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RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION AND REMEDIAL INVESTIGATION SAMPLING AND ANALYSIS PLAN VOLUME 2 NAS KEY WEST FL

6/1/1995

ABB ENVIRONMENTAL SERVICES INC

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RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) FACILITY INVESTIGATION (RFI) AND REMEDIAL INVESTIGATION (RI)

SAMPLING AND ANALYSIS PLAN

NAVAL AIR STATION KEY WEST
KEY WEST, FLORIDA

VOLUME II

Unit Identification Code (UIC): N60201

Contract No. N62467-89-D-0317/114

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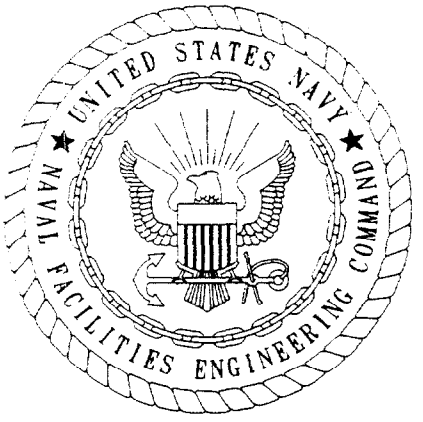

CERTIFICATION OF TECHNICAL
DATA CONFORMITY (MAY 1987)

The Contractor, ABB Environmental Services, Inc., hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-89-D-0317/114 are complete and accurate and comply with all requirements of this contract.

DATE: June 15, 1995

NAME AND TITLE OF CERTIFYING OFFICIAL: Philip Georgariou
Task Order Manager

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Project Technical Lead

(DFAR 252.227-7036)

TABLE OF CONTENTS

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida,

TABLE OF CONTENTS (Continued)

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

LIST OF FIGURES

Supplemental RFI RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

LIST OF FIGURES (Continued)

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

LIST OF TABLES

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida,

GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
AIMD	Aircraft Intermediate Maintenance Department
AOC	Area of Concern
ARAR	applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
bls	below land surface
%C	percent completeness
CAMP	Corrective Action Management Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action, Navy
CLP	Contract Laboratory Program
COC	chain of custody
CTO	Contract Task Order
DDT	dichlorodiphenyltrichloroethane
DOT	Department of Transportation
DQO	data quality objectives
ECBSOPQAM	Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual
ECPC	ecological chemicals of potential concern
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection (as of 7/93)
FNAI	Florida Natural Areas Inventory
FSP	Field Sampling Plan
GC/MS	gas chromatograph and mass spectrometer
HASP	Health and Safety Plan
HSWA	Hazardous and Solid Waste Amendments of 1984
HSW	hazardous waste
IDW	investigation-derived wastes
IR	Installation Restoration
IRA	Initial Removal Action
IT	International Technology Corporation
ℓ	liter
LC	lethal concentration
LOEC	lowest observed effect concentrations
mℓ	milliliter
mℓ/min	milliliters per minute

GLOSSARY (Continued)

NAS	Naval Air Station
NCP	National Oil and Hazardous Substances Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NOAA	National Oceanic and Atmospheric Administration
NOEC	no observed effect concentration
NTU	nephelometric turbidity units
OD	outside diameter
OVA	organic vapor analyzer
PARCC	precision, accuracy, representativeness, comparability, and completeness
PCBs	polychlorinated biphenyls
PID	photoionization detector
PVC	polyvinyl chloride
%R	percent recovery
%RPD	relative percent difference
QA	quality control
QA/QC	quality assurance and quality control
QAM	quality assurance manager
QAPP	Quality Assurance Project Plan
QC	quality control
RAC	Remedial Action Contractor
RCRA	Resource Conservation and Recovery Act of 1976, as amended
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SDWA	Safe Drinking Water Act
SOUTHNAV-FACENGCOM	Southern Division, Naval Facilities Engineering Command
SVOCs	semivolatile organic compounds
SW	solid waste
SWMU	Solid Waste Management Unit
TAL	target analyte list
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION. This Sampling and Analysis Plan (SAP) consists of two primary parts:

- Field Sampling Plan (Chapters 2.0 and 3.0) and
- Quality Assurance Project Plan (Chapter 4.0).

The SAP itself is part of a two-volume set of Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) and Remedial Investigation (RI) planning documents:

Volume I, Workplan; and
Volume II, Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan).

Together, the two volumes present the scope of the RFI/RI program at Naval Air Station (NAS) Key West. The workplan (Volume I) provides a description of the facility, describes regional environmental factors, details previous investigative results, describes the RFI/RI tasks, and site-specific investigative methodologies, project organization, and schedule.

The SAP (Volume II) focuses on the field investigation, analytical methods, and quality assurance and quality control (QA/QC) procedures and describes only those procedures that differ from the original RFI/RI workplan prepared by IT Corporation (1993). This IT RFI/RI workplan (1993), approved by both U.S. Environmental Protection Agency (USEPA) and the Florida Department of Environmental Protection (FDEP), was the workplan under which the RFI/RI was initially executed. This Supplemental RFI/RI Workplan fully adopts all of the procedures detailed in the approved workplan and provides specific details only in those areas or procedures that vary from or augment the original RFI/RI Workplan. Consequently, the SAP provides a project description, describes additional field methods for each site, and describes QA/QC requirements for sample collection and sample analysis that vary from the original RFI/RI workplan. At this time, a Health and Safety Plan (HASP) has not been included in the SAP. However, prior to initiation of the field program, a HASP will be prepared and will be provided to all field personnel working onsite.

The Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPP) have been incorporated into one comprehensive document (SAP) that can be used by teams in the field. This also avoids triplication of many sections that are common to the workplan, the FSP, and the QAPP (i.e., project purpose and description; base history; sampling methods, locations, and procedures; data quality objectives; laboratory analytical methods; data assessment and evaluation; and project organization and schedule).

Volumes I and II of the supplemental RFI/RI workplanning documents have been prepared by ABB Environmental Services, Inc. (ABB-ES), under the Comprehensive Long-Term Environmental Action, Navy (CLEAN) contract (Contract Task Order [CTO] No. 114). The format and scope of these documents are in compliance with the 1989 interim final RFI guidance documents and the Navy and Marine Corps Installation Restoration (IR) program manual of 1992.

A community relations plan, which is currently undergoing revision by ABB-ES, will be provided as needed. This plan describes procedures for public meetings, public comment, and methods of keeping the community informed.

1.2 PURPOSE AND REGULATORY SETTING. This draft Supplemental RFI/RI Workplan is being prepared for the Solid Waste Management Units (SWMUs) in accordance with the Hazardous and Solid Waste Amendment (HSWA) permit No. FL6-170-022-952, issued to NAS Key West by the USEPA on July 31, 1990, and effective until August 30, 2000. In addition, this Supplemental RFI/RI Workplan is being prepared for the IR sites in accordance with the National Oil and Hazardous Substances Contingency Plan (NCP) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act (SARA). This draft Supplemental RFI/RI workplan expands on the previous RFI/RI work that was conducted onsite by International Technology Corporation (IT) from 1991 through 1994.

NAS Key West is located in Key West, Florida, in southern Monroe County (Figure 1-1). An RCRA Facility Assessment (RFA) for NAS Key West was conducted by USEPA Region IV in 1989. The RFA identified seven SWMUs at NAS Key West. All seven of the SWMUs were recommended for further sampling. Subsequent to the RFA, eight additional sites have been identified at NAS Key West. Collectively, these sites include a total of nine SWMUs, and six IR sites at NAS Key West. The RCRA corrective action program for the nine SWMUs is being implemented in accordance

with RCRA and the NAS Key West HSWA permit. The remedial investigation and feasibility study (RI/FS) activities for the six IR sites are being implemented in accordance with the NCP and the CERCLA as amended by SARA. A Corrective Action Management Plan (CAMP) (April 1995) has been prepared to describe the strategy for implementing the RCRA Corrective Action Program at NAS Key West (ABB-ES, 1995).

The purpose of the NAS Key West CAMP was to outline the strategy for finalizing completion of the RFI/RI assessment to confirm and characterize the nature and extent of confirmed releases of hazardous substances to the environment at NAS Key West. The initial RFI/RI confirmed the presence of contamination at specific sites. Two sites, SWMU 6 (Wastewater Treatment Plant) and SWMU 8 (hazardous waste (HSW) building, are currently operating permitted sites and being investigated under the RFI/RI program. The supplemental RFI/RI will further characterize the nature and extent of confirmed contamination in accordance with the requirements of HSWA permit No. FL6-170-022-952. A total of 15 sites, identified at NAS Key West, 13 of which are shown in Figure 1-2, are described in Table 1-1.

1.3 SAMPLING AND ANALYTICAL PROGRAM SUMMARY. The supplemental RFI/RI sampling and analytical program at NAS Key West includes the collection of the following samples for laboratory analysis to further characterize the nature and extent of contamination: surface soil samples (composite samples to be collected from 0 to 12 inches below ground surface), surface water and sediment samples, subsurface soil samples (split-spoon samples to be collected at a minimum of 5-foot intervals from ground surface to soil boring completion depth), and groundwater samples (collected from monitoring wells). Details of the number and locations of samples, as well as laboratory analytical requirements, are provided in the following chapter.

One to two background soil samples per site (surface soil samples only) will be included in this supplemental RFI/RI sampling and analytical program. The analytical results from these background samples, along with existing applicable State and Federal regulatory standards (Table 1-2), will be used to evaluate the analytical results from NAS Key West.

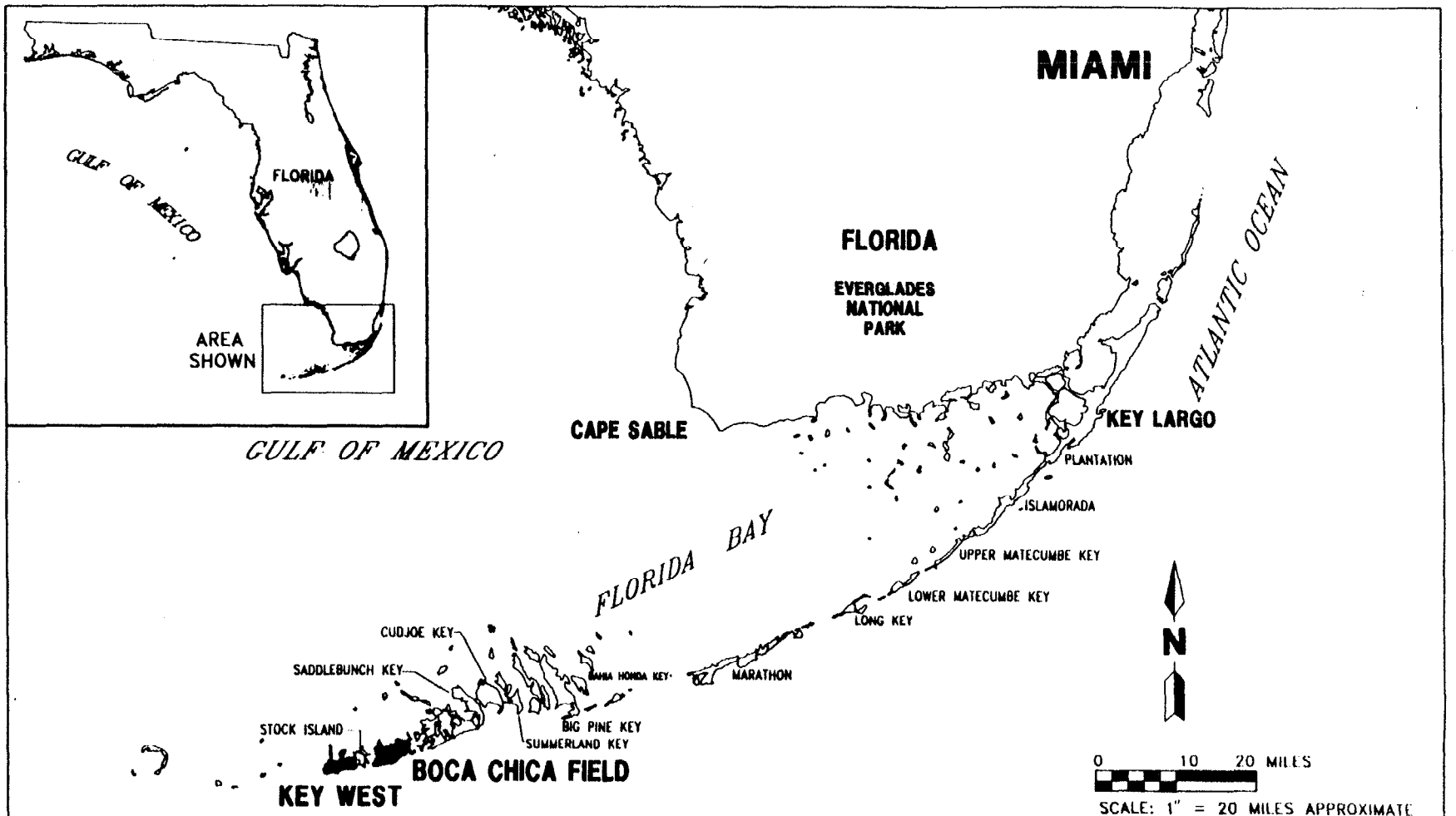

FIGURE 1-1
FACILITY LOCATION MAP
NAS KEY WEST

SUPPLEMENTAL RFI/RI
SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

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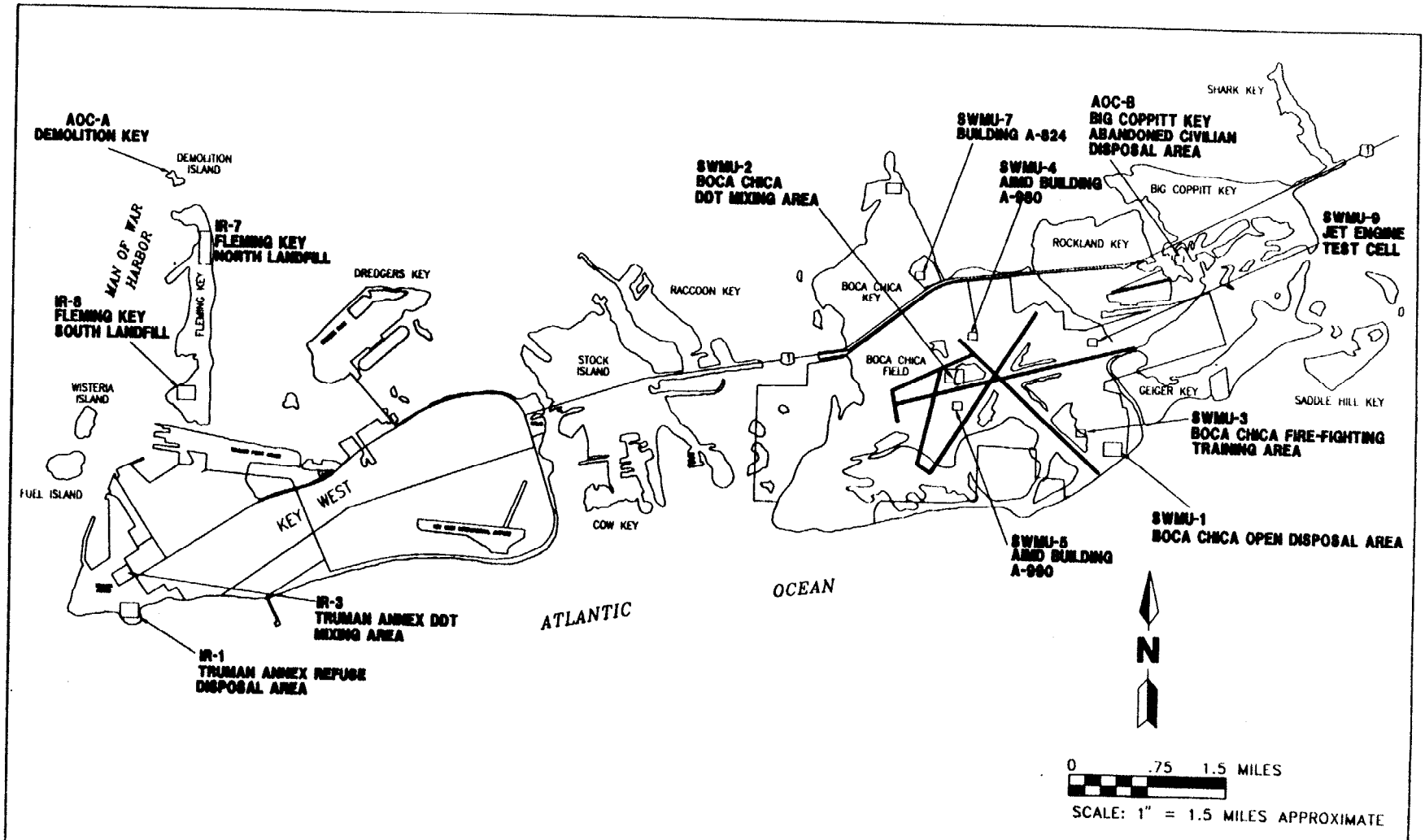

FIGURE 1-2
LOCATION OF SOLID WASTE MANAGEMENT UNITS, AREAS OF CONCERN, AND INSTALLATION RESTORATION SITES

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SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

Table 1-1
Solid Waste Management Units (SWMUs), Installation Restoration (IR) Sites, and Areas of Concern (AOC) Summary

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

Regulatory Program	Site No.	Description
RFI	SWMU 1	Boca Chica Open Disposal Area
RFI	SWMU 2	Boca Chica DDT Mixing Area
RFI	SWMU 3	Boca Chica Fire-Fighting Training Area
RFI	SWMU 4	Boca Chica AIMD Building A-980
RFI	SWMU 5	Boca Chica AIMD Building A-990
RFI	SWMU 6	Waste Water Treatment Plant*
RFI	SWMU 7	Boca Chica Building A-824
RFI	SWMU 8	HSW Storage Building[1]
RFI	SWMU 9	Jet Engine Test Cell (A-969)
RI	IR 1	Truman Annex Refuse Disposal Area
RI	IR 3	Truman Annex DDT Mixing Area
RI	IR 7	Fleming Key North Landfill
RI	IR 8	Fleming Key South Landfill
RI	AOC A	Demolition Key Open Disposal Area
RI	AOC B	Big Coppitt Key Abandoned Civilian Disposal Area

[1]The SWMUs are permitted, currently in operation, and not included in the Resource Conservation and Recovery Act (RCRA) Facility Investigation RFI/RI program.

Notes: RFI = Resource Conservation and Recovery Act (RCRA) Facility Investigation.
SWMUs = solid waste management units.
AIMD = Aircraft Intermediate Maintenance Department.
DDT = dichlorodiphenyltrichloroethane.
HSW = hazardous waste.
RI = Remedial Investigation.
IR = Installation Restoration.
AOC = area of concern.

Table 1-2
Applicable State and Federal Regulatory Standards

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

Regulations	Groundwater	Surface Water	Sediment	Soil
U.S. Environmental Protection Agency (USEPA), Safe Drinking Water Act (SDWA) National Primary Drinking Water Regulation per 40 Code of Federal Regulations (CFR) 141.	X			
USEPA, Draft "Water Quality Criteria Summary," Office of Science and Technology, Health and Ecological Criteria Division.		X		
USEPA, "Drinking Water Regulations and Health Advisories," Office of Water November, 1991.	X			
USEPA, "National Primary and Secondary Drinking Water Regulations: Synthetic Organic Chemicals; Final Rule," 57FR31777, July 17, 1992.	X			
USEPA, "Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper," 56FR26460, June 7, 1991.	X	X		
USEPA, "Soil Screening Guidance," December 1994.				X
USEPA Region IV "Waste Management Division Sediment Screening Value for Hazardous Waste Sites," January 1992.			X	
USEPA Region III "Risk Based Concentration," updated quarterly.	X			X
Florida Administrative Code, 62-550, "Safe Drinking Water Act," September 1994.	X			
Florida Administrative Code, 62-302, "Surface Water Quality Standards," amended January 1995.		X		
Florida "Soil Cleanup Goals for Military Sites," April 1995.				X
Florida "Approach to the Assessment of Sediment Quality in Florida Coastal Waters," November 1994.			X	
National Oceanic and Atmospheric Administration (NOAA) "The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program," March 1990.			X	

2.0 FIELD SAMPLING PLAN

The FSP consists of three elements: site management, RFI/RI data collection methods, and proposed site-specific investigative activities. Site management (Section 2.1) includes activities that will be conducted to support the data collection activities. These activities include mobilization, site access logistics, field documentation, and field monitoring instrumentation. In addition, methods to be used for decontamination and control and disposal of investigation-derived wastes (IDW) are typically included in this section. Many of the site management activities have been previously described in the original RFI/RI workplan prepared by IT (1993). Consequently, no further site management activities are outlined in this FSP. Prior to implementation, the contractor who will conduct the work should prepare an addenda to this Supplemental RFI/RI workplan outlining any additional site management activities that might be conducted.

Section 2.2 (RFI/RI Data Collection Methods) includes descriptions of the methods that will be used to gather the data required to meet the supplemental RFI/RI program objectives. These methods include surface and subsurface soil and groundwater sampling, biological field investigation, and laboratory analytical methods not described in the original RFI/RI workplan (IT, 1993).

The following section, Section 3.0, Proposed Site-Specific Investigative Activities, provides a summary by site of the proposed sampling program. The proposed types of samples, locations,. and analytical protocols have been developed based on a review of the final RFI/RI report prepared by IT (1994).

The technical approach to the program, including investigative rationale and details of proposed investigative methods, sampling, and analysis for each site, is provided below, in Section 3.0, and in the Supplemental RFI/RI Workplan (Volume I).

2.1 SITE MANAGEMENT. As discussed above, site management activities are outlined in the original RFI/RI workplan and are incorporated as the basis for this Supplemental RFI/RI program. Modifications, if any, to that workplan should be prepared as addendum by the contractor who will implement this supplemental RFI/RI program.

2.2 RFI AND RI DATA COLLECTION METHODS. The purpose of the supplemental RFI/RI program at NAS Key West is to further characterize the nature and extent of hazardous waste contamination at the SWMUs, IR sites, and AOCs that have been identified. This section provides a description of specific investigative technique to be used during the supplemental RFI/RI program for NAS Key West that vary from the original RFI/RI workplan prepared by IT (1993). Sufficient detail is included for a trained sampling team that has read the planning documents (RFI/RI Workplan, IT, 1994; Supplemental RFI/RI Workplan, ABB-ES, 1995) to execute the field investigation. Sampling locations for specific sites are illustrated in the figures accompanying the text where they are discussed on a site-specific basis.

This section describes additional or supplemental data collection, management, and assessment activities to be used during field activities for the NAS Key West supplemental RFI/RI program. The goal of the data-gathering process is to obtain site characterization data of known quality. These data are then used to identify contaminants that may pose an adverse risk to human health or the environment and, if necessary, corrective measures at the SWMUs, AOCs, and IR sites, as well as to supplement future environmental investigations at NAS Key West. The exploration and sampling program will include six subtasks:

- surface soil sampling,
- monitoring well installation,
- surface water and sediment sampling,
- groundwater sampling,
- hydrological investigations, and
- biological investigations.

2.2.1 Soil Sampling The purpose of the soil sampling is to assess whether a prior release of contaminants has occurred at the location of site. Background soil samples are collected to assess naturally occurring concentrations of potential contaminants in areas not known to be impacted by a release to the environment. Three types of soil sample collection methods are used during field investigative activities: hand auger, or TerraProbe℠, and split-spoon sampler. All of the methods used for soil sampling and sampling equipment decontamination are described in the original SAP (IT, 1993) with the exception of TerraProbe℠ sampling, which is outlined below

2.2.1.1 **TerraProbe℠ Soil Sampling** The TerraProbe℠ sampling system consists of a van equipped with a hydraulic ram. The hydraulic ram drives a threaded, 1-inch outside diameter (OD), hollow-steel rod assembly attached to an interchangeable stainless-steel sleeve that is driven to the desired sample collection depth. At the soil sample collection depth, the tip of the TerraProbe℠ sampler is retracted from a rigid leading position while hydraulic pressure is applied to advance the sample collection sleeve. As hydraulic pressure is applied the tip of the sampler retracts upward within the sleeve, and material enters the sample collection sleeve. Upon retrieval, the sample is extruded from the sample collection sleeve into a precleaned 8-ounce glass jar using a hydraulic piston. Each soil sample is then described and placed in a cooler refrigerated with ice for transport to the field screening laboratory. The results of the field screening analyses are used to select samples for laboratory confirmatory analysis. TerraProbe℠ borings are self healing and do not require grouting upon completion.

2.2.2 Monitoring Well Installation The purpose of the monitoring wells is to assess groundwater quality at each site. The monitoring wells are also used to characterize groundwater flow directions and horizontal and vertical hydraulic gradients. The rationale for well location and depth placement at each site is presented in Subsection 3.2 Site- and Media-Specific Sampling Activities

The method for installation of monitoring wells is described in the SAP prepared by IT (1993) and is not reiterated in this section.

2.2.3 Surface Water and Sediment Sampling The purpose of the surface water and sediment samples is to assess whether there was a prior release of contaminants from a given site. Background surface water and sediment samples are also collected to assess naturally occurring concentrations of potential contaminants in areas known not to be impacted by a release to the environment.

Surface water samples have the letters "SW" in the alphanumeric sample designation, whereas sediment samples are referred to by the letters "SD."

Details regarding surface water and sediment sample collection methods are described in the SAP prepared by IT (1993) and not duplicated here.

Surface water and sediment samples are collected in accordance with procedures discussed in the USEPA Region IV Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual (ECBSOPQAM) (1991).

Sampling equipment is thoroughly decontaminated in accordance with procedures presented in Appendix B of the USEPA Region IV ECBSOPQAM (USEPA, 1991) and the site-specific QAPP included in Chapter 4.0.

Surface water and sediment samples submitted for laboratory analysis are shipped by overnight delivery to the laboratory under chain-of-custody protocol for analyses of selected analytical compounds listed in Section 3.4 of this document.

2.2.4 Groundwater Sampling The purpose of the groundwater sampling program is to provide data to assess whether contaminants have been released from sites to the shallow surficial aquifer and, if present, assess the horizontal and vertical extent of contamination. Groundwater samples are collected for field screening and confirmatory laboratory analyses from TerraProbe℠ samples and for laboratory analyses from shallow monitoring wells.

Groundwater samples are collected in general accordance with procedures discussed below.

All sampling equipment is thoroughly decontaminated in accordance with procedures presented in Appendix B of the USEPA Region IV ECBSOPQAM (USEPA, 1991) and the

project-specific QAPP presented in Chapter 4.0 of this volume of the Supplemental RFI/RI Workplan.

Groundwater samples selected for laboratory analyses are shipped by overnight delivery to the laboratory under chain-of-custody protocol for analyses of selected analytical compounds listed in the following section.

The following subsections describe the methods that may be used to collect groundwater samples at TerraProbe℠ sampling locations and monitoring wells.

2.2.4.1 **TerraProbe℠ Groundwater Sampling** The TerraProbe℠ consists of a van equipped with a hydraulic ram. The hydraulic ram drives a threaded 1-inch OD hollow steel rod assembly attached to a 2-foot long stainless-steel perforated screen to the desired sample collection depth. Upon reaching the desired groundwater sampling depth a Teflon™ tube is inserted inside the hollow steel rod into the groundwater. A peristaltic pump is then used to collect the groundwater sample, which is placed in three precleaned 40 milliliter (mℓ) glass vials and/or one 1-liter (ℓ) glass sample bottle. Each groundwater sample is placed in a cooler refrigerated with ice for transport to the field screening laboratory. The results of the field screening analyses are used to select some of the samples for laboratory confirmatory analyses. A description of the analytical methods selected for field screening of groundwater samples is provided in the following section of this report.

2.2.4.2 **Monitoring Well Sampling** Monitoring wells will be purged by pumping at a slow rate to assure that representative groundwater samples are obtained. Dissolved oxygen, salinity, pH, specific conductance, temperature, and turbidity will be measured at 1-gallon intervals, and purging will continue until time-consecutive readings are within 5 percent and turbidity is below 5 nephelometric turbidity units (NTUs), if possible. In areas where the groundwater table is less than approximately 9 feet below land surface (bls), monitoring wells will be purged using a peristaltic pump at a "low flow" rate, less than or equal to 100 milliliters per minute (mℓ/min). In monitoring wells in which depth to groundwater exceeds 9 feet bls, monitoring wells will be purged using a stainless-steel electric submersible pump at similar purge rates.

Precleaned Teflon™ bailers and nylon cords dedicated to each monitoring well will be used to collect the groundwater samples for all analyses but metals. Samples for metals analysis will be collected from the peristaltic pump discharge point immediately after field parameter stabilization. The tubing or pump will then be removed and a bailer will be used to collect the remaining sample fractions. Sample bottles will be filled from the bailers in the order of volatile organic compound (VOCs), semivolatile organic compounds (SVOCs), pesticides and polychlorinated biphenyls (PCBs), and other inorganics, and cycanide. After the groundwater samples are placed in the sample containers, the containers will be placed in coolers refrigerated with ice for shipment to the laboratory for analyses.

2.2.5 Hydrogeologic Investigation The purposes of the hydrogeologic investigation at NAS Key West are to assess: fluctuation of the water table, groundwater flow directions, effects of tidal fluctuation, and hydraulic conductivity of the aquifer material to estimate the rates of groundwater flow for the surficial aquifer. The hydrogeologic investigation and methods to be used for conducting the investigation will be as discussed in the RFI/RI workplan prepared by IT (1993).

2.2.6 Biological Field Investigations Limited and qualitative biological field investigations have been completed by IT (1994) as part of the RFI/RI investigations. In June 1994, IT completed a preliminary ecological screening assessment for IR Sites 1, 3, 7, and 8; SWMUs 1, 2, 4, 5, and 7; and AOCs A and B, (IT, 1994). The primary objectives for these preliminary ecological screening assessments were to:

- review ecological data collected during previous studies and during site visits;
- summarize existing data into site-specific descriptions of ecological and stressor conditions;
- select ecological chemicals of potential concern (ECPCs);

- develop conceptual models to identify contaminants, ecological receptors, and exposure pathways at each site;

- screen ECPCs on the basis of their ability to induce adverse ecological effects; and

- identify data gaps, define additional data requirements, and recommend any additional investigations required to support a comprehensive baseline ecological risk assessment.

As part of the supplemental RFI/RI program, additional biological field investigations will be conducted to support the ecological risk evaluation activities at NAS Key West. The investigations will be conducted in a phased manner in order to minimize costs, permit technical flexibility depending upon the results of each individual phase of work, ensure that the needs of the baseline ecological risk assessment are incorporated into the field sampling program, and ensure that ecological activities provide the information required to help make risk-based site management decisions.

The following subsections briefly summarize some of the information from the RFI/RI report (IT, 1994) and discuss possible supplemental RFI/RI biological field investigation activities.

2.2.6.1 **Characterization of Habitats and Ecological Receptors** Based on information contained in the IT ecological assessments (1994), natural areas at NAS Key West can be classified into six major habitat types, as summarized below. In addition to these natural areas, many portions of NAS Key West have been developed and otherwise disturbed, and now contain exotic plant and animal species.

- **Mangrove Tidal Swamp** Mangrove tidal swamps are located around island peripheries and inland lagoons.

- **Salt Marshes** Salt marshes exist at the interface between land and marine water, and consist of communities of non-woody, salt-tolerant plants;.

- **Coastal Rock Barrens** Coastal rock barrens occur upland of salt marsh and mangrove vegetation, and are periodic wetlands, inundated by flood tides.

- **Coastal Berm** Coastal berms are low shell and marl ridges found along edges of shallow lagoons.

- **Beaches** Beaches of the Florida Keys are mostly small, scattered cove beaches. Coastal vegetation occurs in zones parallel to the coast, with patchy, low-growing grasses, vines, and herbaceous plants, with few trees or large shrubs.

- **Rockland Hammocks** Rockland hammocks represent the upland climax community for southern Florida.

Table 2-1 provides a general summary of the habitat types found at each NAS Key West site and was generated based on information contained in the RFI/RI (IT, 1994). Additional detail regarding habitat types and receptor species at each site can be found in Appendix K of the RFI/RI (IT, 1994).

Proposed Activities. Following additional detailed review of the final RFI/RI report (IT, 1994), a qualitative ecological survey will be conducted to confirm potential ecological receptors and exposure pathways at each SWMU and IR site at NAS Key West. Information from the qualitative survey will be incorporated into the baseline ecological risk assessments, and will be used to structure any required biological field and/or toxicological investigation(s).

Ecological receptors in the vicinity of each site which potentially could be exposed to contaminated environmental media will be identified during the qualitative ecological survey. Possible site-specific exposure pathways through which ecological receptors could be exposed to contaminated media will be evaluated, and any observed gross signs and symptoms of stress on biological receptors at the site will be recorded. The qualitative ecological survey will help further define any necessary surface soil, surface water, sediment, and toxicity testing sampling locations. The proposed survey will include a literature review and a field reconnaissance program, as described below.

Table 2-1
Summary of Habitat Types at NAS Key West RFI/RI Sites [1]

Supplemental RFI/RI Sampling and Analytical
Naval Air Station Key West
Key West, Florida

Site	Habitat Type
SWMU-1 - Boca Chica Open Disposal Area	Mangrove tidal swamp. Coastal berm community. Beach.
SWMU-2 - Boca Chica DDT Mixing Area	Sparse, patchy grasses cover site. Mangroves grow along nearby ditch.
SWMU-3 - Boca Chica Fire Fighting Training Area	Few patches of sparse grass. Mangrove swamp in nearby lagoon.
SWMU-4 - Boca Chica AIMD Building A-980	Minimal habitat at site. Nearby ditch contains mangroves.
SWMU-5 - Boca Chica AIMD Building A-990	Minimal habitat at site. Nearby ditch contains marsh and mangrove habitat.
SWMU-7 - Boca Chica Building A-824	Mowed grass at site. Nearby is pond and mangrove swamp.
IR Site 1 - Truman Annex Refuse Disposal Area	Areas of grass cover, devoid of native vegetation. Beach nearby.
IR Site 3 - Truman Annex DDT Mixing Area	Sparse weeds and grass surrounded by roads and buildings.
IR Site 7 - Fleming Key North Landfill	Stands of exotic pine. Mowed grass. Mangrove swamps along shorelines.
IR Site 8 - Fleming Key South Landfill	Stands of exotic pine. Mangrove swamp along shoreline.
AOC A - Demolition Key Open Disposal Area	Site is a dredge spoil island. Mixed native/exotic forest in interior. Edge is fringed with mangroves.
AOC B - Big Coppitt Key Abandoned Civilian Disposal Area	Site supports a mangrove community.

[1] Source: International Technology Corporation (1994).

Notes: NAS = Naval Air Station.
RFI/RI = Resource Conservation and Recovery Act (RCRA) Facility Investigation and Remedial Investigation.
SWMU = Solid Waste Management Unit.
DDT = dichlorodiphenyltrichloroethane.
IR = Installation Restoration.
AOC = area of concern.

A limited literature review will be conducted to evaluate the major floral and faunal receptors and ecological community types likely to be encountered at NAS Key West in general, as well as at the specific sites. Historic information on the biota of the facility will be retrieved from the final RFI/RI report (IT, 1994). Existing information sources related to flora, fauna, and ecological communities in the area will be reviewed, and standard taxonomic sources and references will be identified.

Following the information review, a limited field reconnaissance program will be initiated to characterize the aquatic, wetland, and terrestrial habitats at and in the vicinity of each site. This field program will involve a site walk-over by a wetland-aquatic specialist and a terrestrial ecologist who will identify and confirm major vegetative cover types and dominant taxa at the site.

During the initial walkover, sites without major ecological exposure pathways will be identified. These sites will include sites that are paved, covered with buildings, or otherwise provide minimal ecological habitat. Unless future exposure pathways are identified at these sites (i.e., future groundwater discharge to surface water bodies), no additional ecological field characterization will be conducted at sites without complete ecological exposure pathways.

At those sites with ecological habitat (i.e., those sites with potentially complete ecological exposure pathways), qualitative belt and/or line transect surveys of vegetative community types will be conducted; each identified cover type will be characterized through the use of a minimum of three transects per ecological cover type. Observations of wildlife use of the site will be collected during the qualitative vegetative survey.

At each site with complete ecological exposure pathways, limited habitat mapping will be completed. All cover types, including wetlands, will be identified on not-surveyed-to-scale ecological cover type maps for each site. Maps will include known or suspected locations of rare and endangered species and other critical habitats. Standard cover type descriptions such as those provided by the Florida Natural Areas Inventory (FNAI) will be used to describe cover types.

Observed evidence of ecological stress in plant species, such as yellowing, wilting, or insect infestations, and animal species (disease, parasitism, death, and reduced diversity or abundance) will be noted. Any State or Federally listed rare or endangered species identified during the survey will be documented.

2.2.6.2 **Rare, Endangered, and Threatened Species** The Florida Keys provide habitat for a variety of sensitive species. Several of these species are likely or known to reside at NAS Key West. Rare, endangered, and threatened species at NAS Key West sites have been identified in the RFI/RI report (IT, 1994) (Table 2-2).

Trustee agencies such as the U.S. Fish and Wildlife Service, the Florida Department of Natural Resources, NAS Key West Environmental Management Department, and the Florida Natural Heritage Program will be contacted for information regarding State or Federally listed endangered or threatened species at NAS Key West. The recently completed FNAI/Nature Conservancy NAS Key West Ecological Inventory will be reviewed for site-specific information regarding rare and endangered species and critical habitats at NAS Key West.

2.2.6.3 **Biological and Toxicological Sampling** No biological sampling at NAS Key West sites has been completed as part of the RFI/RI process to date. Based on results of contaminant screening in the RFI/RI report, biological sampling and/or toxicity testing is tentatively proposed at NAS Key West in order to obtain additional information regarding the toxicity of contaminants to ecological receptors at several RI/RFI sites. Typical objectives for biological sampling include the following:

- measurement of the toxicity of contaminated media (soil, sediments, or water) to laboratory test organisms,
- measurement of contaminant exposures to ecological receptors by laboratory tissue analysis, and
- measurement of impacts to community or individual organisms resulting from exposure to contamination.

The results of biological sampling will be used in the ecological risk assessment in the supplemental RFI/RI report.

This section presents a conceptual overview of biological and toxicological sampling that may be necessary at NAS Key West. Additional detail regarding site-specific biological sampling activities can be found in Subsection 2.3.

Table 2-2
Endangered, Threatened, or Special Status Species at RFI/RI Study Sites [1]

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

Species	Scientific Name	Regulatory Status [2]	Site [3]									
			IR-1	IR-3	IR-7	IR-8	SWMU-1	SWMU-2	SWMU-3	SWMU-4	SWMU-5	SWMU-7
FISH												
Key silverside	*Menidia conchorum*	F					?	?	?	?	?	?
Mangrove rivulus	*Rivulus marmoratus*	S			?	?	?	?	?	?	?	?
REPTILES												
Eastern indigo snake	*Drymarchon corais couperi*	T, F					?	?	?	?	?	?
Florida Keys mole skink	*Eumeces egrigius egrigius*	C, S					?				?	
Florida brown snake	*Storeria dekayi victa*	F										
Red rat snake	*Elaphe guttata guttata*	S					?	?	?	?	?	?
American crocodile	*Crocodylus acutus*	E, F					?					
Atlantic loggerhead turtle	*Caretta caretta caretta*	T, F	2,4				?					
Atlantic green turtle	*Chelonia mydas mydas*	E, F	?				?					
Atlantic hawksbill turtle	*Eretmochelys imbricata imbricata*	E, F	?				?					
INVERTEBRATES												
Miami blue butterfly	*Hemiargus thomasi bethune-bakeri*	C					?				?	

See notes at end of table.

Table 2-2 (Continued)
Endangered, Threatened, or Special Status Species at RFI/RI Study Sites [1]

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

Species	Scientific Name	Regulatory Status [2]	Site [3]									
			IR-1	IR-3	IR-7	IR-8	SWMU-1	SWMU-2	SWMU-3	SWMU-4	SWMU-5	SWMU-7
MAMMALS												
Lower Keys marsh rabbit	*Sylvilagus palustris hefneri*	E, F					1,3	2	1,3	?	2,4	2,4
Lower Keys Silver Rice Rat	*Oryzomys palustris natator*	E, F					1	?	1	?	2	2
BIRDS												
White-crowned pigeon	*Columba leucocephala*	C, F									2	
Little blue heron	*Egretta caerulea*	S			2	2	1	2	2	2	2	2
Reddish egret	*Egretta rufescens*	C, S			2	2	1	2	2	2	2	2
Snowy egret	*Egretta thula*	S			2	2	1	2	2	2	2	2
Tricolored heron (Louisiana heron)	*Egretta tricolor*	S			2	2	1	2	2	2	2	2
Arctic peregrine falcon	*Falco peregrinus tundrius*	T, F									?	
Bald eagle	*Haliaeetus leucocephalus*	E, F			?	?	1	2	2	2	2	2
Osprey	*Pandion haliaetus*	S		2,4	2	?	1,4	2	2	2	2	2
Brown pelican	*Pelecanus occidentalis*	S					1					
Least tern	*Sterna antillarum*	F	2,4	2,4				?	1,3	1,3		
Roseate tern	*Sterna dougallii*	T, F	2,4	2,4				?	1,3	2,4		
Bachman's warbler	*Vermivora bachmanii*	E, F					?				?	

See notes at end of table.

Table 2-2 (Continued)
Endangered, Threatened, or Special Status Species at RFI/RI Study Sites [1]

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

Species	Scientific Name	Regulatory Status [2]	Site [3]									
			IR-1	IR-3	IR-7	IR-8	SWMU-1	SWMU-2	SWMU-3	SWMU-4	SWMU-5	SWMU-7
PLANTS												
Golden leather fern	*Acrostichum aureum*	F						?				
Blodgett's wild mercury	*Argythamnia blodgetti*	C, F									?	
Little strongbark	*Bourreria cassinifolia*	F					?				?	
Porter's broom spurge	*Chamaesyce porteriana v. scoparia*	C, F					?				?	
Silver palm	*Coccothrinax argentata*	S									?	
Geiger tree	*Cordia sebestena*	F									?	
Wild cotton	*Gossypium hirsutum*	F					?					
Manchineel	*Hippomane mancinella*	F									?	
Bay cedar	*Suriana maritima*	F			2,4	2,4					?	
Inkberry	*Scaevola plumieri*	F					2,4					
Joewood	*Jacqwinia keyensis*	F			2,4						?	
West Indies mahogany	*Swietenia mahogoni*	F									?	
Brittle thatch palm	*Thrinax microcarpa*	S									?	
Florida thatch palm	*Thrinax floridana*	S									?	
Twisted airplant	*Tillandsia flexuosa*	F									?	

See notes at end of table.

Table 2-2 (Continued)
Endangered, Threatened, or Special Status Species at RFI/RI Study Sites [1]

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

Species	Scientific Name	Regulatory Status [2]	Site [3]									
			IR-1	IR-3	IR-7	IR-8	SWMU-1	SWMU-2	SWMU-3	SWMU-4	SWMU-5	SWMU-7
PLANTS												
Sea lavender	*Mallotonia gnaphalodes*	F					?	?	?	?	?	?

[1] Source: International Technology Corporation (1994).

[2] Regulatory Status codes:
E = Federal endangered species.
T = Federal threatened species.
P = Federal proposed to list species.
C = Federal candidate species.
S = Florida state species of special concern.
F = Florida state endangered or threatened species.

[3] Categories:
1 = suitable habitat present within site boundaries.
2 = suitable habitat within 200 meters of site boundaries.
3 = confirmed species present within site boundaries.
4 = confirmed species present within 200 meters of site boundaries.
? = possible or unconfirmed presence or sighting within or near site boundaries.

Toxicity Testing Laboratory testing will be conducted at NAS Key West to measure the toxicity of contaminants in soil, sediment, surface water, or groundwater to ecological receptors. Although the results of the toxicity tests will be used to predict the effects that might occur to aquatic and terrestrial ecological receptors *in situ*, it is important to recognize that: (1) exposure to contaminated media might be avoided by mobile organisms and (2) toxicity to organisms *in situ* may be dependent upon physical characteristics and equilibrium partitioning that are not replicable under laboratory conditions (American Society for Testing and Materials [ASTM], 1993). Table 2-3 summarizes the species recommended for toxicity testing at NAS Key West.

Terrestrial Laboratory Toxicity Testing. Laboratory toxicity tests that may be completed for NAS Key West surface soil samples include a lettuce seed germination test and a 14-day earthworm survival test (USEPA, 1988a). The objective of the screening level toxicity tests will be to obtain laboratory data to evaluate adverse effects associated with exposure of the earthworm species (*Eisenia foetida*) and lettuce seed (*Lactuca sativa*) to NAS Key West surface soil. The collection of soil samples for analytical chemical analysis and toxicity testing will be conducted concurrently, allowing for evaluation of chemical, physical, and biological stressors in the ecological risk assessment. Data from these toxicity tests will be used to evaluate ecological risks to terrestrial plant and invertebrate receptors.

When necessary, 14-day sub-acute earthworm studies will be conducted to provide a screening level spatial distribution of invertebrate toxicity. Earthworm mortality, growth, and health assessments will be conducted on test days 0, 7, and 14. At test termination, mortality and percent weight loss or gain data for earthworms exposed to each soil sample will be determined. Statistical analyses to assess the significance of any differences in survival and growth between the reference sample and/or negative control soil sample and the site soil samples will be performed.

When necessary, lettuce seed germination studies (120-hour) may be conducted to provide a screening level spatial distribution of contaminant toxicity to plants at selected sites. At test termination, the percent germination for lettuce

Table 2-3
Candidate Species for Toxicity Testing at NAS Key West

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

Common name	Species	Environmental Medium
Near Coastal (salinity > 25 ppt)		
Amphipod crustacean	*Ampelisca abdita*	Bulk sediment
Mysid shrimp	*Mysidopsis* sp.	Bulk sediment
Silversides	*Menidia* sp.	Water (ground and surface)
Mysid shrimp	*Mysidopsis* sp.	Water (ground and surface)
Oyster	*Crassostrea* sp.	Water (ground and surface)
Sea urchin	*Strongylocentrotus* sp.	Water (ground and surface)
Estuarine (salinity 1-25 ppt)		
Amphipod crustacean	*Hyalella azteca*	Bulk sediment
Silversides	*Menidia* sp.	Water (ground and surface)
Terrestrial		
Earthworm	*Eisenia foetida*	Surface soil
Lettuce seed	*Lactuca sativa*	Surface soil

Notes: ppt = parts per trillion.
sp. = spanish.

seeds will be determined for each sample and the control(s). Statistical analyses to assess the significance of any differences in survival between the reference sample and/or negative control soil sample and the site soil samples will be performed.

Depending on the results of the screening level surface soil toxicity tests, a limited dilution series toxicity study may be conducted using one or two surface soil samples per site from the original collected samples. The dilution experiments will be used to calculate no observed effect concentrations (NOECs) and lowest observed effect concentrations (LOECs) (and if necessary the median lethal concentration [LC_{50}]) to the test species evaluated in the investigation (i.e., *L. sativa* and *E. foetida*). The dilution series will employ surface soil from selected stations diluted with a range of reference surface soil. Potential surface soil dilutions include 100 percent, 50 percent, 25 percent , and 12.5 percent; however, the lower range of dilutions may not be required if NOECs and LOECs are determined at the higher end of the range. The results of the surface soil dilution series will be used to help establish ecological remedial goals for NAS Key West surface soil.

Aquatic Laboratory Toxicity Testing. In order to determine effects of contaminated water and sediments from selected sites at NAS Key West on aquatic organisms, controlled whole sediment, surface water, and groundwater laboratory toxicity tests may be recommended. Different test species and protocols are recommended for areas with high salinity (= Near Coastal) and for brackish areas with lower salinity (= Estuarine).

Near Coastal (Salinity > 25 parts per thousand).

Bulk Sediment Toxicity Tests. The primary objective of the bulk sediment toxicity tests will be to obtain laboratory data to evaluate the toxicity associated with exposure to contaminated sediments collected from various sites in NAS Key West. Two species of benthic organisms have been proposed for use in the Near Coastal sediment toxicity tests, an amphipod crustacean (*Ampelisca abdita*) and a mysid shrimp (*Mysidopsis* sp.).

Short-term, 10-day static sediment toxicity tests may be conducted on both the amphipod crustacean and the mysid shrimp (with whole sediment samples and no dilutions) to provide screening-level spatial distribution of sediment toxicity. The ASTM *Standards on Aquatic Toxicology and Hazard Evaluation* (E 1367-92; ASTM, 1993) shall be used as the laboratory standard. Specific test protocols for the amphipod crustacean (10-day growth and survival) and mysid shrimp (10-day growth and survival) will be followed. Sediment samples for toxicity testing and analysis will be stored and handled according to protocols in the ASTM *Standard Guide for the Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing* (E 1391-90, ASTM, 1993). Sediment sampling for analytical chemistry analysis and toxicity testing will be conducted concurrently, allowing for evaluation of chemical, biological, and physical stressors in the baseline ecological risk assessment.

Water Phase Toxicity Test. Near coastal water phase toxicity tests may be used to determine the affects of short-term exposure of benthic and free-swimming organisms to contaminated surface and/or groundwater from various sites at NAS Key West. Two species of benthic organisms and two species of free swimming organisms have been proposed for use: silverside (*Menidia* sp.), the mysid shrimp (*Mysidopsis* sp.), oyster (*Crassostrea* sp.), and sea urchin (*Strongylocentrotus* sp.).

Short-term, 96-hour static water phase toxicity tests will be conducted on the both the benthic and free swimming organisms to provide screening-level information regarding water toxicity. Undiluted water collected from various sites in NAS Key West will be utilized for the water phase bioassay. The ASTM *Standards on Aquatic Toxicology and Hazard Evaluation* (E 729-88; ASTM, 1993) shall be used as the laboratory standard. Water samples for analytical chemistry analysis and toxicity testing shall be collected concurrently for evaluation of chemical and physical stressors in the baseline ecological risk assessment.

Estuarine (Salinity 1-25 parts per thousand).

Bulk Sediment Bioassay. Any required sediment toxicity testing in estuarine areas will be conducted in similar manner to that described for near coastal areas. One benthic species, *Hyalella azteca* (an amphipod crustacean) will be used for estuarine sediment toxicity testing. This species has the ability to survive at a lower salinity than *Ampelisca abdita*, the near shore test amphipod. Study duration and endpoint measurement will be as described for *Ampelisca*.

Water Phase Bioassay. Any required estuarine water phase toxicity testing will be conducted in a similar manner to the near coastal toxicity testing. Tests will be conducted at a lower salinity and will use only one species, the silverside (*Menidia* sp.). The estuarine toxicity test study duration and endpoint measurement will be as described for near coastal areas.

Tissue Analysis Analyses of contaminant concentrations in plant and/or animal tissue provide a direct measurement of contaminant exposure for ecological receptors. In the absence of measurements, contaminant exposures for ecological receptors will be estimated based on literature-reported bioconcentration or bioaccumulation factors.

To determine bioaccumulation of pesticides or inorganic chemicals by terrestrial organisms, earthworms may be reared on NAS Key West surface soil for an additional 14 days beyond the 14-day toxicity test described above. Following the 28-day study duration, earthworms from these samples will be frozen and shipped to an analytical laboratory for chemical analysis. These samples will be handled and conveyed to the analytical laboratory in accordance with specified chain-of-custody procedures.

If bioaccumulation or bioconcentration of contamination into aquatic biota is a concern at RFI/RI sites at NAS Key West, site-specific sampling of finfish and/or shellfish may be conducted. As required, site-specific SAPs will be prepared whenever bioaccumulation or bioconcentration data is collected.

3.0 SITE SPECIFIC RFI AND RI SAMPLING PROGRAM

This supplemental RFI/RI sampling program scope was developed to provide, on a site-specific basis, sufficient data to satisfy program requirements and base appropriate action (remediation, no further action, etc.). In general, the rationale for specific sampling tasks includes addressing a need to provide more information on which appropriate risk assessment criteria can be developed. For specific sites, additional information may required to further characterize the nature and extent of contamination, or to assess the success of an Interim Removal Action (IRA). The rationale for sampling, on a site-by-site basis, is discussed below. Considered in the development of the sampling scope for this supplemental program is that IRAs and associated sampling work are being performed by others and their data can be used for RFI/RI site characterization purposes. However, until the IRA at the designated sites are complete, it will be difficult to assign clear responsibilities for either the RFI/RI contractor or the IRA contractor. The rationale for sampling as part of this supplemental RFI/RI program will be based solely on data needs and related activities that extend outside the areas of removal verification sampling or monitoring well replacement as a result of removal actions.

3.1 BACKGROUND CHARACTERIZATION Background samples were collected from several locations in NAS Key West as described in the RFI/RI workplan (IT, 1993). Background samples were collected from groundwater, surface water, soil, and sediment media. These samples were analyzed for the same parameters as the site characterization samples collected during the RFI/RI. The analytical results of the background samples were evaluated to determine if the samples were representative of background conditions.

After determining which samples were representative of background conditions, IT determined that the data set was too small to statistically represent site-specific background conditions and, therefore, the samples were grouped by media to provide a data set that was representative of a regional condition (IT, 1994). Based on a review of these results and the soil types that are characteristic of sites at Truman Annex and Boca Chica Key, it has been determined that two different data sets must be defined for the IR sites located at Truman Annex and the SWMUs and AOCs located at Boca Chica Key.

The results from the samples collected during the RFI/RI (IT, 1994) are discussed below along with an outline of the investigative activities that are being proposed for characterization of background at both the IR sites and SWMUs.

3.1.1 Boca Chica Key Sites During the RFI/RI conducted by IT and detailed in the RFI/RI Report (IT, 1994), 25 background samples were collected from surface soil, sediment, surface water, and groundwater at five sites. Out of 25 samples collected, only 9 of the samples (surface soil, surface water, and groundwater) were retained. The analytical results suggested that some of the background samples were contaminated with organic compounds or high concentrations of inorganics when compared to other site samples.

Based on the analytical results and the need for a separate background data set for Boca Chica Key sites, additional background samples (surface soil, surface water, sediment, and groundwater) are proposed for this investigation and are discussed below by media.

Surface Soil. The surface soil at Boca Chica Key is classified as rockland; compacted made land; and coastal beach, dunes, and water (IT, 1994). Background surface soil samples (0-1 foot bls) are proposed for collection at each SWMU and AOC and at random locations facility-wide in each of the three soil types. The specific sampling locations and sampling rationale are discussed in the following subsections for each site. In general, soil samples are proposed to be collected at locations hydraulically upgradient from the sites.

In addition to the proposed site-specific background surface soil samples, background surface soil samples will be collected at nine locations throughout the Boca Chica Facility in each of the three soil types, three per soil type. The actual locations will be determined in the field based on review of site aerial photos and historical maps. Samples will be collected at locations that are not likely to have been subject to extensive human activity and previous development.

Subsurface Soil. No subsurface soil background samples are proposed due to the shallow depths of surface soil and the presence of rock at or near the land surface.

Surface Water and Sediments. Since none of the sites are located adjacent to open marine waters, no site-specific background surface water and sediment samples are proposed. However, up to three facility wide background sediment and surface water samples are proposed for collection around Boca Chica Key. Their locations will be confirmed in the field during the investigation.

Groundwater. Hydraulically upgradient monitoring wells are proposed at each of the following SWMUs: 1, 2, 3, 4, 5, 7, and 9.

Analytical Protocols. All of the background samples collected at Boca Chica Key will be analyzed for Appendix IX organics, target analytes list (TAL), metals, and cyanide

3.1.2 Truman Annex Sites. During the RFI/RI conducted by IT Corporation and detailed in the RFI/RI Report (IT, 1994), 15 background samples were collected from surface soil, sediment, surface water, and groundwater at 4 sites. Out of a total of 15 samples collected from all media, only 5 of the samples (sediment, surface water, and groundwater) were retained. The analytical results suggested that some of the background samples contained organic compounds or high concentrations of inorganics when compared to other site samples.

Based on the analytical results, additional background samples from surface soil, surface water, sediment, and groundwater are proposed for this investigation and are discussed below.

Surface Soil. The surface soil at Truman Annex is classified as shallow fill for the entire facility. Background surface soil samples (0-1 foot bls) are proposed for collection at each site and at random locations facility-wide. The specific sampling locations and sampling rationale are discussed in the following subsection for each site. In general, surface soil samples are to be collected at locations hydraulically upgradient from the sites.

In addition to the proposed site-specific background surface soil samples, facility wide background surface soil samples will be collected at five locations. These actual locations will be determined in the field based on a review of site aerial photos and historical maps. Samples will be collected at

locations which are not likely to have been subject to extensive human activity and previous development.

Subsurface Soil. No subsurface soil background samples are proposed due to the shallow depths of surface soil and the presence of rock at or near the land surface.

Surface Water and Sediments. Since some of the sites (IR-1; IR-7; IR-8, and AOCA) are adjacent to open marine waters. Up to five representative background sediment and surface water samples are proposed. Their locations will be confirmed in the field during the investigation.

Groundwater. Permanent upgradient monitoring wells are proposed for two sites at Truman Annex (IR-1 and IR-2). Temporary upgradient monitoring wells are proposed at AOCs A and B. IR-7 and IR-8 already have upgradient monitoring wells which will be resampled during the supplemental RFI/RI field program.

Analytical Protocols. All of the background samples collected at Truman Annex will be analyzed for the Appendix IX organics, TAL metals, and cyanide.

3.2 SITE- AND MEDIA-SPECIFIC SAMPLING ACTIVITIES.

3.2.1 SWMU 1, Boca Chica Open Disposal Area The supplemental field activities at SWMU 1 will include surface soil sampling to characterize background conditions; surface water/sediment sampling to further delineate contaminants detected in earlier activities; and monitoring well installation and groundwater sampling to characterize background and confirm previously detected target analytes. Because the site adjoins wetland areas and previous work has sufficiently characterized surface soil within the disposal area, soil sampling will be restricted to non-inundated areas offsite for use in background comparisons.

Surface water and sediment samples will be collected in areas along the disposal area perimeter where the extent of contamination has not been sufficiently delineated, particularly within the mangroves located to the south-southeast of the main disposal area. Groundwater sampling will be conducted to characterize

background (hydraulically upgradient) groundwater chemistry and areas hydraulically downgradient as necessary, particularly with respect to lead, mercury, cyanide, vinyl chloride, and chrysene. A monitoring well will be installed hydraulically upgradient from the site to characterize background groundwater quality. As many as three additional monitoring wells may need to be installed to replace existing wells that are likely to be destroyed by IRAs that are to be performed prior to the execution of this workplan scope.

The number of samples and target analytes proposed include:

Surface soil - three background locations west of the road (Figure 3-1); analysis for Appendix IX organics (VOCs, SVOCs, pesticide and PCBs), TAL metals, and cyanide.

Surface water and sediment - four locations within the mangrove swamp adjoining the open disposal area to the southeast and south (Figure 3-2); analysis for Appendix IX organics, TAL metals and cyanide.

Groundwater monitoring wells - installation of one upgradient and three hydraulically downgradient monitoring wells to replace wells destroyed by IRA (Figure 3-3).

Groundwater sampling - sample groundwater at four locations (Figure 3-3); analysis for Appendix IX VOCs, SVOCs, TAL metals, and cyanide.

3.2.2 SWMU 2, Boca Chica DDT Mixing Area The primary objectives of supplemental sampling activities at SWMU 2 are to further characterize background surface soil in the immediate area surrounding the site, determine the extent to which pesticides have migrated within the canal system that adjoins the site; and delineate the area of groundwater contamination with respect to contaminants that were detected in previous work (IT, 1994). Existing surface soil data suggest that the area of pesticide residue has not been defined. Therefore, the scope of this workplan includes additional sampling in outlying areas to further assess the areal extent of pesticides. It should be noted that the data may suggest that the existing outlying samples reflect background. Sediment and surface water samples will be collected for similar purposes, to assess the extent

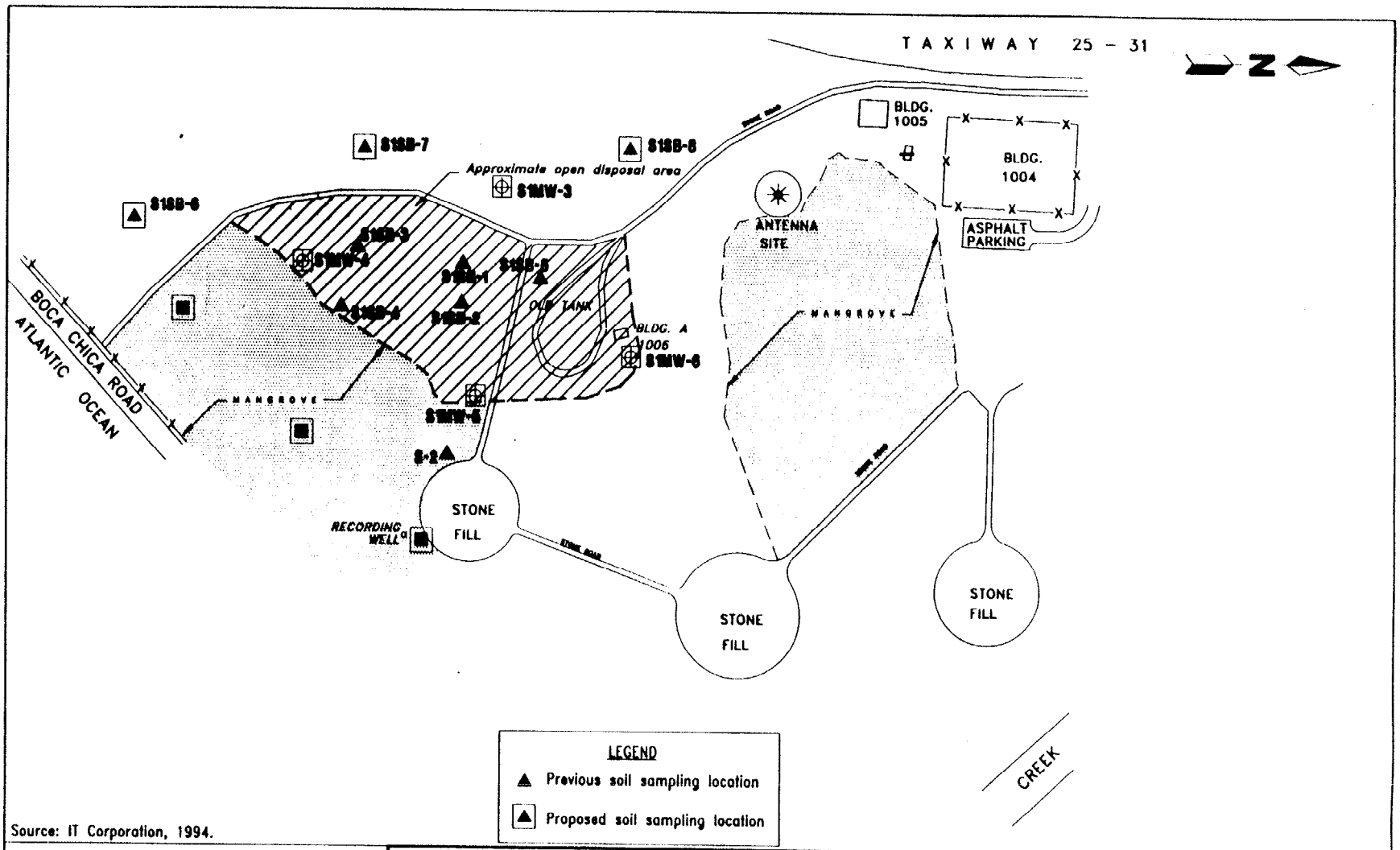


FIGURE 3-1
PREVIOUS AND PROPOSED SOIL SAMPLING LOCATIONS SWMU NO. 1, BOCA CHICA OPEN DISPOSAL AREA

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

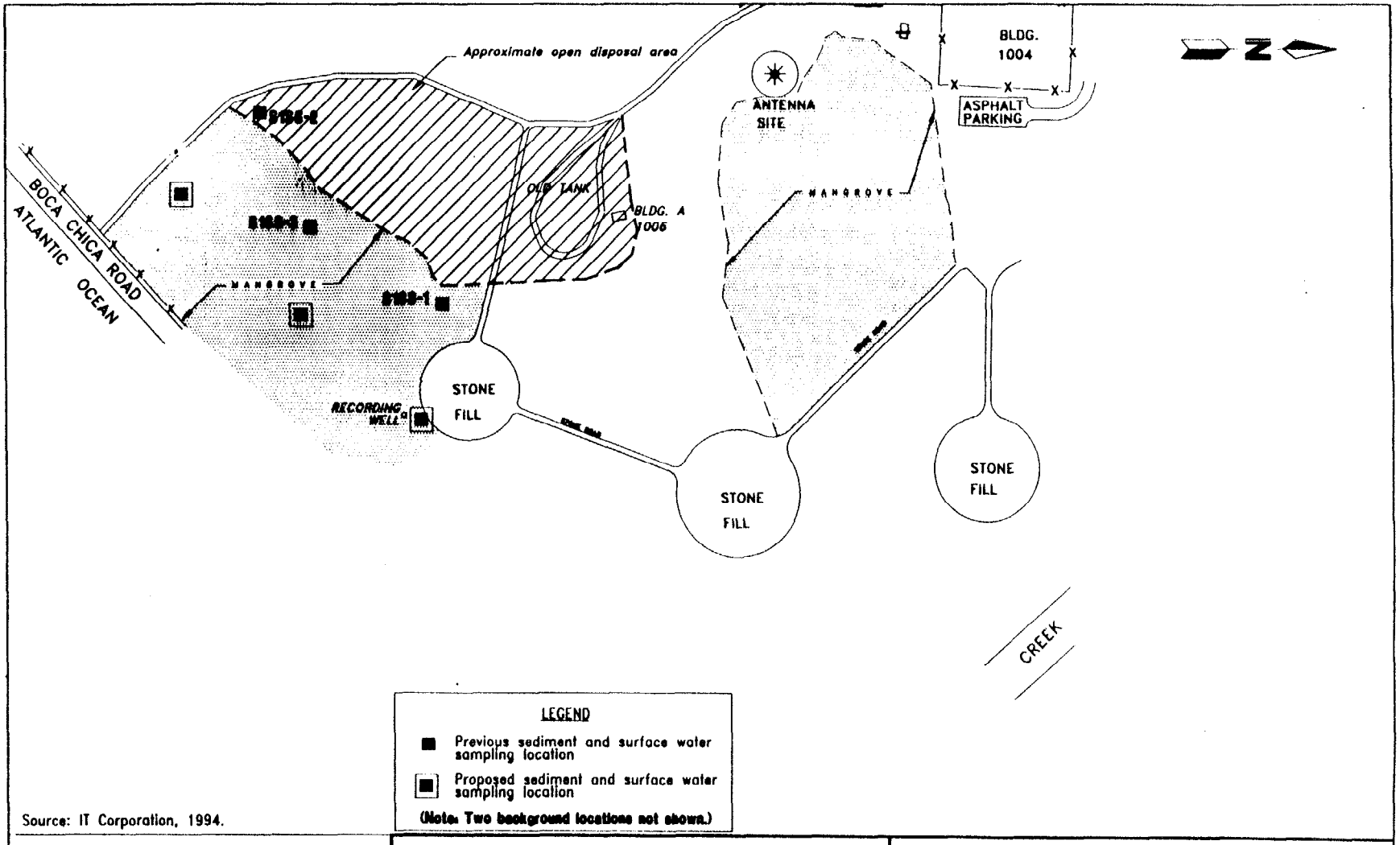
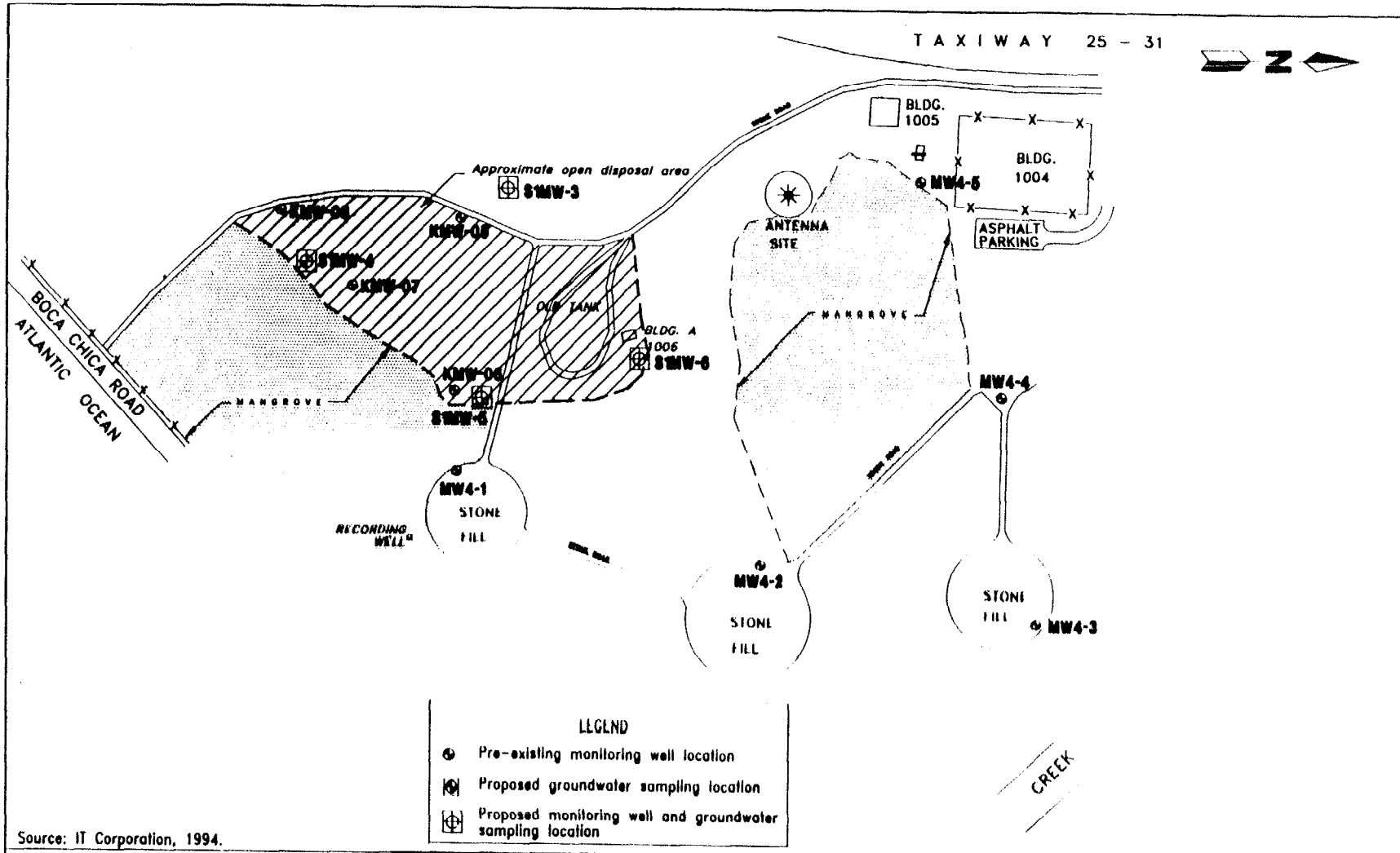


FIGURE 3-2
PREVIOUS AND PROPOSED SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS
SWMU NO. 1, BOCA CHICA
OPEN DISPOSAL AREA

SUPPLEMENTAL RFI/RI
SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



Source: IT Corporation, 1994.

0 125 250

SCALE: 1" = 250'

FIGURE 3-3
PRE-EXISTING AND PROPOSED MONITORING WELL AND GROUNDWATER SAMPLING LOCATIONS
SWMU NO. 1, BOCA CHICA OPEN DISPOSAL AREA

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

pesticides have migrated within the ditch where it continues offsite. This may also lead to the discovery of anthropogenic pesticide concentrations in sediment. The distribution of pesticides within groundwater at the site was not completely delineated in previous work (IT, 1994). The scope of this workplan includes installation and sampling of additional monitoring wells that will be installed at locations to supplement existing data and complete the delineation.

The number of sample and target analytes proposed include:

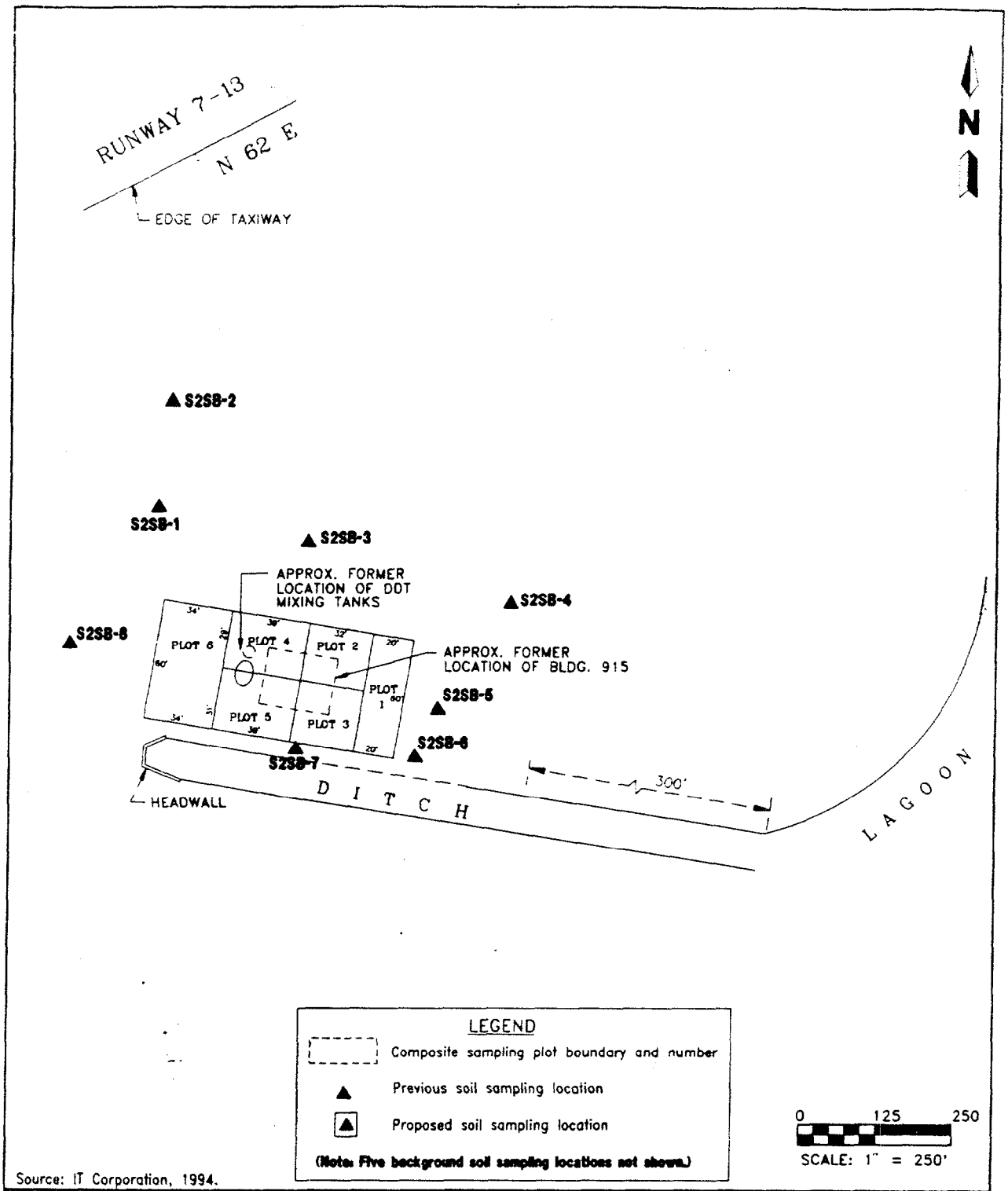
Surface soil - five locations along periphery of site (Figure 3-4); analysis for Appendix IX pesticides, TAL metals, and cyanide.

Surface water and sediment - four locations along canal downgradient from site (Figure 3-5); locations to be determined in field; analysis for Appendix IX pesticides, TAL metals, and cyanide;.

Groundwater monitoring wells - installation of one hydraulically upgradient and three hydraulically downgradient monitoring wells (Figure 3-6).

Groundwater sampling - sample groundwater at five locations (Figure 3-6), including four new monitoring wells and existing well MW-5-1; analysis Appendix IX pesticides, TAL metals, and cyanide.

3.2.3 **SWMU 3, Boca Chica Fire-Fighting Training Area** Supplemental RFI/RI activities at SWMU 3 will include sampling of sediment and surface water and monitoring well installation and groundwater sampling. Because concentrations of lead in sediments collected in the original RFI/RI program from the lagoon shoreline may be attributable to other sources, this will include collection of sediment samples at locations within the mangrove fringe between the site and the lagoon. Data from the new locations will be used to assess whether the lead is attributable to the site or other potential sources. Monitoring well installation and groundwater sampling are proposed to delineate the extent of vinyl chloride previously detected in the groundwater samples.



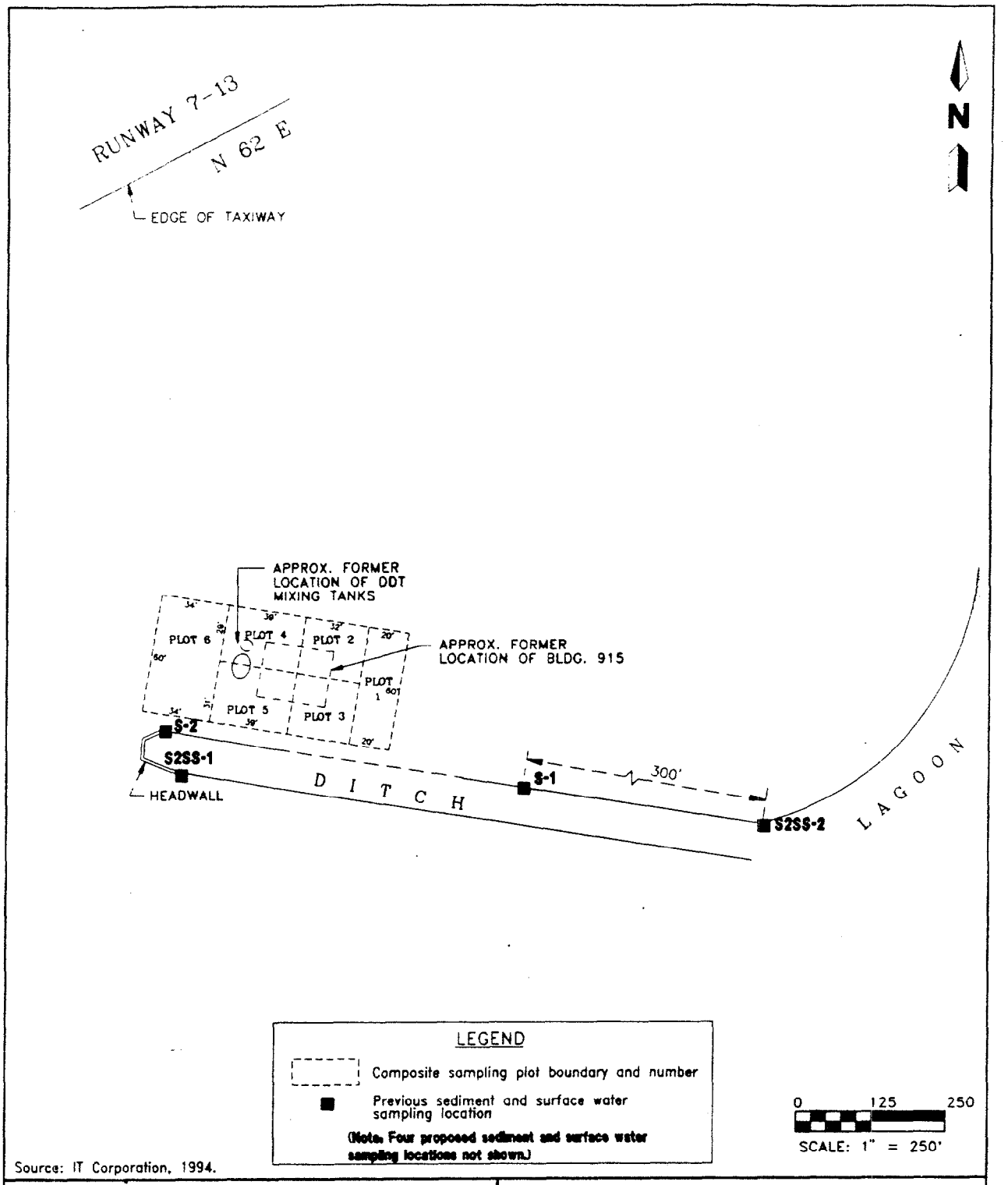
Source: IT Corporation, 1994.

FIGURE 3-4
PROPOSED AND PREVIOUS SOIL SAMPLING LOCATIONS
SWMU NO. 2, BOCA CHICA DDT MIXING AREA

H:\KEYWEST\RFI-RI\2028B14\WDW-SB\06-15-95

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



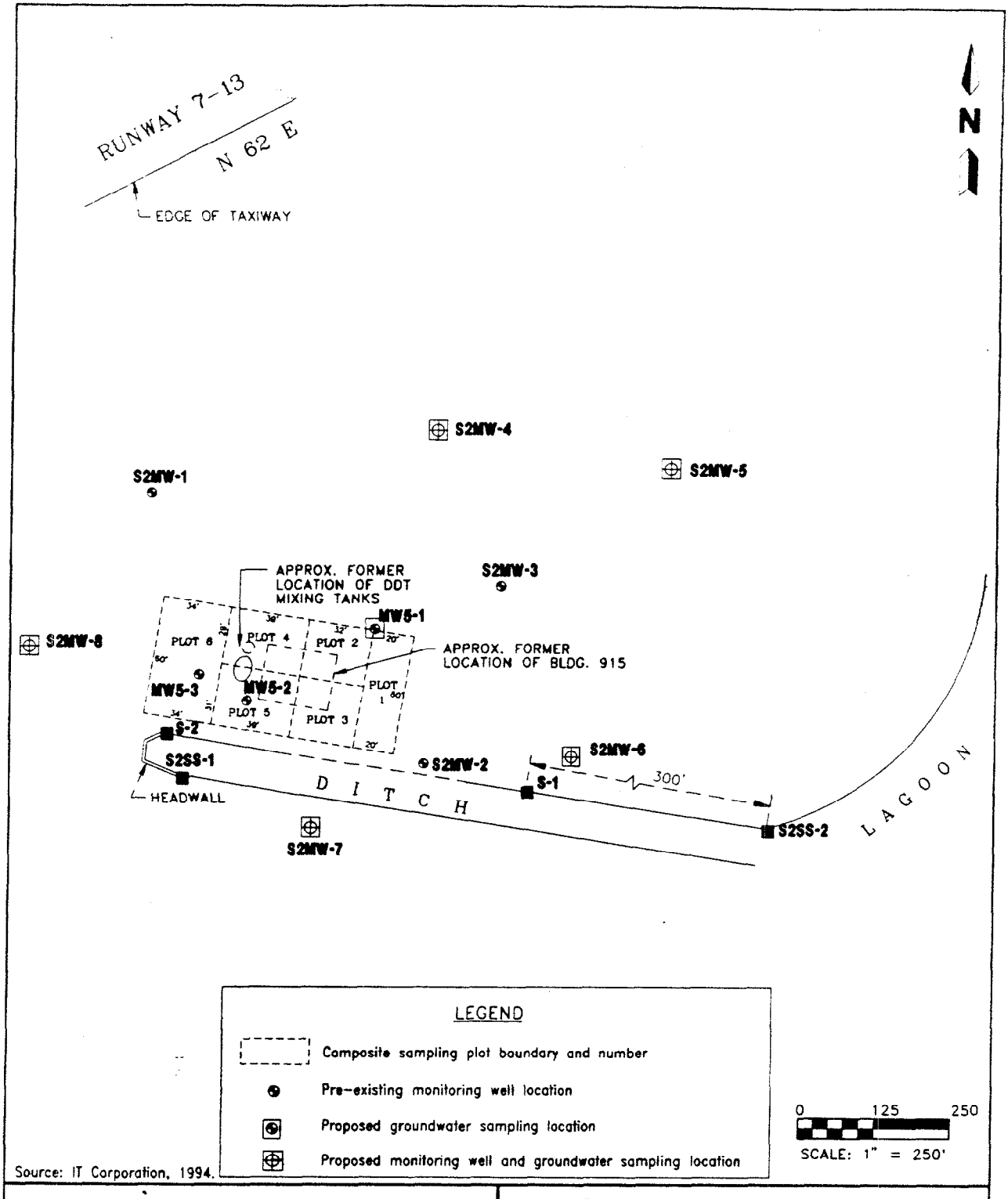
Source: IT Corporation, 1994.

FIGURE 3-5
PROPOSED AND PREVIOUS SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS
SWMU NO. 2, BOCA CHICA
DDT MIXING AREA

H:\KEYWEST\RFI-RI\2028B14\WDW-SB\06-15-95

SUPPLEMENTAL RFI/RI
SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



Source: IT Corporation, 1994.

FIGURE 3-6
PROPOSED AND PRE-EXISTING MONITORING WELL LOCATIONS
SWMU NO. 2, BOCA CHICA
DDT MIXING AREA

H:\KEYWEST\RFI-RI\2028814\WOW-SB\06-15-95

SUPPLEMENTAL RFI/RI
SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

The number of samples and target analytes proposed include:

Surface soil - no surface soil samples will be collected (Figure 3-7).

Surface water and sediment - five locations within mangrove swamp west and southwest of fire training pits (Figure 3-8) analysis for TAL metals and cyanide.

Groundwater monitoring wells - installation of four shallow wells to delineate extent of chlorinated solvents, benzene, and naphthalene (Figure 3-9).

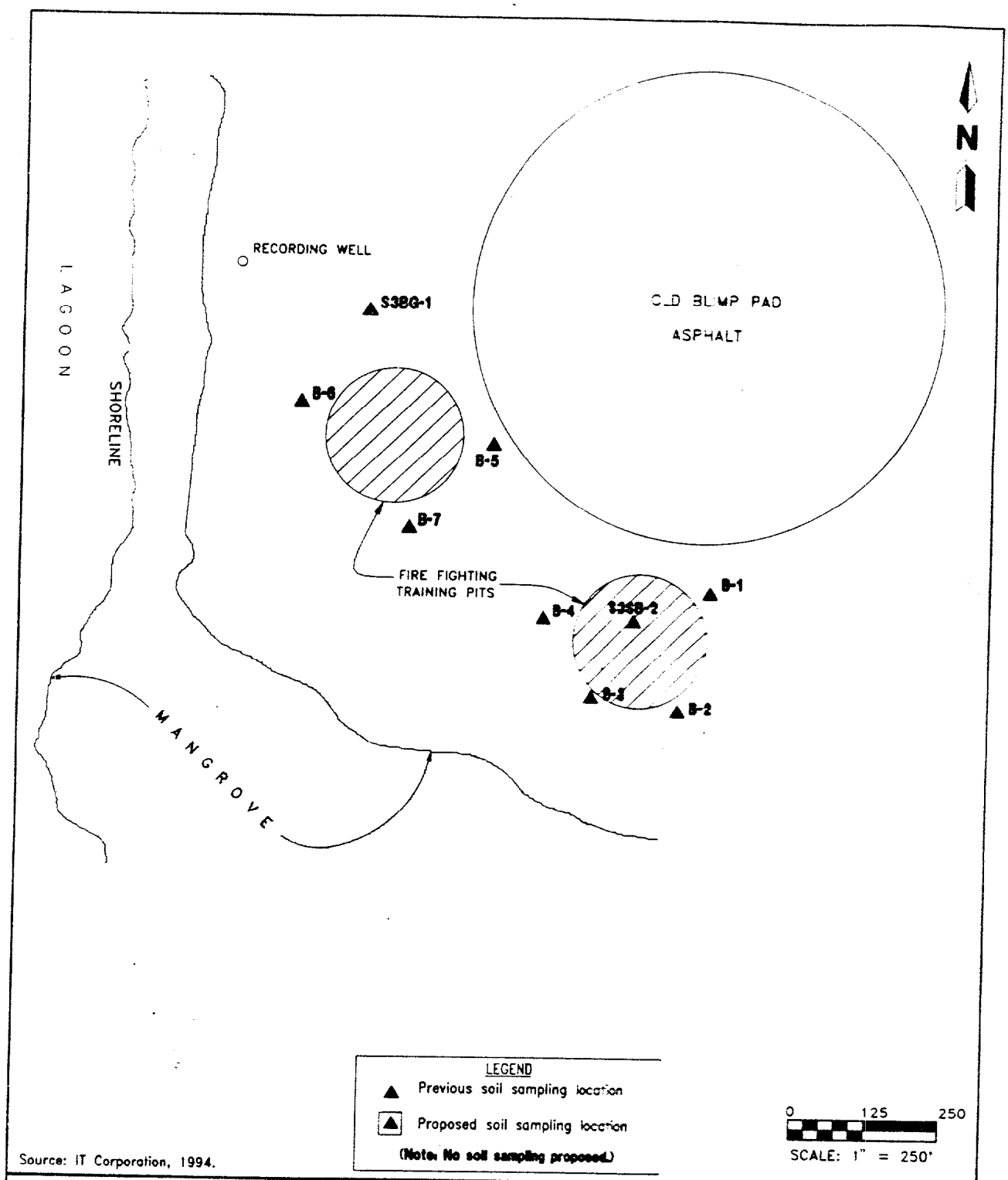
Groundwater sampling - sample groundwater at six locations, including four new monitoring wells and existing wells MW 10-1 and S3MW-1 (Figure 3-9); analysis for Appendix IX VOCs and SVOCs.

3.2.4 SWMU 4, Boca Chica AIMD Building A-980 Field activities at this site include collection of sediment and surface water samples and monitoring well installation and groundwater sampling. Additional sediment and surface water samples will be collected to assess the extent of lead concentrations detected above background screening values within the wetland area adjoining the site to the north. Resampling of existing monitoring wells and installation and sampling of new monitoring wells are included in the supplemental activities to delineate the extent of cyanide and chlorinated solvents that were previously detected in groundwater during original RFI/RI sampling (IT, 1994).

The number of samples and target analytes proposed include:

Surface soil - two background locations along Midway Avenue, analysis for Appendix IX organics, TAL metals, and cyanide (Figure 3-10).

Surface water and sediment - three locations within wetland north and northwest of AIMD Building A-980 and from one location in east end of ditch south of building (Figure 3-11), analysis for Appendix IX VOCs and extractable organics, TAL metals, and cyanide;



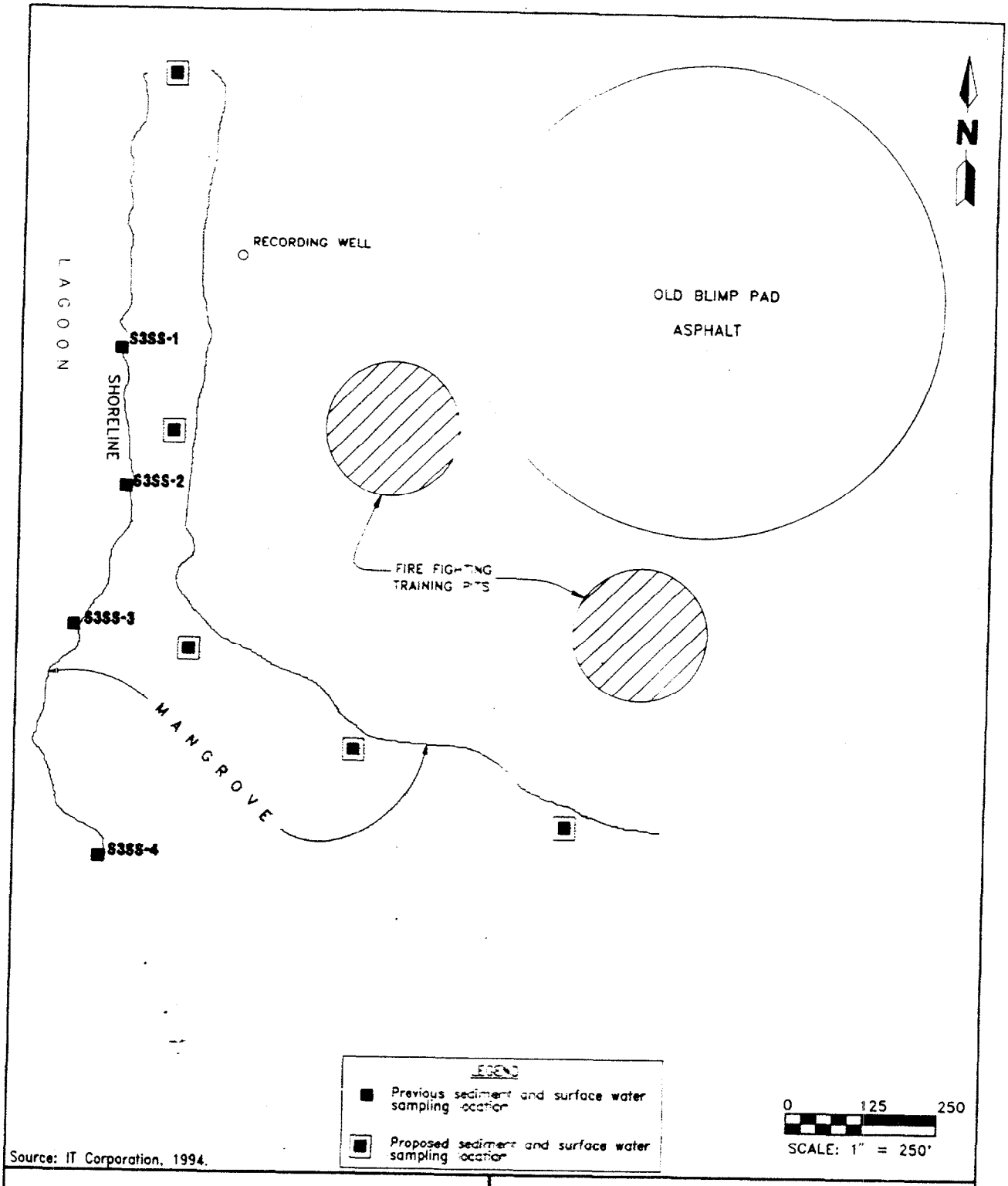
Source: IT Corporation, 1994.

FIGURE 3-7
PROPOSED AND PREVIOUS SOIL SAMPLING LOCATIONS SWMU NO. 3, BOCA CHICA, FIRE FIGHTING TRAINING AREA

H:\KEYWEST\RFI-RI\0028B27\WDW-SB\06-15-95

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



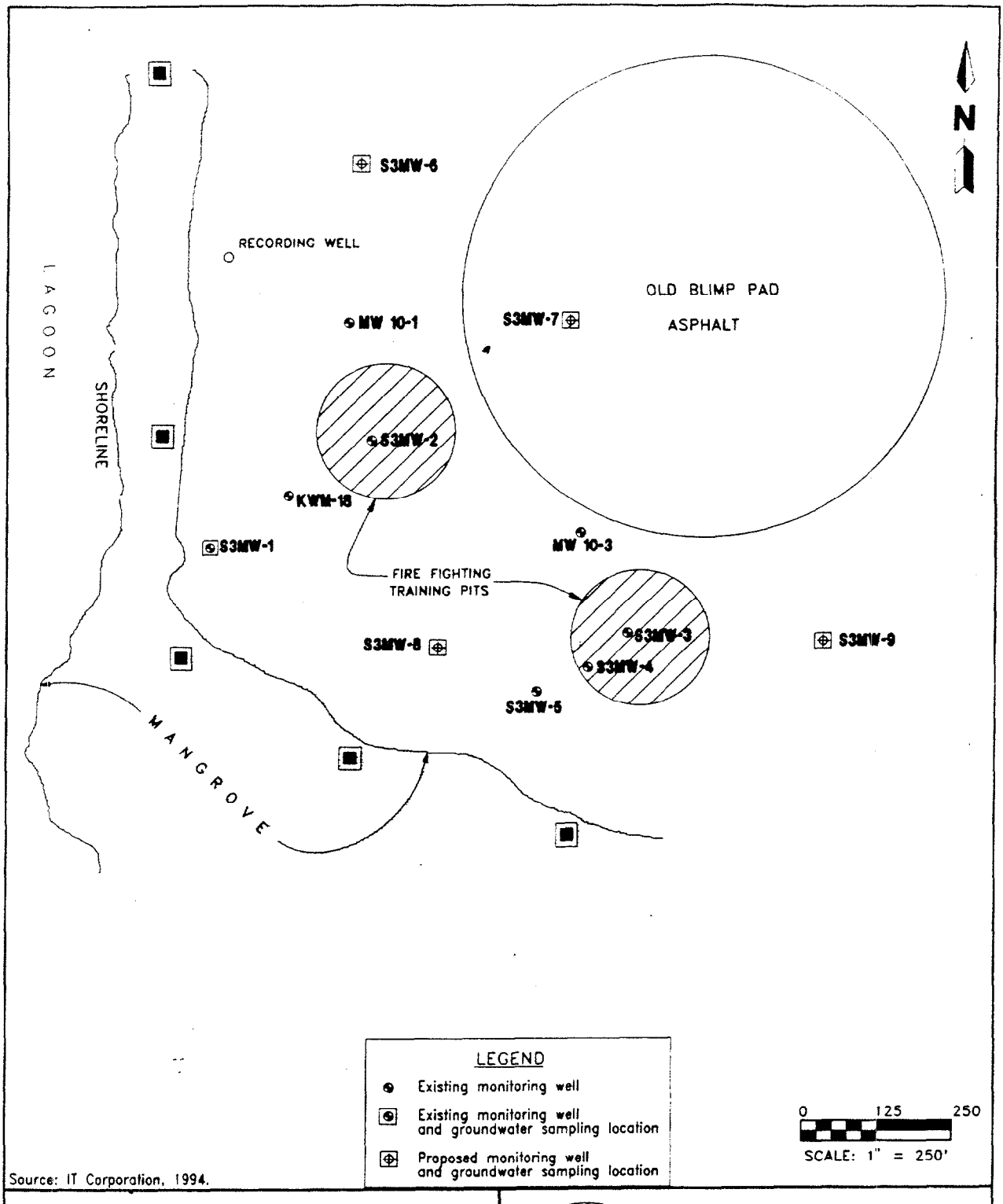
Source: IT Corporation, 1994.

FIGURE 3-8
PROPOSED AND PREVIOUS SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS
SWMU NO. 3, BOCA CHICA,
FIRE FIGHTING TRAINING AREA

H:\KEYWEST\RFI-RI\2028827\WDW-SB\06-15-95

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



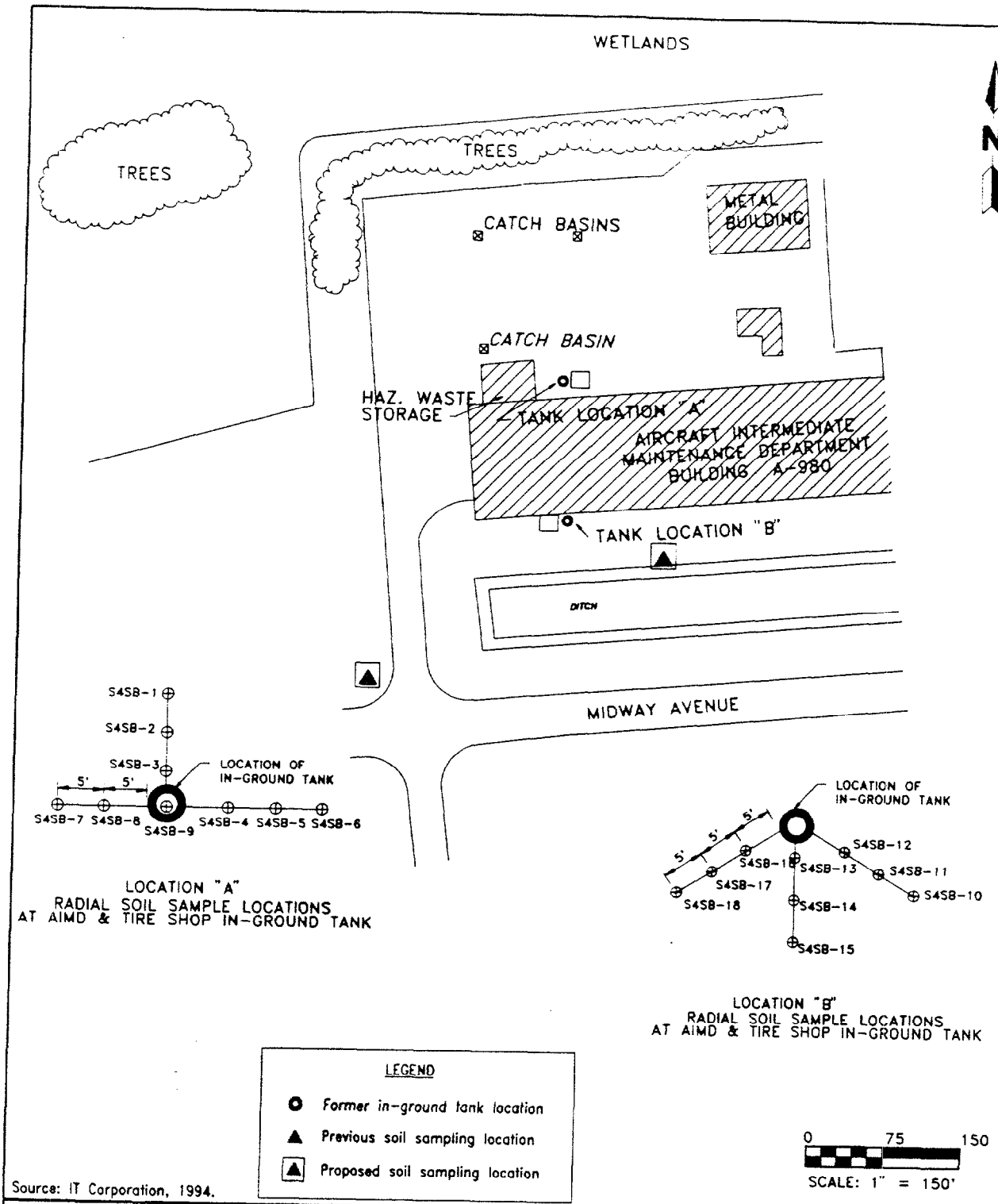
Source: IT Corporation, 1994.

FIGURE 3-9
PROPOSED AND PRE-EXISTING MONITORING WELLS AND GROUNDWATER SAMPLING LOCATIONS, SWMU NO. 3, BOCA CHICA, FIRE FIGHTING TRAINING AREA

H:\KEYWEST\RFI-RI\2028B27\WDW-SB-GLC\06-15-95

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



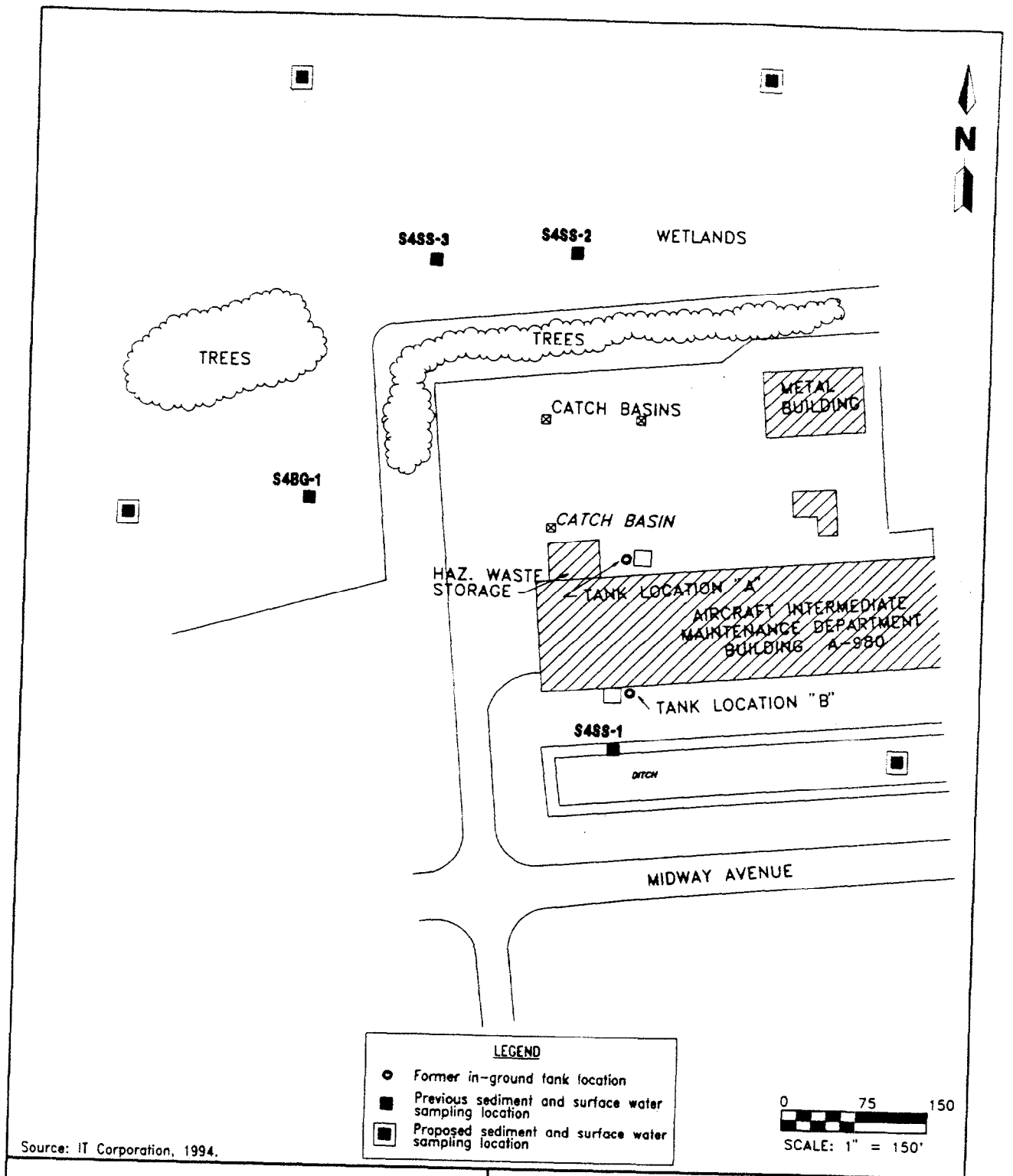
Source: IT Corporation, 1994.

FIGURE 3-10
PROPOSED AND PREVIOUS SOIL SAMPLING LOCATIONS SWMU NO. 4, AIMD BUILDING A-980

H:\KEYWEST\RFI-RI\2028B28\WDW-SB-GLC\06-15-95

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



Source: IT Corporation, 1994.

FIGURE 3-11
PROPOSED AND PREVIOUS SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS SWMU NO. 4, AIMD BUILDING A-980

H:\KEYWEST\RFI-RI\2028828\WDW-SB-GLC\06-15-95

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

Groundwater monitoring wells - installation of four shallow monitoring wells, one hydraulically upgradient and three hydraulically downgradient from Building A-980, to delineate area of chlorinated solvent and cyanide contamination (Figure 3-12).

Groundwater sampling - sample groundwater at six locations, including four new wells and existing wells S4MW-2 and S4MW-3 (Figure 3-12); analysis for Appendix IX VOCs, and cyanide.

3.2.5 SWMU 5, Boca Chica AIMD Building A-990 Supplemental field activities at this site address delineation of contamination within sediment and surface water and groundwater that was detected in initial RFI/RI sampling program (IT, 1994). Sediment and surface water sampling is required to delineate the extent of metals contamination along the reach of the concrete-lined ditch and surface water body to which it discharges. Because only two monitoring wells are present at this site and cyanide has been detected above background screening values at one existing location, this scope of work will include resampling of the two existing monitoring wells and installation of two additional wells to delineate the contamination and assess the groundwater flow gradient and direction.

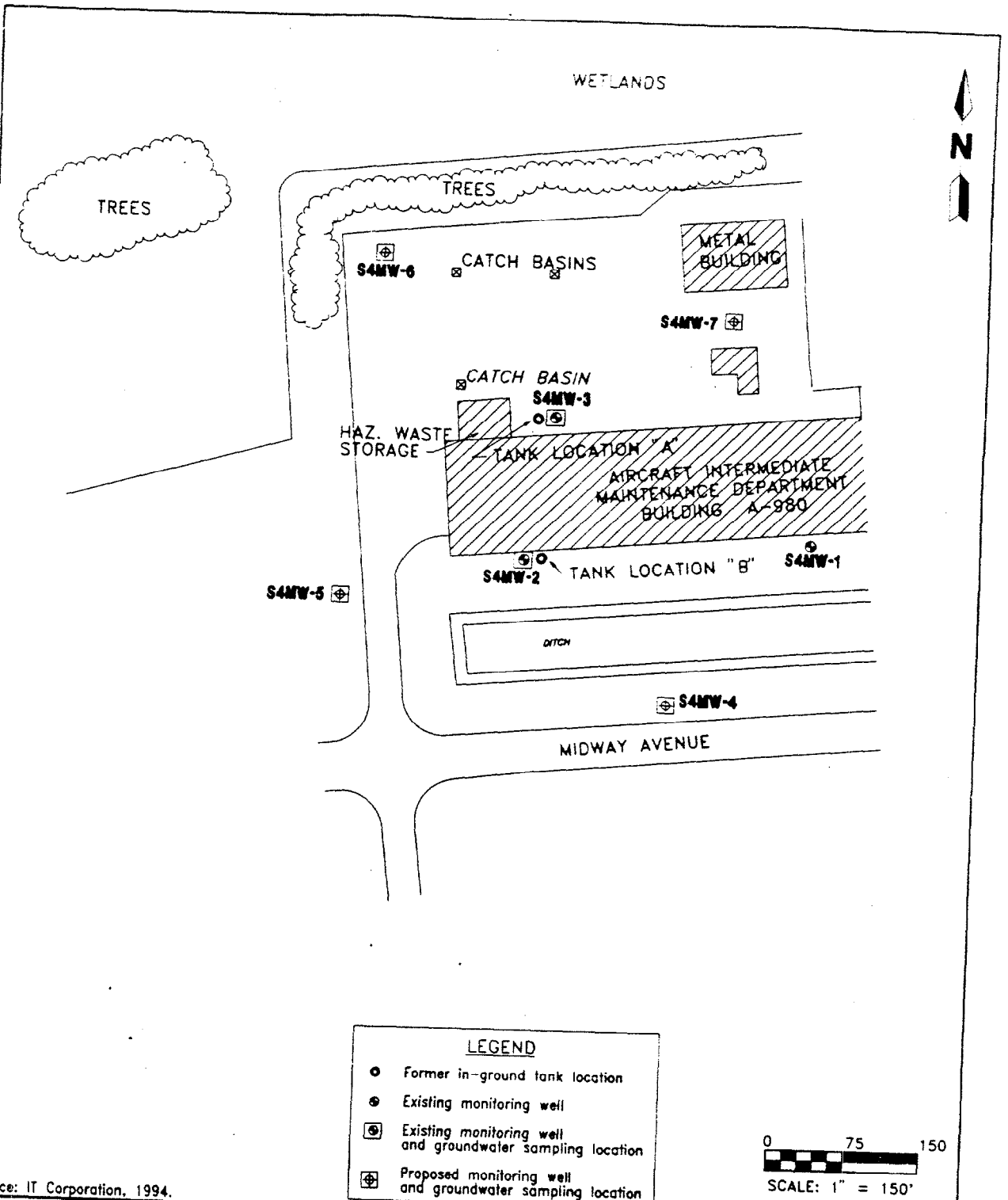
The number of samples and target analytes proposed include:

Surface soil - no surface soil samples will be collected (Figure 3-13).

Surface water and sediment - two locations within wetland west of site and two locations in concrete-lined ditch, one downstream from sand blasting area and one for background upgradient from site (Figure 3-14), analysis for Appendix IX VOCs, SVOCs, TAL metals, and cyanide.

Groundwater monitoring wells - installation of two shallow monitoring wells north and east of the former sand blasting area (Figure 3-15).

Groundwater sampling - four locations, including two new monitoring wells and existing wells S5MW-2 and S5MW-3 (Figure 3-15), analysis Appendix IX SVOCs, TAL metals and cyanide.



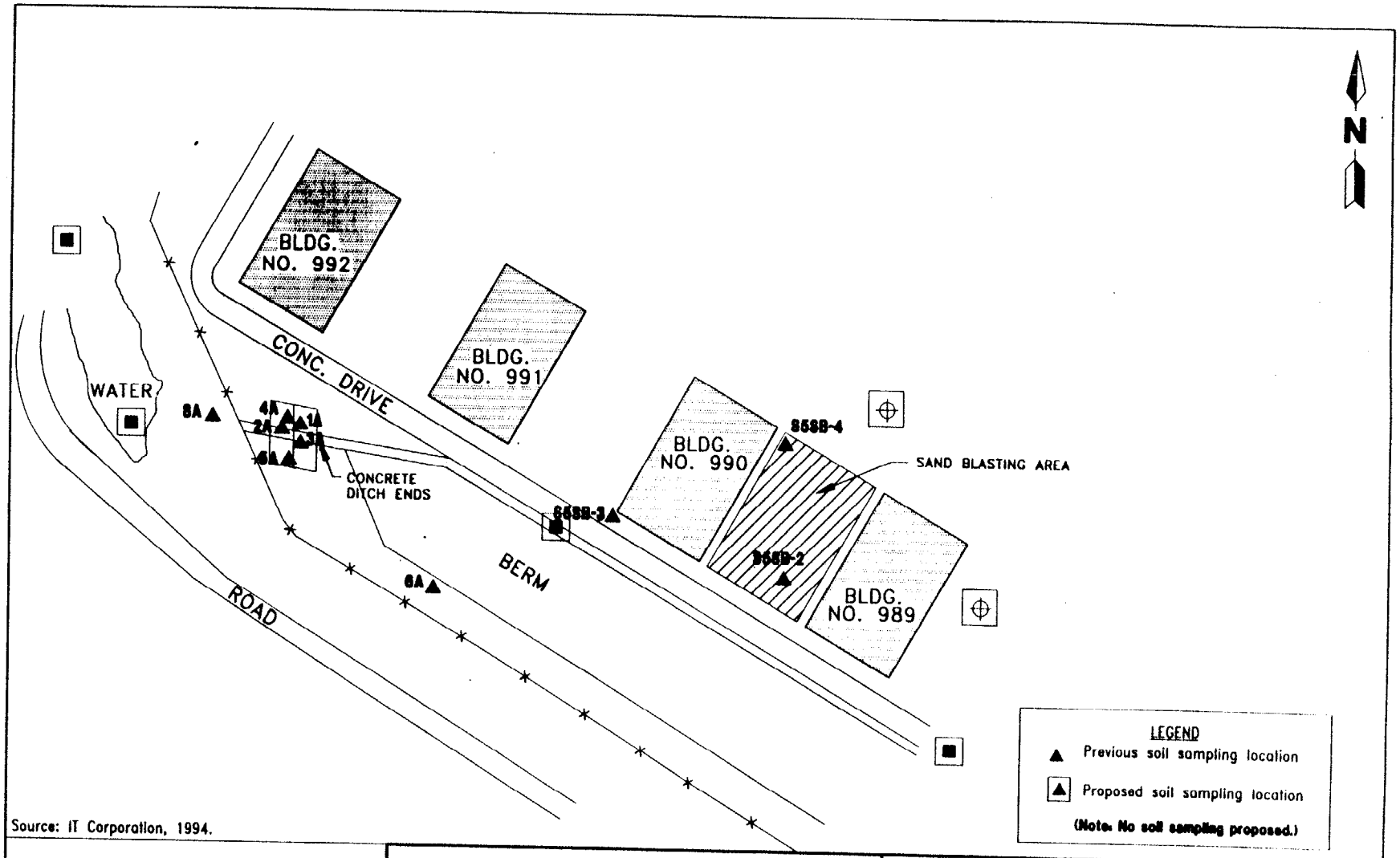
Source: IT Corporation, 1994.

FIGURE 3-12
PROPOSED AND PRE-EXISTING MONITORING WELLS AND GROUNDWATER SAMPLING LOCATIONS, SWMU NO. 4, AIMD BUILDING A-980

H:\KEYWEST\RFI-RI\2028B28\WOW-SB-GLC\06-15-95

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



Source: IT Corporation, 1994.

0 100 200

SCALE: 1" = 200'

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FIGURE 3-13
PROPOSED AND PREVIOUS SOIL SAMPLING LOCATIONS SWMU NO. 5, AIMD BUILDING A-990

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST KEY WEST, FLORIDA

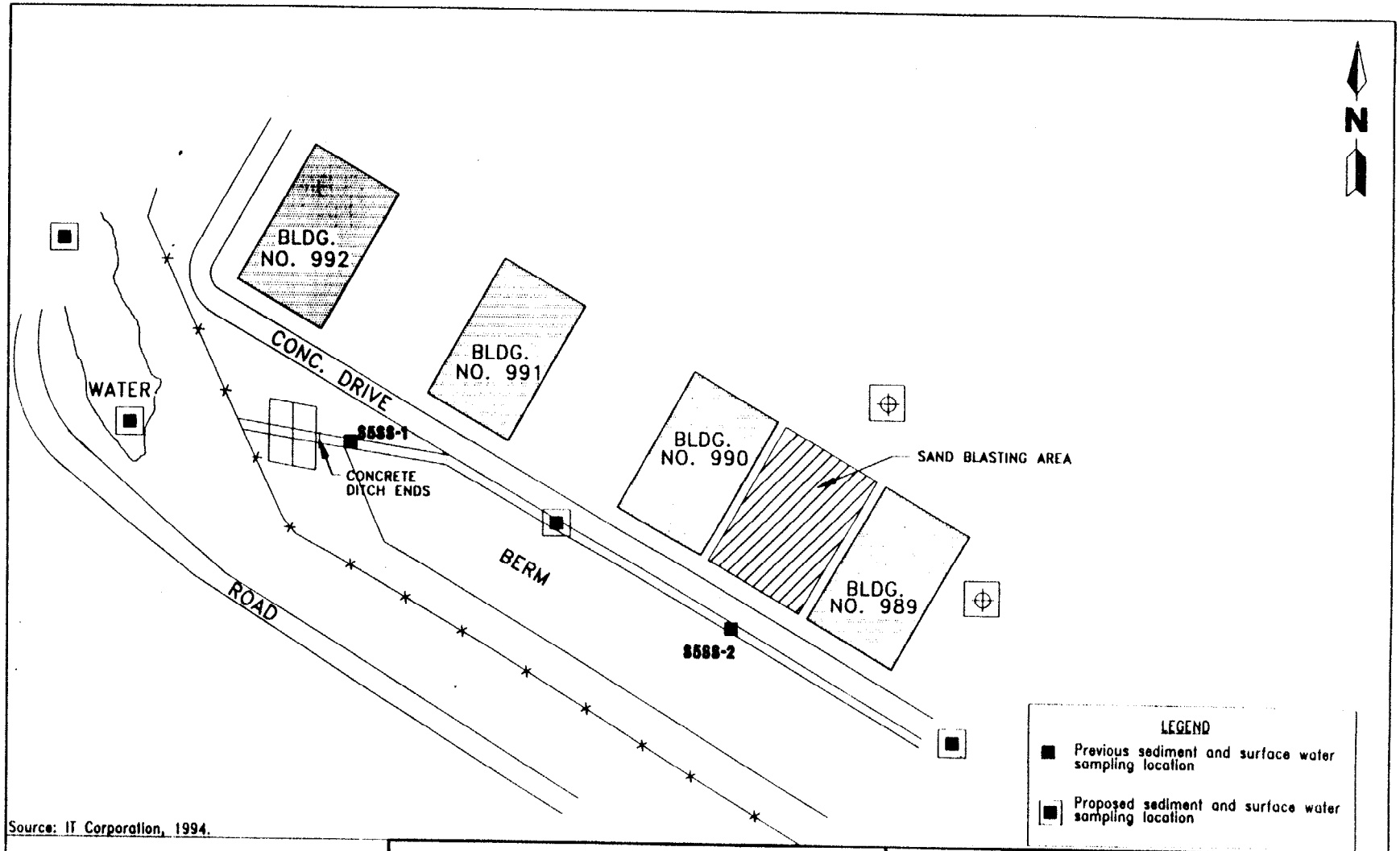
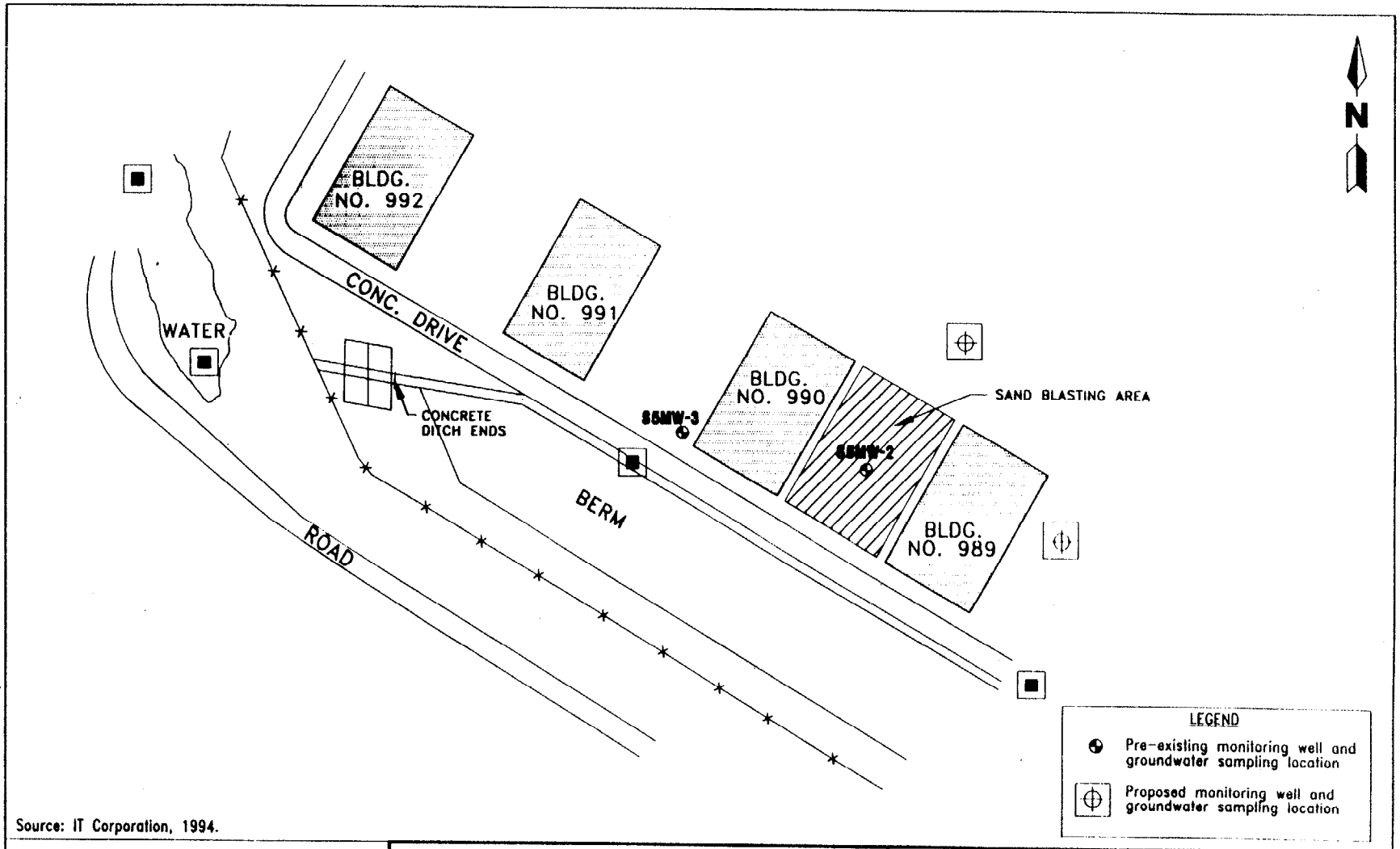


FIGURE 3-14
PROPOSED AND PREVIOUS SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS
SWMU NO. 5, AIMD BUILDING A-990

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



Source: IT Corporation, 1994.

0 100 200

SCALE: 1" = 200'

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FIGURE 3-15
PROPOSED AND PRE-EXISTING MONITORING WELL AND GROUNDWATER SAMPLING LOCATIONS SWMU NO. 5, AIMD BUILDING A-990

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

3.2.6 SWMU 7, Boca Chica Building A-824 Previous RFI/RI sampling data suggest that hydrocarbons are present in soil along the entrance road, outside the site boundary. Further assessment of the extent of hydrocarbon in the soil is necessary to confirm that it is unrelated to SWMU 7 and to determine its origin. Further assessment of pesticides, PCBs, and metals in sediment and surface water within the ditch and stormwater pond adjacent to Building A-824 also is necessary. Previous sampling did not include the stormwater pond or areas hydraulically downgradient within the ditch.

The number of samples and target analytes proposed include:

Surface soil - four locations along road to define hydrocarbon contamination (Figure 3-16), analysis for Appendix IX VOC, extractable organics, pesticides and PCBs, TAL metals, and cyanide.

Surface water and sediment - one location within stormwater pond and four locations within ditch downstream from site (Figure 3-17), analysis for Appendix IX extractable organics, pesticides and PCBs, TAL metals, and cyanide.

Groundwater monitoring wells - no monitoring wells will be installed.

Groundwater sampling - no groundwater sampling will be conducted.

3.2.7 SWMU 9, Boca Chica Jet Engine Test Cell Building A-969 The petroleum contamination assessment performed at this site did not delineate the source or extent of chlorinated solvent-related contamination in soil and groundwater nor did it include assessment of potential contamination present in the nearby inlet. Supplemental field activities will include surface and subsurface soil sampling to assess and delineate the source area of chlorinated solvents. An interim groundwater control measure is planned at this site by the Remedial Action Contractor (RAC) and will be conducted prior to the supplemental RFI/RI field activities. The objective of the IRA is to delineate the extent of the chlorinated solvent contamination within groundwater and to install a source

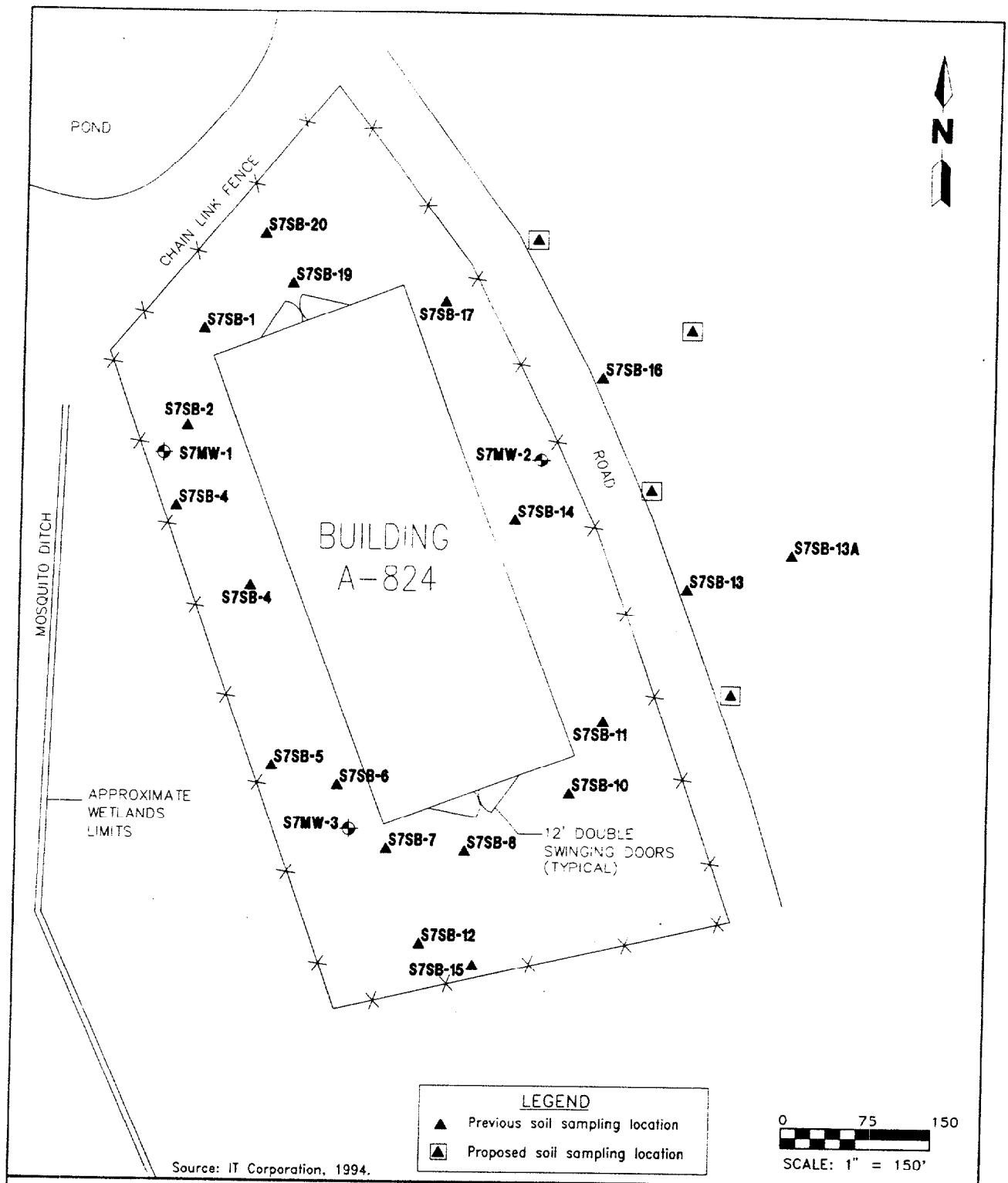


FIGURE 3-16
PROPOSED AND PREVIOUS SOIL SAMPLING LOCATIONS
SWMU NO. 7, BUILDING A-824

H:\KEYWEST\RFI-RI\A824\SB-GLC\06-15-95

SUPPLEMENTAL RFI/RI
SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

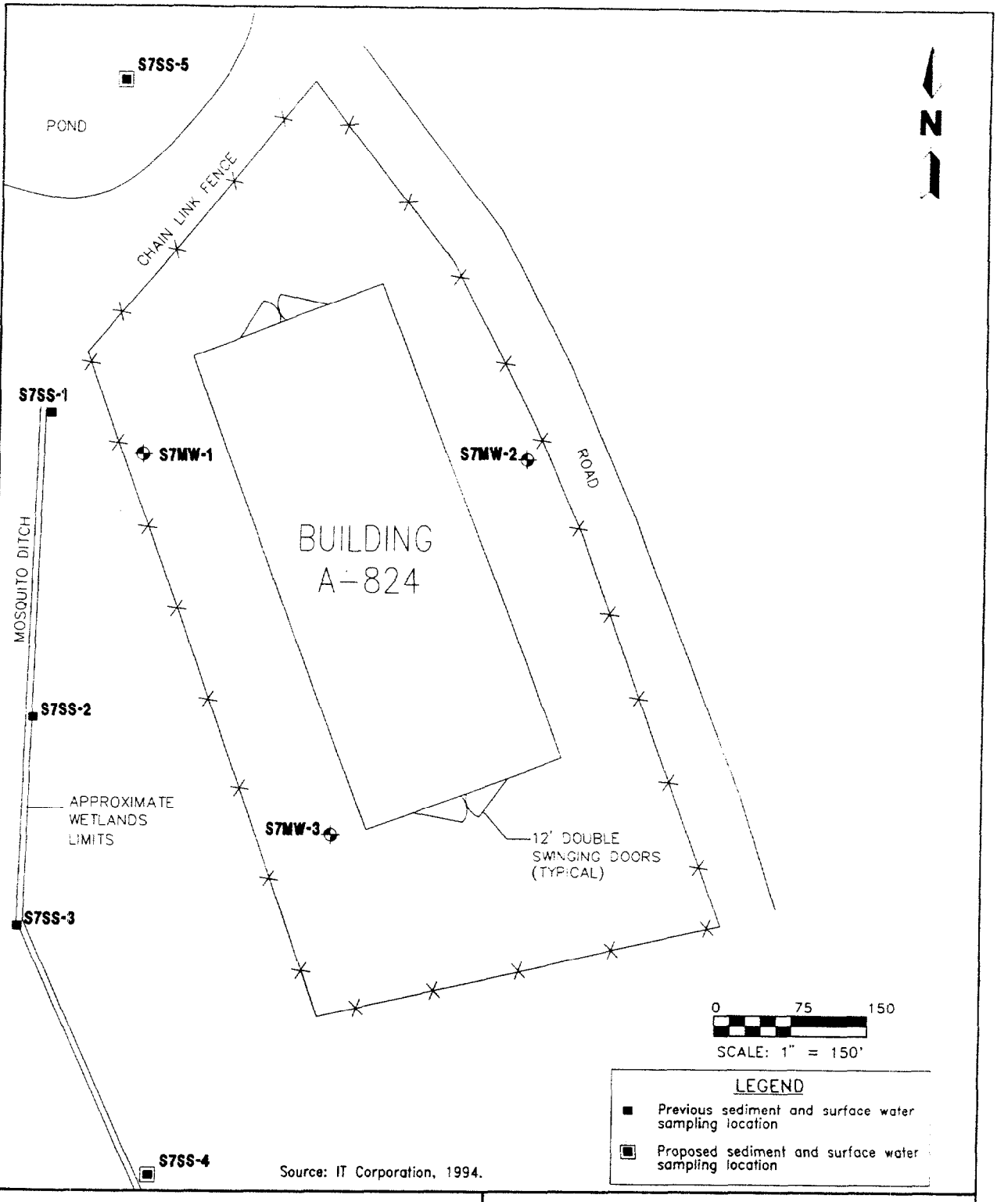


FIGURE 3-17
PROPOSED AND PREVIOUS SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS SWMU NO. 7, BUILDING A-824

H:\KEYWEST\RFI-RI\A824\SB-GLC\6-15-95

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

control measure, i.e., pump and treat groundwater system. Therefore groundwater additional groundwater samples will be collected from existing and any new wells installed as part of the IRA. Collection of sediment and surface water samples from the inlet north of the site will be included in the supplemental RFI/RI program also.

The number of samples and target analytes proposed include:

Surface soil - surface and subsurface soil sampling with direct push sampling system and screening onsite a portable gas chromatograph to assess the extent of soil contamination by chlorinated solvents in area of former jet engine testing area (Figure 3-18) laboratory analysis for verification from five surface and five subsurface soil sample locations, Appendix IX VOCs, SVOCs, pesticides and PCBs, TAL metals, and cyanide.

Surface water and sediment - five locations along shoreline of inlet north of site (Figure 3-19), analysis for Appendix IX VOCs, SVOCs, pesticides and PCBs, TAL metals, and cyanide.

Groundwater monitoring wells - installation of approximately four shallow monitoring wells by RAC is anticipated to delineate chlorinated solvent plume, no monitoring well installation included in this scope (Figure 3-20).

Groundwater sampling - sample groundwater at eight locations, including new monitoring wells installed by RAC plus 4 additional existing wells (Figure 3-20), analysis for Appendix IX VOCs, SVOCs, pesticides and PCBs, TAL metals, and cyanide.

3.2.8 IR Site 1, Truman Annex Open Disposal Area The supplemental field activities at IR Site 1 will include surface soil sampling to delineate the area of surface soil contamination and to characterize background conditions, resampling of surface water and sediment sampling to confirm findings of earlier activities and monitoring well installation and groundwater sampling to characterize background and confirm previously-detected levels of contamination (IT, 1994). Because the extent of surface soil contamination has not been

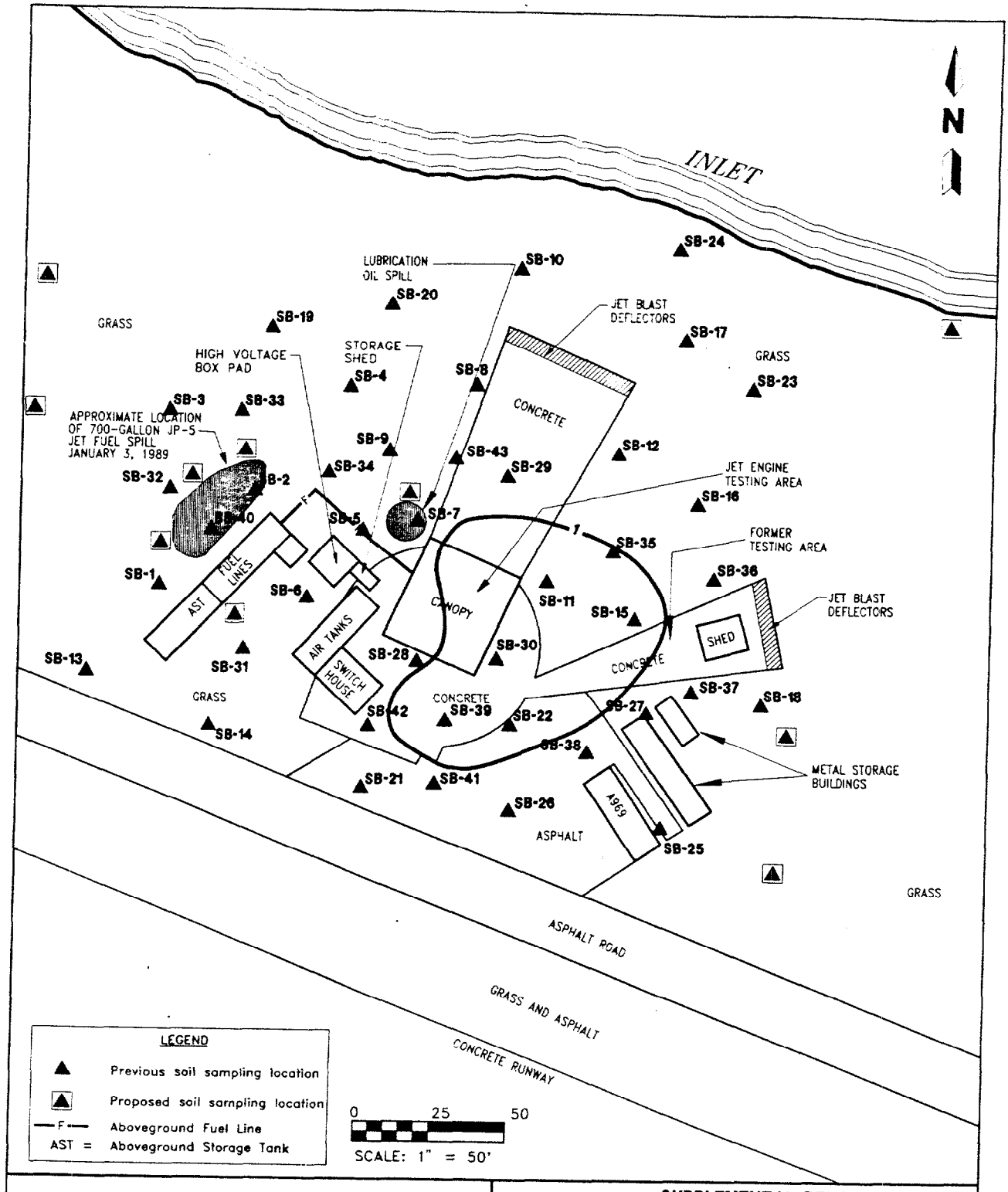


FIGURE 3-18
PROPOSED AND PREVIOUS SOIL SAMPLING LOCATIONS
SWMU NO. 9, JET ENGINE TEST CELL

H/KEYWEST/CELL/MP-SB-CLC/06-15-95

SUPPLEMENTAL RFI/RI
SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

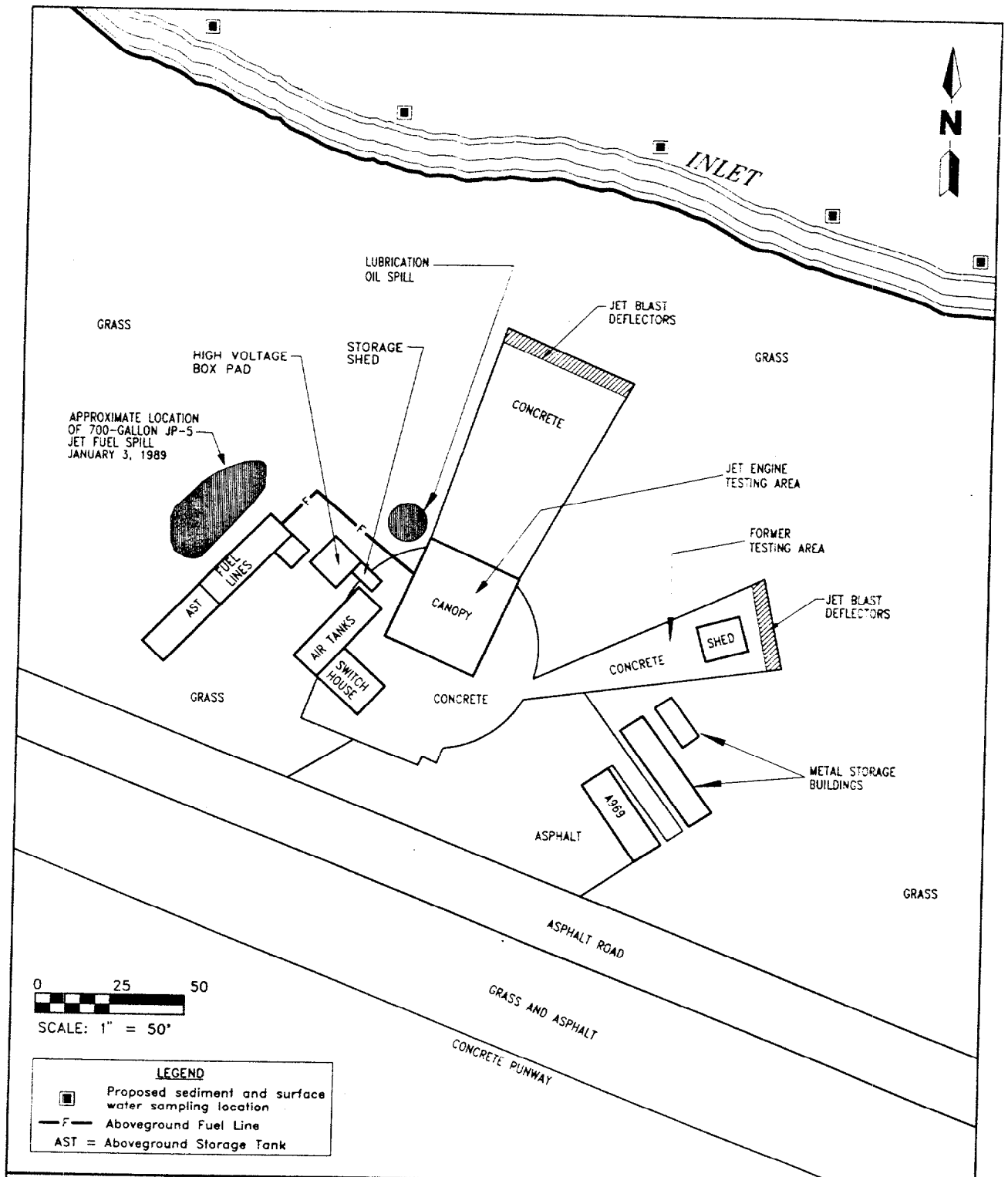


FIGURE 3-19
PROPOSED SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS
SWMU NO. 9, JET ENGINE TEST CELL

H:\KEYWEST\CELL\NP-SB-GLC\8-15-95

SUPPLEMENTAL RFI/RI
SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

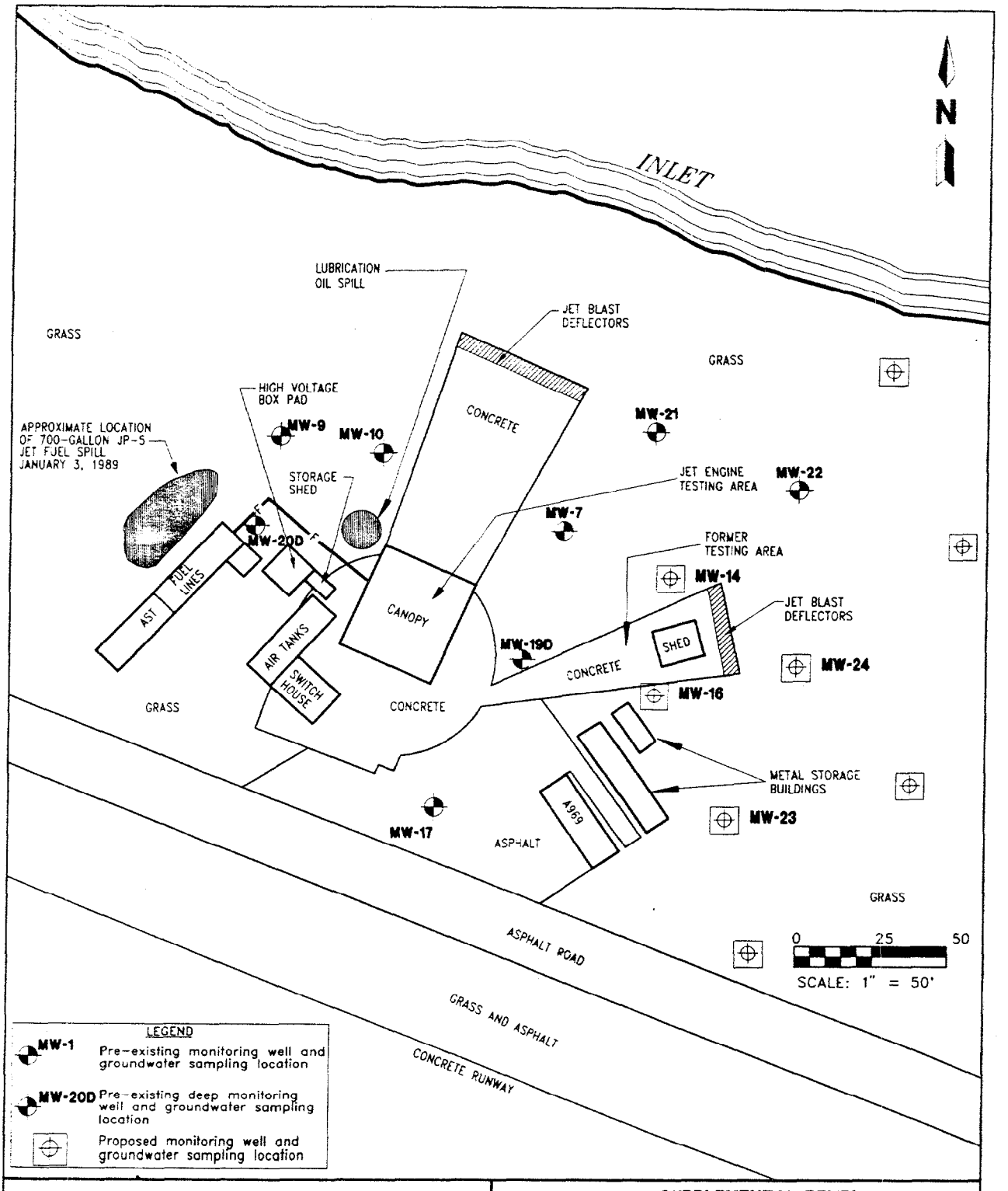


FIGURE 3-20
PROPOSED AND PRE-EXISTING MONITORING WELL/ GROUNDWATER SAMPLING LOCATIONS SWMU NO. 9, JET ENGINE TEST CELL

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST KEY WEST, FLORIDA

sufficiently delineated, the exposure to human or ecological receptors cannot be adequately characterized. The supplemental sampling program will include the collection of surface soil samples using a grid pattern, focusing on metals. A portion of the proposed sampling area may be removed prior to the proposed sampling depending on the area and extent of a proposed IRA that is to be performed prior to execution of the supplemental RFI/RI sampling activities. Regulatory reviewers believe that recollection of sediment and surface water samples at the original RFI/RI field program locations is necessary to confirm the presence or absence of previously detected target analytes (IT, 1994) (FDEP, 1995b). Collection of additional data at these locations should provide a statistically representative data set for risk assessment. Five additional monitoring wells will be installed, one in a upgradient location for background. Groundwater will be sampled at the five new monitoring wells and will be resampled at four of the existing monitoring well locations to previous detections of metals and pesticides (IT, 1994). Previously detected concentrations of metals could be attributable to turbidity.

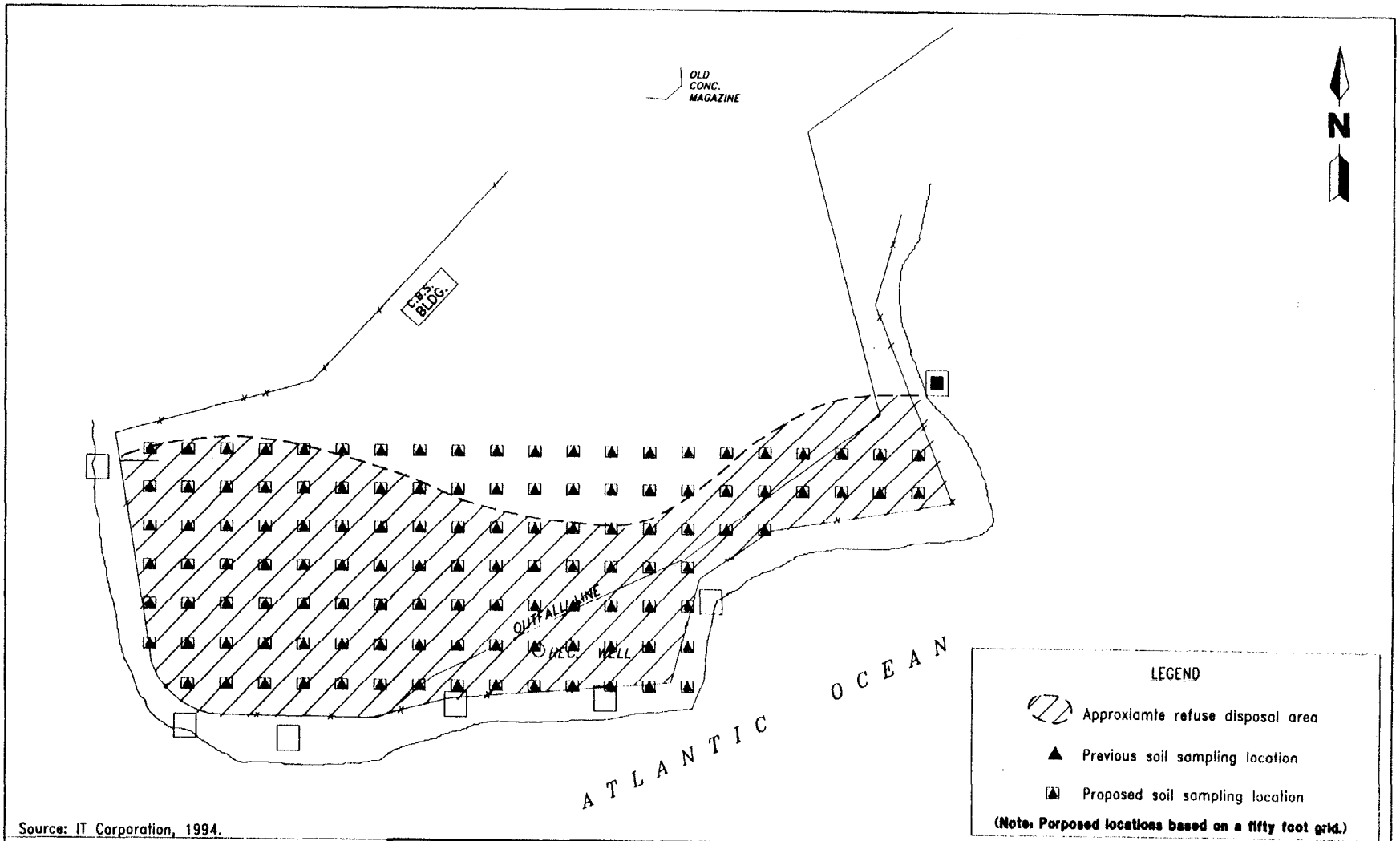
The number of samples and target analytes proposed include:

Surface soil - for delineation purposes, establish a 50-foot-grid over site from which to collect surface soil samples for TAL metals analysis only (Figure 3-21).

Surface water and sediment - seven locations previously sampled in RFI and RI (Figure 3-22), analysis for Appendix IX SVOCs, pesticides and PCBs, TAL metals, and cyanide

Groundwater monitoring wells - installation of five monitoring wells (Figure 3-23).

Groundwater sampling - sample groundwater at nine locations, including one new monitoring well (Figure 3-23), analysis for Appendix IX pesticides and PCBs, TAL metals, and cyanide.



Source: IT Corporation, 1994.

0 100 200

SCALE: 1" = 200'

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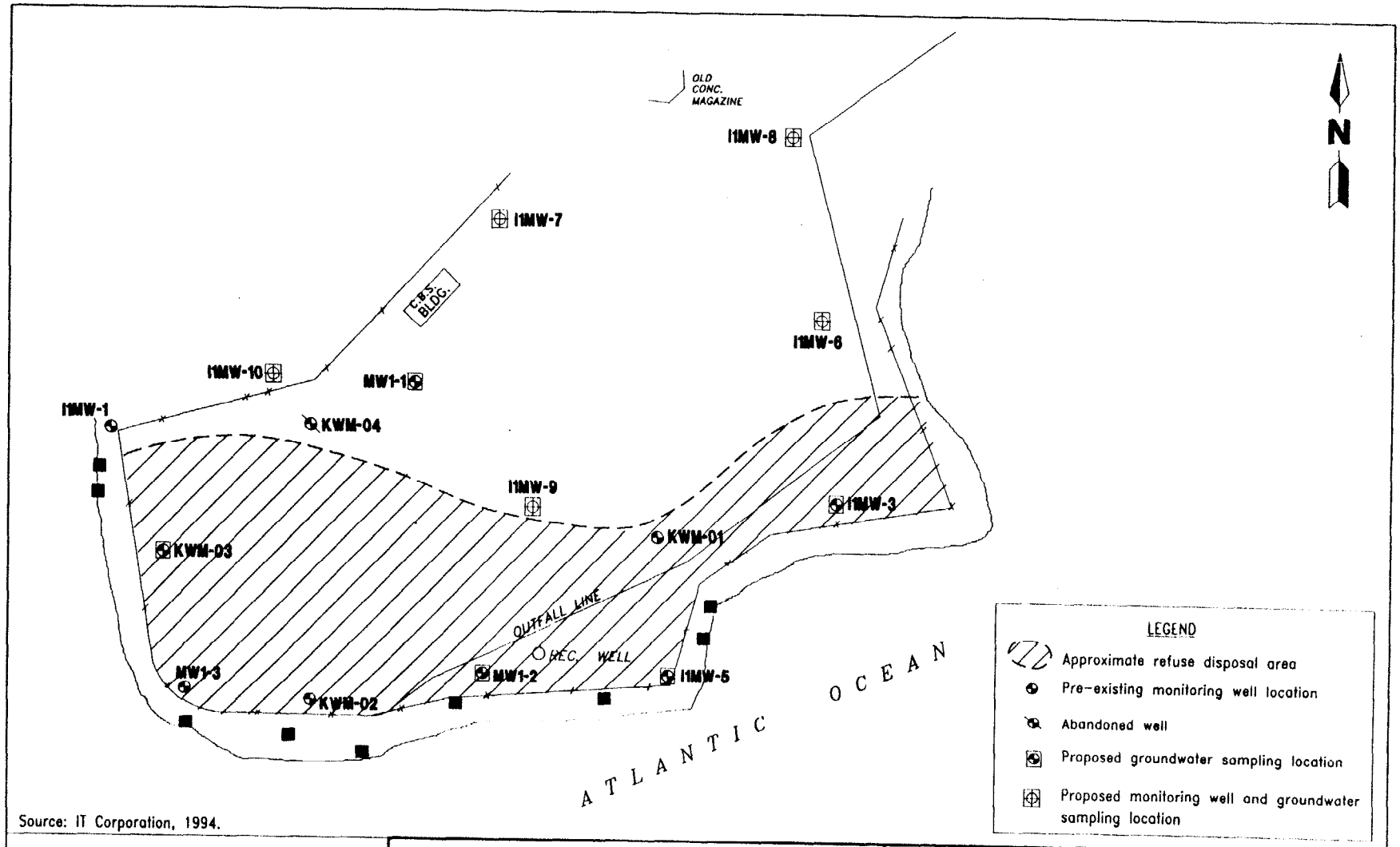
FIGURE 3-21
PROPOSED AND PREVIOUS SOIL SAMPLING LOCATIONS
IR NO. 1, TRUMAN ANNEX
REFUSE DISPOSAL AREA

SUPPLEMENTAL RFI/RI
SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



Source: IT Corporation, 1994.

0 100 200

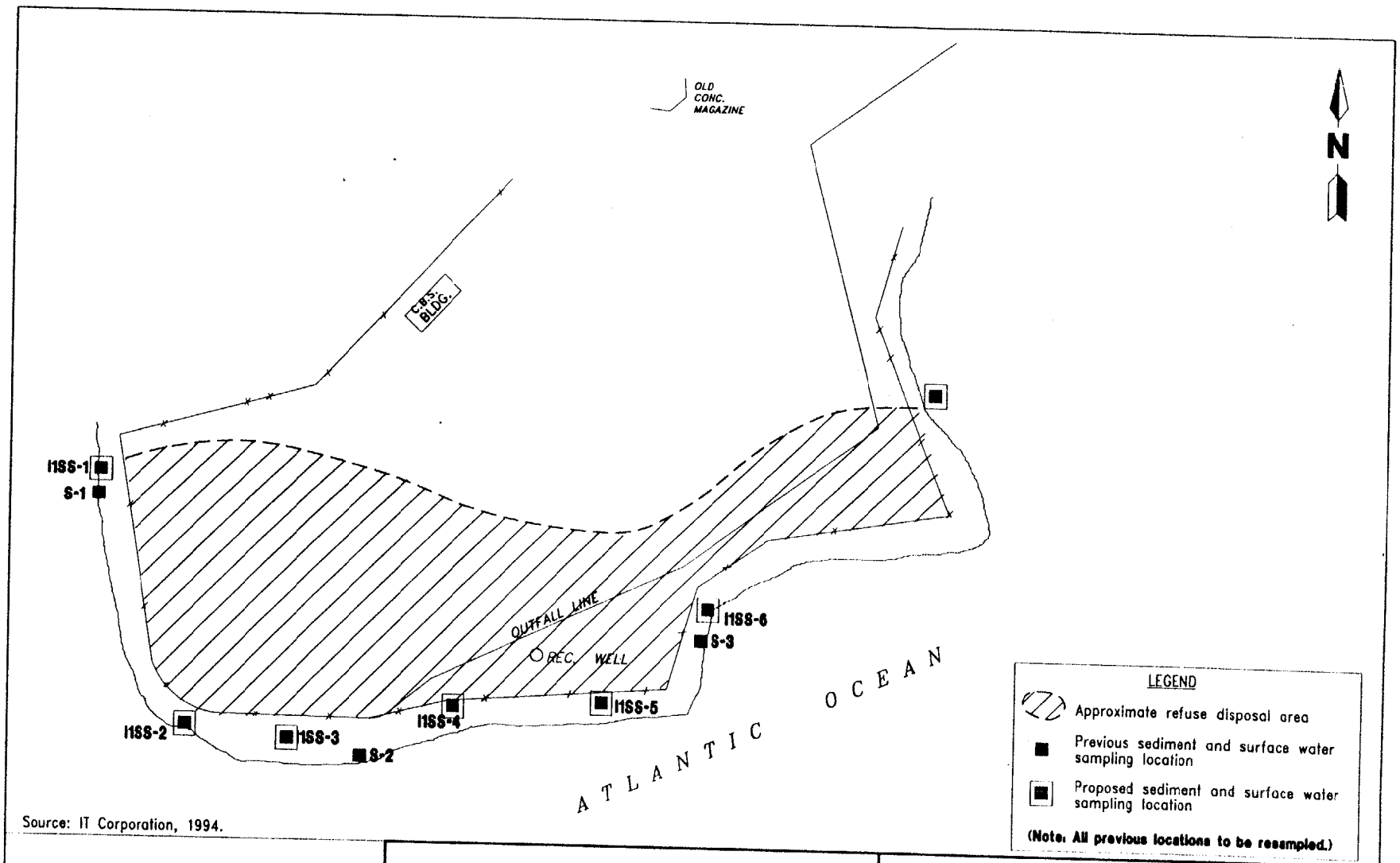
SCALE: 1" = 200'

H:\KEYWEST\RF-RI\202897\WDW-SB-GLC\06-15-95

FIGURE 3-23
PROPOSED AND PRE-EXISTING MONITORING WELLS AND GROUNDWATER SAMPLING LOCATIONS
IR NO. 1, TRUMAN ANNEX
REFUSE DISPOSAL AREA

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



Source: IT Corporation, 1994.

0 100 200

SCALE: 1" = 200'

H:\KEYWST\RF-RI\20288\WDW SB-GLC\06-15-95

FIGURE 3-22
PROPOSED AND PREVIOUS SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS
IR NO. 1, TRUMAN ANNEX
REFUSE DISPOSAL AREA

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

3.2.9 IR Site 3, Truman Annex DDT Mixing Area The primary objectives of supplemental sampling activities at IR Site 3 are to delineate and further characterize background surface soil characteristics in the immediate area surrounding the site and to delineate the area of groundwater contamination with respect to contaminants that were detected in previous work (IT, 1994). Surface soil data from the earlier RFI/RI program suggest that the area of pesticide contamination may not have been completely defined or that it is possible that outlying areas with pesticide residue in surface soil may reflect background conditions. Therefore the scope of activities at this site include additional surface soil sampling in outlying areas to further assess the areal extent of pesticide contamination and to determine if existing outlying surface soil may reflect background conditions. The surface soil data will be supplemented by soil sampling results from the IRA to be performed by the RAC. The area and distribution of pesticides within groundwater at the site has not been completely delineated in previous work (IT, 1994). The scope of this workplan also includes the installation and sampling of additional monitoring wells at locations that will facilitate the delineation of pesticide contamination in groundwater.

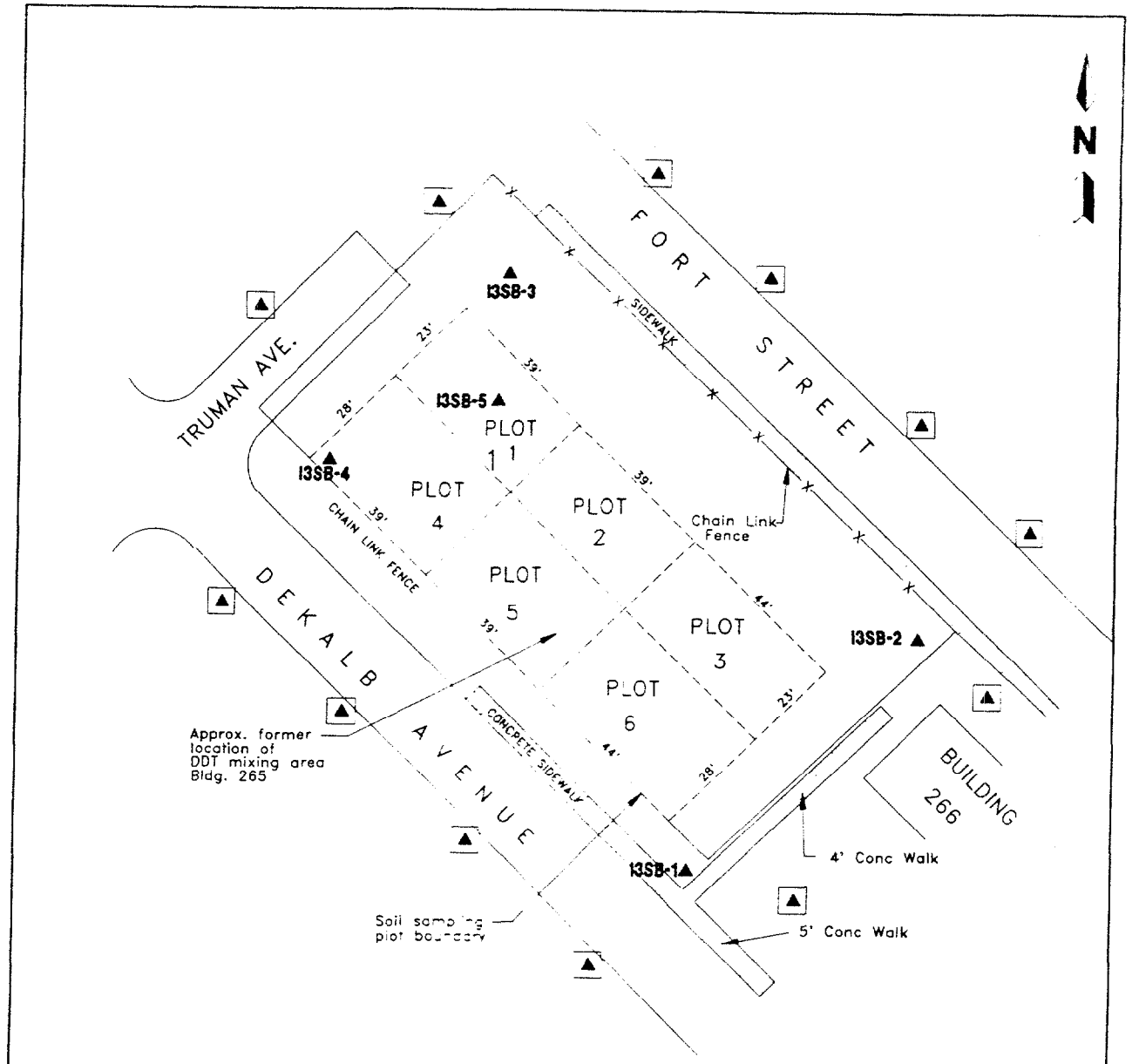
The number of samples and target analytes proposed include:

Surface soil - for delineation purposes and background characterization, collect surface and subsurface samples from 12 offsite locations (Figure 3-24).

Surface water and sediment - no surface water and sediment samples will be collected.

Groundwater monitoring wells - installation of six monitoring wells offsite to delineate pesticide and metal contamination in groundwater (Figure 3-25).

Groundwater sampling - sample groundwater at eight locations, including six new monitoring wells (Figure 3-25), analysis for Appendix IX pesticides and PCBs, TAL metals, and cyanide.



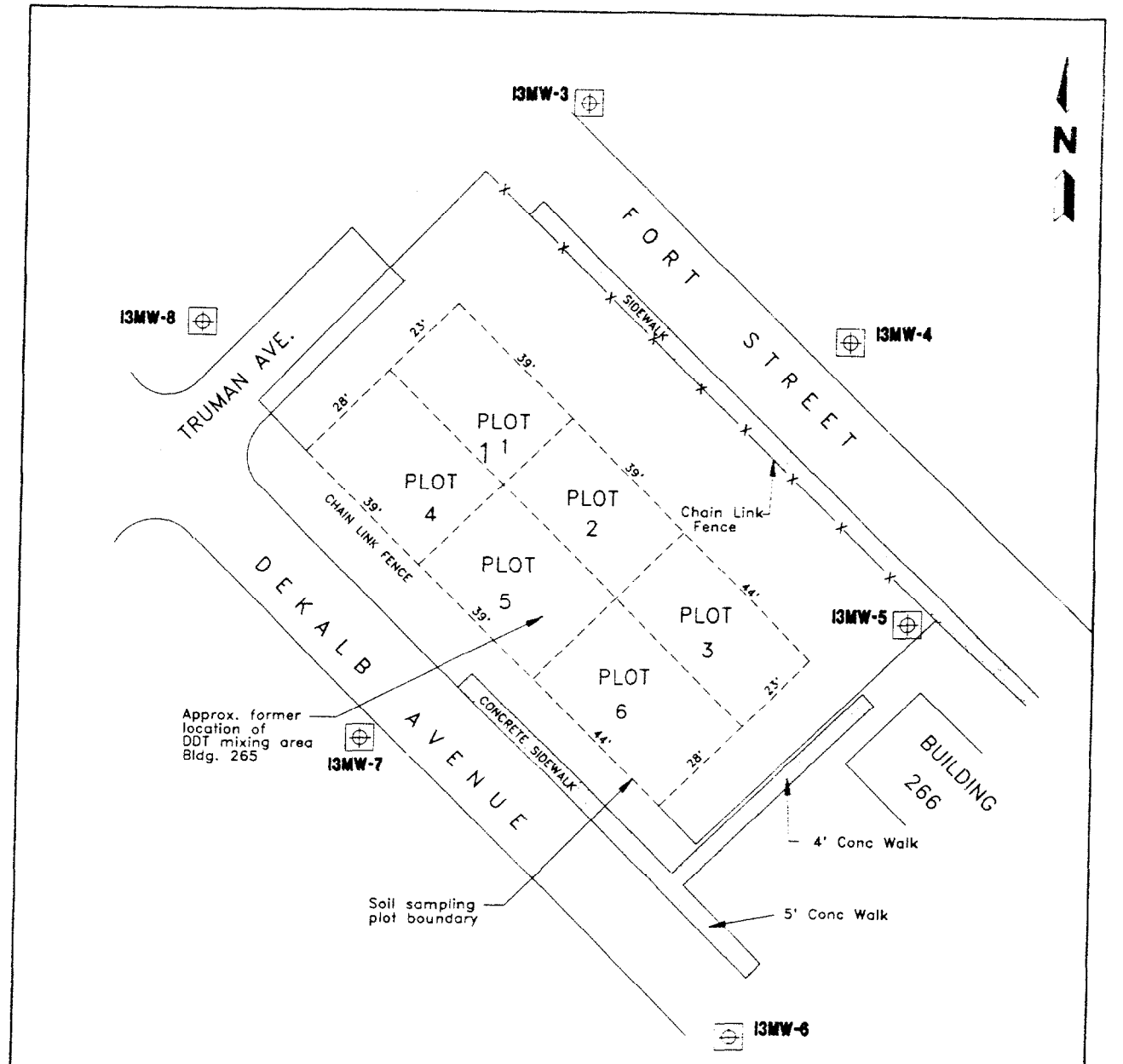
Source: IT Corporation, 1994.

FIGURE 3-24
PROPOSED AND PREVIOUS SOIL SAMPLING LOCATIONS
IR NO. 3, TRUMAN ANNEX
DDT MIXING AREA

SUPPLEMENTAL RFI/RI
SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

\KEYWEST\RFI-RI\202868\WDW-SB-NP\06-15-35



Source: IT Corporation, 1994.

FIGURE 3-25
PROPOSED AND PRE-EXISTING MONITORING WELLS AND GROUNDWATER SAMPLING LOCATIONS, IR NO. 3, TRUMAN ANNEX DDT MIXING AREA

\KEYWEST\RFI-RI\223SB81\WDW-SB-NP\06-15-95

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

3.2.10 IR Site 7, Fleming Key North Landfill Supplemental field activities at IR Site 7 will include sampling of sediment and surface water and groundwater sampling. Data from previously collected surface soil should be sufficient for risk assessment studies. Sediment and surface water will be sampled at the locations previously sampled in the RFI/RI to confirm the earlier findings in accordance with regulatory reviewer comments (IT, 1994) (FDEP, 1995b). Groundwater samples will be collected from all permanent existing monitoring well locations to confirm previously detected metals, cyanide, and pesticide concentrations. Many of the positive contaminant detections in the earlier RFI/RI were from temporary wells that could have yielded nonrepresentative samples that were biased by turbidity.

The number of samples and target analytes proposed include:

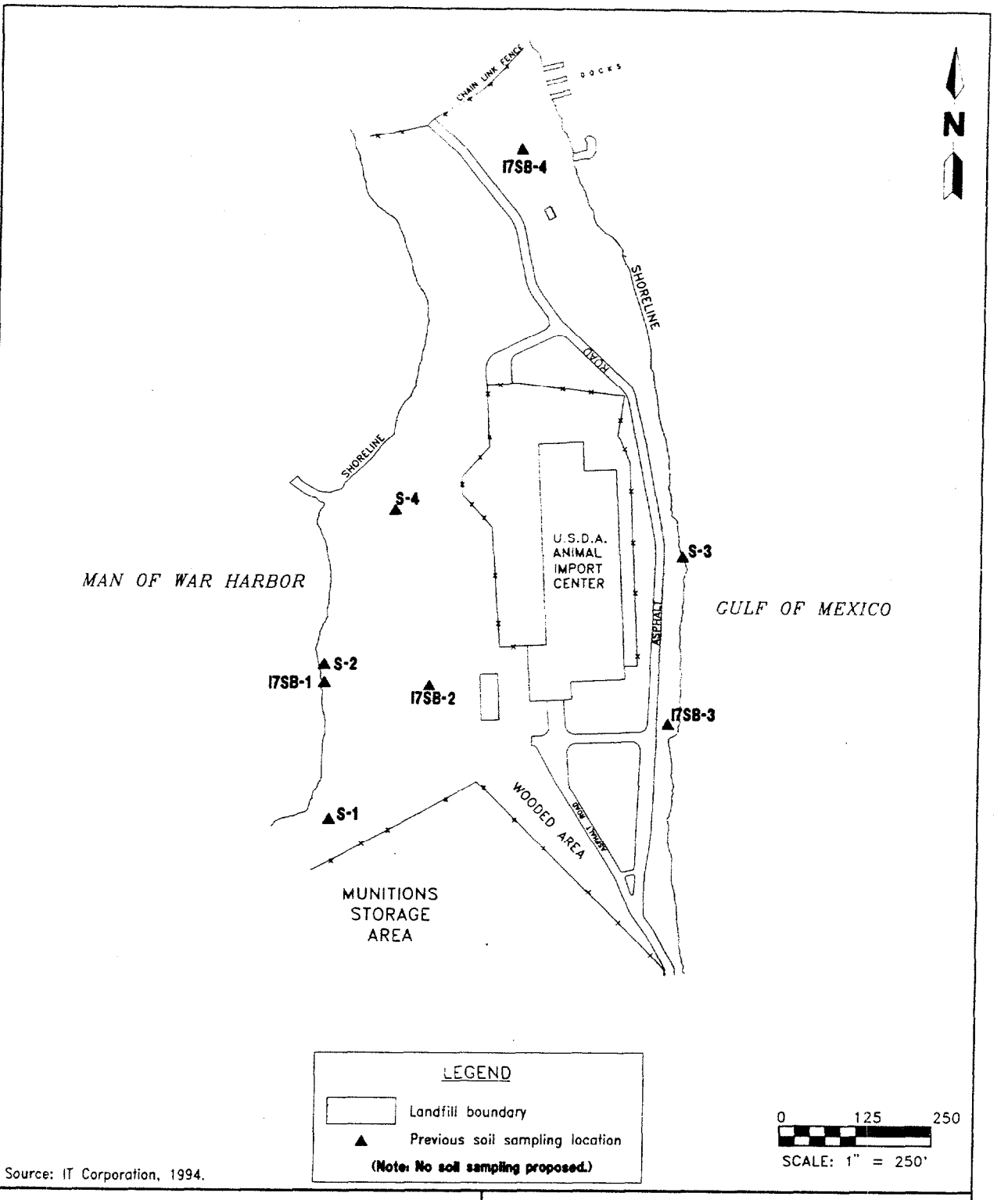
surface soil - no surface soil samples will be collected (Figure 3-26).

Surface water and sediment - resample 10 locations that were previously sampled in RFI and RI (Figure 3-27), analysis for Appendix IX SVOCs, pesticides and PCBs, TAL metals, and cyanide.

Groundwater monitoring wells - no monitoring wells will be installed (Figure 3-28)

Groundwater sampling - sample groundwater at nine existing wells (Figure 3-28), analysis for Appendix IX pesticides and PCBs, TAL metals, and cyanide.

3.2.11 IR Site 8, Fleming Key South Landfill Field activities at this site include collection of sediment and surface water samples and groundwater sampling. No surface soil sampling is proposed. Sediment and surface water samples will be collected from the same locations as in the original RFI/RI program for the purpose of confirming the previous data (in accordance with regulatory review comments) (FDEP, 1995b). Groundwater samples will be collected from existing permanent monitoring wells in order to confirm previously detected metals concentrations and determine the contribution of turbidity to the metals findings reported (IT, 1994).



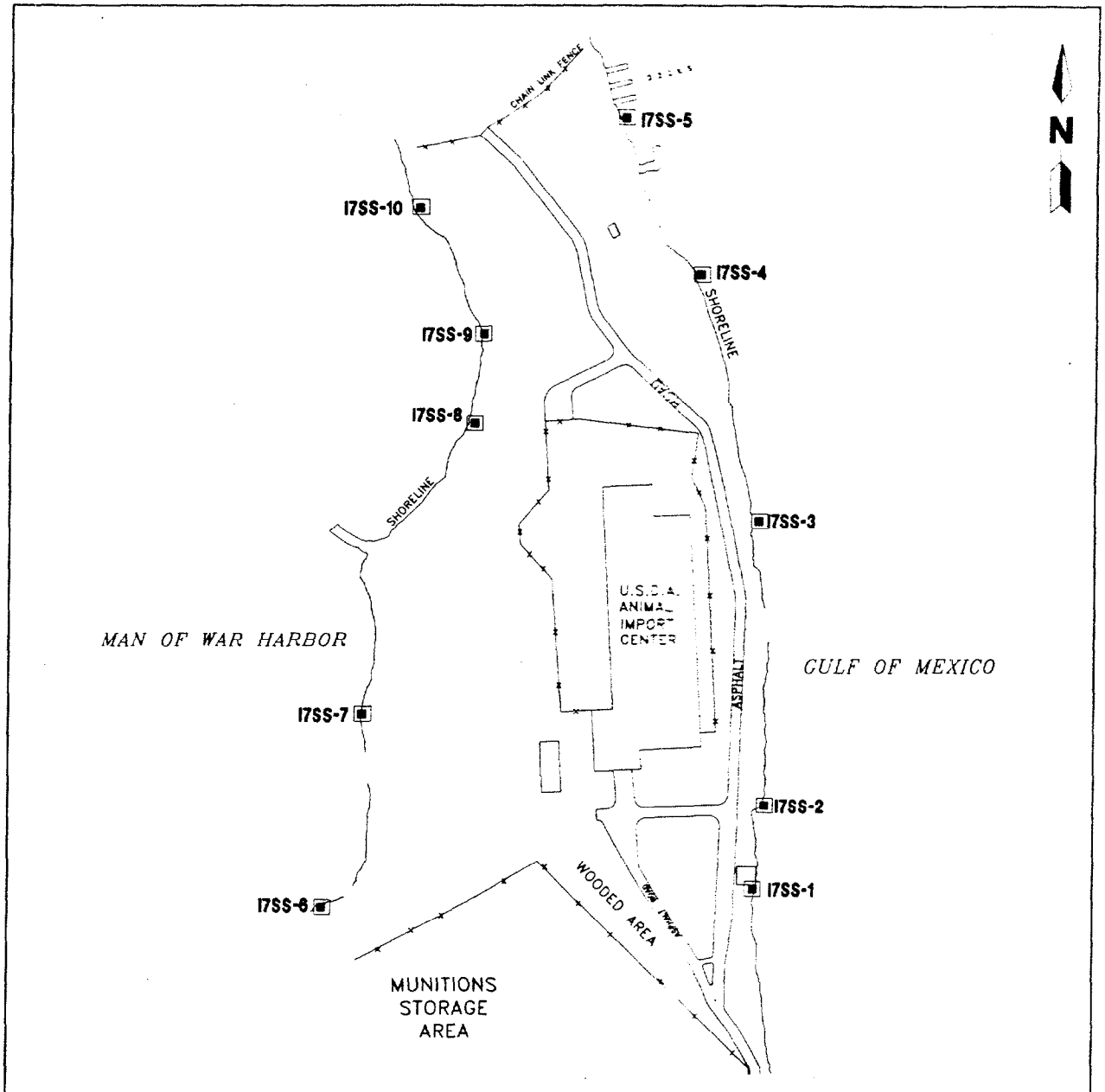
Source: IT Corporation, 1994.

FIGURE 3-26
PROPOSED AND PREVIOUS SOIL SAMPLING LOCATIONS
IR NO. 7, FLEMING KEY
NORTH LANDFILL

H:\KEYWEST\RFI-RI\2028B21\WDW-SB-NP\06-15-95

SUPPLEMENTAL RFI/RI
SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



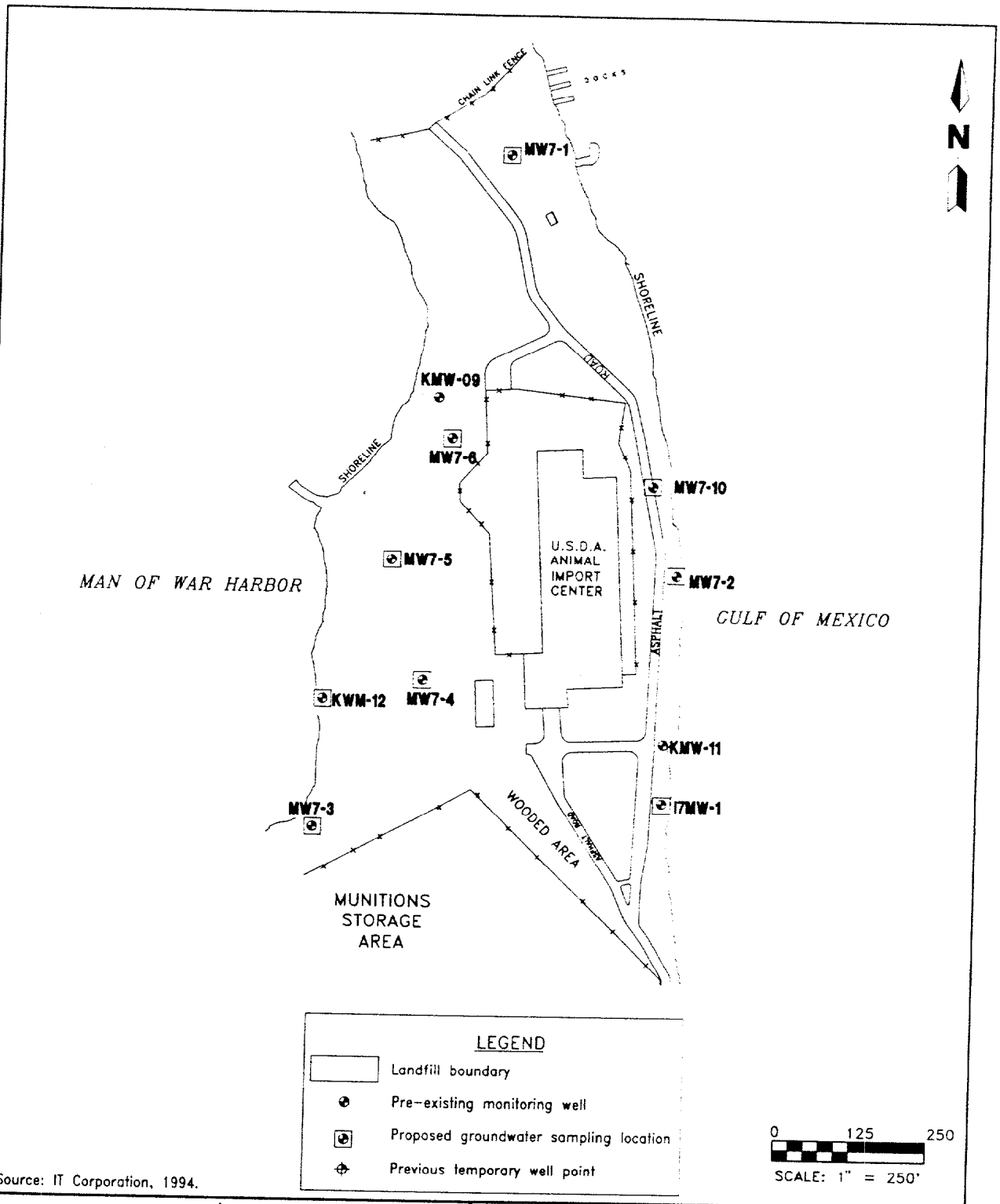
Source: IT Corporation, 1994.

FIGURE 3-27
PROPOSED AND PREVIOUS SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS
IR NO. 7, FLEMING KEY
NORTH LANDFILL

H:\KEYWEST\RFI-RI\2028821\WDW-SB-NP\06-15-95

SUPPLEMENTAL RFI/RI
SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



Source: IT Corporation, 1994.

FIGURE 3-28
PROPOSED AND PRE-EXISTING MONITORING WELLS AND GROUNDWATER SAMPLING LOCATIONS
IR NO. 7, FLEMING KEY
NORTH LANDFILL

H:\KEYWEST\RFI-RI.2028821\WDW-SB-NP\06-15-95

SUPPLEMENTAL RFI/RI
SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

The number of samples and target analytes proposed include:

Surface soil - no soil sampling will be conducted (Figure 3-29).

Surface water and sediment - resample 10 locations that were previously sampled in RFI and RI (Figure 3-30), analysis for Appendix IX SVOCs, pesticides and PCBs, TAL metals, and cyanide.

Groundwater monitoring wells - no monitoring wells will be installed (Figure 3-31).

Groundwater sampling - sample groundwater at 9 existing wells (Figure 3-31), analysis for Appendix IX SVOCs, pesticides and PCBs, TAL metals, and cyanide.

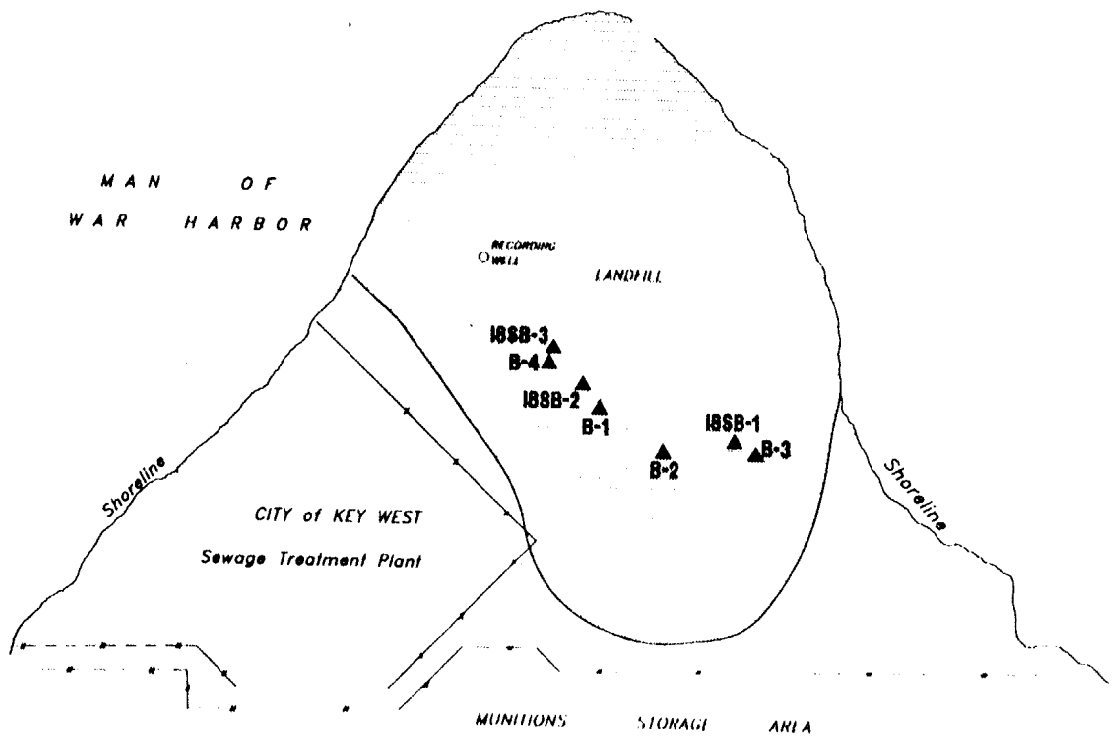
3.2.12 AOC A, Demolition Key Open Disposal Area The supplemental field activities at this site address additional work to assess the presence and nature of contaminants within groundwater onsite and sediment and surface water offshore from the ordnance demolition and burning area and groundwater onsite. Prior to initiating any work onsite an unexploded ordnance survey will be conducted on the site. Only two sediment samples were collected in the original RFI/RI program (IT, 1994). Combined with the additional sediment and surface water data and groundwater data, existing surface soil data should be sufficient for development of risk criteria, considering the main pathway for exposure is via surface water and sediment. Three temporary monitoring wells are also proposed for this site.

The number of samples and target analytes proposed include:

Surface soil - no surface soil samples will be collected (Figure 3-32).

Surface water and sediment - resample two locations that were previously sampled in RFI/RI plus four additional locations (Figure 3-32), analysis for Appendix IX SVOCs, pesticides and PCBs, TAL metals, and cyanide.

Groundwater monitoring wells - three temporary monitoring wells will be installed (Figure 3-32).



LEGEND

▲ Previous soil sampling location

▲ Proposed soil sampling location

(Note: No soil sampling proposed.)

Source: II Corporation, 1994

0 150 300

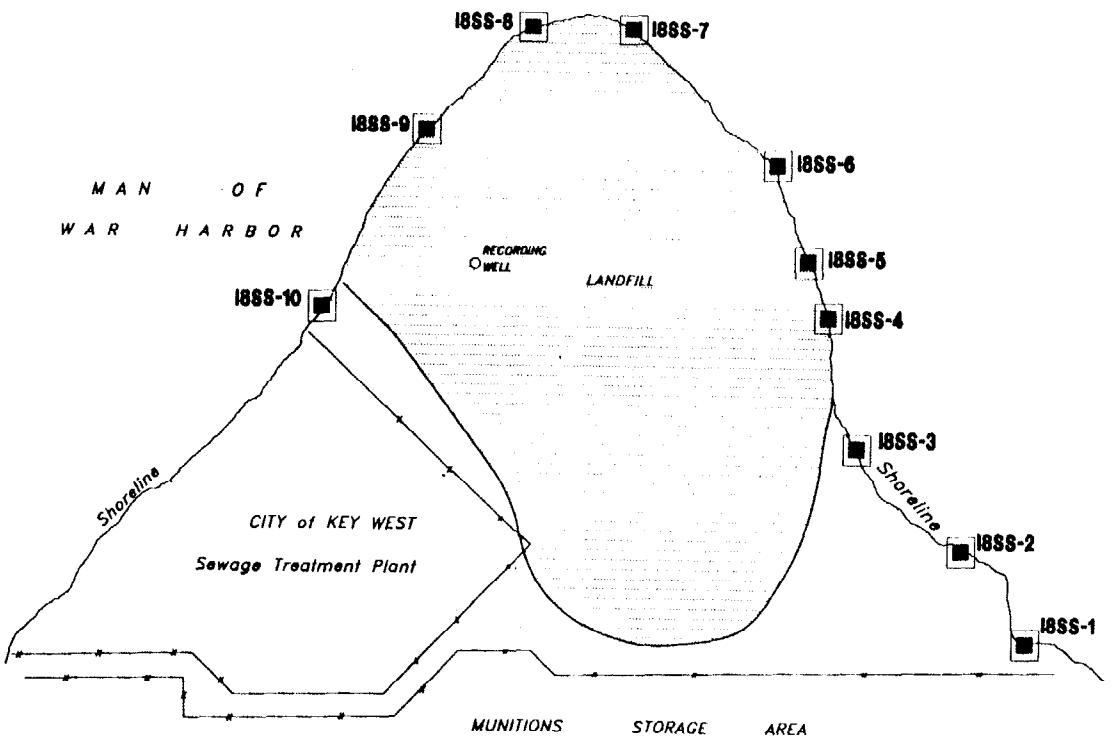
SCALE: 1" = 300'

H:\KEYWEST\RF-RI\2028833\WDW-SB-NP\06-15-95

FIGURE 3-29
PROPOSED AND PREVIOUS SOIL SAMPLING LOCATIONS
IR NO. 8,
FLEMING KEY SOUTH LANDFILL

SUPPLEMENTAL RFI/RI
SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



LEGEND

- Previous sediment and surface water sampling location
- Proposed sediment and surface water sampling location

(Note: All previous locations to be resampled.)

Source: IT Corporation, 1994.

0 150 300

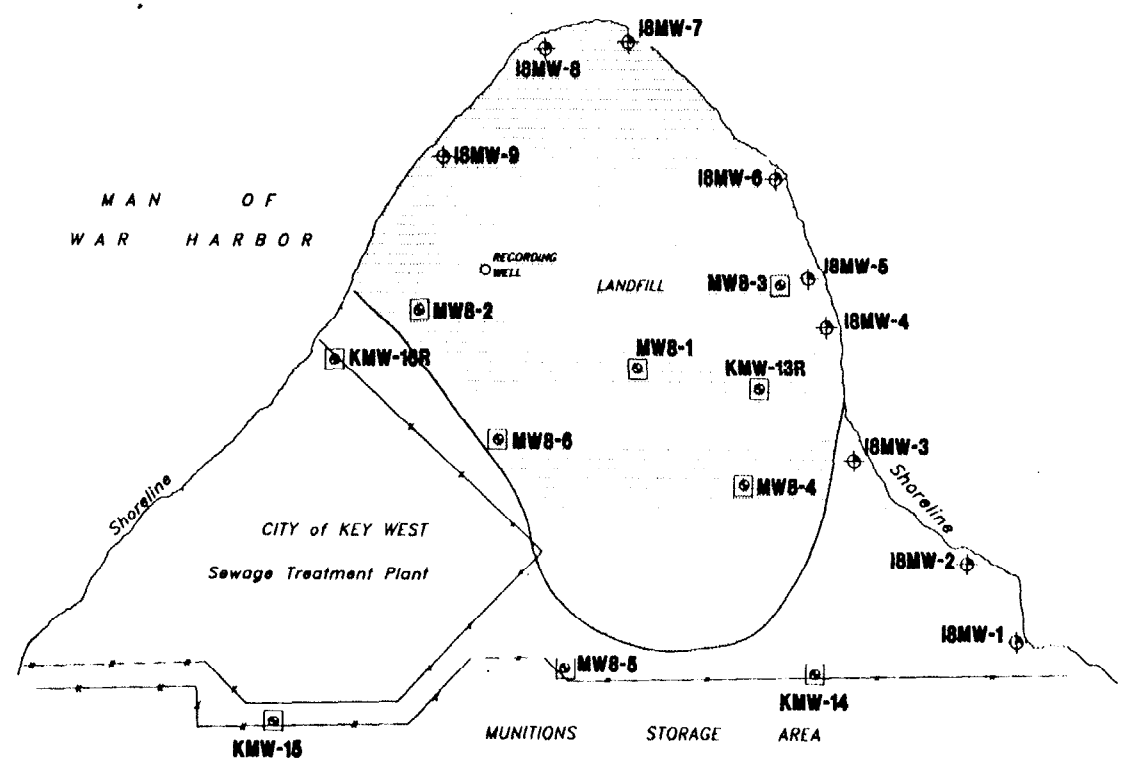
SCALE: 1" = 300'

H:\KEYWEST\RF-RI\20208133\WOW-SB-NP\06-15-95

FIGURE 3-30
PROPOSED SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS
IR NO. 8,
FLEMING KEY SOUTH LANDFILL

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



LEGEND

- Pre-existing monitoring well location
- Previous temporary well point
- Proposed groundwater sampling location

Source: IT Corporation, 1994.

0 150 300

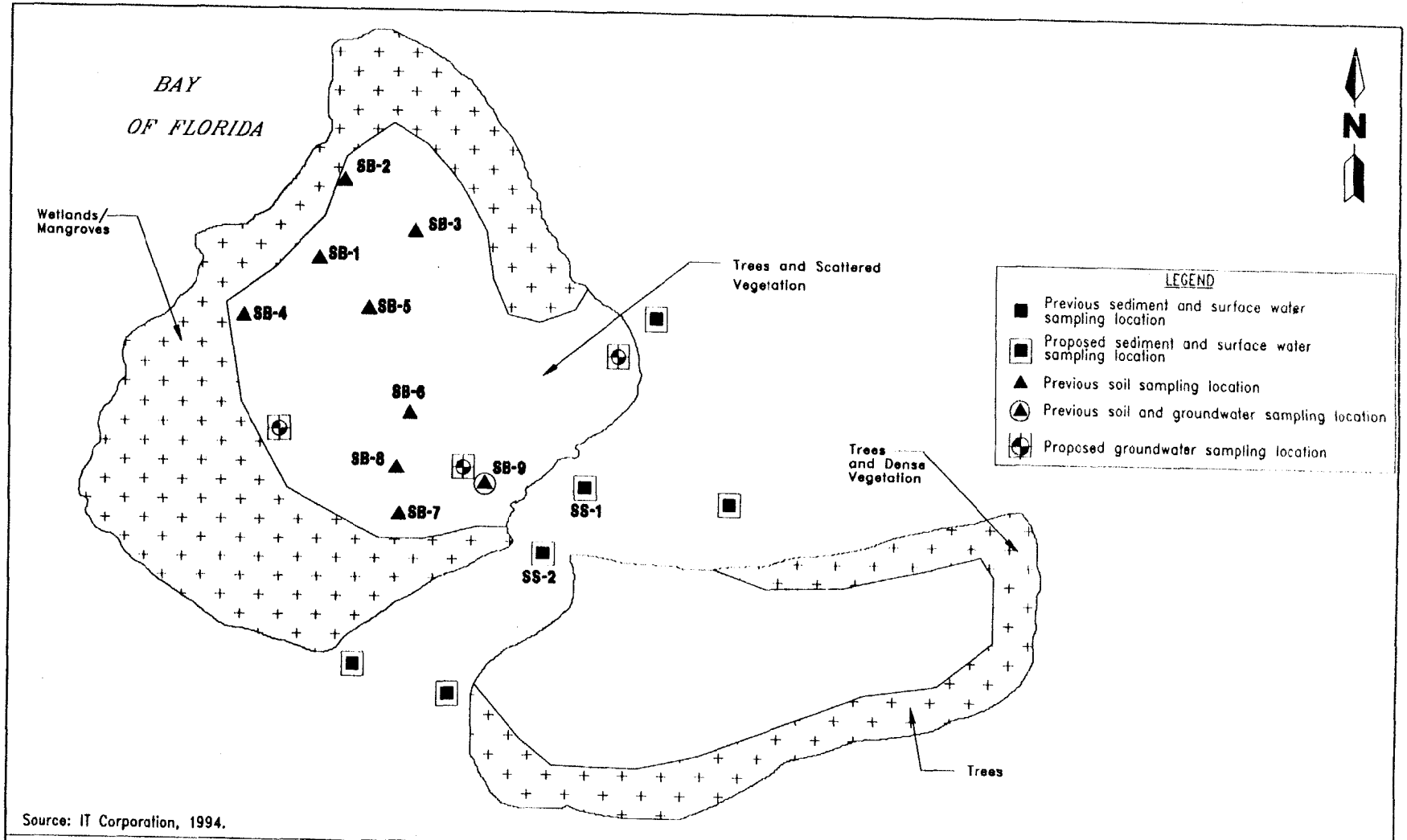
SCALE: 1" = 300'

H:\KEYWEST\RF-RI\2028833\MDW-SB-NP\08-15-95

FIGURE 3-31
PROPOSED AND PRE-EXISTING MONITORING WELLS AND GROUNDWATER SAMPLING LOCATIONS
IR NO. 8,
FLEMING KEY SOUTH LANDFILL

SUPPLEMENTAL RFI/RI
SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA



Source: IT Corporation, 1994.

0 100 200

SCALE: 1" = 200'

H:\KEYWEST\RF-RI\202BB23\WDW-SB-NP\06-15-95

FIGURE 3-32
PROPOSED AND PREVIOUS SAMPLING LOCATIONS FOR SOIL, GROUNDWATER, AND SEDIMENT AND SURFACE WATER
AOC SITE A, DEMOLITION KEY
OPEN DISPOSAL AREA

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST
KEY WEST, FLORIDA

Groundwater sampling - three groundwater samples will be collected, analyses for Appendix IX VOCs, SVOCs, and metals including explosives related containments (Figure 3-32).

3.2.13 AOC B, Big Coppitt Key Abandoned Civilian Disposal Area Supplemental field activities at AOC B will be limited to resampling of sediment and surface water and installation of three temporary monitoring wells. Because the disposal area lies within a tidal fluctuation zone surrounded by mangrove swamp, soil exposure and groundwater migration would not be of concern. The sediment and surface water samples will be collected from approximately the same locations as those sampled in the previous RFI/RI sampling program (IT, 1994). Resampling will occur after the IRA is completed by the RAC.

The number of samples and target analytes proposed include:

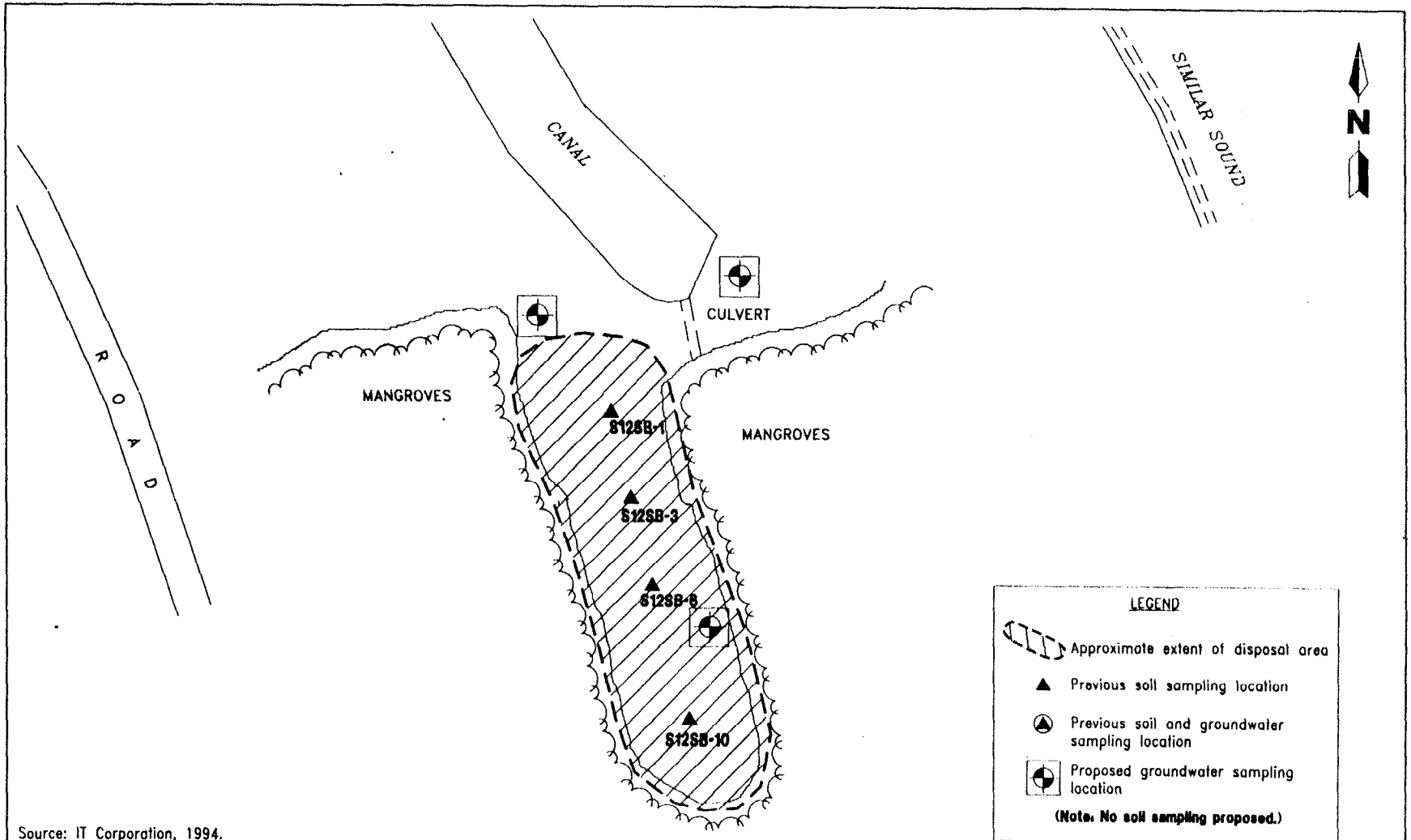
Surface soil - no surface soil samples will be collected (Figure 3-33).

Surface water and sediment - resample 10 locations that were previously sampled in RFI and RI (Figure 3-34), analysis for Appendix IX pesticides and PCBs, TAL metals, and cyanide.

Groundwater monitoring wells - three monitoring wells will be installed (Figure 3-34).

Groundwater sampling - three groundwater samples will be collected, analyses for Appendix IX VOCs, SVOCs, pesticides and PCBs, TAL metals, and cyanide.

3.2.14 Summary by Site A summary of the specific sampling tasks and analytical requirements are presented by site in Tables 3-1 and 3-2.



Source: IT Corporation, 1994.

0 125 250

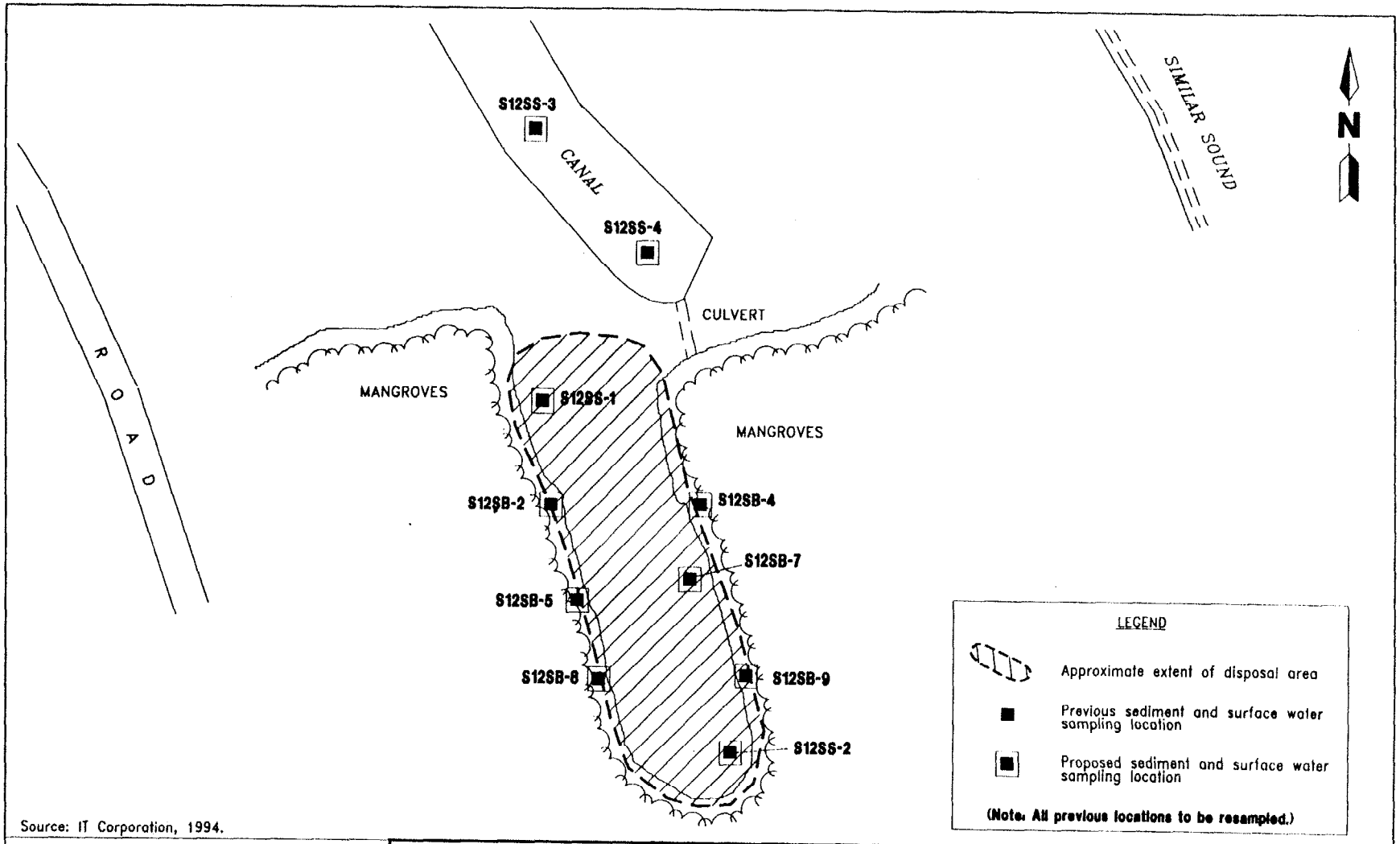
SCALE: 1" = 250'

H:\KEYWEST\RFI-RI\2028824\WDW SB-MP\08-15-95

FIGURE 3-33
PROPOSED AND PREVIOUS SOIL AND GROUNDWATER SAMPLING LOCATIONS AOC SITE B, BIG COPPITT KEY ABANDONED CIVILIAN DISPOSAL AREA

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST KEY WEST, FLORIDA



Source: IT Corporation, 1994.

0 125 250

SCALE: 1" = 250'

FIGURE 3-34
PROPOSED AND PREVIOUS SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS AOC SITE B, BIG COPPITT KEY ABANDONED CIVILIAN DISPOSAL AREA

SUPPLEMENTAL RFI/RI SAMPLING AND ANALYSIS PLAN

NAS KEY WEST KEY WEST, FLORIDA

Table 3-1
Field Program Activity Summary

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

Site	Monitoring Well Installation (number of wells/ average depth in feet)	Groundwater Sampling (number of samples)	Soil Sampling (number of samples at common location for surface [SS] and subsurface [SB])	Sediment Sampling (number of samples and locations)	Surface Water Sampling (number of samples and locations)
SWMU 1: Boca Chica Open Disposal Area	4/12	4	3-SS	6	6
SWMU 2: Boca Chica DDT Mixing Area	3/12	6	5-SS	4	4
SWMU 3: Boca Chica Fire-Fighting Training Area	4/12	6		5	5
SWMU 4: Boca Chica AIMD Building A-980	4/12	6		4	4
SWMU 5: Boca Chica AIMD Building A-989	2/12	4		5	5
SWMU 7: Boca Chica Building A-824			4-SS	5	5
SWMU 9: Jet Engine Test Cell Building A-969		8	5-SS 5-SB	4	4
Facility Wide Background			9-SS	3	3
IR Site 1: Truman Annex Open Disposal Area	5/12	9	118-SS	7	7
IR Site 3: Truman Annex DDT Mixing Site	6/12	8	12-SS 12-SB		
IR Site 7: Fleming Key North Landfill		9		10	10
IR Site 8: Fleming Key South Landfill		9		10	10
AOC A: Demolition Key Open Disposal Area	3/10			6	6
AOC B: Big Coppitt Key Abandoned Civilian Disposal Area	3/10			10	10
Facility Wide Background			5SS	5	5

Notes: SWMU = solid waste management unit.
DDT = dichlorodiphenyltrichloroethane.
AIMD = Aircraft Intermediate Maintenance Department.
IR = Installation Restoration.
AOC = area of concern.

Table 3-2
Summary of Laboratory Analytical Requirement

Supplemental RFI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

Site	Volatile Organics (Appendix IX)	Semivolatile Organics (Appendix IX)	Pesticides and PCBs (Appendix IX)	Target Analyte List Inorganics
SWMU 1: Boca Chica Open Disposal Area	GW - 4 SO - 3 SD - 6 SW - 6	GW - 4 SO - 3 SD - 6 SW - 6	GW - 4 SO - 3 SD - 6 SW - 6	GW - 4 SO - 3 SD - 6 SW - 6
SWMU 2: Boca Chica DDT Mixing Area	GW - 5 SO - 5 SD - 4 SW - 4	GW - 1	GW - 5 SO - 5 SD - 4 SW - 4	GW - 5 SO - 5 SD - 4 SW - 4
SWMU 3: Boca Chica Fire-Fighting Training Area	GW - 6	GW-6		SD - 5 SW - 5
SWMU 4: Boca Chica AIMD Building A-980	GW - 6 SO - 2 SD - 5 SW - 5	GW - 6 SD - 4 SW - 4 SO - 2	SO - 2	GW - 6 SD - 4 SW - 4 SO - 2
SWMU 5: Boca Chica AIMD Building A-990	SO - 5 SW - 5	GW - 4 SD - 5 SW - 5		GW - 4 SD - 5 SW - 5
SWMU 7: Boca Chica Building A-824	GW - 3 SO - 4 SD - 5 SW - 5	GW - 3 SO - 4 SD - 5 SW - 5	GW - 3 SO - 4 SD - 5 SW - 5	GW - 3 SO - 4 SD - 5 SW - 5
SWMU 9: Jet Engine Test Cell Building A-969	GW - 8 SO - 10 SD - 4 SW - 4	GW - 8 SO - 10 SD - 4 SW - 4	GW - 8 SO - 10 SD - 4 SW - 4	GW - 8 SO - 10 SD - 4 SW - 4
Facility Wide Background	SO - 9 SD - 3 SW - 3	SO - 9 SD - 3 SW - 3	SO - 9 SD - 3 SW - 3	SO - 9 SD - 3 SW - 3
IR Site 1: Truman Annex Open Disposal Area	GW - 9 SO - 1	GW - 9 SO - 1	GW - 9 SD - 7 SW - 7 SO - 1	GW - 9 SO - 118 SD - 7 SW - 7
IR Site 3: Truman Annex DDT Mixing Site	SO - 3	SO - 3	GW - 8 SO - 24	GW - 8 SO - 24
IR Site 7: Fleming Key North Landfill	GW - 2	GW - 2 SD - 10 SW - 10	GW - 9 SD - 10 SW - 10	GW - 9 SD - 10 SW - 10
IR Site 8: Fleming Key South Landfill	GW - 2	GW - 9 SD - 10 SW - 10	GW - 9 SD - 10 SW - 10	GW - 9 SD - 10 SW - 10

See notes at end of table.

Table 3-2 (Continued)
Summary of Laboratory Analytical Requirement

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

Site	Volatile Organics (Appendix IX)	Semivolatile Organics (Appendix IX)	Pesticides and PCBs (Appendix IX)	Target Analyte List Inorganics
AOC A: Demolition Key Open Disposal Area	GW - 3*	GW - 3 SD - 6* SW - 6		GW - 3 SD - 6 SW - 6
AOC B: Big Coppitt Key Abandoned Civilian Disposal Area	GW - 3	GW - 3 SD - 10 SW - 10	GW - 3 SD - 10 SW - 10	GW - 3 SD - 10 SW - 10
Facility Wide Background	SO - 5 SD - 5 SW - 5	SO - 5 SD - 5 SW - 5	SO - 5 SD - 5 SW - 5	SO - 5 SD - 5 SW - 5

Notes: Volatile organics per U.S. Environmental Protection Agency (USEPA) Method 8240.
Semivolatile organics per USEPA Method 8270.
Pesticides and polychlorinated biphenyls (PCBs) per USEPA Method 8080.
Target analyte list inorganics include metals and cyanide.

PCBs = polychlorinated biphenyls.
SWMU = solid waste management unit.
DDT = dichlorodiphenyltrichloroethane.
GW = groundwater.
SO = soil.
SD = sediment.
SW = surface water.
AIMD = Aircraft Intermediate Maintenance Department.
IR = Remedial Investigation.
AOC = area of contamination.
* = includes explosives-related analytes.

3.3 ECOLOGICAL AND BIOLOGICAL FIELD SAMPLING PROGRAM.

3.3.1 Ecological and Biological Field Sampling Program for SWMUs An ecological and biological field sampling program for the NAS Key West SWMUs will be developed based on the process outlined in Appendix A, Volume I of the workplan. In general, the process will include a review of the existing analytical chemistry data, an analysis of the results from the RFI/RI preliminary ecological risk evaluation (IT, 1994), and a site visit. Information obtained in this step will be used in a preliminary problem formulation for the sites. The preliminary screening and problem formulation may be sufficient to determine that no further action is necessary at an individual site, or, if uncertainties exist, additional data may be collected to reduce the uncertainties associated with the preliminary problem formulation. An ecological risk assessment will be completed at each site where the preliminary problem formulation suggests that ecological risk is a concern. The ecological risk assessment will commence with a second problem formulation phase; in this step the need for biological and toxicological sampling on a site-by-site basis will be evaluated. When biological and/or toxicological sampling is required to evaluate ecological risks, an SAP addendum will be prepared to provide specific details regarding the sampling event(s). Final recommendations for biological field sampling (toxicity testing, tissue analysis, or a community survey) will be made in the SAP addendum. Additional detail regarding the biological and toxicity evaluation tool that will be used at NAS Key West can be found in Subsection 2.2.6.3 of this Supplemental RFI/RI Workplan.

Results for the final RFI/RI report (IT, 1994) preliminary ecological risk evaluations suggest that toxicity sampling may be recommended for SWMUs 1, 2, and 5. In addition, tissue contaminant burden analysis may provide information regarding those compounds that bioaccumulate and/or bioconcentrate in food chains. Bioaccumulation and biomagnification of environmental contaminants in plant or animal tissues may need to be evaluated at SWMUs 1 and 2, based on concentrations of DDT, lead, mercury, and silver. Table 3-3 presents a preliminary set of biological and ecological field sampling recommendations, which will be finalized in future SAP addenda for the sites.

3.3.2 Ecological and Biological Field Sampling Program for IR Sites An ecological and biological field sampling program for the NAS Key West IR sites will be developed based on the process outlined in Appendix A of Volume I of the workplan. In general, the process will include a review of the existing analytical chemistry data, an analysis of the results from the RFI/RI preliminary ecological risk evaluation (IT, 1994), and a site visit. Information obtained in this step will be used in a preliminary problem formulation for the sites. The preliminary screening and problem formulation may be sufficient to determine that no further action is necessary at an individual site, or, if uncertainties exist, additional data may be collected to reduce the uncertainties associated with the preliminary problem formulation. An ecological risk assessment will be completed at each site where the preliminary problem formulation suggests that ecological risk is a concern. The ecological risk assessment will commence with a second problem formulation phase; in this step the need for biological and toxicological sampling on a site-by-site basis will be evaluated. When biological and/or toxicological sampling is required to evaluate ecological risks, a SAP addendum will be prepared to provide specific details regarding the sampling event(s). Final recommendations for biological field sampling (toxicity testing, tissue analysis, or a community survey) will be made in the SAP addendum. Additional detail regarding the biological and toxicity evaluation tool that may be used at NAS Key West can be found in Subsection 2.2.6.3 above.

Results from the final RFI/RI report (IT, 1994) preliminary ecological risk evaluations suggest that toxicity sampling may be recommended for IR Sites 1, 7, 8, and AOC A. In addition, tissue contaminant burden analysis may provide information regarding those compounds that bioaccumulate and/or bioconcentrate in food chains. Bioaccumulation and biomagnification of environmental contaminants in plant or animal tissues may need to be evaluated at IR Sites 1 and 7, based on concentrations of PCBs, DDT, lead, mercury, and silver. Table 2-4 presents a preliminary set of biological and ecological field sampling recommendations, which will be finalized in future SAPs addenda for the sites.

Table 3-3
Proposed Ecological Activities at SWMU Sites

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

Site ID	Site Name	Toxicity Testing		Tissue Analysis/ Bioaccumulation Study	
		Terrestrial	Aquatic	Terrestrial	Aquatic
SWMU-1	Boca Chica Open Disposal Area	X	X	X	X
SWMU-2	Boca Chica DDT Mixing Area		X		X
SWMU-5	Boca Chica AIMD Building A-990		X		

Notes: X = based on a review of the Resource Conservation and Recovery Act (RCRA) Facility Investigation and Remedial Investigation (RFI/RI) (International Technology Corporation, 1994), biological sampling may be recommended. A final determination regarding the need for and scope of biological sampling at these sites will be made in the Problem Formulation #2 phase of work.
SWMU = solid waste management unit.
DDT = dichlorodiphenyltrichloroethane.

Table 3-4
Proposed Ecological Activities at IR Sites

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

Site ID	Site Name	Toxicity Testing		Tissue Analysis/ Bioaccumulation Study	
		Terrestrial	Aquatic	Terrestrial	Aquatic
IR Site-1	Truman Annex Refuse Disposal Area		X		X
IR Site-7	Fleming Key North Landfill		X		X
IR Site-8	Fleming Key South Landfill		X		
AOC B	Big Coppitt Key Abandoned Civilian Disposal Area		X		

Notes: X = based on a review of the Resource Conservation and Recovery Act (RCRA) Facility Investigation and Remedial Investigation (RFI/RI) (International Technology Corporation, 1994), biological sampling may be recommended. A final determination regarding the need for and scope of biological sampling at these sites will be made in the Problem Formulation #2 phase of work.
RI = Remedial Investigation.
AOC = area of concern.

4.0 QUALITY ASSURANCE PROJECT PLAN

4.1 QUALITY ASSURANCE OBJECTIVES. The Quality Assurance Project Plan (QAPP) previously prepared and included in the SAP by IT (1993) for the RFI/RI program at NAS Key West is fully adopted and incorporated as the basis for this supplemental RFI/RI QAPP. This QAPP consequently provides details only in those areas or procedures that vary from or augment the original RFI/RI workplan.

4.2 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT. Parameters used within the data validation process to evaluate data quality include measurement of precision, accuracy, representativeness, completeness, and comparability (PARCC). The achievable limits for these parameters vary with the data quality objective (DQO) level of the data. These parameters are defined here and methods of calculation are discussed in Section 3.11. The quality assurance (QA) objectives for the proposed analytical methods are presented in the USEPA SW 846 (USEPA, 1986).

Precision and Accuracy. Precision, the ability to replicate a value, and accuracy, the ability to obtain a true value, are addressed for all generated data. Precision and accuracy requirements vary depending on intended data uses and are selected in accordance with project requirements. DQOs for precision and accuracy are established for each major parameter to be measured at the site based on knowledge of the capabilities of available measurement systems and the analytical detection limit required.

Representativeness. Representativeness expresses the degree to which sample data depict an existing environmental condition. Representativeness is accomplished through proper selection of sampling locations and sampling techniques and collection of a sufficient number of samples.

The sampling locations in this supplemental RFI/RI program will be chosen in a biased approach based on previous analytical data, screening data collected in the field, and apparent and measured groundwater flow directions.

Sampling and analytical protocols have been chosen so that measurements of samples will be as representative of the media and conditions being measured as possible.

Sample collection, handling, and documentation will be performed in accordance with the ECBSOPQAM (USEPA, 1991) to ensure that collection and handling techniques do not alter the sample and to provide an adequate tracking mechanism from the time of collection through laboratory analytical.

Completeness. The characteristic of completeness is a measure of the amount of valid data obtained compared to the amount of data originally intended to be obtained. The completeness goal for DQO Level III will be consistent with the SW-846 requirements of 95 percent.

Field activities performed at DQO Levels I and II are onsite measurement techniques that provide information in real-time or after minimal delay. The completeness achieved for these methods may be more variable than those for standard analytical methods. A higher degree of completeness may be achieved because measurements can be readily repeated. However, site conditions may constrain the use of some techniques, resulting in fewer valid analyses than anticipated.

The sampling objectives described in these planning documents allow for a sufficient number of samples to accomplish the project objectives. However, the number of samples presented are estimates that may be revised based on screening data collected in the field. Examples of circumstances that may cause variations might include increasing or decreasing the number of samples needed for adequate delineation or characterization of IDW, and/or decreasing the number of screening samples.

Comparability. The characteristic of comparability reflects the confidence with which one data set can be compared with other measurements and the expression of results consistent with other organizations reporting similar data. This will be accomplished through the use of standard techniques for sample collection analytical and the reporting of results in appropriate units. Comparability of analytical procedures also implies using analytical methodologies that produce

results comparable in terms of precision, accuracy, and effective range of calibration.

4.3 SAMPLING PROCEDURES. Step-by-step instructions for each type of sampling activity are necessary to enable the field team to gather data that will meet the DQOs. Sampling procedures for each sample matrix are outlined in the FSP (Chapter 2.0) above and in the approved SAP prepared by IT (1993).

4.4 SAMPLE CUSTODY. Each sample received by the analytical laboratory for processing must be properly documented to ensure complete and accurate analytical for all parameters requested.

4.4.1 Chain-of-Custody After the sample is collected, the outside of the sample container is properly decontaminated, and documentation for sample shipment is completed, a chain of custody (COC) record must be prepared to maintain the legal transfer of the sample from the field team to the laboratory. The COC lists each sample in that shipment. The COC record is used to record the custody of samples and will accompany samples at all times. Procedures for maintaining the appropriate sample custody information will be in accordance with the ECBSOPQAM (USEPA, 1991). The COC record will contain the following information:

- project name;
- signature of samplers;
- sampling station number or sample number;
- date and time of collection;
- brief description of the type of sample and sampling location;
- analytical to be performed and sample bottle type;
- for each sample, the number of containers for each bottle type;
- signatures of individuals involved in sample transfer (i.e., relinquishing and accepting samples);
- sample label number; and
- matrix.

All samples will be accompanied by the COC record. The original and one copy of the record will be shipped inside the shipping container if samples are shipped. By using a unique sample identification number for each sample, all ancillary records can be traced to specific sampling events. One copy of the COC record will be retained by the field investigator. The original record will be transmitted to the field investigator after samples are accepted by the laboratory. This copy will become part of the project records. The COC record will be signed and dated upon receipt by the laboratory. Custody tracking will be maintained by the laboratory from sample receipt through storage, analytical, and disposal in accordance with the individual laboratory's QA plan.

When samples are relinquished to a shipping company for transport, the tracking number from the shipping bill or receipt will be recorded on the sample COC record. As necessary, ABB-ES uses carriers (i.e., Federal Express) to ship samples. In these cases, the airbill tracking number becomes part of the COC.

4.4.2 Sample Labels Samples, other than those collected for field measurements or analyses, are identified by using a standard sample label that is attached to the sample container. The following information is included on the sample label:

- site name,
- field identification or sample station number,
- date and time of sample collection,
- designation of the sample as a grab or composite,
- the signature(s) of the sampler(s),
- sample preservation and preservative used, and
- the general types of analyses to be conducted.

4.4.3 Handling, Packaging, and Shipping Requirements After the sample labels are affixed to the sample container and the COC record is completed, shipping containers can be prepared.

Sample packaging and shipping procedures should protect the integrity of the samples and prevent detrimental effects from leakage or breakage. Regulations for packaging, marking, labeling, and shipping hazardous materials and wastes are promulgated by the U.S. Department of Transportation (DOT) and described in the

Code of Federal Regulations (49 CFR 171 through 177; in particular 172.402h, Packages Containing Samples). In general, these regulations were not intended to hamper shipment of samples collected at controlled or uncontrolled hazardous waste sites or samples collected during emergency responses. However, the USEPA has agreed through a Memorandum of Agreement to package, mark, label, and ship samples observing DOT procedures.

Prior to packaging, each sample container should be inspected to confirm correct labeling. Labels should be secured to containers with clear tape. Samples will be shipped to the laboratory via commercial ground or air carrier within 24 hours of sample collection.

All breakable sample containers (glass) will be protected with packing. Bubble-pack bags or strips are acceptable. Sample containers may be placed together in heavy duty garbage bags and sealed.

Samples will be shipped in durable coolers packed with bubble-pack or vermiculite. Samples will be kept cool with double-bagged clean ice. Completed COC records will be placed in a plastic bag and taped to the inside lid of the shipping container. If COC records refer to multiple containers, they will be placed in the lead container.

A signed and dated COC seal will be secured with clear tape over the front of the container lid. The container will be sealed by wrapping it in filament tape.

Until relinquished to the carrier, the shipping containers are to remain with ABB-ES personnel or remain in a locked vehicle so as not to be accessible to others. Upon shipping, the laboratory will be contacted and advised of the contents, arrival date and time, carrier, and number of containers.

4.5 CALIBRATION PROCEDURES. Procedures and documentation required for calibration of field instruments and laboratory instruments and equipment are contained in the ECBSOPQAM (USEPA, 1991) and USEPA SW-846 procedure manuals for organic and inorganic analyses. It should be noted that some of the calibration and maintenance procedures specified in the ECBSOPQAM are specific to the

Environmental Control Branch operations and are not applicable to NAS Key West supplemental RFI/RI field operations.

Field instruments and equipment will be calibrated and inspected daily before field activities begin, as suggested by the manufacturers. Calibration information will be recorded in a calibration log, which will be kept on file at the field office trailer. Malfunctioning instruments will be repaired or replaced. Monitoring equipment will be protected from contamination during field exploration activities as much as possible without hindering operation of the unit. Equipment maintenance will be performed according to manufacturer specifications before field use, or by cycling units out of the field. As appropriate, routine periodic maintenance may be performed as a function of field calibration. Calibration and maintenance information for the field equipment to be used during the RI investigation can be found in Appendix B. Where the requirements found in the ECBSOPQAM (1991) and manufacturers' instructions conflict, the most rigorous will apply.

All offsite laboratories will have an in-place program for equipment calibration procedures and frequency that meets standards established by the USEPA SW-846.

4.6 ANALYTICAL PROCEDURES. Laboratory analytical procedures will be conducted in conformance with USEPA SW-846 requirements. Sample matrices and types to be collected and analyzed are summarized in the previous section in Tables 3-1 and 3-2. Laboratory analytical samples will be collected and analyzed in conformance with Level III DQOs and the ECBSOPQAM (USEPA, 1991). The subcontracted laboratories will have an active internal quality assurance/quality control (QA/QC) program and will be Naval Energy and Environmental Support Activity (NEESA) approved.

The analytical parameters are proposed based on confirmed and identified waste types as discussed in this Workplan. A list of the sample types, parameters, and methods to be used by all laboratories supporting this supplemental RI/FS program provided in Tables 4-1.

4.7 DATA REDUCTION, VALIDATION, AND REPORTING. Data collected from investigative activities include survey data, field screening data, and onsite and offsite laboratory analytical data. The ultimate data uses include site characterization, the assessment of potential risk to human health and the environment, and the development of effective remedial measures, where necessary.

Upon receipt of samples for analytical (accompanied by a completed COC record detailing requested analytical), both the onsite and offsite laboratories will:

- confirm all COC records;
- log in samples, assign unique log numbers, and attach numbers to the sample containers;
- open project file and enter data on laboratory computer;
- assign priority and hazard rating criteria; and
- store samples in refrigerated sample bank.

Samples will be analyzed by chemists and/or technicians using approved analytical procedures presented in Section 3.6. The chemist or technician will then record the results of analyses and detail all procedural modifications, deviations, or problems associated with the analyses in a parameter workbook.

4.7.1 Field Screening Data Screening data will include results from soil and groundwater sample screening with an organic vapor analyzer (OVA) and/or photoionization detector (PID) at discrete depths, air quality monitoring, and field parameter (pH, temperature, specific conductivity, and turbidity) measurement.

Screening activities allow real-time or rapid analytical of contaminant distribution or of indicator parameters that may correlate with the presence of contamination. This information is useful for site characterization and for determining strategic sampling locations. Quarterly Control (QC) procedures used with qualitative screening instruments (e.g., pH meter, PID, etc.) include calibration and comparison of results.

Table 4-1
Laboratory Analytical Methods

Supplemental RFI/RI Sampling and Analytical Plan
Naval Air Station Key West
Key West, Florida

Matrix	Parameter	Method Reference
Offsite laboratory: All media	Appendix IX VOCs	USEPA Method 8240
	Appendix IX SVOCs	USEPA Method 8270
	Appendix IX Pesticide/PCBs	USEPA Method 8080
	TAL compounds (all sites)	CLP SOW No. ILM03 with all revisions
	Nitroaromatic compounds (Sites 14 and 15 only)	USEPA Method 8330

Notes: VOC = volatile organic compound.
SVOC = semivolatile organic compound.
TAL = target analyte list.
PCBs = polychlorinated biphenyls.
CLP = Contract Laboratory Program.
USEPA = U.S. Environmental Protection Agency.
SOW = statement of work.

4.7.2 **Laboratory Data and Validation** DQO Level III laboratory analyses will be in conformance with USEPA SW-846 requirements. Upon receipt, DQO Level III analytical data will be systematically validated in conformance with USEPA *Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses* (USEPA, 1988a) and *Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (USEPA, 1988b). These guidelines provide a systematic procedure for evaluating laboratory QA/QC measures such as holding times, blank analyses, surrogate recoveries, matrix spike results, gas chromatography and mass spectroscopy (GC/MS) tuning, instrument calibration, compound identification, and method performance. PARCC parameters will be evaluated during validation of the laboratory analytical results, as described in below in Section 4.11.

Validated data will be prepared in three initial formats: raw laboratory data, data marked with validation qualifiers or annotations, and corrected or validated data. The validated data can then be used for contaminant characterization and assessment at each site. A validation summary of the data will be included as part of the supplemental RFI/RI report.

Greater variability may be expected from field screening methods and, due to time constraints, the field screening data will not be formally validated. However, the data will be generally evaluated for accuracy. Records of field QA/QC data will be maintained, out-of control conditions will be noted, and, where appropriate, the data will be rejected or annotated.

4.7.3 **Data Management** These requirements were developed to provide a standardized reporting system for locating and tracking environmental data. A data management system that includes maintaining field logs, sample management and tracking procedures, and document control and inventory procedures for both laboratory data and field measurements will be implemented to ensure that the data collected during the investigation are of adequate quality and quantity to support the risk assessment. Data will be stored in an automated computer data management system with hard copy backup.

4.7.4 **Data Evaluation** Chemical and physical data collected during the supplemental RFI/RI program will be used to characterize the sites and to

evaluate the potential levels of risk posed to human health and the environment. Physical and chemical data will be integrated to form a conceptual overview of each site.

Data will be summarized and plotted on scaled maps to facilitate interpretation of the areal distribution of analytical contaminants and potential mechanisms of transport. Chemical data will be compared to applicable or relevant and appropriate requirements (ARARs) and contaminants of potential concern will be identified.

Physical and chemical data will be evaluated to determine the distribution of contaminants, contaminant interactions, transport mechanisms, and potential fate. This includes an evaluation of: groundwater transport, groundwater-surface water interactions, surface water transport, vadose zone transport, volatilization, soil erosion, retardation, degradation, and transformation. The evaluation of the factors listed above will be subject to the availability of sufficient experimental and empirical reference data.

Plausible exposure pathways and exposure scenarios will be evaluated to assess potential levels of risk posed by the contaminants of potential concern. The risk assessment is based on an evaluation of exposure patterns, available toxicity data, and dose-response relationships.

Ultimately, the data collected will be evaluated to support no further action or remedial action decisions.

4.7.5 **Evaluation of Data Gaps** All data will be continually assessed and each site will be evaluated to confirm: (1) the lateral and vertical extent of contamination that is present, (2) if it presents a threat, (3) if it has been completely defined, and (4) what further action is needed. The goal is to eliminate lengthy interim report development and review times by allowing continual data assessment and rapid decision making.

4.8 **INTERNAL QUALITY CONTROL**. Internal QC procedures are designed to assure the consistency and continuity of data. The frequency of QC checks is based on the

type of QC analytical. Standard sample QC analyses include, but are not limited to, duplicate samples, equipment rinsate blanks, trip blanks, matrix spike and matrix spike duplicate samples, and field water blanks. All QC samples will be analyzed by the offsite laboratory performing Appendix IX and TAL analyses at DQO Level III. Only duplicate samples and field blanks will be analyzed by the onsite laboratory. QC samples will be analyzed for the same parameters as the environmental samples collected during the site-specific sampling event, except for trip blanks, which will be analyzed for Appendix IX VOCs only. Each of these types of QC samples is explained below.

Other internal QC activities are undertaken during the performance of work to ensure that the service, designs, and documents produced meet currently accepted professional standards. Small assignments or tasks entail periodic discussions among the technical staff, the Project Manager, and Program Manager. QC on larger assignments may require professional review teams and/or internal audits.

Duplicate Samples. Duplicate samples are two or more samples collected simultaneously into separate containers from the same source under identical conditions. One duplicate will be collected for every 10 samples of a single matrix (from a single site). Duplicate samples are intended to assess the homogeneity of the sampled media and the precision of the sampling protocol.

Trip Blanks. Trip blanks are prepared by the laboratory prior to the sampling event and accompany empty sample bottles to the facility when samples are collected. The trip blanks are kept with the investigative samples throughout the sampling event and are packaged and shipped with the investigative samples. These containers should never be opened prior to laboratory analytical. One trip blank will be included with each shipment of samples scheduled for VOC analysis. Trip blanks are required for assessing the potential for contaminating samples with VOCs during sampling or in transit.

Equipment Rinsate Blanks. Equipment rinsate blanks are collected by running organic-free water over and/or through sample collection equipment after it has been decontaminated. Equipment rinsate blanks will be collected at a frequency of one per day or one per decontamination event. These blanks are used to assess

the adequacy of decontamination procedures and to trace potential cross contamination.

Matrix Spike and Matrix Spike Duplicates. Matrix spike and matrix spike duplicate samples are additional samples collected in the field from a single sampling location. These samples are spiked in the laboratory with a known compound (or set of compounds) of known concentration. The concentration detected, after analytical, provides an estimate of the amount of compound "lost" (e.g., sorbed to glassware, volatilized, degraded, etc.) during the analytical procedure. A comparison of the original concentration to the final concentration provides data concerning analytical precision and accuracy. One set of matrix spike and matrix spike duplicate samples will be collected per 20 samples per matrix.

Field Water Blanks. Field water blanks include a complete set of samples collected from each water source used in the investigation. One set of samples will be collected from each water source used at the beginning of the project and one set at the completion of the project. Samples may be collected in the middle of the project if deemed necessary. These samples should account for potential artifacts that could be introduced through decontamination procedures.

4.9 PERFORMANCE AND SYSTEMS AUDITS. Audits are performed to confirm that work being completed within the supplemental RFI/RI program complies with QA program goals. Internal ABB-ES audits of laboratory subcontractors are routinely conducted and subcontracted laboratories must be both CLP and SW-846 qualified and NEESA approved.

System audits may be conducted on system components to evaluate appropriate selection and utilization. The project system audit includes evaluation of field, office, and laboratory procedures. System audits may address the following components:

- organization and personnel,
- facilities and equipment,
- analytical methodology,

- sampling and sample handling procedures, and
- data handling.

All primary documents will receive internal technical reviews and a minimum of one internal audit will be scheduled for the supplemental RFI/RI field program. Technical reviews and internal audits will be performed in accordance with the ABB-ES CLEAN Quality Assurance Program Plan. A minimum of one internal audit will be scheduled by the Quality Assurance Manager (QAM) in coordination with the Task Leader during the supplemental RFI/RI sampling activities. All audit records, including audit plans, reports, written responses, and corrective action forms, will be maintained with the project files.

4.10 PREVENTIVE MAINTENANCE. Preventive maintenance for laboratory equipment and instruments will be performed in accordance with SW-846 requirements and the individual laboratory QA/QC program. An inventory control system including all field equipment and instrumentation used by ABB-ES personnel will be maintained by the equipment manager as the basis for maintenance and calibration control.

Problem prevention can be applied to all phases of project implementation. The key to preventing and resolving problems is careful advanced planning and close communications between management and technical personnel in both client and contractor organizations. Problems will be anticipated and prevented by undertaking the following measures:

- identifying possible problems that have a high probability of occurrence of a potentially significant negative impact on performance (e.g., quality of services performed, schedules, and costs);

- identifying events, observations, or other signals possibly indicative of a developing problem;

- identifying the organizational level most likely to recognize a developing problem and the level with authority to react to the problem;

- developing preventive measures for avoiding or reducing the impact of a problem that preferably can be implemented at the same organizational level at which the problem is recognized; and

- communicating the information generated in the preceding steps to appropriate staff.

4.11 DATA ASSESSMENT PROCEDURES. The assessment of data measurements is an activity that affects data quality. Procedures to be used for calculating PARCC parameters are discussed below.

4.11.1 Parameters for Level III DQOs The acceptance criteria for PARCC parameters for Level III and DQOs are defined by the SW-846 guidelines and by the laboratory analytical methods chosen. SW-846 contract required quantitation limits (CRQLs) will be requested for laboratory analyses.

Precision. Laboratory analytical precision is a quantitative measurement of reproducibility. Precision is the variability of a group of measurements compared to their average value, monitored and evaluated on this project through comparison of duplicate samples (including matrix spike duplicate samples).

Precision is a parameter evaluated during the data validation process. Precision will be calculated as Relative Percent Difference (%RPD) using the formula:

$$\% \; RPD = \frac{D_1 - D_2}{(D_1 + D_2)/2} \times 100 \qquad (1)$$

where
%RPD = relative percent difference,
D_1 = first sample value, and
D_2 = duplicate sample value.

Field and laboratory measurement precision will be established by the collection and analytical of field and laboratory duplicate samples. Ten percent of the field samples will be collected in duplicate. Laboratory duplicates will be prepared in accordance with SW-846 requirements or guidance stated in specific

testing methods, as appropriate. Although a quantitative goal cannot be set due to field variability, field duplicate %RPD values will be reviewed to estimate precision.

Accuracy Accuracy is the quantitative measurement of the bias of a system, relating a reported sample concentration to its actual value. Analytical accuracy is quantified by calculation of "spike" recovery. In the laboratory an aliquot of either a surrogate or a specific target compound(s) (i.e., spike), at known concentrations, is added to the sample. The concentration of the recovered spike is compared to the original concentration added and expressed as a percent recovery (%R). This measurement provides an estimate of the percentage loss of a given compound during analytical (e.g., loss due to sorption to glassware, volatilization, degradation, etc.). The percent recovery is calculated by the formula:

$$\% R = \frac{SSR-SR}{SA} \times 100 \qquad (2)$$

where
%R = percent recovery,
SSR = spike sample results,
SR = sample results, and
SA = spike added from spiking mix.

The comparison of matrix spike and matrix spike duplicate samples to the original sample, as well as calculation of surrogate recoveries in original samples, will be used to measure accuracy. Accuracy for laboratory measurements will in accordance with SW-846 SOW requirements or guidance stated in specific testing methods, as appropriate.

Completeness. Percent completeness (%C) is the number of valid measurements collected compared to the number of samples collected for analytical. Valid measurements refer to data validated in conformance with USEPA SW-846 guidelines. It is calculated by the formula:

$$\% C = \frac{N_A}{N_1} x\ 100 \qquad (3)$$

where

%C = percent completeness,

N_A = actual number of valid measurements, and

N_1 = number of samples collected.

Completeness will be ensured by collecting an adequate number of samples to meet project objectives. A completeness goal of 95 percent will be established for chemical results.

Representativeness and Comparability. Representativeness and comparability is qualitatively measured through an evaluation of the consistency of sample collection, handling, analytical, validation, and reporting. Sample collection through reporting will be conducted consistent with the DQO requirements outlined in the ECBSOPQAM (USEPA, 1991), USEPA SW-846 requirements, and USEPA data validation requirements.

4.11.2 Parameters for Level I and II DQOs For Levels I and II field measurement data, the objective for precision is to maintain factory equipment specifications to the best extent possible. For example, for the pH meter, precision will be tested by multiple readings in the medium of concern. Consecutive readings should agree within ± 0.1 standard pH units after the instrument has been field calibrated with standard buffers before each use. Likewise, water level indicator readings will be precise within ± 0.01 foot for duplicate measurements. Air monitoring instruments will be calibrated prior to field use.

As with precision, accuracy of field measurements is achieved through maintenance of equipment in accordance with factory specifications and calibration instructions. For many instruments, accuracy can be assessed through comparison of instrument response to an independent, known standard. For example, the pH meter and conductivity meters are calibrated with buffer solutions. A calibration check will be made on all water level indicators before the initiation of field work. The calibration check will be made using a surveyor's tape or other standard measuring device. If the calibration check is not within

± 0.01 foot, the instrument will be returned for service. Air monitoring instruments will be calibrated prior to shipment to the field.

Field activities performed at DQO Levels I and II are onsite measurement techniques that provide information in real-time or after minimal delay. The completeness achieved for these methods may be more variable than those for standard analytical methods. A higher degree of completeness may be achieved because measurements can be readily repeated. However, at each site, conditions may constrain the use of some techniques, resulting in fewer valid analyses than anticipated.

Comparability of Level I and II data will be maintained through consistent sample collection, handling, analytical, data evaluation, record keeping, and reporting.

4.12 CORRECTIVE ACTION. Corrective or preventive actions to improve project quality will be implemented if potential or existing conditions are identified that may have an adverse impact on data quantity or quality. Corrective actions may be immediate or long term. Corrective action identification, implementation, and recording will be conducted in accordance with the ABB-ES CLEAN Quality Assurance Program Plan. Any member of the supplemental RFI/RI program who identifies a condition adversely affecting quality can initiate corrective action by completing a nonconformance report, or by issuing a memo to the QAM. The written communication must identify the condition and explain how it may affect data quantity or quality.

Immediate corrective action is applied to spontaneous, nonrecurring problems, such as instrument malfunctions. Staff who detect or suspect nonconformance to previously established criteria or protocol in equipment, instruments, data, or methods should immediately notify his or her Project Manager. If the problem is limited in scope, the Project Manager decides on the corrective action measure, documents the solution, and notifies the Program Manager and the QAM in a memorandum. If the problem has impaired the quality of the project or could re-occur in the future, the Project Manager will follow procedures outlined in the ABB-ES CLEAN Quality Assurance Program Plan and a Corrective Action form will be placed with the project files.

Corrective actions may also be initiated as a result of performance evaluations, system audits, laboratory and field comparison studies, QA project audits conducted by the QAM or Navy CLEAN QA specialists, or other activities. The QAM is responsible for documenting notifications, recommendations, and final decisions. The Project Manager is jointly responsible for notifying program staff and implementing the agreed-upon course of action. The QAM is responsible for confirming the efficiency of the implemented actions. To the extent possible, the development and implementation of preventive and corrective actions should be timed to not adversely impact project schedules or subsequent data generation and processing activities. The QAM will also be responsible for developing and implementing routine program controls to minimize the need for corrective actions.

4.13 QUALITY ASSURANCE REPORTS. Management personnel at all levels will receive QA reports appropriate to their level of responsibility. The QAM will receive copies of all QA documentation. QC documentation will be maintained in the project files.

Other types of QA reports may include periodic assessment of measurement data accuracy, precision and completeness; results of performance audits and/or systems audits; significant QA problems and recommended solutions for future projects; and status of solutions to any problems previously identified. Additionally, incidents requiring corrective action will be fully documented. These reports will be provided to the QAM and, in turn, will be submitted to management. The summary of findings will be factual, concise, and complete. Supporting information will be appended to the report.

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