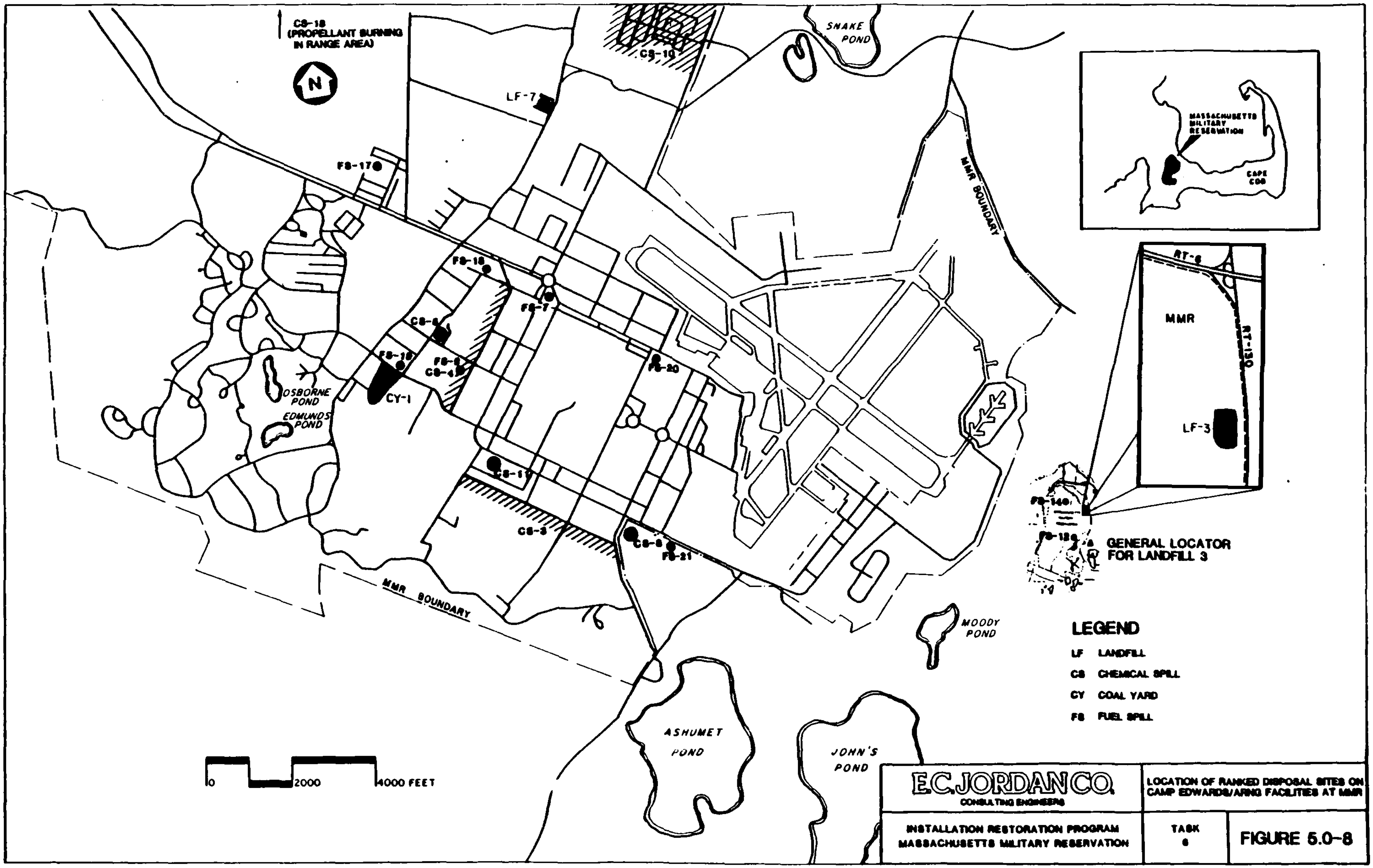
SUMMARY OF CONCLUSIONS REGARDING ANG RANKED DISPOSAL SITES (Keyed to Figure 5.0-9)

Site Designation	Site Description	Site Type	Potential for Contamination	Potential for Migration	Referred To Base Environmental Program	Harm Ranking	Recommended For Phase II Action
FTA - 1	Current Fire-Fighting Training Area	Fire-Fighter Training Area	Yes	Yes	No	92.6	Phase II studies in progress
LF - 1	Main Base Landfill	Landfill	Yes	Yes	No	90.0	Phase II studies in progress
FTA - 2	Former Fire-Fighter Training Area (1948-1956)	Fire-Fighter Training Area	Yes	Yes	No	82.6	Phase II studies recommended
FS - 2	Railroad Fuel Pumping Area	Fuel spill/disposal site	Yes	Yes	No	80.7	Phase II studies recommended
FS - 1	Avgas Fuel Valve Test Dump Site	Fuel spill/disposal site	Yes	Yes	No	78.9	Phase II studies recommended
SD - 5	Aqua Farm Drainage Swale	Storm drainage disposal site	Yes	Yes	No	76.1	Phase II studies recommended
SD - 4	Hangar 158, Aircraft Maintenance Storm Drainage Ditch	Storm drainage disposal site	Yes	Yes	No	75.1	Phase II studies recommended
CS - 16	Sewage Treatment Plant	Chemical spill/disposal site	Yes	Yes	No	73.7	Phase II studies in progress
SD - 2	Runway/Aircraft Maintenance Storm Drainage Ditch	Storm drainage disposal site	Yes	Yes	No	71.6	Phase II studies recommended
CS - 15	Former Engine Run-up Area	Chemical spill/disposal site	Yes	Yes	No	70.2	Phase II studies recommended
CS - 2	East Truck Road Motor Pools	Chemical spill/disposal site	Yes	Yes	No	66.4	No Phase II studies recommended
FTA - 3	Former Fire-Fighter Training Area (1956-1958)	Fire-Fighter Training Area	Yes	Yes	No	64.9	Phase II studies recommended
SD - 1	Runway/Aircraft Maintenance Storm Drainage Ditch	Storm drainage disposal site	Yes	Yes	No	64.2	Phase II studies recommended
CS - 14	Bldg. 156 Vapor Degreaser Leaching Pit	Chemical spill/disposal site	Yes	Yes	No	63.8	Phase II studies recommended
CS - 9	Former Main USAF Motor Pool	Chemical spill/disposal site	Yes	Yes	No	62.8	Phase II studies recommended
SD - 3	Coal/Ash Runoff Drainage Ditch	Storm drainage disposal site	Yes	Yes	Yes	60.7	Phase II studies recommended
FS - 13	Leak in Fuel Line-Cantonment Area	Fuel spill/disposal site	Yes	Yes	No	58.7	Phase II studies recommended
FS - 4	Current Product Tanks 100, 101	Fuel spill/disposal site	Yes	Yes	No	56.1	Limited Phase II studies recommended
CY - 2	Former USAF/ANG Coal Yard	Coal storage yard	Yes	Yes	No	54.9	Phase II studies recommended
CS - 17	Former Sewage Sludge Disposal	Chemical spill/disposal site	Yes	Yes	No	53.2	Phase II studies in progress
CS - 1	North Truck Road Motor Pool	Chemical spill/disposal site	Yes	Yes	No	52.4	No Phase II studies recommended
CS - 6	Current ANG Motor Pool	Chemical spill/disposal site	Yes	Yes	No	44.4	No Phase II studies recommended

TABLE 5.0-4

SUMMARY OF CONCLUSIONS REGARDING VA AND OFF-BASE RANKED DISPOSAL SITES

Site Designation	Site Description	Site Type	Potential for Contamination	Potential for Migration	Referred To Base Environmental Program	Harm Ranking	Recommended For Phase II Action
VA (Keyed to Figure 5.0-10)							
CS - 12	VA Roads and Ground Shop	Chemical spill/disposal site	Yes	Yes	Yes	63.1	No Phase II studies recommended
CY - 3	Former Hospital Coal Yard and Ash Disposal	Coal storage yard	Yes	Yes	No	52.8	No Phase II studies recommended
Off-Base Sites (Keyed to Figure 5.0-9)							
CS - 13	Former Contractors Yard Near Well J	Chemical spill/disposal site	Yes	Yes	Yes	80.8	Phase II studies recommended
LF - 4	Johns Pond Dump	Landfill	Yes	Yes	No	72.5	Phase II studies recommended
FS - 3	Johns Pond Road Fuel Dump Site	Fuel spill/disposal site	Yes	Yes	No	66.2	Phase II studies recommended



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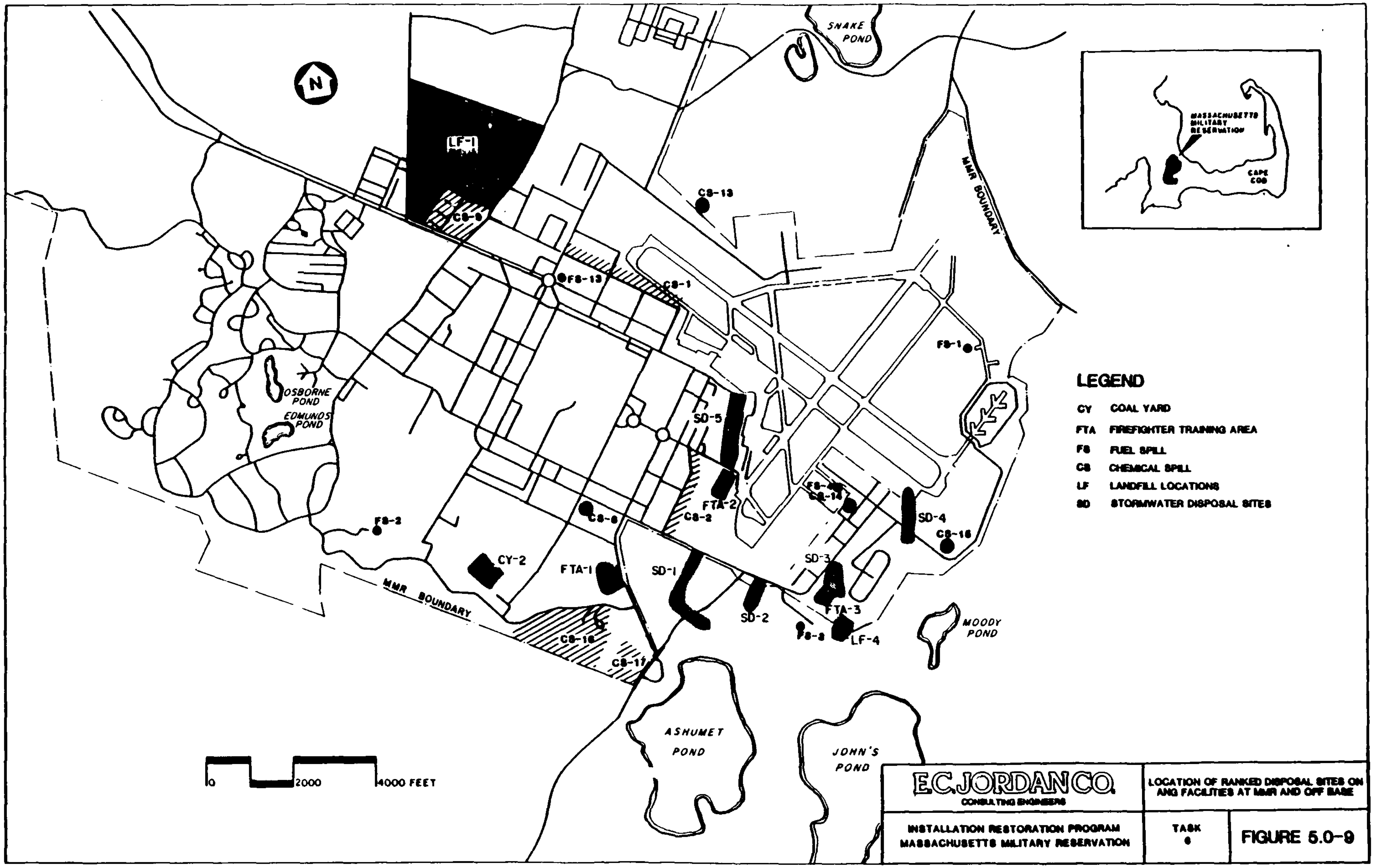
INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

LOCATION OF RANKED DISPOSAL SITES ON CAMP EDWARDS/ARNG FACILITIES AT MMR

TASK 6

FIGURE 5.0-8



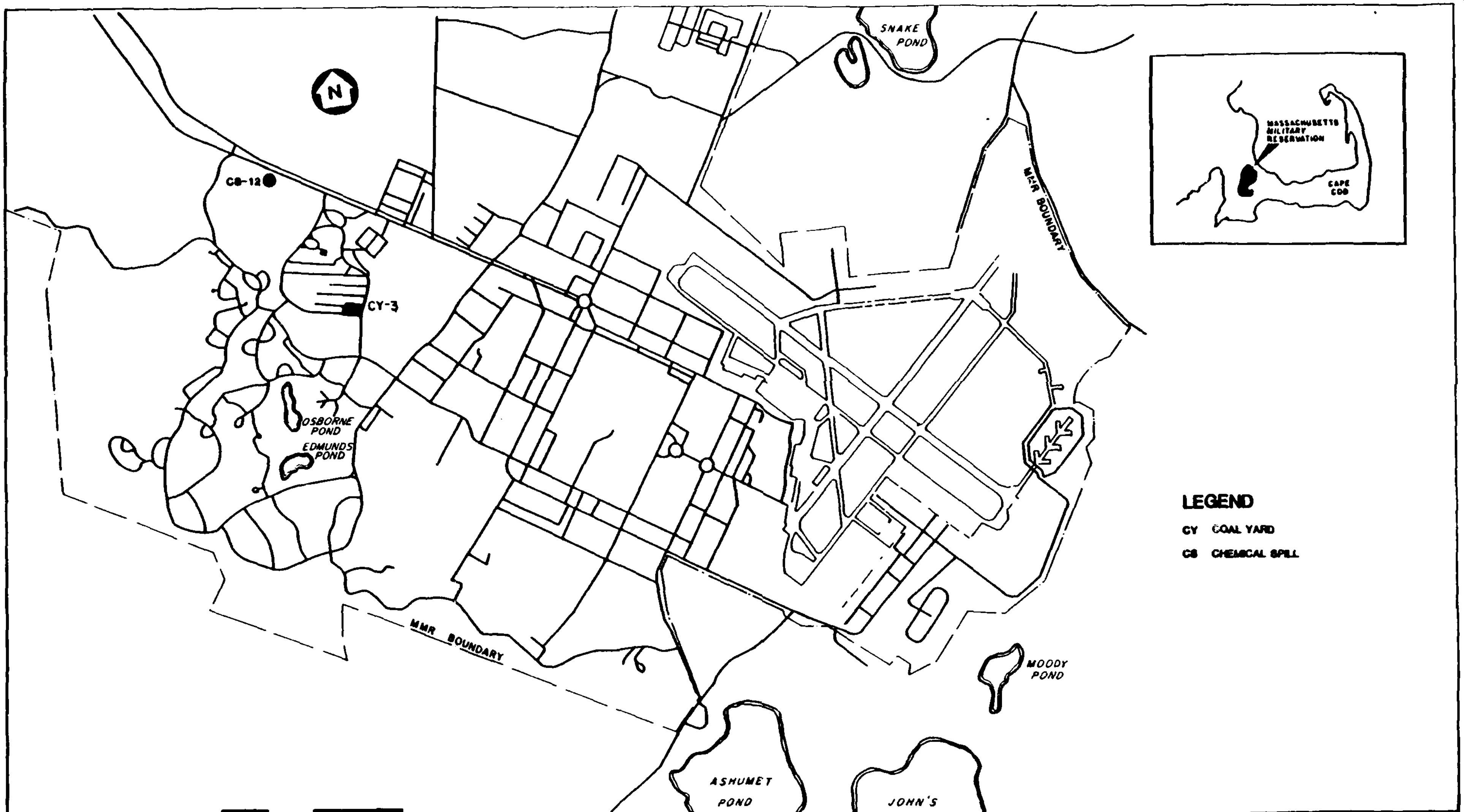
E.C.JORDAN CO.
CONSULTING ENGINEERS

LOCATION OF RANKED DISPOSAL SITES ON ANG FACILITIES AT MMR AND OFF BASE

INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

TASK 6

FIGURE 5.0-9



E.C.JORDAN CO.
CONSULTING ENGINEERS

LOCATION OF RANKED DISPOSAL SITES ON VA FACILITIES AT MMR

INSTALLATION RESTORATION PROGRAM
MASSACHUSETTS MILITARY RESERVATION

TASK 6

FIGURE 5.0-10

6.0 RECOMMENDATIONS

6.1 PHASE II, STAGE 1 MONITORING RECOMMENDATIONS

Forty-six sites were identified on the ANG, Camp Edwards/ARNG, USAF, and VA facilities at MMR as having potential for environmental contamination and contaminant migration. These sites have been evaluated using the HARM system, and the relative potential of these sites for environmental contamination was assessed. Phase II, Stages 1 and 2 studies are ongoing at MMR, as well as Phase IV-A studies as other components of the current IRP. Recommendations for Phase II studies at the 46 ranked sites consider data being gathered as a part of these programs. Recommendations for Phase II, Stage 1 verification study and monitoring are summarized by Command Unit in Tables 5.0-2 through 5.0-4. Rationale for the recommendations are described in this section. Of the 46 sites, a total of 37 have been selected and are recommended for further study under the MMR IRP. Of that total, seven are recommended for limited Phase II investigations; eight have various stages (1 or 2) of Phase II studies either already in progress or in the work plan development stage; and the remainder are recommended for Phase II, Stage 1. For the nine remaining sites not included in the above total, recommendations for Phase II study should be deferred pending the results of both the ongoing Phase II studies and the results of those sites selected for initial study.

The intent of the HARM system is to identify potential for contamination; it is expected that not all sites ranked and selected for Phase II study will show contamination during the verification program. As applied to the Phase I studies at MMR, the HARM constitutes an extremely conservative approach to site evaluation. This is because of three environmental factors specific to MMR. First, MMR is a major recharge area for a designated sole source aquifer. As a result, the receptor subscores for all sites are high compared with most installations. Second, the unconsolidated surface substrate is extremely permeable. Minimal surface water transport occurs, but groundwater movement is rapid. The pathways subscore is, therefore, also relatively high although this score is partially mitigated by the presence of a thick vadose zone (approximately 50 ft in the cantonment area). Third, the HARM lists POL-related aliphatic and aromatic hydrocarbons as persistent. The length of time that these compounds, as well as halogenated solvents, persist after a spill or disposal may be much shorter at MMR than most areas because the soils are very low in organic content and may not retard migration. Under these environmental conditions, the HARM may overrate the chemical characteristics subscore by overrating persistence. The low soil organic content and probable low levels of nitrogen and phosphorus, however, would tend to reduce the capacity or rate for microbiological degradation or transformation.

Because of these environmental conditions, some sites at MMR may receive high HARM scores when residual contamination is no longer present. This is especially likely where the disposal or spill occurred relatively long ago. Contaminants at such sites may have migrated into the groundwater or deep into the vadose zone. Generalized groundwater contamination at MMR may exist as a result of contaminants that have migrated from sources that no longer exist.

Because of the these factors, the recommended Phase II, Stage 1 studies should generally be focused on verifying whether a residual contaminant source exists at sites identified in this Phase I program. Groundwater contamination already is documented at MMR. Overall characterization of contamination of groundwater and consequent contaminant control strategies focused on receptors are ongoing as components of existing Phase II and Phase IV-A studies. MMR IRP studies are already in progress to further characterize groundwater contaminant distribution on MMR and to determine the distribution and impact off-base. Phase II source verification and/or characterization is currently being implemented at these sites as a result of data obtained in the earlier Phase II, Stage 1 program (Weston, 1985). Work plans have been developed for recommended additional studies at the remaining four sites. These seven sites were reassessed during the current records search to support recommendations for immediate continuation of Phase II characterization. The correlation of the current records search site identification to the Weston (1985) site designations is presented below. The current IRP Phase II status is also shown as follows:

MMR Task 6 Designation	Weston (1985) Site Designation	Status of Current Phase II Study
FTA-1	Site 1: CFTA	Implemented
SD-2, SD-5	Zone 1 (Site 2: FFTA and Site 6: NDI Lab)	Work plan under review
LF-1	Site 3: Base landfill	Implemented
FS-1	Site 4: AFTDS	Work plan under review
FS-2	Site 5: RFPS	Work plan under review
FS-10 (not separately ranked but included under SD-2)	Site 7: PFSA	Implemented
CS-16	Site was not addressed	Implemented
CS-17	Site was not addressed	Implemented

The current Phase II studies will provide documentation of migration and/or persistence of most of the potential contaminants as a function of MMR site conditions. The recommendation for Phase II studies at the 46 sites identified in the current records search should be reevaluated based on the findings of the current Phase II studies.

Phase II, Stage 1 studies are not recommended for certain sites (see Tables 5.0-2 through 5.0-4) because of the age of the disposals (1941-1960). If studies of other similar sites in which disposals are more recent indicate residual contamination, the sites not initially examined should be sampled in a second, expanded verification phase.

Based on this rationale, recommendations for Phase II studies, limited Phase II studies, or no Phase II studies were developed for each of the 46 ranked sites and tabulated in Tables 5.0-2 through 5.0-4.

Groundwater contamination has been documented at MMR. However, the multiplicity of potential disposal sites, the complexity of the timing of disposals, the rapid rate of groundwater movement, and pumping history of the MMR water supply wells have resulted in a subsurface environment where groundwater monitoring has limited potential for attributing contamination to any specific source. Because of this, groundwater monitoring at MMR has been primarily receptor-oriented. Groundwater contamination may partially result from sources from which contaminants have migrated. Additionally, because of environmental conditions and the age of the disposal, it is possible that residual contamination no longer exists at the source or that it has infiltrated deep into the vadose zone.

Phase II, Stage 1 study recommendations, therefore, are focused primarily on verification that residual contamination exists at a specific disposal site. This is done by a program of shallow soil borings, test pit excavations, and deeper soil borings (to sample intervals representing the complete vadose zone) that are adequate to determine the nature of residual contamination at each site. The geological program is coupled with field measurements of parameters such as pH and conductivity, borehole air monitoring, and field gas chromatographic analysis of soil and water samples. This is similar to the program currently being implemented. Geophysical methods that are generally useful in contamination exploration will also be applied where appropriate.

The limited Phase II studies category is recommended for sites where only a few samples or limited testing is required, such as to confirm the status of underground tanks suspected of leaking.

The only site recommended for Phase II study in which monitoring well installation may be required beyond the existing monitoring wells or wells being installed in conjunction with existing work plans is the UTES/BOMARC site (CS-10). The existing monitoring well array at this location needs to be reviewed to determine if it is adequate to define the direction and distribution of migration. Semivolatiles by GC/MS should be a component of monitoring at this location to determine the presence of N-nitrosodiphenylamine, which is a UDMH breakdown product.

Well constructions sampling methodology, and analytical technologies should be identical to those performed in other parts of the ongoing Phase II IRP at MMR to provide consistency. Analytical methods to be used for soil and groundwater should be identical to those used in ongoing Phase II activities using the Contract Laboratory Program. These are described in the MMR Quality Assurance Program Plan (QAPP). Detailed placement and number of borings and/or wells and sampling strategy for each site should be determined for new sites based on results of the ongoing Phase II studies.

Phase II studies were recommended at three off-base sites, shown in Table 5.0-4. Recommended identification of the presence of contamination at each is required to completely address the off-base groundwater contamination to the south of MMR and, in the case of site CS-13, to determine if the site could contribute future contamination to well J. If contamination is found, identification of all responsible parties through the actions of MMR, the DOD, the state and federal regulatory agencies, and local health officials will be required to properly assign responsibility for possible remedial actions.

6.2 RECOMMENDED GUIDELINES FOR LAND USE

It is desirable to have temporary land use restrictions for the identified disposal sites for the following reasons: to 1) provide the continued protection of human health, welfare, and the environment; 2) limit the potential for migration of potential contaminants through improper land use; 3) facilitate the development of future facilities in a manner that will prevent contaminant migration; and 4) allow for identification of property that may be proposed for excess or outlease.

The recommended guidelines for temporary land use restriction at the potential disposal sites are presented in Table 6.2-1. Land use restrictions at individual sites should be considered and reevaluated upon completion of the Phase II monitoring program. Changes should be made where appropriate, based on the findings and based on any remedial action plan development.

TABLE 6.2-1.

DESCRIPTION OF GUIDELINES FOR LAND-USE RESTRICTIONS

Guideline	Description
Construction on the site	Restrict the construction of structures that make permanent (or semipermanent) and exclusive use of a portion of the site's surface.
Excavation	Restrict the disturbance of the cover or subsurface materials.
Well construction on or near the site	Restrict the placement of any wells (except for monitoring purposes) on or within a reasonably safe distance of the site. This distance will vary from site to site, based on prevailing soil conditions and groundwater flow.
Agricultural use	Restrict the use of the site for agricultural purposes to prevent food-chain contamination.
Silvicultural use	Restrict the use of the site for silvicultural uses (root structures could disturb cover or subsurface materials).
Water infiltration	Restrict water run-on, ponding, and/or irrigation of the site. Water infiltration could produce contaminated leachate.
Recreation use	Restrict the use of the site for recreational purposes.
Burning or ignition sources	Restrict any and all unnecessary sources of ignition, due to the possible presence of flammable compounds.
Disposal operation	Restrict the use of the site for waste disposal operation, whether aboveground or below ground.
Vehicular traffic	Restrict the passage of unnecessary vehicular traffic on the site due to the presence of explosive material(s) and/or of an unstable surface.
Material storage	Restrict the storage of any and all liquid or solid materials on the site.
Housing on or near the site	Restrict the use of housing structures on or within a reasonably safe distance of the site.

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