Work Plan (WP)

Red Hill Oily Waste Disposal Pit Remedial Investigation/Feasibility Study (RI/FS)

Naval Supply Center Pearl Harbor O'ahu, Hawai'i

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LIST OF ACRONYMS

AA	Atomic Absorption
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society for Testing Materials
ATT	Aqua Terra Technologies
BHC	Benzene Hexachloride
BTXE	Benzene, Toluene, Xylene, and Ethylbenzene
BWS	Board of Water Supply (City and County of Honolulu)
CBC	Circulating Bed Combustion
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CRP	Community Relations Plan
CZMA	Coastal Zone Management Authority
DLNR	Department of Land and Natural Resources (State of Hawaii)
DOH	Department of Health (State of Hawaii)
DOT	Department of Transportation (State of Hawaii)
DQO	Data Quality Objectives
EDB	Ethylene Dibromide
EIC	Engineer-in-Charge
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency (United States)
ERCE	ERC Environmental and Energy Services Company
FR	Federal Register
FRF	Fuel Reclamation Facility (NSC)
FS	Feasibility Study
FSP	Field Sampling Plan
GC/MS	Gas Chromatography/Mass Spectroscopy
HSP	Health and Safety Plan
IAS	Initial Assessment Study
ICP	Inductively Coupled Plasma
ID	Identification

LIST OF ACRONYMS (Continued)

HRS	Hazard Ranking System
HSP	Health and Safety Plan
IAS	Initial Assessment Study
ID	Identification
IRP	Installation Restoration Program
LC_{50}	Lethal Concentrations
LD_{50}	Lethal Dose
LNALP	Light, non-aqueous Phase Liquid
LOAEL	Lowest Observed Adverse Effects Levels
LPMM	Leacheate Plume Migration Model
MCL	Maximum Contaminant Level
mg/l	milligrams per liter
mg/kg	milligrams per kilogram
MOGAS	Motor Gasoline
MSL	Mean Sea Level
NAAQS	National Air Attainment Quality Standards
NACIP	Navy Assessment and Control of Installation Pollutants
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NOAEL	No Observed Adverse Effects Levels
NOEL	No Observed Effects Levels
NSC	Naval Supply Center
OSHA	Occupational Safety and Health Act
PA	Preliminary Assessment
PACNAVFACENGCOM	Pacific Division (Naval Facilities Engineering Command)
PAH	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
ppb	parts per billion
ppm	parts per million
PRP	Potentially Responsible Party
PRZM	Pesticide Root Zone Model
PWC	Public Works Center
QAPP	Quality Assurance Project Plan
QL	Quantification Limits

SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act of 1986
STEL	Short Term Exposure Limit
SVOC	Semi-volatile Organic Compounds
TBC	To Be Considered
TCL	Target Compound List
TFH	Total Fuel Hydrocarbons
TOX	Total Organic Halogens
TPH	Total Petroleum Hydrocarbons
TR	Trace Concentration
TRC	Technical Review Committee
TVH	Total Volatile Hydrocarbons
TWA	Time-weighted Average
USC	United States Code
USGS	United States Geological Survey
UST	Underground Storage Tank
WP	Work Plan
XRF	X-Ray Fluorescence
µg/L	micrograms Per Liter

EXECUTIVE SUMMARY

This document serves as the Work Plan (WP) for the Remedial Investigation/Feasibility Study (RI/FS) of the Red Hill Oily Waste Disposal Pit site (herein referred to as the "Red Hill Site") located within the boundaries of the Red Hill Fuel Storage Facility, Pearl Harbor Naval Supply Center (NSC), Oahu, Hawaii. The purpose of the WP is to outline the procedures and methodologies to be followed during conduct of the RI/FS study at the site. This WP has been prepared in accordance with the approach described by the United States Environmental Protection Agency (EPA) document entitled *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final* (EPA, October 1988).

The WP first describes site background information, including the physical setting of the site, site history, and the results of previous investigations; and then presents an initial evaluation of that background information, as well as a preliminary identification of remedial alternatives. The various tasks to be performed during both the RI and the FS portions of the project, along with the data quality objectives (DQOs) for those tasks are also outlined. Finally, the proposed schedule for conducting the work is presented.

The history of operations at the Red Hill Site may be separated into three distinct phases. The first of these phases encompassed the years during which the original Red Hill Oily Waste Disposal pit was constructed and operated (approximately 1943 to 1948). The pit was used to treat oily residue which was generated during periodic cleaning operations performed on a series of underground fuel storage tanks located approximately 2000 feet to the southeast of the Red Hill Site. The pit was also used to hold oily waste generated by leaks and drips from the piping system located within the fuel line tunnels. During the second phase, which lasted from approximately 1949 to 1972, no disposal pits were in operation at the site, although the site was apparently used to collect and store waste materials. The third phase began in 1972, when a new waste disposal pit was constructed and again received wastes from cleaning of the underground tanks. The new pit, referred to as a "Stilling Basin", was in operation until 1987 and is still in place, although it no longer serves any waste handling purpose.

The geologic setting in the vicinity of the project site consists of near-surface fill and alluvial deposits underlain by basaltic lavas of the Koolau Volcanic Series. Three types of aquifers are generally found within this hydrogeologic setting: perched, and dike-impounded aquifers; and the basal aquifer. The basal aquifer represents the major ground-water resource in this area and a ground-water extraction tunnel intersecting this aquifer is located within 700 feet of the project site.

A conceptual site model has been developed for the Red Hill Site. The model presents an overall evaluation of sources, transport mechanisms, receptors, exposure points, and exposure routes. Five major potential sources of contamination have been identified at the site: 1) old waste pits; 2) stilling basin; 3) waste sumps; 4) piping system; and 5) unauthorized surface discharge. Three major contaminant and exposure pathways are believed to exist at the site: 1) air transport; 2) surface water flow; and 3) subsurface transport. The suspected contaminants of concern currently identified include hydrocarbon constituents, polynuclear aromatic hydrocarbons, phenols, metals, and solvents. General receptors may include area residents, aquatic and terrestrial biota, and site visitors.

The overall objective of the RI/FS is to determine the nature and extent of the environmental hazards posed by the release of hazardous substances and to evaluate proposed remedial actions for the site. Achieving this broad objective requires the performance of numerous interrelated tasks, each with its own objectives, and acceptable levels of data quality. Specific objectives of the RI/FS will include:

- Assessment of the nature and extent of soil and potential ground-water contamination;
- Assessment of the potential migration pathways of the identified site contamination;
- Evaluation of the impacts of site contamination on the environment and potential receptors; and
- Identification and evaluation of appropriate remedial action alternatives.

The RI and FS are to be conducted concurrently and are both interactive and inactive in nature.

There are two components to the RI: a site characterization component and a treatability investigation component. The site characterization process begins with a scoping of the initial phase of the investigation. Subsequently, field investigation, sample analysis/data validation, and data evaluation activities will be performed. The interactive nature of the RI/FS approach becomes apparent at this stage, when decision points are reached at which it must be determined if the data acquired are sufficient to develop and screen remedial action alternatives. If the collected data are not adequate, a second iteration of site characterization activities will be performed, and if necessary, repeated until it is determined that sufficient data have been developed. A report will be prepared at the conclusion of each phase of the site characterization process. This report will document the findings pertinent to that phase of the investigation as well as present recommendations for further work. Once the site characterization phase of the RI has produced sufficient and appropriate data, a preliminary baseline risk assessment will be conducted to assess the potential human health and environmental risks posed by the site in the absence of any remedial action. Based upon the results of the risk assessment, it will then be determined if treatability studies are necessary to further evaluate the feasibility of selected remedial action alternatives. If so, such studies will be performed as part of the remedial investigation. Following completion of the treatability studies, the draft RI report will be prepared.

The initial task in the FS is to develop response actions for each of the contaminated media at the site identified during the site characterization process. General response actions broadly define the nature of the response to a particular site problem. Following development of the general response actions, potential remediation technologies for each general response action will be identified. Following selection of potential remediation technologies, process options are evaluated.

The interactive nature of the RI/FS approach asserts itself again during evaluation of remediation technologies and process options. Decision points are reached at various times when it is necessary to determine whether the data developed during the site characterization portion of the RI are adequate to: 1) conduct a preliminary baseline risk assessment, and if deemed necessary; 2) evaluate remediation technologies and/or process options. If the data are not sufficient for either task, further iterations of the site characterization process will be performed until an appropriate data set has been developed.

The objective of screening the various process options will be to select a representative process option which for each of the identified treatment technologies. The identified process options which are media-specific, will then be combined into a set of remedial action alternatives. In general, three types of remedial action alternatives will be identified: 1) a no-action alternative; 2) containment/long-term monitoring alternatives; and 3) various treatment alternatives. For the Red Hill Site, it is anticipated that a minimum of five remedial action alternatives will be developed, including a no-action alternative, one containment/ monitoring alternative, and at least three treatment alternatives.

Once the remedial action alternatives have been developed, it will be necessary to assess the need to perform treatability studies prior to conducting detailed analysis of the alternatives. Such studies will be performed as part of the RI, if necessary. A detailed analysis of the remedial action alternatives will then be performed on the basis of the following evaluation criteria:

- overall protection of human health and the environment;
- compliance with applicable or relevant and appropriate requirements (ARARs);
- long-term effectiveness and permanence;
- reduction of toxicity/mobility/volume through treatment;
- short-term effectiveness;
- implementability;
- cost;
- regulatory agency acceptance; and
- community acceptance.

Following the detailed analysis, the FS report will be prepared, after which remediation implementation will proceed.

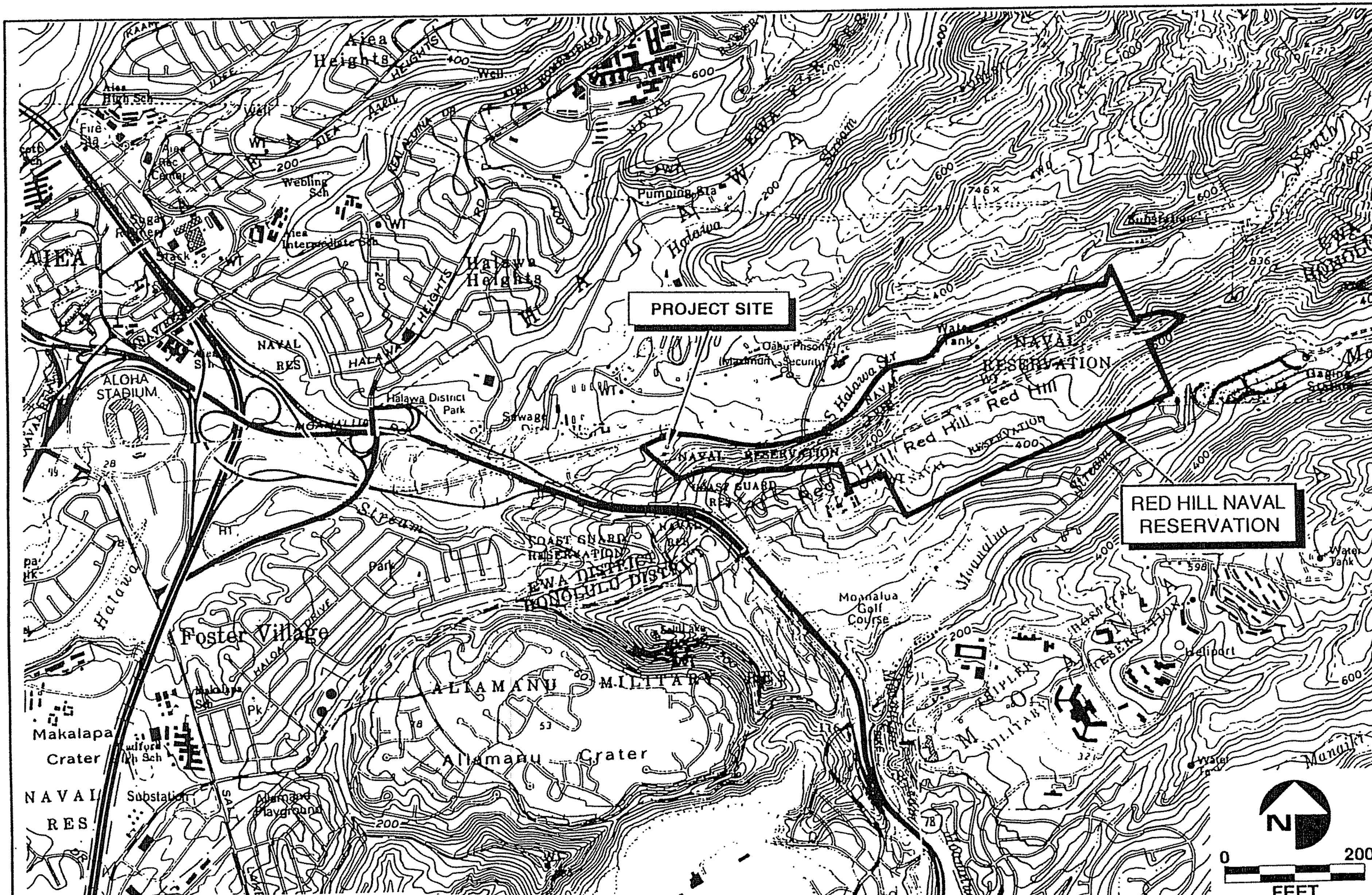
SECTION 1
INTRODUCTION

This document serves as the WP for the Naval Supply Center (NSC) Red Hill Oily Waste Disposal Pit site (herein after referred to as the Red Hill Site), which is located within the boundaries of the Red Hill Fuel Storage Facility, Pearl Harbor Naval Supply Center, Oahu, Hawaii, as shown on Figure 1-1. The purpose of the WP is to outline the procedures and methodologies to be followed during conduct of a remedial investigation/feasibility study (RI/FS) for the site. ERC Environmental and Energy Services Company (ERCE) has prepared this WP for the Pacific Division, Naval Facilities Engineering Command (PACDIV), under Contract Number N62742-88-D-0032. The WP has been prepared in accordance with the approach described by the United States Environmental Protection Agency (EPA) guidance document entitled *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final* (EPA, October 1988).

The WP describes site background information, including the physical setting of the site, site history, and the results of previous investigations, and then presents an initial evaluation of that background information, as well as a preliminary identification of remedial alternatives. The various tasks to be performed during both the RI and the FS portions of the project, along with the data quality objectives (DQOs) for those tasks are outlined. The WP also outlines the proposed schedule for conducting the work. The remainder of this introductory section details the project history, the RI/FS project objectives, and the technical approach that will be used to conduct the RI/FS. The WP has three companion documents. The first of these, the Sampling and Analysis Plan (SAP), consists of two parts, a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP). The SAP describes the methods and procedures to be utilized during the first phase of the RI. The other two companion documents are the Health and Safety Plan (HSP), which supports field investigation efforts, and the Community Relations Plan (CRP), which outlines the techniques necessary to achieve the objectives of a community relations program.

1.1 PROJECT HISTORY

The Naval Assessment and Control of Installation Pollutants (NACIP) program was established to direct the investigation and remediation of uncontrolled hazardous waste



SOURCE: USGS 7.5' Oahu, Hawaii Quadrangle

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Site Location Map

FIGURE 1-1

disposal sites associated with operations at U.S. Navy and Marine Corps installations. To correspond with EPA terminology, and as prompted by the signing into law of the Superfund Amendments and Reauthorization Act (SARA) of 1986 (U.S. EPA, 1986), the NACIP program was replaced by the Installation Restoration (IR) Program. The RI/FS described in this Work Plan is being conducted under the IR Program in accordance with statutory requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and SARA.

An Initial Assessment Study (IAS) for the Pearl Harbor Naval Base, performed by the Naval Energy and Environmental Support Activity (NEESA) in October 1983 under the NACIP program, originally identified the Red Hill Site as potentially contaminated as a result of past hazardous materials operations. The first part of the confirmation study for the site, referred to as the verification phase, was performed by Aqua Terra Technologies (ATT) for PACDIV in March 1988. The second part of the confirmation study for the site, referred to as the characterization phase, has not yet been performed; rather, the tasks normally included in the characterization phase have been incorporated into the RI/FS tasks described in this WP.

1.2 PROJECT OBJECTIVES

The overall objective of the RI/FS is to assess the nature and extent of the environmental hazards posed by the release of hazardous substances and to evaluate proposed remedial actions for the site. Achieving this broad objective requires the performance of numerous interrelated tasks, each with its own objectives, and acceptable levels of data quality. Specific objectives of the RI/FS include:

- Assessment of the nature and extent of soil and ground-water contamination;
- Assessment of the potential migration pathways of the identified site contamination;
- Evaluation of the impacts of site contamination on the environment and potential receptors; and
- Identification and evaluation of appropriate remedial action alternatives.

1.3 TECHNICAL APPROACH

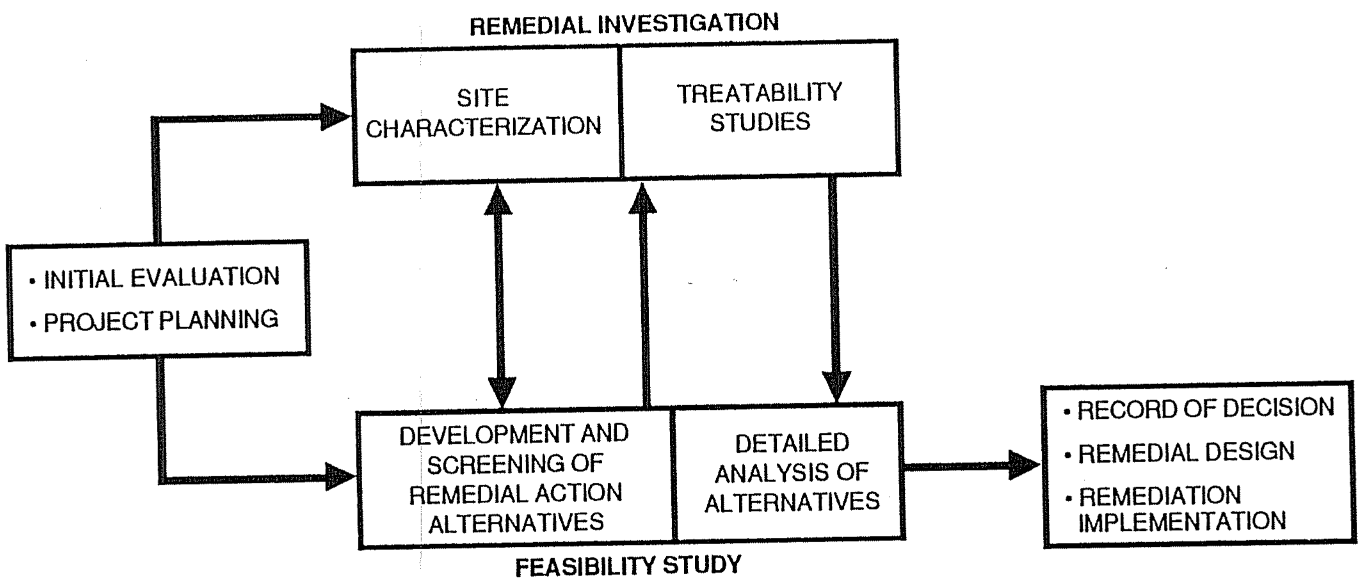
This subsection describes the technical approach which will be utilized by ERCE to meet the identified objectives of the RI/FS. A schematic of the RI/FS process is presented in Figure 1-2. It is important to note that the RI and FS are to be conducted concurrently, and are both interactive and in in nature. The data collected during the initial phases of site characterization activities affect the development and preliminary screening of remedial action alternatives, which in turn affect the scope of subsequent phases of site characterization activities and the performance of any treatability investigations. The technical approach for both the RI and the FS, as well as their interactions, are described in further detail below.

1.3.1 Remedial Investigation

There are two components to the remedial investigation: a site characterization component and a treatability investigation component. The approach to the site characterization process is presented in Figure 1-3. It is desirable to use a phased approach for the site characterization component so that sampling efforts can be appropriately focused, and therefore, more cost-effective.

The site characterization process begins with a scoping of the initial investigatory phase, which consists of identifying data needs and preparing this WP, and the associated SAP and HSP. Subsequently, field investigation, sample analysis/data validation, and data evaluation activities will be performed. It is at this point that the interactive nature of the RI/FS approach becomes apparent as decision points are reached, at which it must be determined if the data acquired are sufficient to: 1) conduct a preliminary baseline risk assessment to assess potential human health and environmental risks posed by the site in the absence of any remedial action, and if deemed necessary: 2) develop and screen remedial action alternatives. If so, the development and screening activities will proceed; if not, a second iteration of site characterization activities will be performed. This iterative process will be repeated until it is determined that the data developed are sufficient to conduct the risk assessment and/or evaluate remedial alternatives.

Since information on any site is usually somewhat limited prior to conducting the RI, several phases of site characterization activities are virtually always necessary. In typical RIs, the first phases of investigation encompass activities aimed at determining the nature



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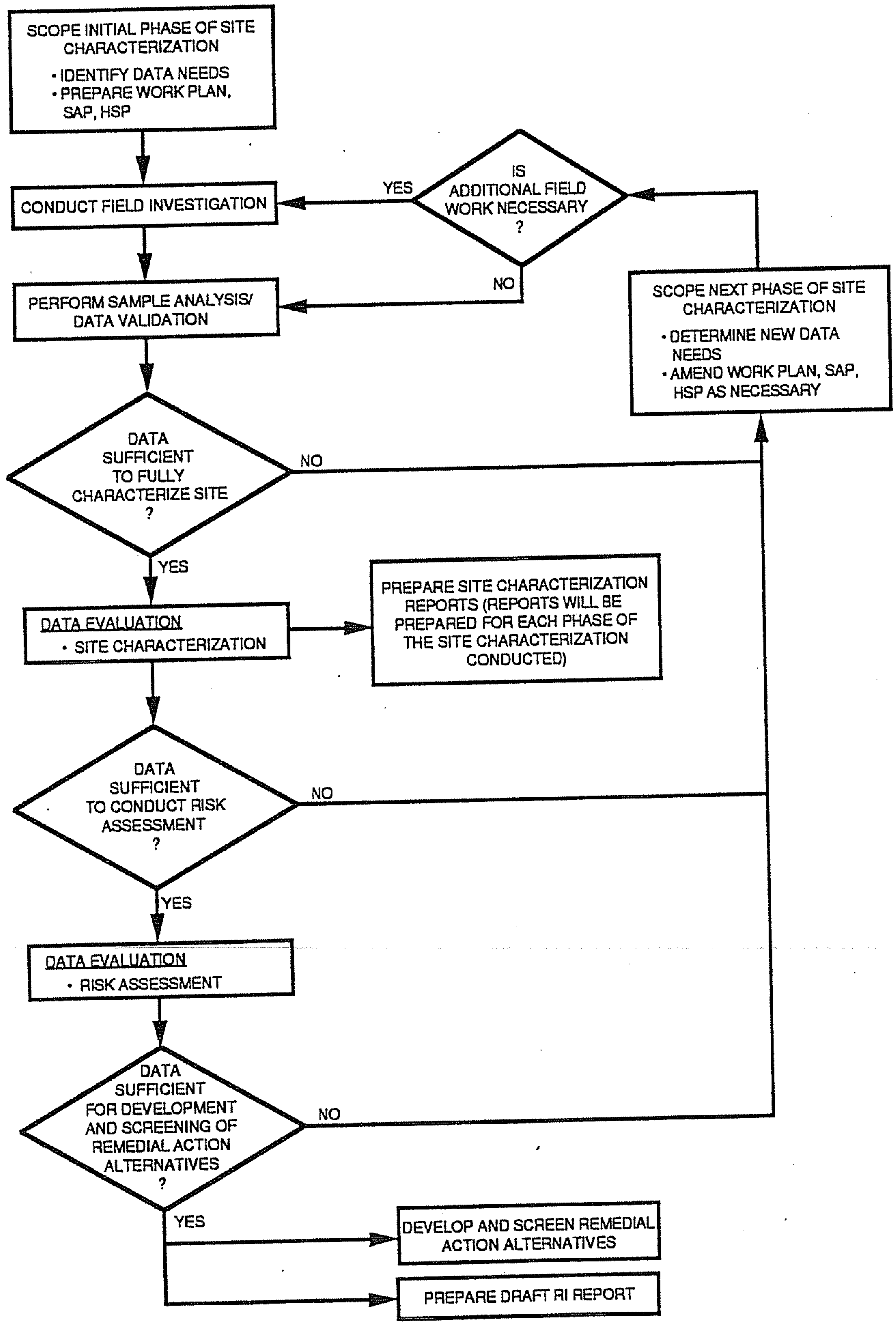
RI/FS Process

FIGURE 1-2



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Site Characterization Process

FIGURE 1-3

of contamination; the later phases are generally aimed at determining the extent of contamination and establishing a sufficient data base to evaluate remedial alternatives. Since existing information on the Red Hill Site is somewhat limited, it is anticipated that a minimum of two, and probably more, phases of site characterization activities will be necessary.

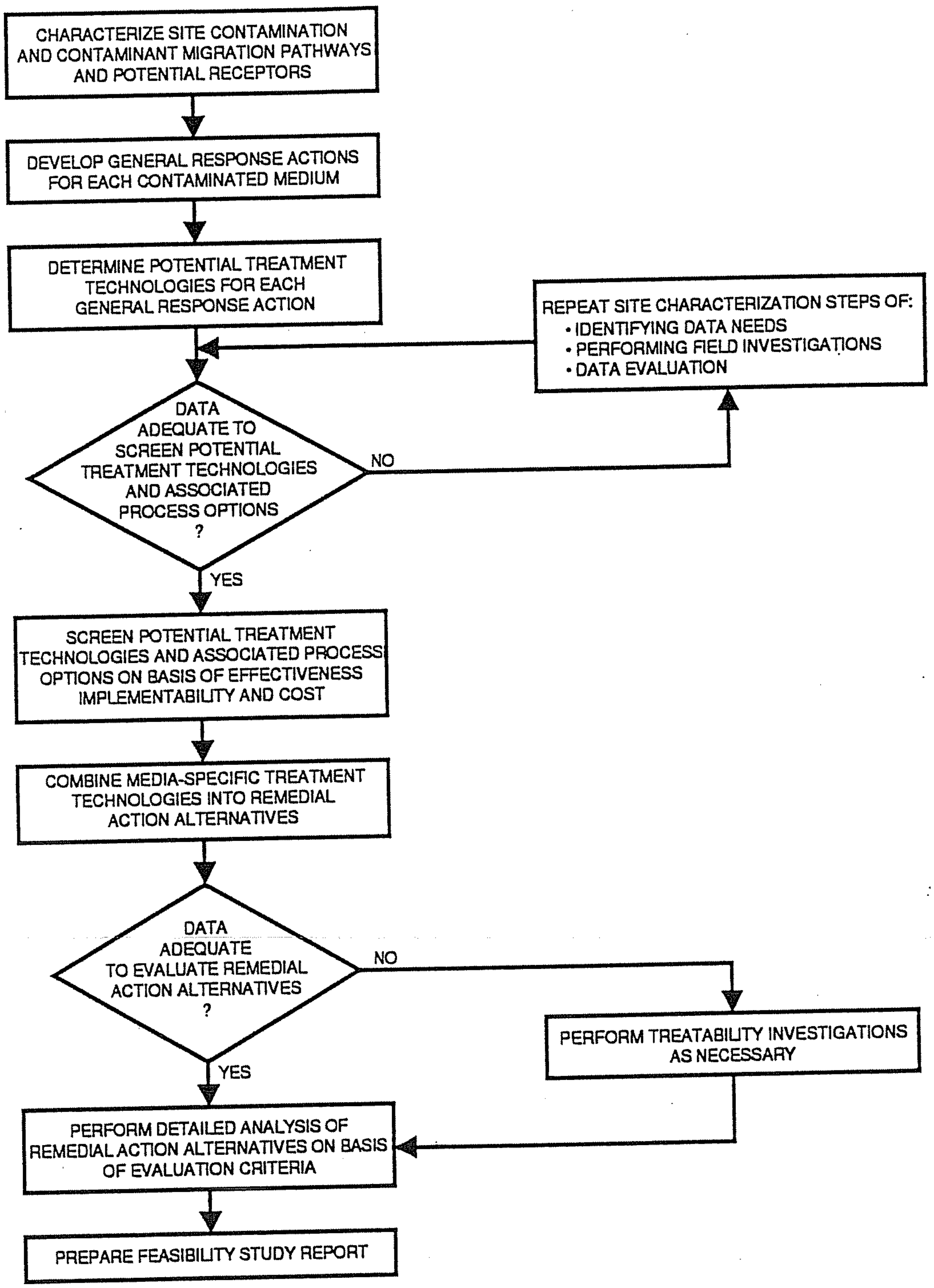
Once data sufficient to screen remedial action alternatives have been developed, a determination will be made as to whether treatability studies are necessary to further evaluate the feasibility of selected remedial action alternatives. If so, such studies will be performed as part of the RI. Following completion of the treatability studies, the draft RI report will be prepared.

1.3.2 Feasibility Study

The approach to the FS process is presented in Figure 1-4. Initially, general response actions will be developed for each of the contaminated media at the site identified during the site characterization process. General response actions broadly define the nature of the response to a particular site problem. Examples of general response actions for contaminated soils might include containment actions, excavation and treatment actions, or in-situ treatment actions.

Following development of the general response actions, the potential remediation technologies for each general response action will be identified. The potential remediation technologies associated with an excavation and treatment response action, for example, might include incineration, vapor extraction, or bioremediation. At this point, technologies associated with containment and treatment will be screened to identify those which appear to be practical and cost effective. The objective of this screening is to reduce the number of alternatives to a manageable number. Preliminary treatability tests may be performed to aid in the screening, if these tests can be performed quickly and cost effectively. Following selection of potential remediation technologies, process options are evaluated. Examples of a process option, such as incineration treatment technology, include circulating bed combustion (CBC) units, rotary kiln units, and infrared thermal units.

The interactive nature of the RI/FS approach again becomes evident during evaluation of remediation technologies and process options. Decision points are reached at various times when it is necessary to determine whether the data developed during the site



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Feasibility Study Process

FIGURE 1-4

characterization portion of the RI are adequate to evaluate remediation technologies and/or process options. If sufficient data are available, the screening process will be performed; if not, further iterations of the site characterization process will be performed until the developed data are adequate to screen the options.

The objective of screening the various process options will be to select a representative process option for each of the identified treatment technologies. The identified process options, which are media-specific, will then be combined into a set of remedial action alternatives. In general, three types of remedial action alternatives will be identified: 1) a no-action alternative; 2) containment/long-term monitoring alternatives; and 3) various treatment alternatives. For the Red Hill Site, it is anticipated that a minimum of five remedial action alternatives will be developed, including a no-action alternative, one containment/ monitoring alternative, and at least three treatment alternatives.

Once the remedial action alternatives have been developed, it will be necessary to assess the need to perform treatability studies prior to conducting detailed analysis of the alternatives. Such studies will be performed as part of the RI, if necessary. A detailed analysis of the remedial action alternatives will then be performed on the basis of the following evaluation criteria: overall protection of human health and the environment, compliance with applicable or relevant and appropriate requirements (ARARs), long-term effectiveness and permanence, reduction of toxicity/mobility/volume through treatment, short-term effectiveness, implementability, cost, and regulatory agency and community acceptance. Following the detailed analysis, the FS report will be prepared, and subsequently implementation of remedial action(s) will proceed.

SECTION 2
SITE BACKGROUND

The Red Hill Site is located in the foothills of the Koolau Mountain Range on the Island of Oahu, Hawaii, as shown on Figure 2-1. The site is located within the boundaries of the Red Hill Fuel Storage Facility, Pearl Harbor Naval Supply Center, approximately 1.8 miles east of the East Loch of Pearl Harbor. It is situated about 3,300 feet west of the Red Hill underground fuel storage tanks, about 700 feet west of the Red Hill fresh water pumping station, and about 200 feet south of the channelized portion of South Halawa Stream. The existing site facility layout is shown on Figure 2-2.

This section discusses existing information regarding the physical setting of the site and historical waste disposal operations which are believed to have occurred at the site. Additionally, it summarizes previous site investigation data and discusses the representativeness and quality of such data.

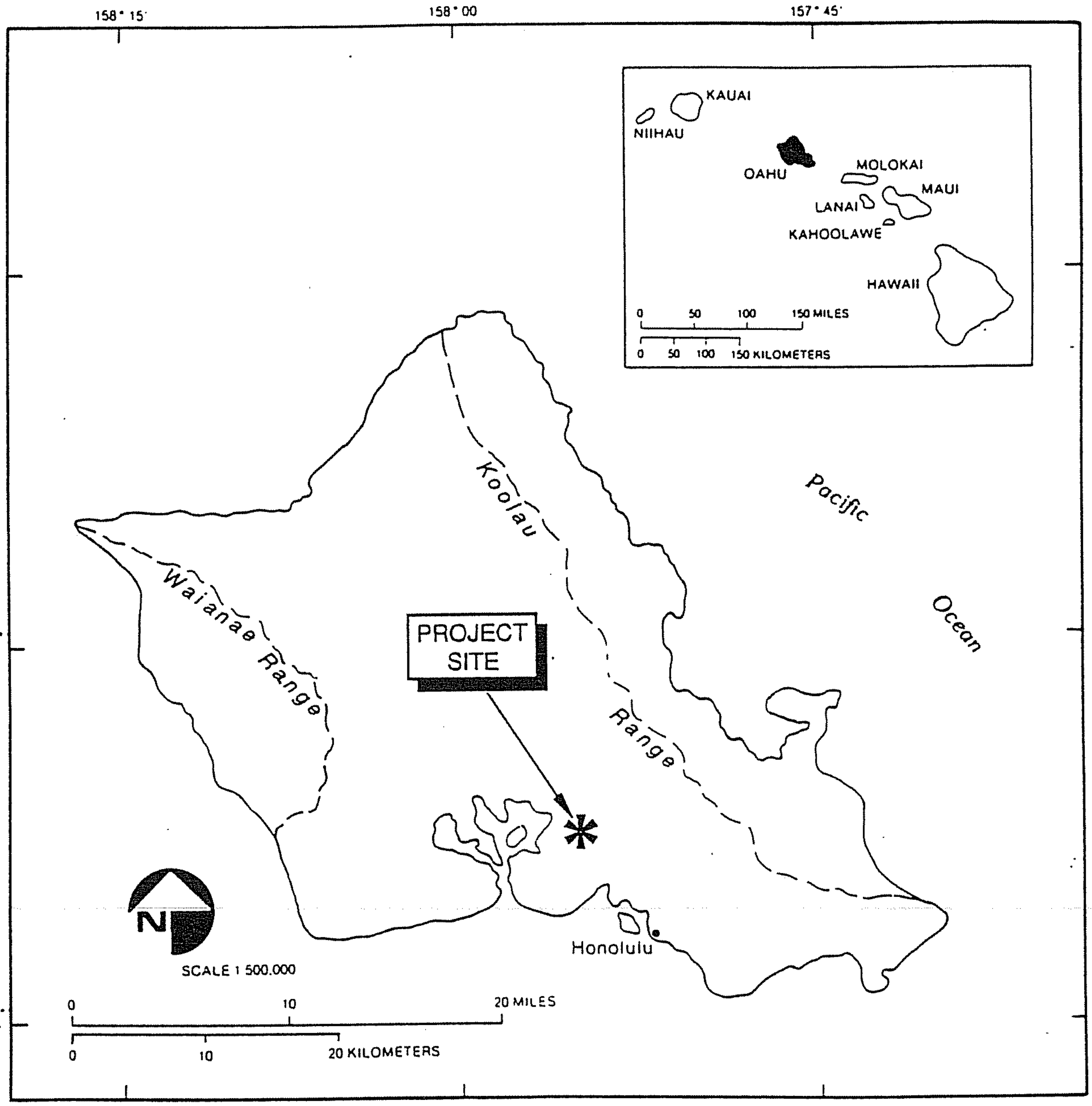
2.1 PHYSICAL SETTING

Regional and site-specific information describing the physical setting of the site, including climatology, physiography, hydrogeology, land use, and flora and fauna are discussed in the following sections.

2.1.1 Climatology

The primary controls of climate on the island of Oahu and the rest of the Hawaiian Islands are related to its subtropical locale, the surrounding Pacific Ocean, and variations in topography that are common throughout the islands. Oahu is located within the oceanic subtropics where atmospheric circulation is dominated by an anticyclonic (clockwise-flowing) area of high pressure known as the North Pacific high. The climate is mild and generally uniform, with occasional deviations caused by cyclonic storms associated with cold fronts originating from the north, and tropical disturbances moving from the south, east, or west (Lau *et. al.*, 1971).

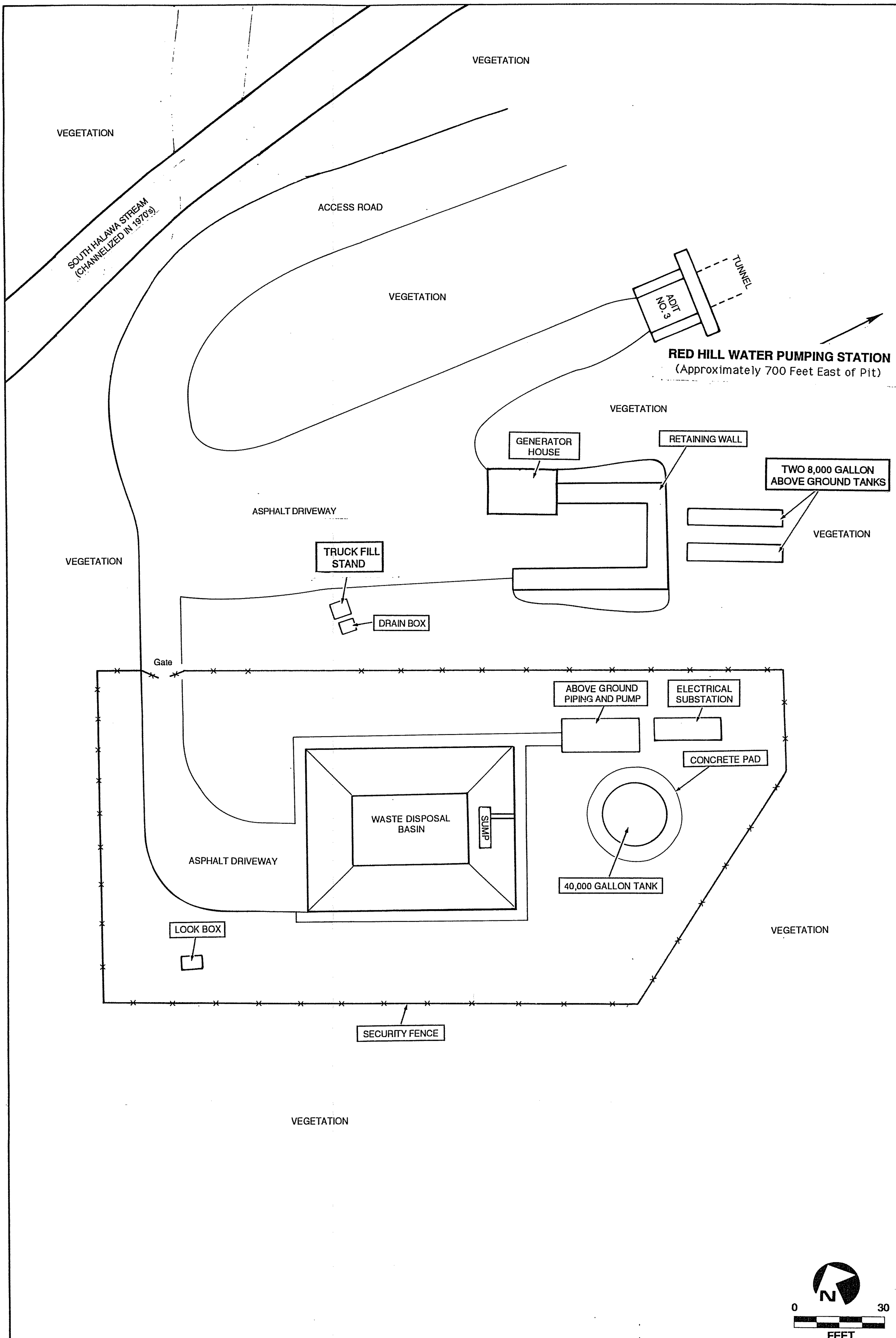
Mean temperature in Honolulu is approximately 75 degrees Fahrenheit, with temperatures generally ranging between 55 and 90 degrees Fahrenheit. Mean relative humidity ranges from 65 to 80 percent, with values above 70 percent common (Giambelluca, *et. al.*, 1986).



ERCE

Site Location, Island of Oahu, Hawaii

FIGURE 2-1



ERCE

Facility Layout, 1989

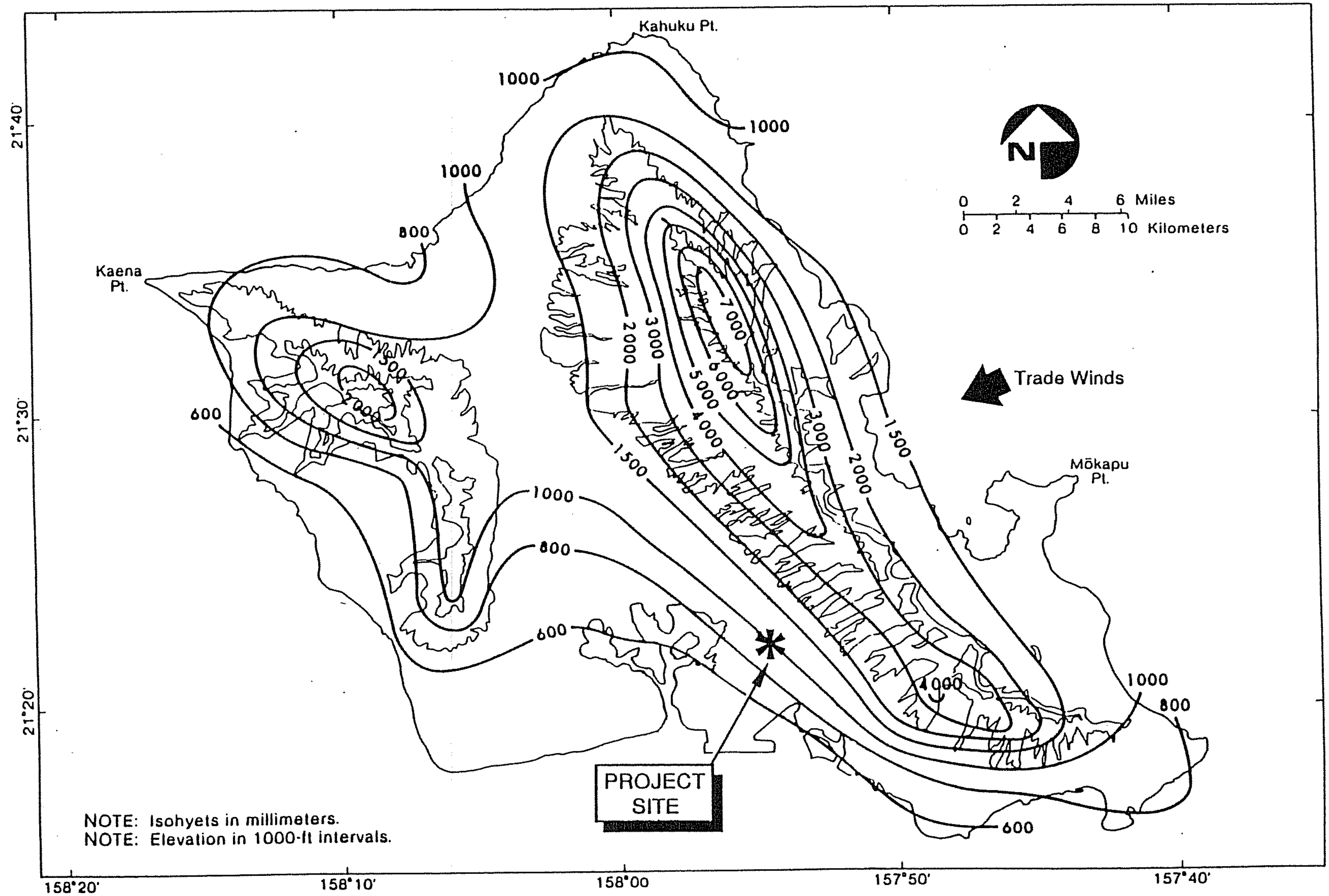
FIGURE 2-2

The existence of prevailing northeasterly trade winds on Oahu as shown on Figure 2-3, is directly related to the location of the island within the North Pacific high. The North Pacific high is an extensive area of elevated atmospheric pressure that exerts a strong influence on weather patterns in the region surrounding the Hawaiian Islands. Trade winds are common on the island throughout much of the year, with variations in frequency of occurrence ranging from approximately 90 percent in July to about 50 percent in January (Lau, *et. al.*, 1971). The trades may be entirely absent for days to weeks, particularly during the winter season. During these periods, hot and humid "Kona" conditions often prevail, with the dominant wind direction being from the southwest. Variations in wind speed and direction, which are related to seasonal changes in both intensity and position of the North Pacific High due to its north-south migration, influence rainfall patterns over the Hawaiian Islands throughout the year.

The presence of southeast- to northwest-trending mountains on Oahu provides topographic barriers to wind flow patterns. As trade winds encounter these topographic features, they ascend and adiabatic cooling of the air occurs, which subsequently causes condensation and a loss of moisture as rainfall. Rainfall related to this orographic effect is well in excess of what might otherwise be expected to occur in the absence of the mountains. Isohyetal patterns (lines connecting points of equal rainfall) on Oahu (Figure 2-3) are much more complex that they might be if the mountains were not present (Giambelluca *et.al.*, 1986).

Mean rainfall is generally greater along northeast-facing coasts and slopes exposed to trade winds where the air is rising, and less along leeward slopes, where the air is descending. The highest mean annual rainfall on Oahu is 200 to 300 inches and occurs just leeward of the crest of the Koolau Range. Leeward coastal areas may receive as little as 20 inches or less per year. Rainfall in the vicinity of the project site, located about two miles to the northeast of Pearl Harbor, is approximately 45 inches (1150 millimeters) per year.

Evapotranspiration losses vary markedly over short distances on Oahu, due to the island's extreme areal variations in elevation, rainfall, cloud cover, humidity, and exposure to wind. Evapotranspiration in an area covered by a full sugarcane canopy has been measured at a station on the island to be approximately 65 inches per year. In contrast, evapotranspiration of water by a pineapple culture with plastic mulch in the same area has been measured to be approximately 18 inches per year (Hawaii Water Authority, 1959).



SOURCE: Giambelluca, et.al., 1986

ERCE

Median Annual Rainfall, Island of Oahu, Hawaii

FIGURE 2-3

Average evapotranspiration for the Honolulu-Pearl Harbor area has been estimated to be 50 inches/year (Ekern and Chang, 1985).

2.1.2 Regional Physiography

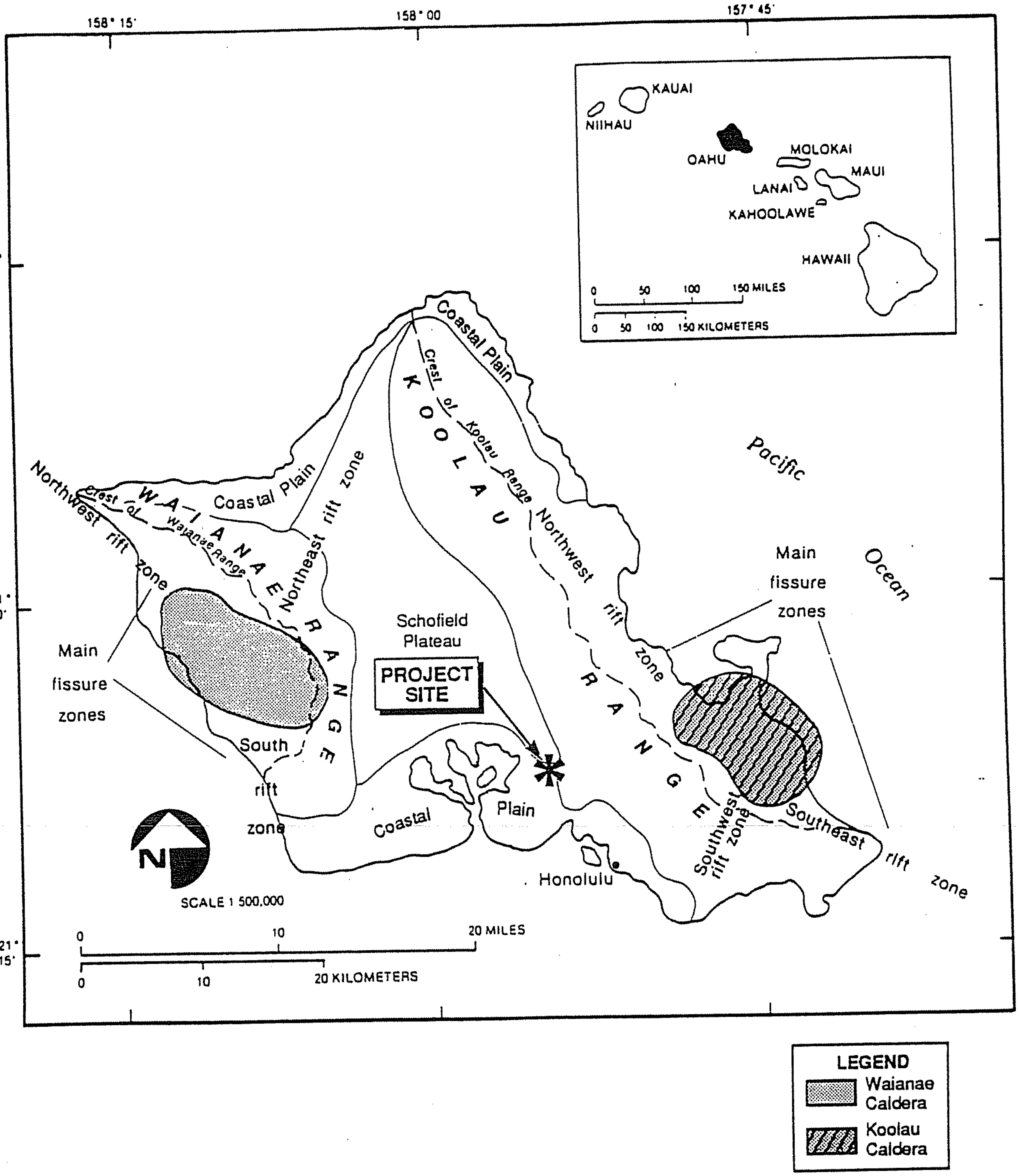
The primary agents that have shaped the geomorphic features of the Hawaiian archipelago include volcanic activity, sea level fluctuations, erosion of bedrock basalts, deposition of alluvium, and marine deposition and erosion (Wentworth, 1951).

The Hawaiian Islands consist primarily of basaltic lavas that first emerged from fractures on the seafloor during the Pliocene Epoch (Stearns and Vaksvik, 1935). Layers of lava subsequently accumulated in sufficient quantities to create the dome-shaped masses that rose above the sea to form the characteristic geomorphic features of the islands that are visible today.

The island of Oahu was formed through the emergence and coalescence of two large shield volcanoes, the Waianae and Koolau Volcanoes (Stearns and MacDonald, 1940). Eroded remnants of these volcanoes form two of Oahu's four geomorphic provinces - the Waianae Range on the west and the younger Koolau Range on the east. The other two provinces are the Schofield Plateau and the Coastal Plain. The four geomorphic provinces are located as shown on Figure 2-4.

Lava flows from the Koolau volcano flowed up against the eroded east slope of the Waianae volcano to form the gently sloping surface of the Schofield Plateau. After a long period of quiescence, during which extensive erosion occurred, volcanic activity resumed and a series of lava flows (the Honolulu Volcanic Series), cinder cones, and tuff cones were formed (Wentworth, 1951).

Sea level changes have played an important role in the development of the island of Oahu, particularly along coastal areas where extensive emerged reefs are present. Shifts in sea level and erosion allowed deposits of marine and terrestrial sediments to accumulate behind barrier reefs, forming coastal plains in some areas. The most prominent example of this is the coastal plain of the southern portion of Oahu, which is underlain by a broad elevated coral reef that is partially buried by alluvium eroded from upland areas (Stearns and Macdonald, 1940). Drilling data have shown that lava flows of the Honolulu Volcanic



SOURCE: Modified from Ewart, 1986

ERCE

Geomorphic Provinces on the Island of Oahu, Hawaii

FIGURE 2-4

Series are interbedded with the reef deposits, indicating that the two deposits must have been formed contemporaneously (Stearns and Vaksvik, 1935).

2.1.3 Site Physiography

The site is located in the South Halawa Stream watershed basin on the leeward (southwest) side of the Koolau Mountain Range. South Halawa Stream, which flows from the Koolau Range southwest into Pearl Harbor, is the major surface drainage feature in the site area. Surface topography in the vicinity of the site ranges from approximately 100 to 200 feet above mean sea level, generally sloping down from the site towards South Halawa Stream. When construction of the H-3 freeway began in the early 1970s, a portion of the stream was redirected and channelized by paving with concrete. This channelization moved the stream to the south, closer to the northern boundary of the site.

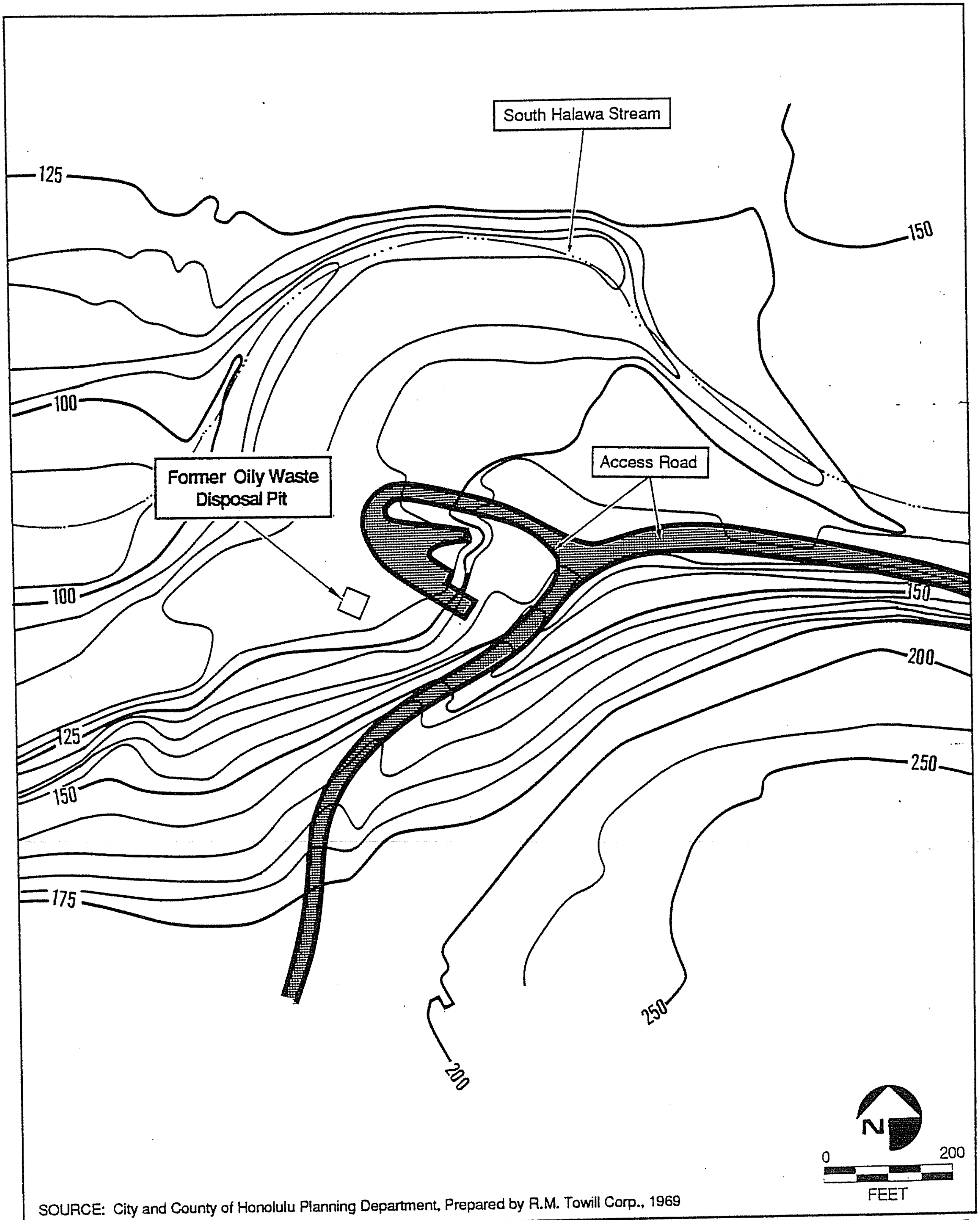
An elevation contour map of the site and its surrounding area, prior to channelization of South Halawa Stream, is shown in Figure 2-5.

2.1.4 Regional Hydrogeology

The aquifers of Oahu exist in an island environment which is surrounded by sea water. Numerous aquifer systems are present on the island and are shown in Figure 2-6. Three types of ground-water bodies provide the primary sources of water supplies on the island: the basal aquifer, dike-impounded water, and perched ground water. These three types of ground-water bodies are depicted on Figure 2-7 (Stearns and Vaksvik, 1935; Wentworth, 1951; Vischer and Mink, 1964).

The most extensive resource is the basal ground water. Basal water is a local term that has been developed to describe a body of ground water floating on, and in dynamic equilibrium with, the underlying oceanic seawater that has penetrated into the island. Water levels within the basal ground water tend to range approximately 20 to 30 feet above mean sea level (MSL) in inland areas, gradually decreasing to sea level towards the coast (Mink, 1980). The basal aquifer is the primary ground-water resource on Oahu (Vischer and Mink, 1964).

Throughout much of the island, water contained within the basal aquifer is generally present under unconfined conditions. In certain areas, however, particularly along the coast



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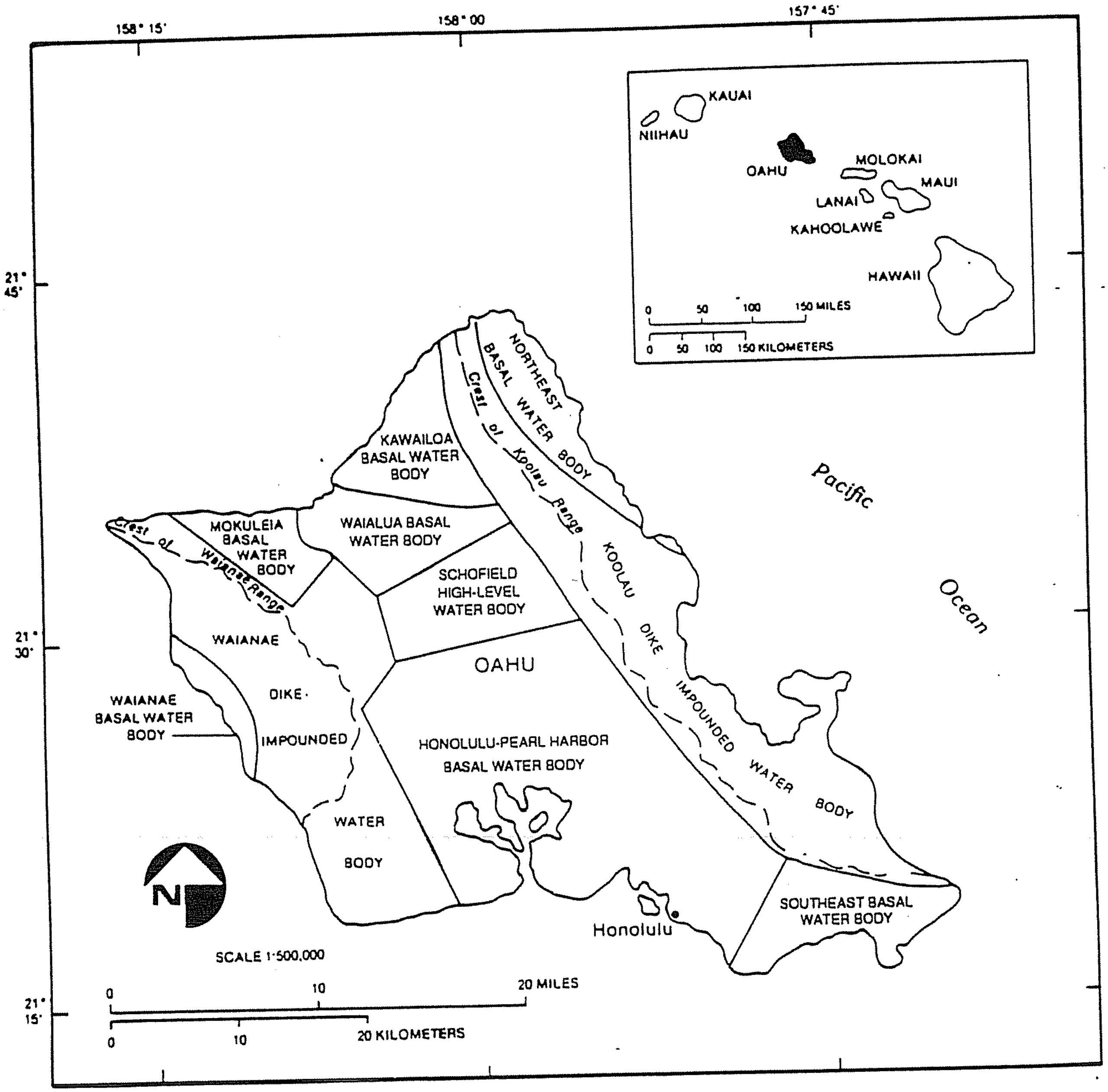
Elevation Contour Map, 1969
(Prior to Channelization)

FIGURE 2-5

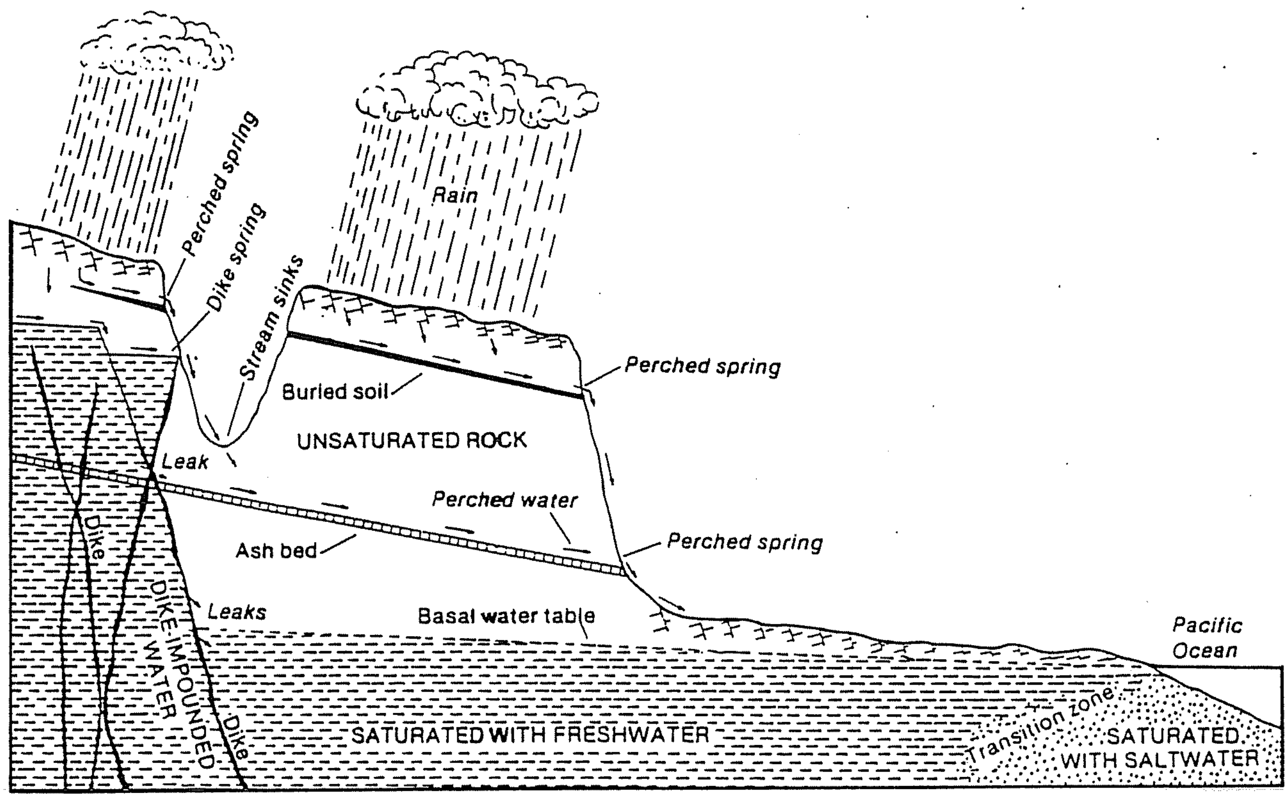


(modified from Dale and Takasaki, 1976)

ERCE

Major Aquifers, Island of Oahu, Hawaii

FIGURE 2-6



SOURCE: Ewart, 1986

ERCE

Occurrence of Ground Water in the Oahu Regional Aquifer System

FIGURE 2-7

where it is covered by lower permeability marine and alluvial deposits, artesian conditions may exist. The confining deposits are referred to by local geologists as caprock (Stearns and Vaksvik, 1935; Vischer and Mink, 1964).

A second source of ground water, dike-impounded water, is stored in permeable lavas situated between relatively impermeable intrusion dikes. Dike-impounded ground water generally occurs under confined conditions (Vischer and Mink, 1964).

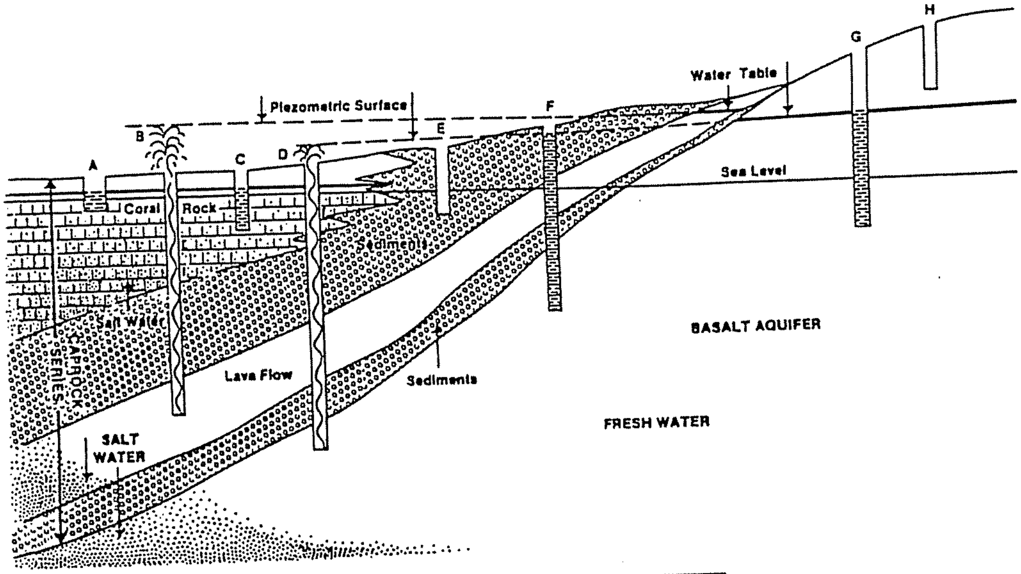
The third ground-water source, perched ground water, generally occurs under unconfined conditions and is separated from the underlying basal water body by an unsaturated zone. The perched ground water is generally underlain by confining layers such as ash beds or other low permeability materials. Both dike-impounded and perched ground water often occur at elevations much higher than the expected basal ground-water table and are collectively referred to as high-level ground water (Ewart, 1986).

Tunnels and wells tapping the basal aquifer are of primary importance in ground-water development on Oahu, and are shown schematically on Figure 2-8. Collection tunnels located in inland areas skim water from the top of the basal lens and have been used on Oahu since the early part of the century (Stearns and Vaksvik, 1935). These tunnels function as horizontal wells and tend to minimize degradation by salt water intrusion. The inclined or vertical shafts are excavated through the overburden into unweathered rock. A large room is constructed for the pumps and controls, and the collection tunnels are driven laterally from a sump located at the base of the shaft (Hawaii Water Authority, 1959).

Dike zones are often exploited by construction of shafts that may be horizontal, inclined, or vertical. Horizontal and inclined shafts are usually more productive than vertical shafts because of the greater likelihood of penetrating more than one dike zone (Ewart, 1986).

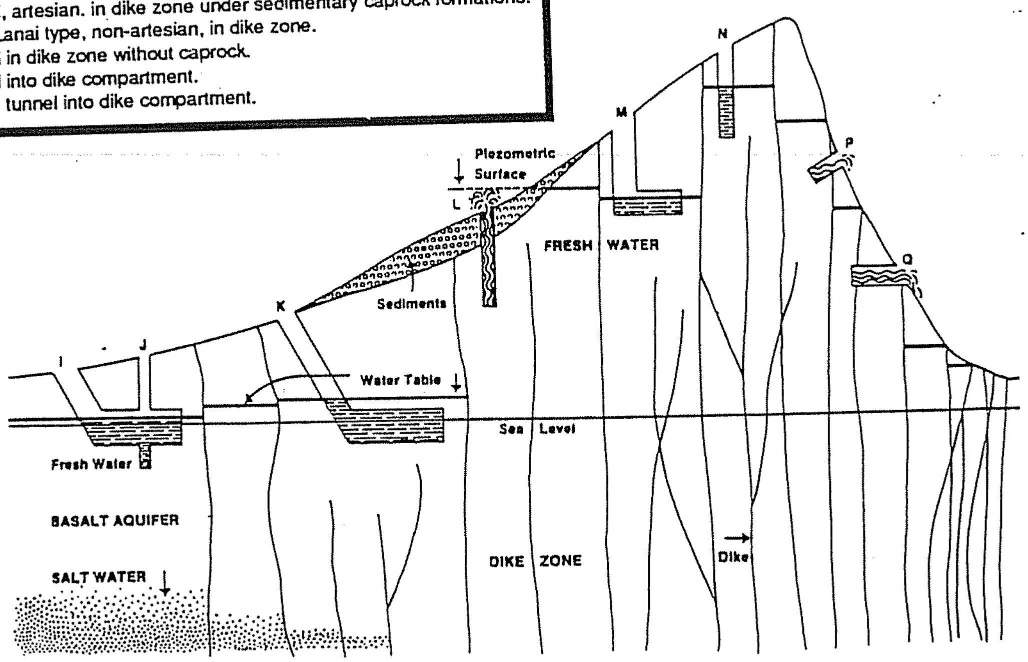
Natural ground-water discharge in the form of springs may occur from perched, dike, or basal water sources. Perched water springs are generally small and only of local importance, whereas basal water springs may have significant discharge that has been used in the past for irrigation and industrial cooling purposes. Dike springs have been, in most cases, replaced by dike tunnels (Honolulu Board of Water Supply, 1981).

Water occurring in alluvial deposits has not been developed extensively in the past due to the ease with which basal supplies could be developed. However, development of alluvial



LEGEND

- A Dug well, non-artesian, in formations of caprock series.
- B Drilled well, artesian, in water bearing formations of caprock series.
- C Drilled well, non-artesian, in lava or sediments of caprock series.
- D Drilled well, artesian, in lava confined under caprock formations, water in equilibrium with salt water.
- E Drilled well, dry, in non-water bearing sediments.
- F Drilled well, non-flowing artesian, in basalt aquifer confined by caprock formations, water in equilibrium with salt water.
- G Drilled well, non-artesian, in basalt aquifer not confined by caprock.
- H Drilled well, dry, bottom above water table.
- I Dug well, Maui type, non-artesian, in basalt aquifer, water in equilibrium with salt water.
- J Drilled well, to supplement Maui type dug well.
- K Dug well, Oahu type, non-artesian, in dike zone with water in equilibrium with salt water.
- L Drilled well, artesian, in dike zone under sedimentary caprock formations.
- M Dug well, Lanai type, non-artesian, in dike zone.
- N Drilled well in dike zone without caprock.
- P Drilled well into dike compartment.
- Q High Level tunnel into dike compartment.



SOURCE: HONOLULU BWS (1981)

ERCE

Schematic Diagram, Oahu Ground Water Development

FIGURE **2-8**

water with gravel-packed wells has been demonstrated to be economically feasible (Vischer and Mink, 1964).

Water quality of the three major types of ground-water bodies present on Oahu is generally good, with natural variations caused by factors such as rainfall and geology; and man-induced variations caused primarily by ground-water withdrawals, and infiltration of domestic, agricultural, and industrial wastes (Swain, 1973). Heavy pumping in the basal aquifer significantly increases chloride concentrations by inducing sea-water intrusion, particularly in coastal areas.

High-level water is generally dominated by sodium magnesium bicarbonate ions, with low-chloride ion and dissolved-solids concentrations (Swain, 1973). Some exceptions have been noted, however, in coastal and geothermal areas (Swain, 1973). High-level water is generally protected from sea water intrusion by the presence of high fresh water heads and dikes that serve as impermeable boundaries (Vischer and Mink, 1964).

Basal ground-water quality in southern Oahu exhibits significant variability, but is generally a sodium chloride type (Swain, 1973; Hufen, *et. al.*, 1980). Cation exchange, involving primarily sodium, calcium, and magnesium, has been shown to be a very dominant process in the basal ground water of the southern Oahu area (Mink, 1961). Where ground-water development is greatest, as in the Pearl Harbor and Honolulu areas, the rate of sea water intrusion is significant (Ewart, 1986).

2.1.5 Site Hydrogeology

Subsurface deposits present beneath the project site generally consist of rocks of the Koolau Volcanic Series with a veneer of residuum and possibly some alluvium from the South Halawa Stream. The basalts are jointed, dense, and vesicular. Geologic logs from boreholes drilled in the vicinity of the project site indicate that the sedimentary cover in this area is approximately 5 to 25 feet thick. The sediments generally consist of silts, sandy clays, and gravels (Division of Water and Land Development Driller Logs, 1988; Hawaii Department of Transportation Interstate Route H-3 Construction Plans, 1988).

Fill, alluvial deposits, and fractured basalt have been detected beneath the site based on lithologic sampling of four boreholes drilled around the Stilling Basin supervised by Aqua Terra Technologies (ATT, 1988). The fill and alluvium was described as consisting of medium-stiff to stiff clayey materials containing numerous basalt fragments, with fragments of coral and limestone present near the top of the fill. The underlying basalt bedrock appears to vary significantly in hardness and degree of weathering. The rock was sufficiently hard that it could not be penetrated with either hollow stem or solid flight auger drilling equipment.

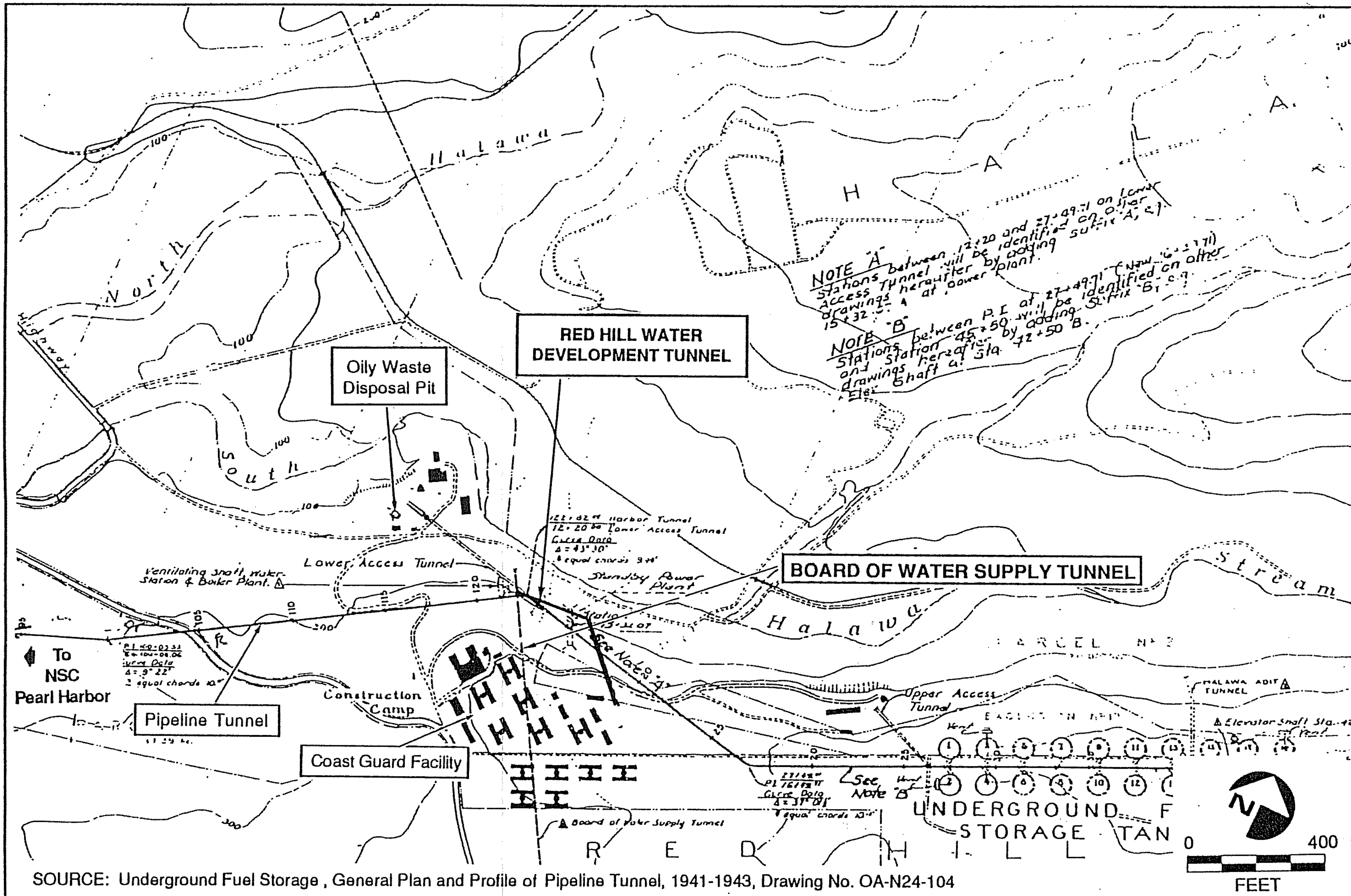
The four boreholes were left open for a period of at least 24 hours following completion to see if any water accumulation would occur. Three of the four borings remained dry, while some ground-water seepage was observed in the fourth borehole drilled, labelled RH-B3. Based on water level data obtained during this study, the water measured in the borehole drilled appears to be related to the presence of a perched water zone at the site (ATT, 1988).

The Red Hill water development tunnel, which draws water to supply the Pearl Harbor area from basalts forming the Honolulu-Pearl Harbor basal aquifer, is located approximately 550 feet to the east-southeast and 100 feet topographically upgradient from the Red Hill Site. The tunnel is approximately 1,200 feet long. The location of this tunnel is shown on Figure 2-9. The base elevation of the tunnel varies from 3 feet above MSL on the north end to 10 feet above MSL on the south end. Production from the tunnel is on the order of approximately 17 million gallons per day (USGS, 1987).

A determination of number and locations of wells and other water supply shafts within the vicinity of the Red Hill Site was made by conducting a search of files at the U.S. Geological Survey (USGS) Honolulu District Office, Hawaii Department of Land and Natural Resources (DLNR), Honolulu Board of Water Supply (BWS), and Hawaii Department of Health Services (DOH). Locations of water supply shafts and wells located in the vicinity of the site are shown in Figure 2-10. Boring logs and construction diagrams of the wells are included in Appendix B.

2.1.6 Land Use

The region around the Red Hill Site comprises a mixture of land uses. Military, industrial, transportation, institutional, commercial, residential, and recreational land uses can be found in the immediate vicinity of the site. Land use in the general area of the site is shown on Figure 2-11.

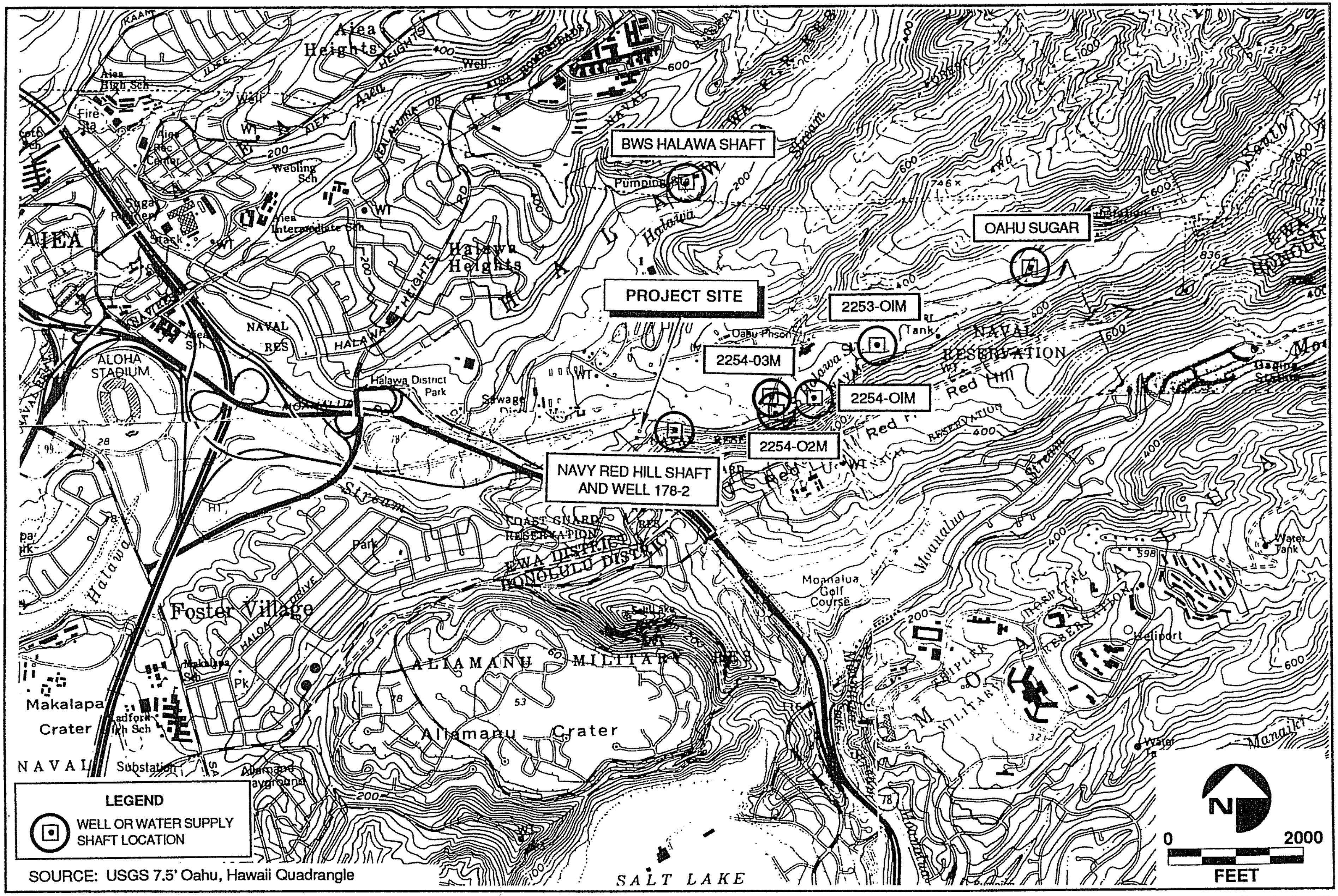


SOURCE: Underground Fuel Storage , General Plan and Profile of Pipeline Tunnel, 1941-1943, Drawing No. OA-N24-104

ERCE

Location of Water Development Tunnel

FIGURE 2-9



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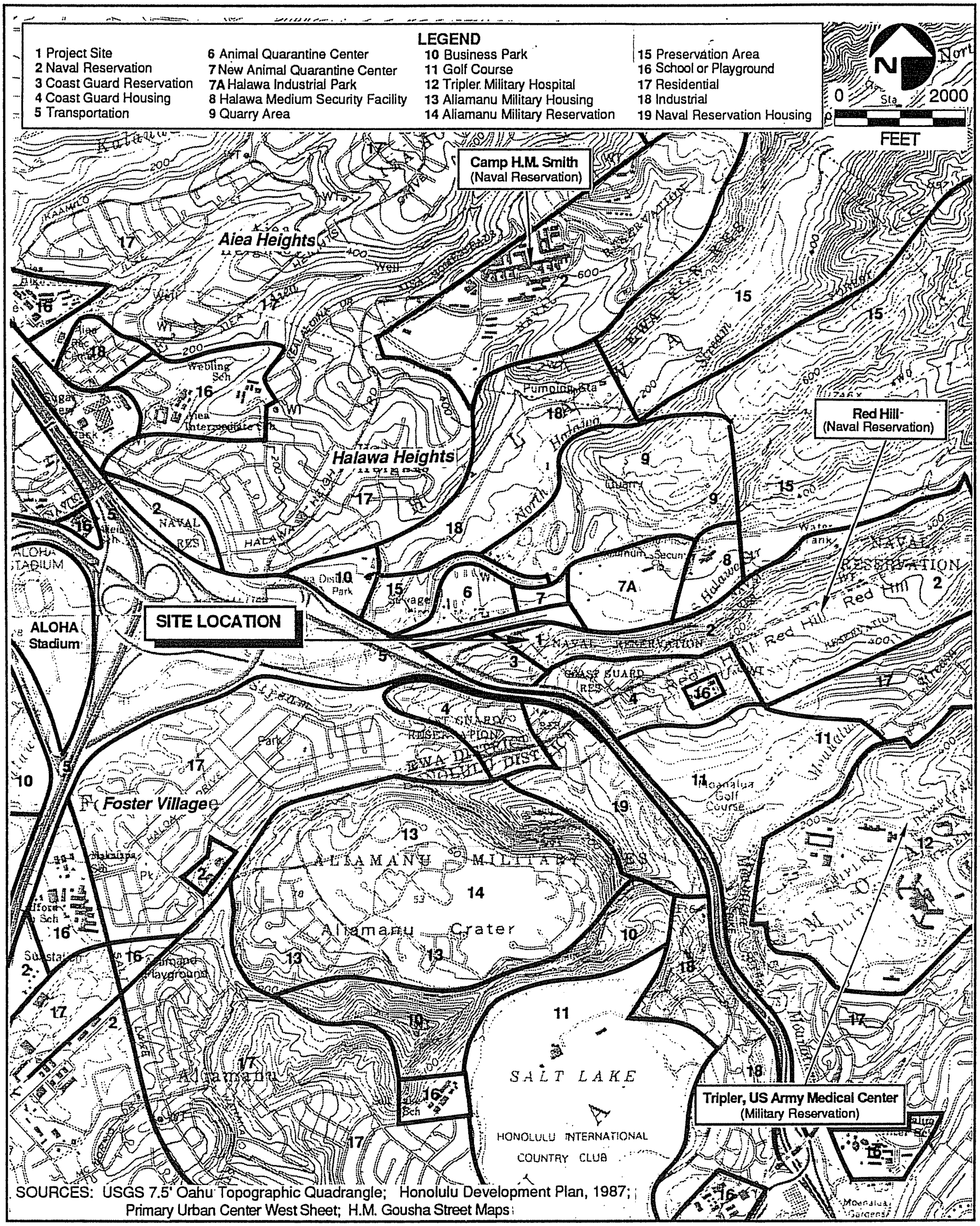
Wells and Water Supply Shafts in Vicinity of Site

FIGURE **2-10**



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Land Use in the Site Vicinity

FIGURE

2-11

Residential communities in the site vicinity include Foster Village, Moanalua Valley, Halawa Heights, Aiea Heights, and Aliamanu. The residential communities to the southeast and south of the Red Hill Site consist primarily of Navy and Coast Guard housing, with the closest buildings being Coast Guard structures located approximately 400 feet to the southeast. Non-military residential communities located closest to the site are Halawa Heights to the west and Foster Village to the northwest; the minimum distance between the site and both of these communities is approximately 2,500 feet.

Also located in the vicinity of the Red Hill Site are the State of Hawaii Animal Quarantine Station, Halawa Quarry, and the Halawa High and Medium Security Facilities. Of the three facilities, the Animal Quarantine Station is closest to the project site. The facility is approximately 50 feet from the Red Hill site perimeter and 250 feet from the Stilling Basin.

The vegetated section of land less than 50 feet to the south and west of the Red Hill Site is owned by the Coast Guard. Moanalua Highway (Highway 78) is located about 800 feet to the south. Coast Guard housing is located uphill from the site to the south and southeast, while the heavily vegetated Red Hill Naval Reservation is located to the east. The Halawa High and Medium Security Facilities are situated northeast across the stream approximately 3,000 feet away. A state forest reserve is located to the northeast at a distance of approximately 4,000 feet.

Due to its relatively small size, South Halawa Stream, which was channelized in the mid-1970's and is concrete-lined in the vicinity of the Red Hill Site, has limited recreational potential. There is also limited recreational potential for the stream from the location where it merges with North Halawa Stream to discharge into the East Loch of Pearl Harbor.

2.1.7 Flora and Fauna

An environmental impact statement (EIS) performed by the Hawaii State Department of Transportation (DOT) in connection with the construction of Interstate Route H-3 states that wild pigs, cats, mongoose, mice, and rats inhabit the North Halawa Valley, less than half a mile to the north of the South Halawa Valley (U.S. DOT, 1977). The mongoose and rat were identified as introduced species. Also, the EIS summarized a previous study performed in the Moanalua Valley and South Halawa Valley which provided some information on wildlife observed in these areas (Berger, 1971). The summary listed

12 avifaunal (bird) species observed about 5 to 10 miles east of the site, none of which were endangered species.

Additionally, the EIS discusses an avifaunal survey conducted in the north Halawa Valley which provided regional information (Shallenberger, 1977). Nineteen avifaunal species were observed in this area, none of which were on the endangered species list. Native species included the Black-crowned Night Heron, Hawaiian Owl or Pueo, Oahu 'Elepaio, Oahu Amakihi, and 'Apapane. Non-native species included the Spotted Dove, Barred Dove, Edible-nest Swiftlet, Melodiue Laughing-thrush, Red-billed Leiothrix, Red-vented Bulbul, Shama, Japanese Bush Warbler, Japanese White-eye, Common Myna, Spotted Munia, Cardinal, House Finch, and Yellow-faced Grassquit.

A second EIS, prepared for the Halawa Medium Security Facility 3,000 feet northeast of the Red Hill Site, summarized the regional vegetation as mainly Haole Koa along with some Christmas Berry, both ranging from shrubs to small trees (Wilson Okamoto and Associates, 1983). Opiuma and monkeypod trees are also located in this area. Morning glory vine was the only native species identified, with the others having been introduced.

The North Halawa Stream Valley from Moanalua Highway to the water pumping station has a long history of disturbance. Weedy herbs and shrubs are reported to be characteristic of this area. No rare or endangered species were observed in this area (U.S. DOT, 1977).

A study specific to the Red Hill fuel storage area was conducted by Hawaiian Agronomics (International), Inc. for the PACDIV Facility in 1986. Results of this study are presented in a report entitled *Final Report for Flora, Fauna, and Water Resources Survey of the Pearl Harbor Area Facilities, Hawaii*, dated April 1, 1986.

Excerpts from the Hawaiian Agronomics findings regarding endangered or threatened species during the survey of Red Hill Fuel Storage Facility flora, fauna, and water resources of August 1985 through April 1986 are given below:

> "a. Flora. A total of 90 species of plants were recorded within the study area; 83 species (92.2%) are alien introductions, 3 species (3.3%) are indigenous (occur naturally in Hawaii as well as in similar habitats elsewhere); and 4 species (4.5%) are endemic (occur nowhere else in the world outside Hawaii). Two alien species, haole koa (*Leucaena leucocephala*) and Christmas berry (*Schinus terebinthifolius*), form the dominant

vegetation types at Red Hill. No species currently listed in the U.S. federal list of endangered and threatened species or proposed, rare, or depleted species were found at the Red Hill Fuel Storage Area.

b. Birds. Thirteen species of birds were detected during this survey. Another four species are expected to occur but were not observed. Only one native species, the Golden Plover (*Pluvialis dominica*), was observed at Red Hill. No U.S. federally listed endangered or threatened species of birds were found. The Short-eared Hawaiian owl or pueo (*Asio flammeus sandwichensis*), not detected during this survey, is believed to infrequently visit the facility's wooded areas. This species is listed as endangered (Oahu only) by the State of Hawaii.

c. Mammals. Five species of mammals were detected at the facility none of which are rare, threatened, or endangered species. Mammalian species observed included the mongoose, the black rat, the house mouse and feral dogs and pigs."

Excerpts of recommendations made in this report are as follows:

"1. Flora. The large expanses of the noxious scrub *Schinus* (Christmas berry) should not be disturbed or destroyed for the dense thickets formed by these plants are providing erosion control and bank stabilization on the lower slopes bordering the facility. Bank stabilization and revegetation are recommended for eroded slopes to protect against further soil loss and sedimentation of adjacent streams. Species of preference for use are Bermuda grass (*Cynodon dactylon*), three flowered beggarweed (*Desmodium trifolium*) and 'ulei (*Osteomeles anthyllidifolia*).

2. Fauna. Feral pigs should be eradicated from Red Hill to help aid in reducing soil erosion. Also, feral dogs should be controlled, particularly along the outskirts of the housing subdivisions, for, if not controlled, they pose a serious threat to public safety.

3. Agriculture. Due to prohibitive water development costs; i.e., $1.00/1,000 gal., agricultural activities requiring supplemental irrigation are not recommended. Further, percolation of irrigation contaminants may adversely affect underground storage facilities.

4. Grazing. Grazing of any type is not a recommended use at Red Hill due to the susceptibility of the facility's soils to erosion.

5. Fire Prevention. The facility should take careful precautions to prevent the chance occurrence of accidental wildfires. Fire prevention measures should include considerations of implementing a multi-agency fire response plan; constructing fire breaks in critical areas; creating buffer zones by frequently

mowing unimproved grounds; and providing upgraded fencing to discourage trespass.

6. Hunting. Due to the close proximity of residential areas and the presence of fuel storage vents along the ridgeline at Red Hill, use of the area for regulated public hunting or hiking should not be encouraged."

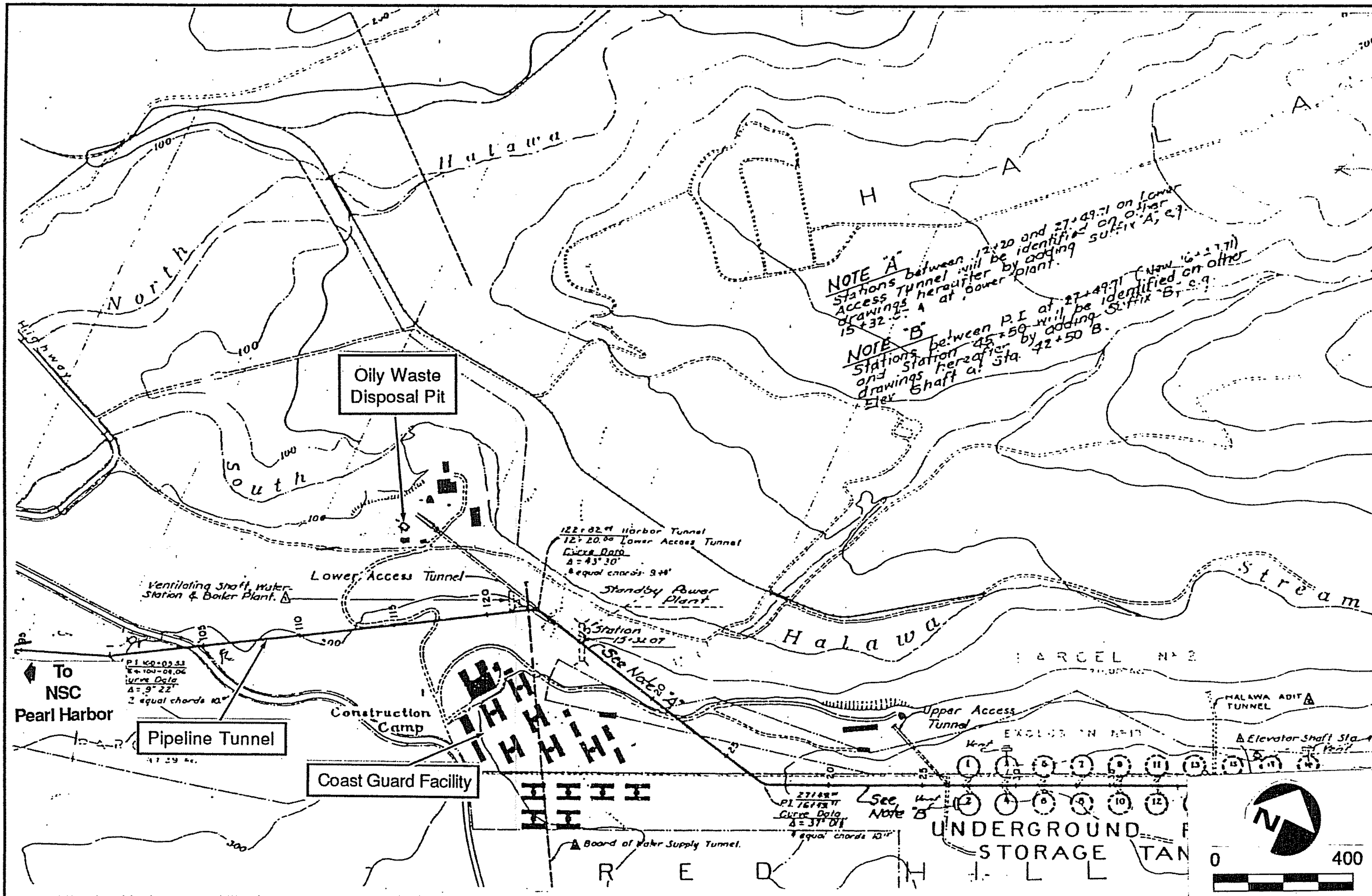
2.2 SITE HISTORY

The history of operations at the site may be separated into three distinct phases. The first phase encompassed the years during which the original Red Hill Oily Waste Disposal pit was constructed and operated (approximately 1943 to 1948). The original pit is hereafter referred to as the "old" pit. During the second phase, which lasted from approximately 1949 to 1972, no disposal pits were in operation at the site, although the site was apparently used to collect and store waste materials. The third phase began in 1972, when a new waste disposal pit, referred to as a "Stilling Basin" was constructed; this pit is hereafter referred to as the "Stilling Basin". It was in active operation until 1987 and is still in place, although it no longer serves any waste handling purpose. This section describes historical site activities during these three distinct periods of site operations.

2.2.1 Construction and Operation of the Old Pit

The Navy began construction of the fuel storage facility at Red Hill in 1938. Upon completion, the facility encompassed 20 massive underground fuel storage tanks. An associated waste disposal pit was constructed at the site to collect the oily waste, bottom sludges, and rinse waters which were generated during cleaning of the underground fuel storage tanks. Oily waste from drips and small leaks from the valves and piping in the Red Hill tunnels were also directed into this pit. The layout of the Red Hill Fuel Storage Facility in 1943 is shown on Figure 2-12.

"As-built" drawings reveal that the old pit had a base dimension of approximately 25 feet by 50 feet, a surface dimension of approximately 45 feet by 70 feet, and an approximated depth of 14 feet (U.S. Navy 1943b). The pit was underlain by one foot of "lava rock" and had earthen sides sloped at an angle of approximately 45 degrees. The location of the old pit in relationship to the current site layout is shown on Figure 2-13, while cross-

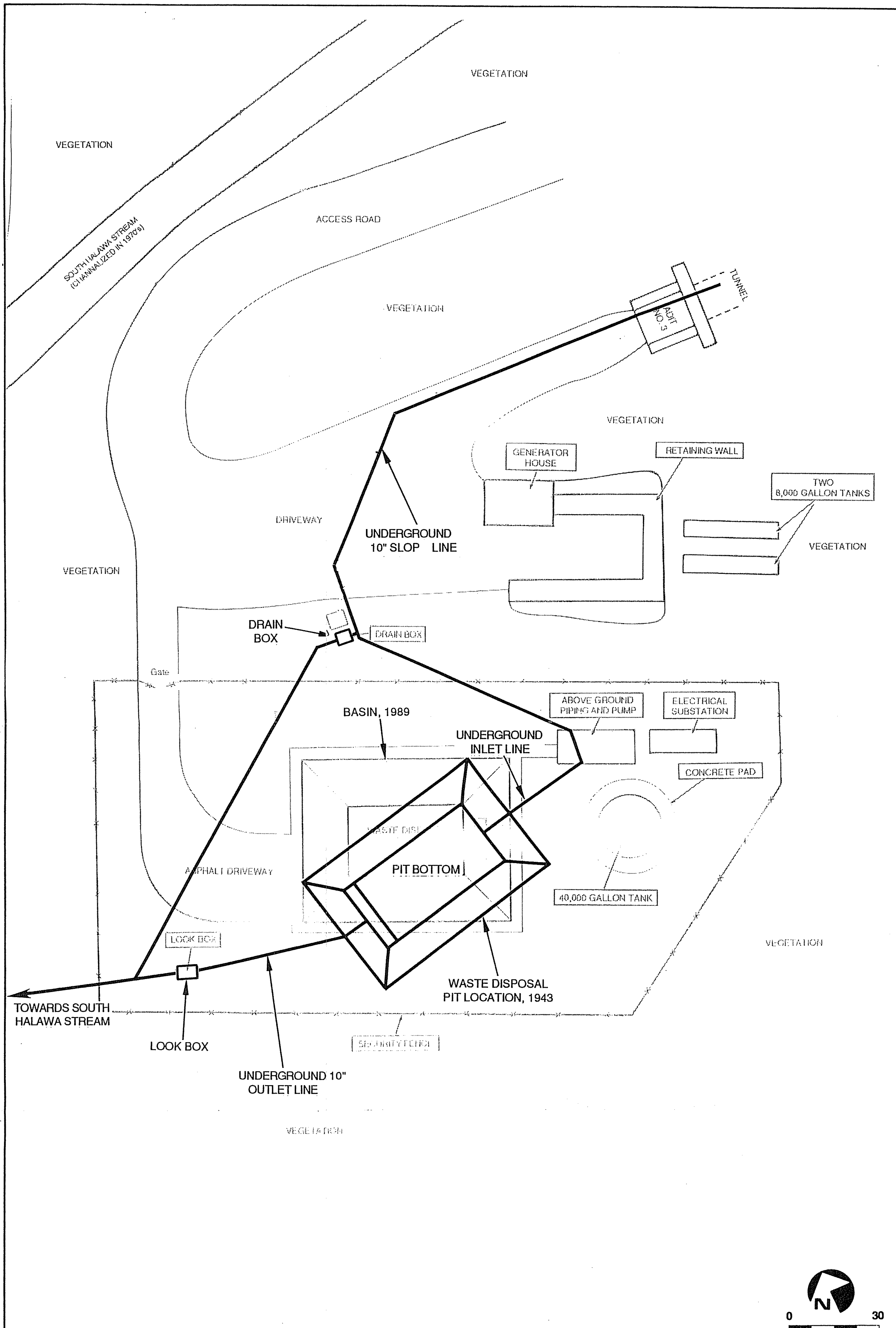


SOURCE: Underground Fuel Storage, General Plan and Profile of Pipeline Tunnel, 1941-1943, Drawing No. OA-N24-104

ERCE

Red Hill Fuel Depot, 1943

FIGURE 2-12



SOURCE: Plan & Profile on Waste Oil Disposal Pit Showing Pipe Lines, Y & D Drawing No. 294223, 1943

ERCE

Location of Waste Disposal Pit and Underground Fuel Piping, 1943

FIGURE 2-13

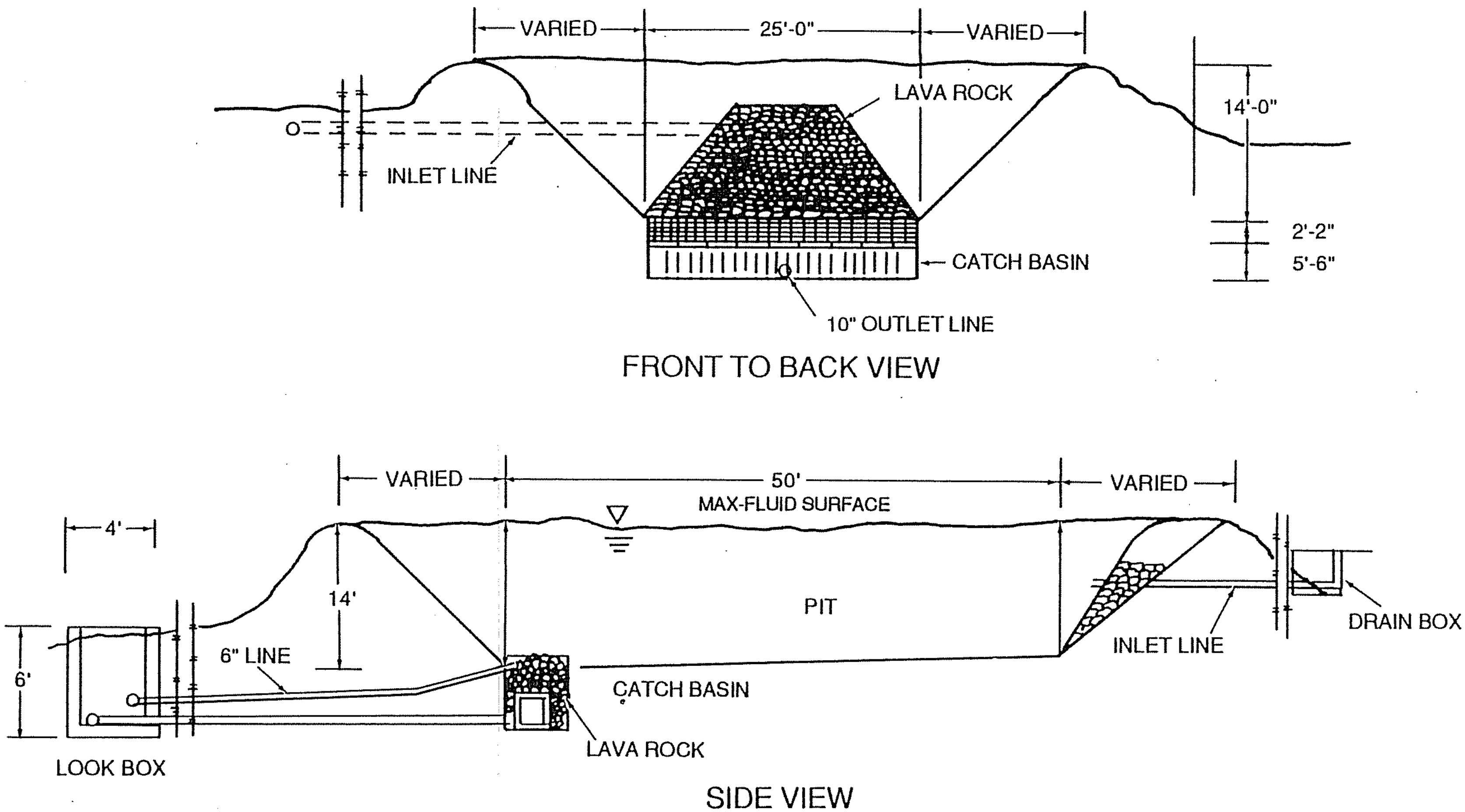
sectional drawings of the old pit are shown on Figure 2-14. A site photograph taken of the old pit shortly after construction is shown on Figure 2-15.

Several structures were located near the old pit, as shown on Figure 2-15. These included a change house, a transformer station, a steel fabrication shop, a rock crusher, and Adit No. 3, which is an entrance to the tunnel leading to the Red Hill underground fuel tank facility. A railcar transportation system is situated within the adit. The rock crusher and Adit No. 3 are shown in more detail on Figure 2-16. A 1943 plot plan of the lower portion of the fuel depot (Figure 2-17) shows the existence of a machine shop, machine shop warehouse, and service station, all of which were located near the steel fabrication shop, to the northeast of the old pit. No evidence had been found at the time of preparation of this WP to suggest that the rock crusher, service station, steel fabrication shop, or machine shop were related to the waste disposal activities at the site.

Oily waste residues were pumped from the Red Hill underground fuel tanks to the site via a series of pipelines, emerging from Adit No. 3 as the pipeline labeled "underground 10" slop line" shown on Figure 2-13. From this underground slop line, the wastes could either be routed into the old pit or into a bypass-type piping arrangement which led towards South Halawa Stream, as shown on Figure 2-13. When wastes were routed to the old pit, recoverable oil was skimmed off the fluid surface and collected in the two aboveground 8,000 gallon storage tanks located to the northeast of the old pit (Gammon, 1989). Fluid could be drained from the old pit via the "look box" into the bypass piping which led to South Halawa Stream.

Following draining of the fluids from the old pit, the sludge residue left in the bottom of the pit was ignited and allowed to burn on at least one occasion (Jensen, November 1989). A photograph of one documented burn, conducted in March 1948, is shown in Figure 2-18. Flammable liquids such as gasoline were dumped into the pit prior to the burn in order to enhance combustion of the residue, as shown in Figure 2-19. It can also be seen from Figure 2-19 that miscellaneous debris such as tires and wood were also burned during this event. Another site photograph, taken of the bottom of the old pit in March 1948, is shown in Figure 2-20.

According to a former Red Hill fuel depot employee, the burning activities were only conducted once, because they were not very effective in terms of reducing the volume of sludge in the bottom of the old pit (Jensen, November 1989). This former employee stated

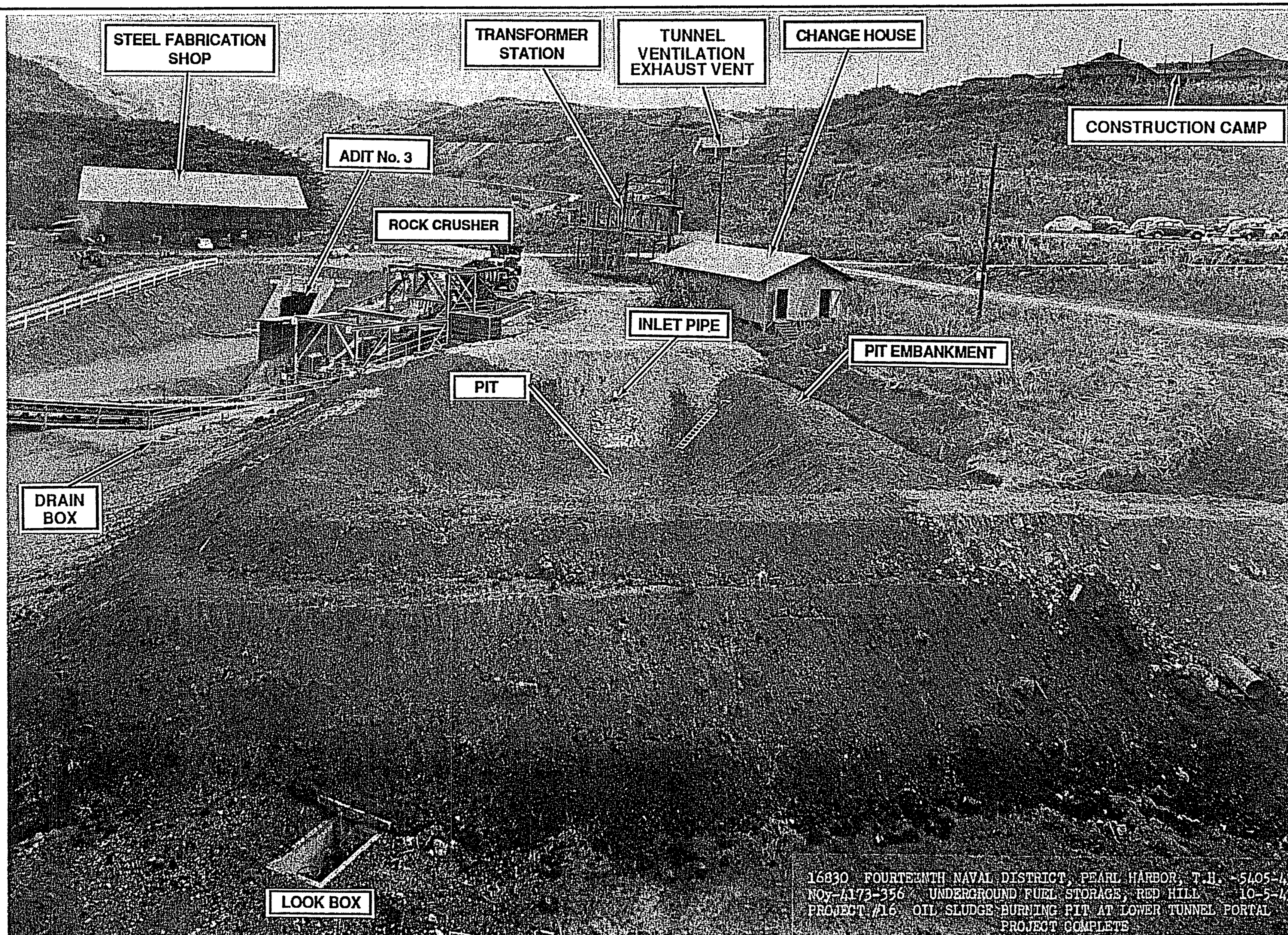


SOURCE: Fuel Depot, South Halawa, Oahu, Underground Fuel Storage, Fourteenth Naval District, September 1943

ERCE

Cross-Sections of Oily Waste Disposal Pit, 1943

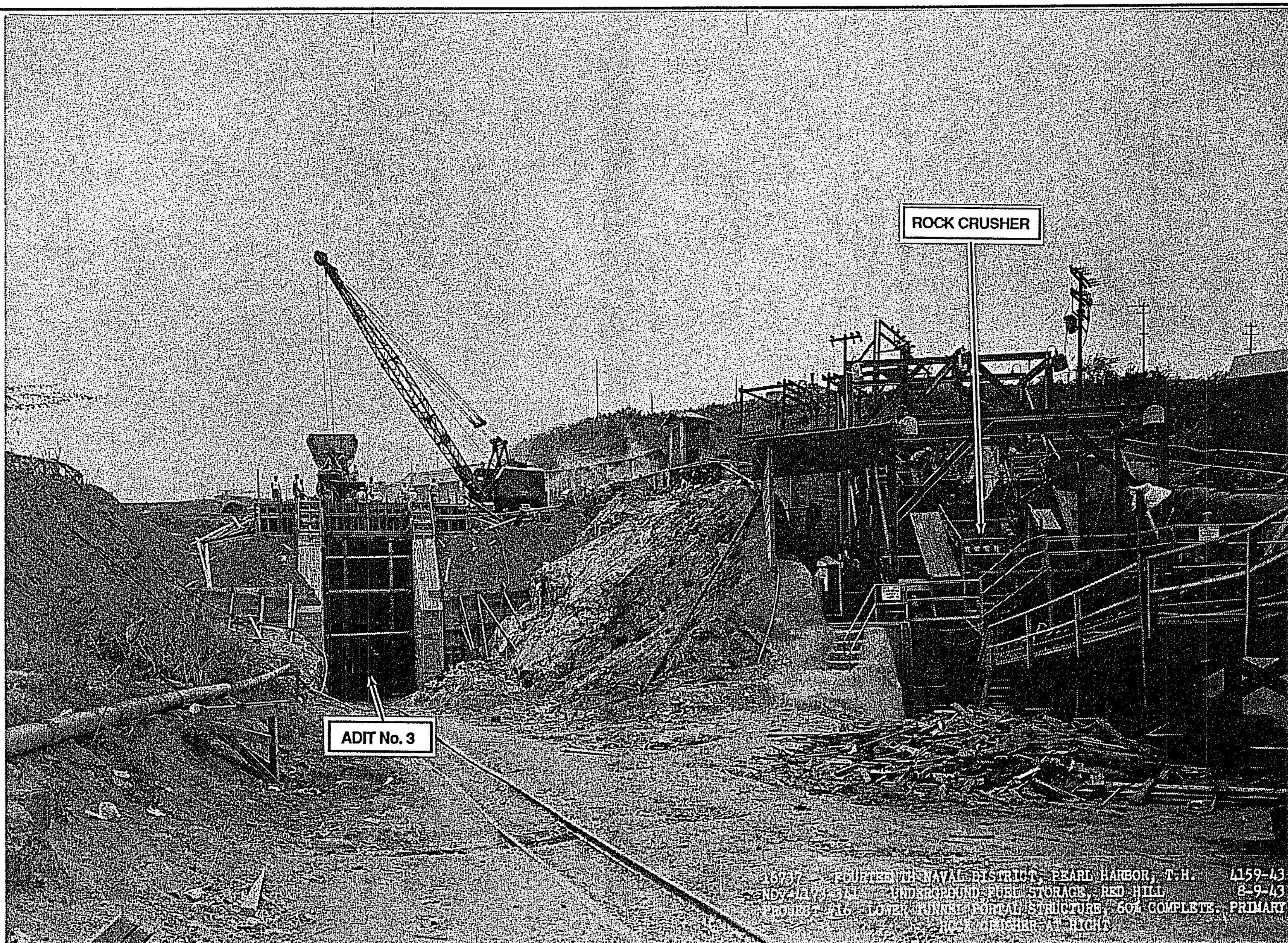
FIGURE **2-14**



ERCE

Site Photograph, Oily Waste Disposal Pit Construction, October 1943

FIGURE 2-15

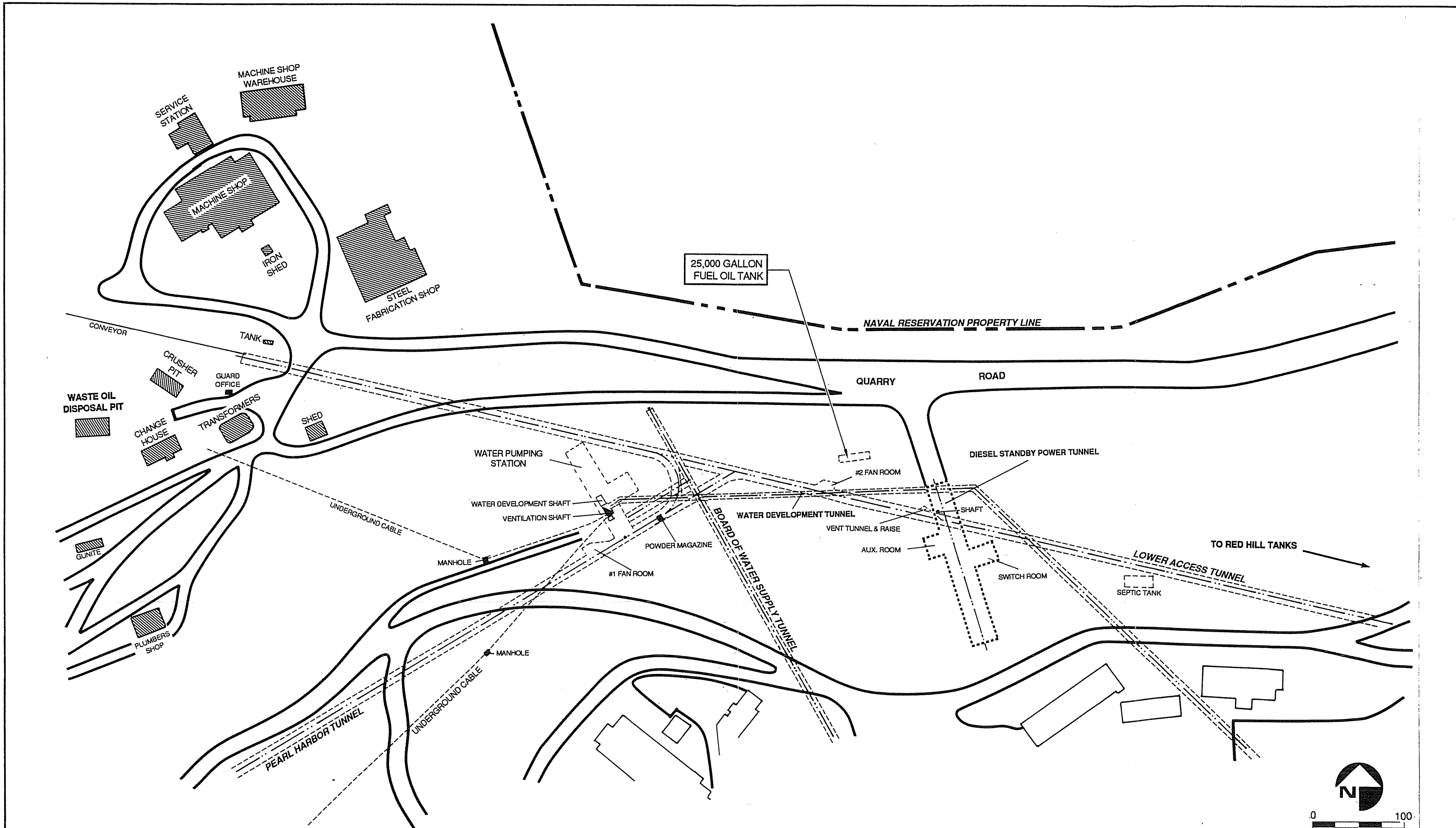


ERCE

Site Photograph, Adit Number 3 and Rock Crusher, August 1943

FIGURE

2-16

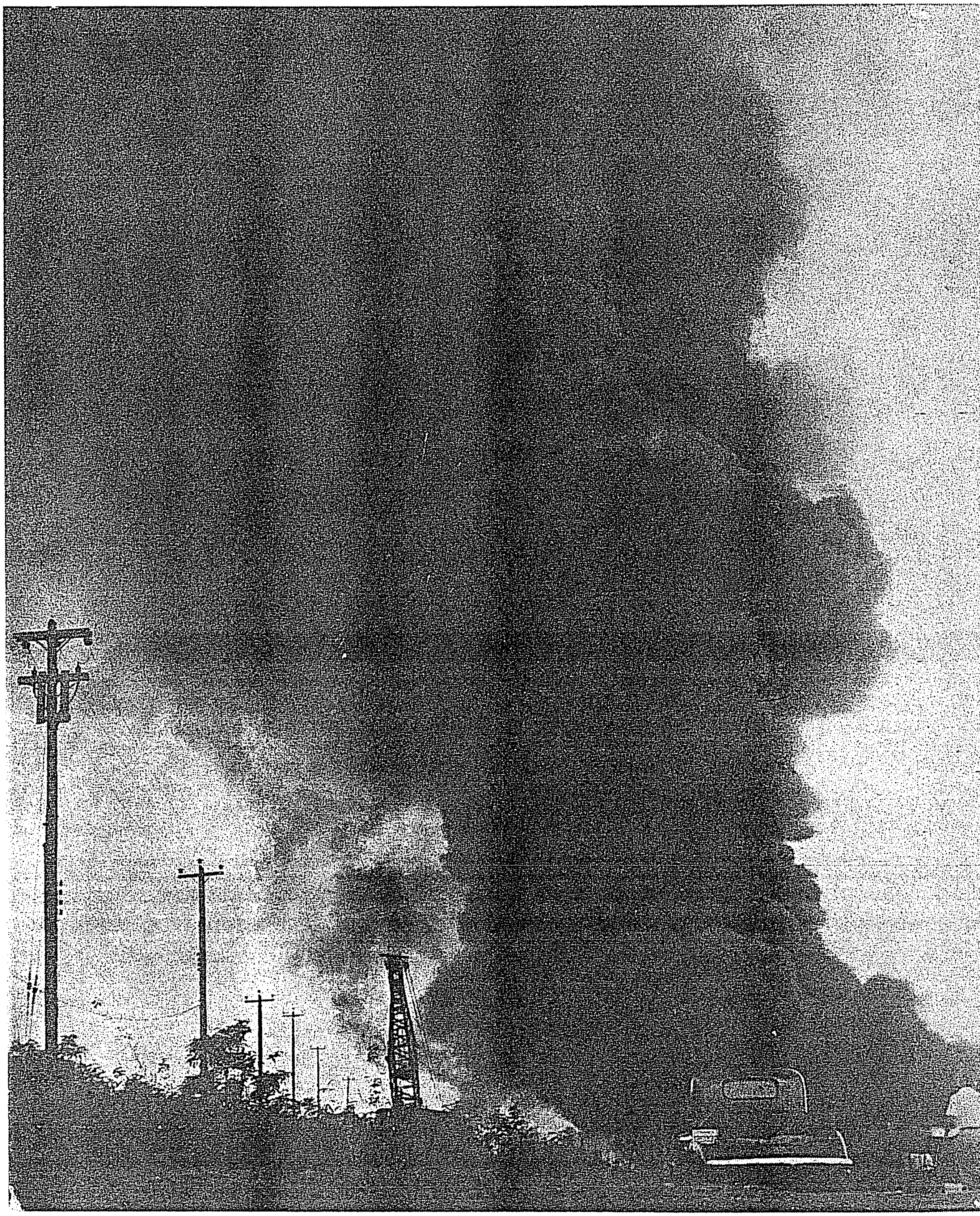


SOURCE: NSC Fuel Depot, Underground Piping, Drawing No. 293893, Approved September 21, 1943

ERCE

Plot Plan, Lower Portion of Fuel Depot, 1943

FIGURE 2-17



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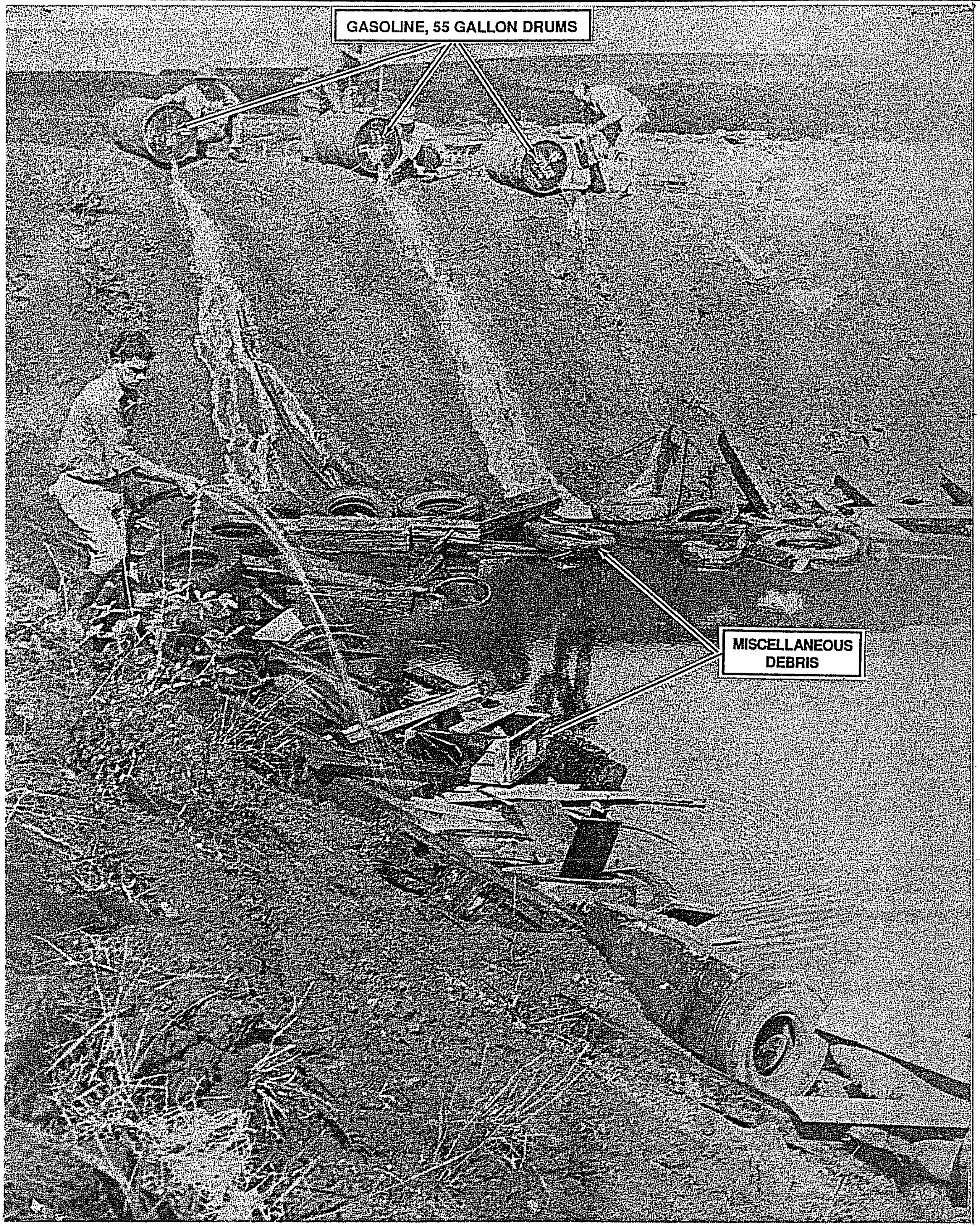
Site Photograph, Burn Operations, March 1948

FIGURE

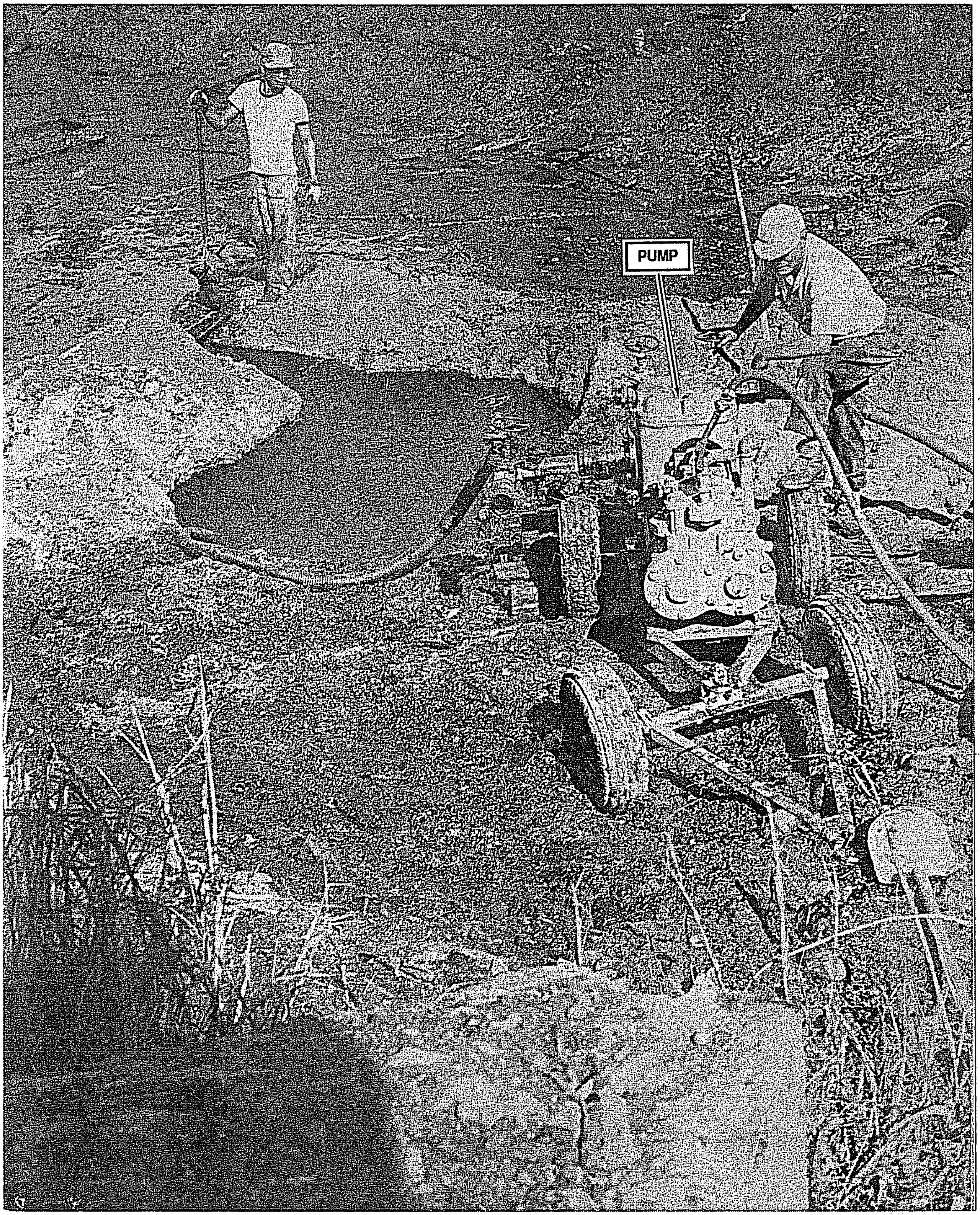
2-18



ERCE

Site Photograph, Old Waste Disposal Pit, March 1948

FIGURE 2-19

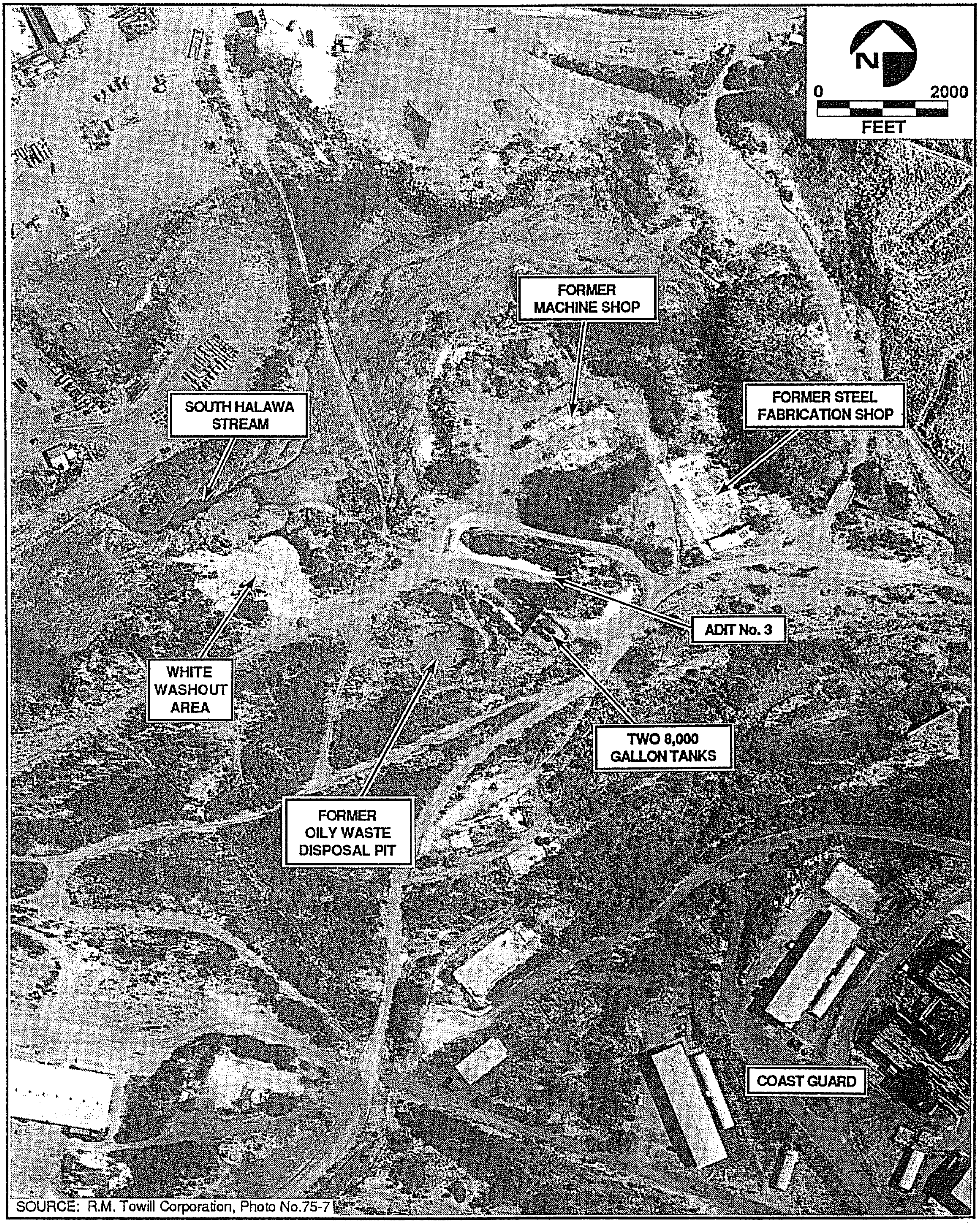


FIGURE

ERCE

Site Photograph, Bottom of Old Waste Disposal Pit, March 1948

2-20



ERCE

Aerial Photograph of Site, May 8, 1949

FIGURE 2-21

that gasoline and miscellaneous debris, including old tires and waste wood, were added to the bottom of the old pit prior to conducting the burning operation.

Also according to this former employee, a fuel spill of approximately 30,000 barrels, or 1.3 million gallons, occurred at the Red Hill Fuel Storage Facility at some point during the 1943-1945 time period. The spill was apparently the result of improper valve operation during the routine fueling of a naval vessel in Pearl Harbor. The fuel spill is reported to have flowed downhill from the Red Hill underground fuel tanks through the Lower Access Tunnel to the Adit No. 3 portal, where it apparently discharged to ground and flowed westward into South Halawa Stream. Written documentation of this incident is unavailable.

In 1948, the PWC Water Development Tunnel was reportedly contaminated due to a diesel fuel spill unrelated to the waste disposal activities at the old pit (Gammon, 1989). Due to this contamination, the water pumping station was shut down from February 19, 1948, until April 27, 1948. An investigation conducted by the Navy concluded that the source of contamination was a 25,000 gallon diesel underground storage tank used to supply fuel for the Red Hill standby power generation station under construction at the time (COMM14, 1949). The location of the tank and its relationship to the water supply tunnel and pumping station and the site is shown in Figure 2-17. In reference to this incident, however, a report also addressed actions taken at the old pit with the following passage (COMM14, 1949):

> "...For the record, it is noted that the "Slop or Disposal Pit" shown on enclosure (F-1) [Dwg. OA-N24-357 (293879)] has been cleaned out and excavated beyond the depths of oil penetration. There is no indication of oil seepage beyond the rock immediately in contact with the waste oil, but, to preclude any possibility of contamination of water supply from this source, the pit has been abandoned as a disposal facility and waste oil is now hauled to tanks in the Shipyard pending shipment to California."

Available data is insufficient to allow calculation of the volume of soil removed and ultimate disposition of the excavated soils is unknown. No other written or oral documentation was available to confirm or deny this cleanup of the old pit.

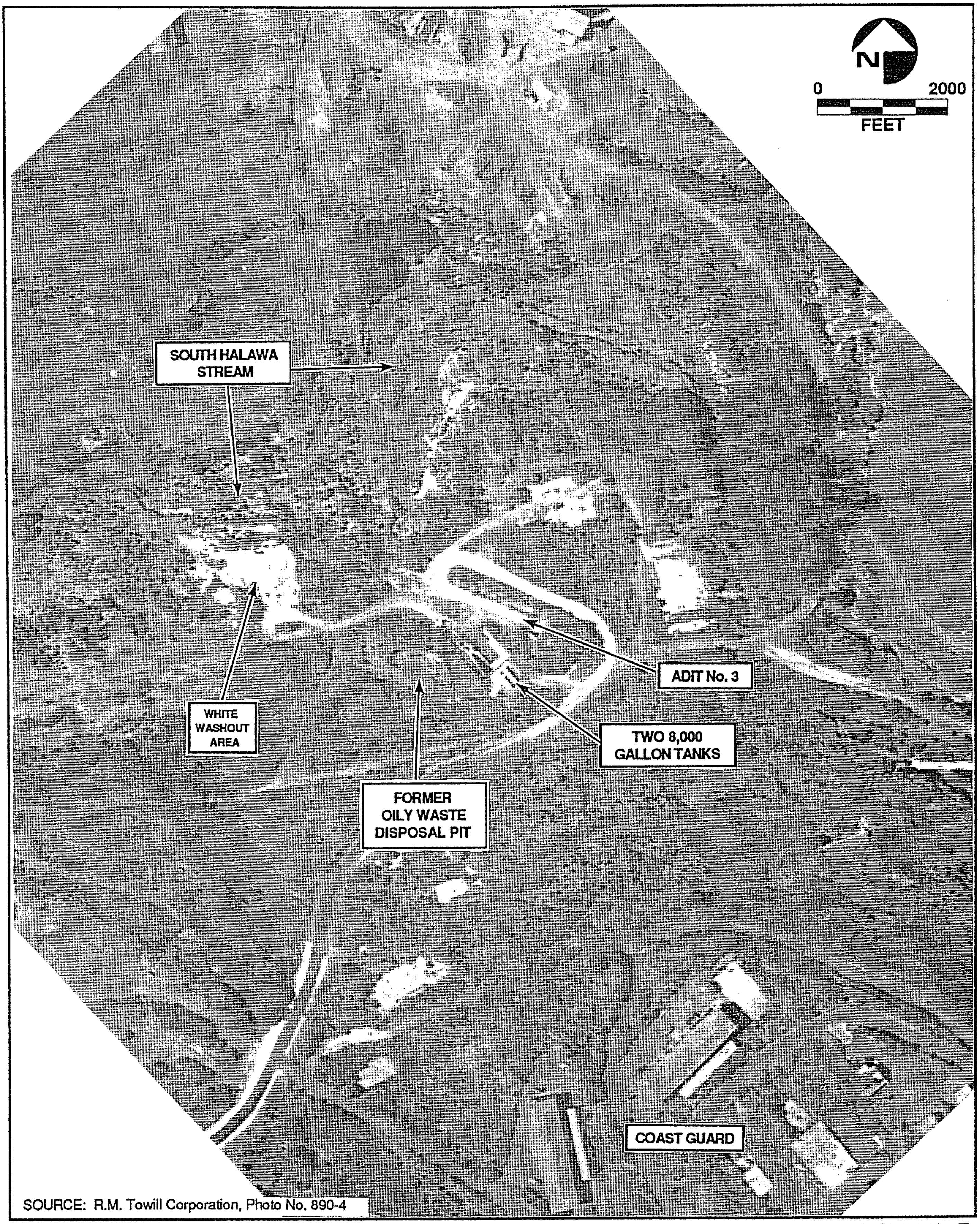
2.2.2 Site Operations Following Deactivation of Old Disposal Pit

Aerial photographs of the site for the years 1949, 1952, 1955, 1962, 1966, and 1970 appear to indicate that the old pit area was not actively in use between the years 1949 and 1970; these aerial photographs are reproduced in Figures 2-21 through 2-26. During this time period, the access roads to the old pit eventually became overgrown with vegetation. The photograph from 1949 appears to show a slight topographic depression in the location of the old pit possibly indicating that the old pit was not closed by filling. The photograph from 1970 appears to indicate that the area of the old pit had become lightly vegetated, but it was still readily apparent where the old pit had been located. Additional confirmation that the old pit was not in use during this time period is reflected by the fact that a 1954 Master Shore Station Development Plan incorporates the site but shows no evidence of the old waste disposal pit (NSC, 1954).

During the period from 1949 to 1970 when the disposal pit was not used, wastes from the underground fuel tank farm were probably pumped from the slop line to the two aboveground 8,000 gallon tanks. Other possibilities are that wastes were being moved directly from the underground slop line through the drain box and then routed through the bypass-type piping arrangement which led to South Halawa Stream. It is also possible that not as much waste was being generated as was previously the case.

In addition to the old pit, a second distinct feature, which is labelled "white washout area," is noticeable on the aerial photographs. On the 1949 photograph, this feature shows up as a somewhat circular white area situated approximately 200 feet west of the old pit. This area became progressively more vegetated over time as shown in the photographs. Although the exact nature of this white area is difficult to assess, two explanations are possible. One possible explanation is that it represents waste materials that were dumped by vehicles. A second explanation is that it represents discharge from the site bypass waste line which led to South Halawa Stream.

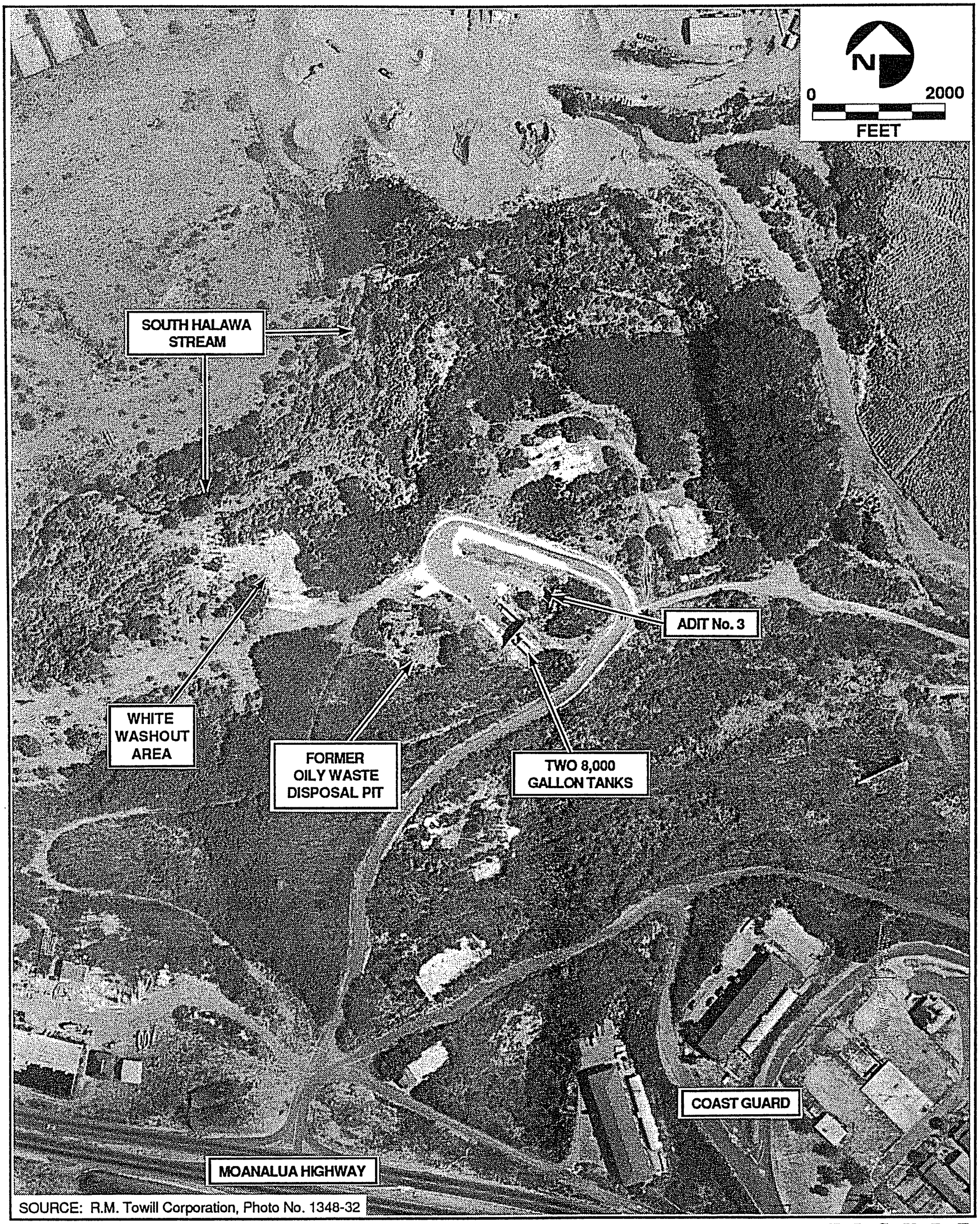
In 1960, four of the twenty Red Hill underground fuel storage tanks were converted from the storage of Navy Special Fuel Oil (NSFO) to jet fuel and aviation gas storage. The tanks undergoing this conversion were cleaned, sandblasted, repaired, and coated with a polyurethane coating (Gammon, 1989). A new, separate adit and pipeline system leading towards Pearl Harbor was installed for these converted tanks, which were disconnected from the various existing waste disposal/collection/handling systems at the site.



ERCE

Aerial Photograph of Site, September 20, 1952

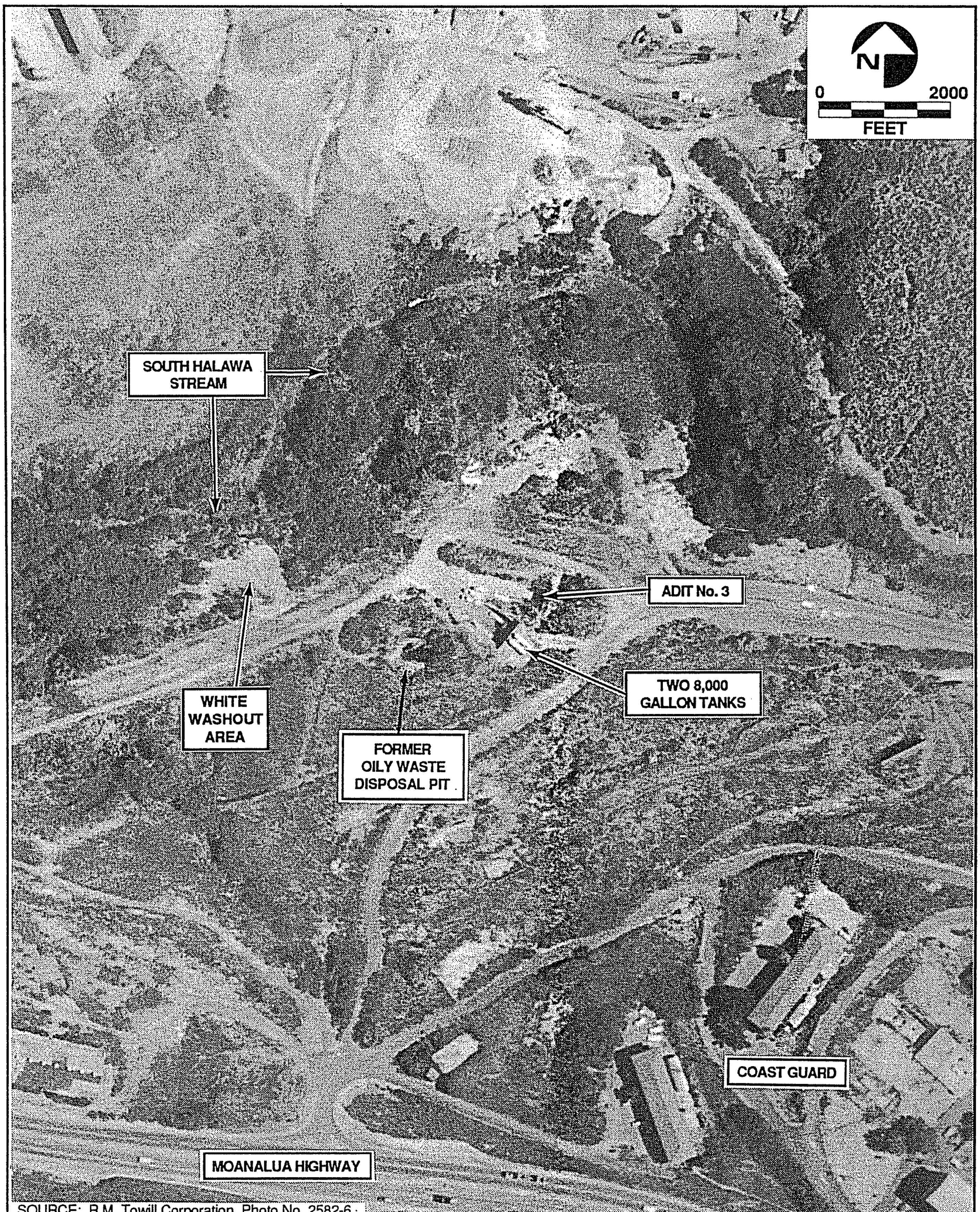
FIGURE 2-22



ERCE

Aerial Photograph of Site, July 22, 1955

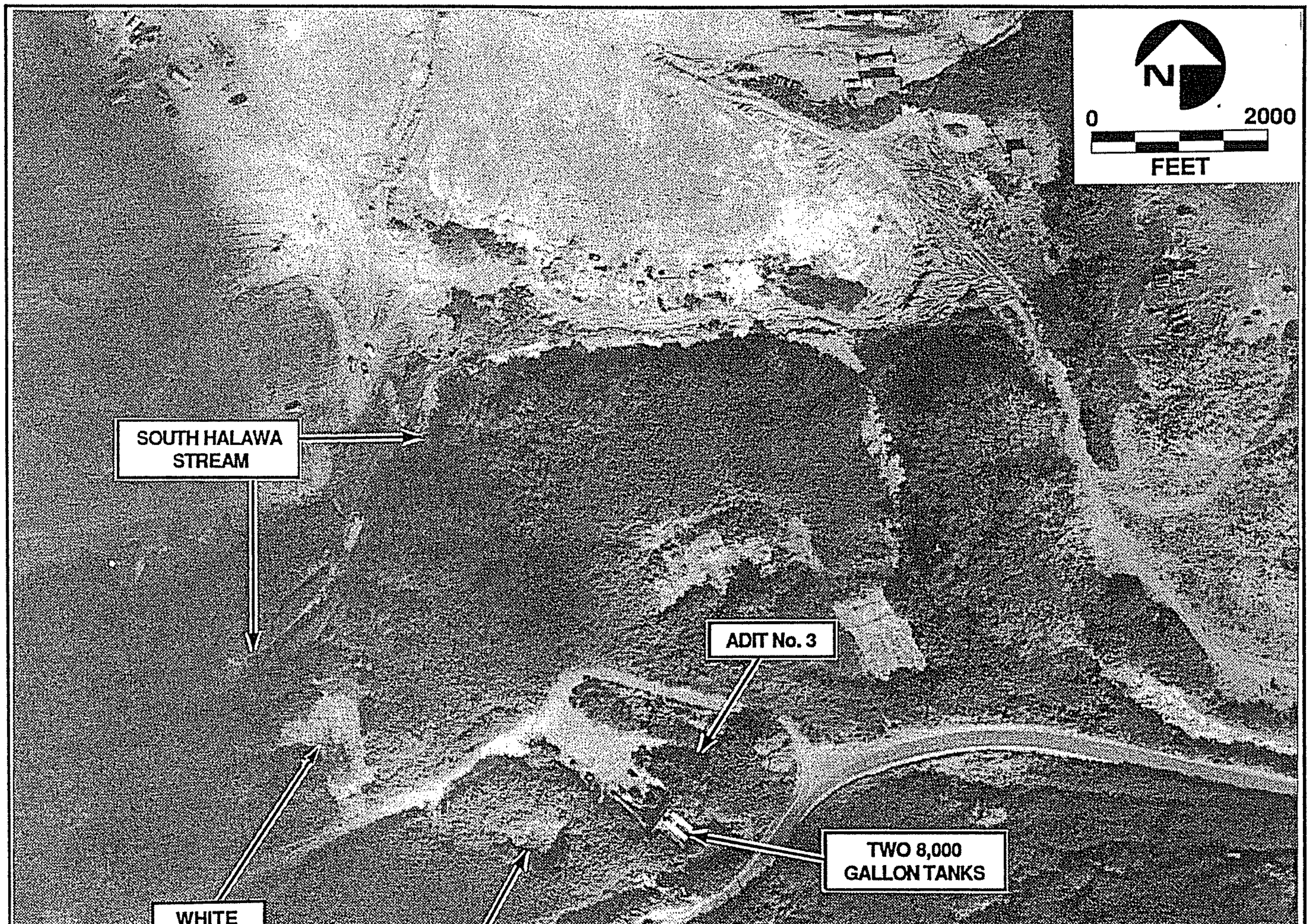
FIGURE **2-23**



ERCE

Aerial Photograph of Site, August 24, 1962

FIGURE 2-24

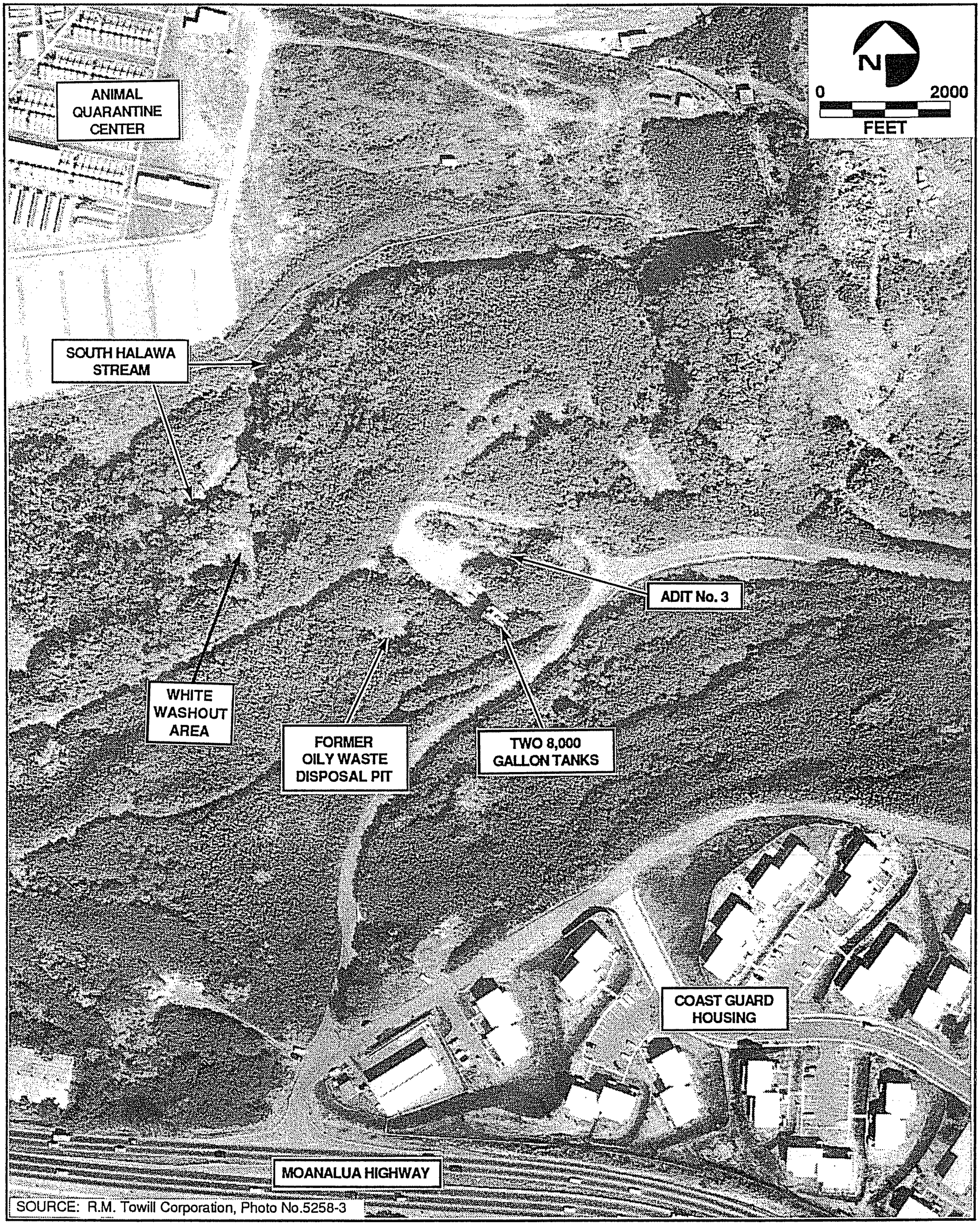


SOURCE: R.M. Towill Corporation, Photo No. 3558-3

ERCE

Aerial Photograph of Site, January 14, 1966

FIGURE 2-25



ERCE

Aerial Photograph of Site, January 15, 1970

FIGURE 2-26

2.2.3 Construction and Operation of the Stilling Basin

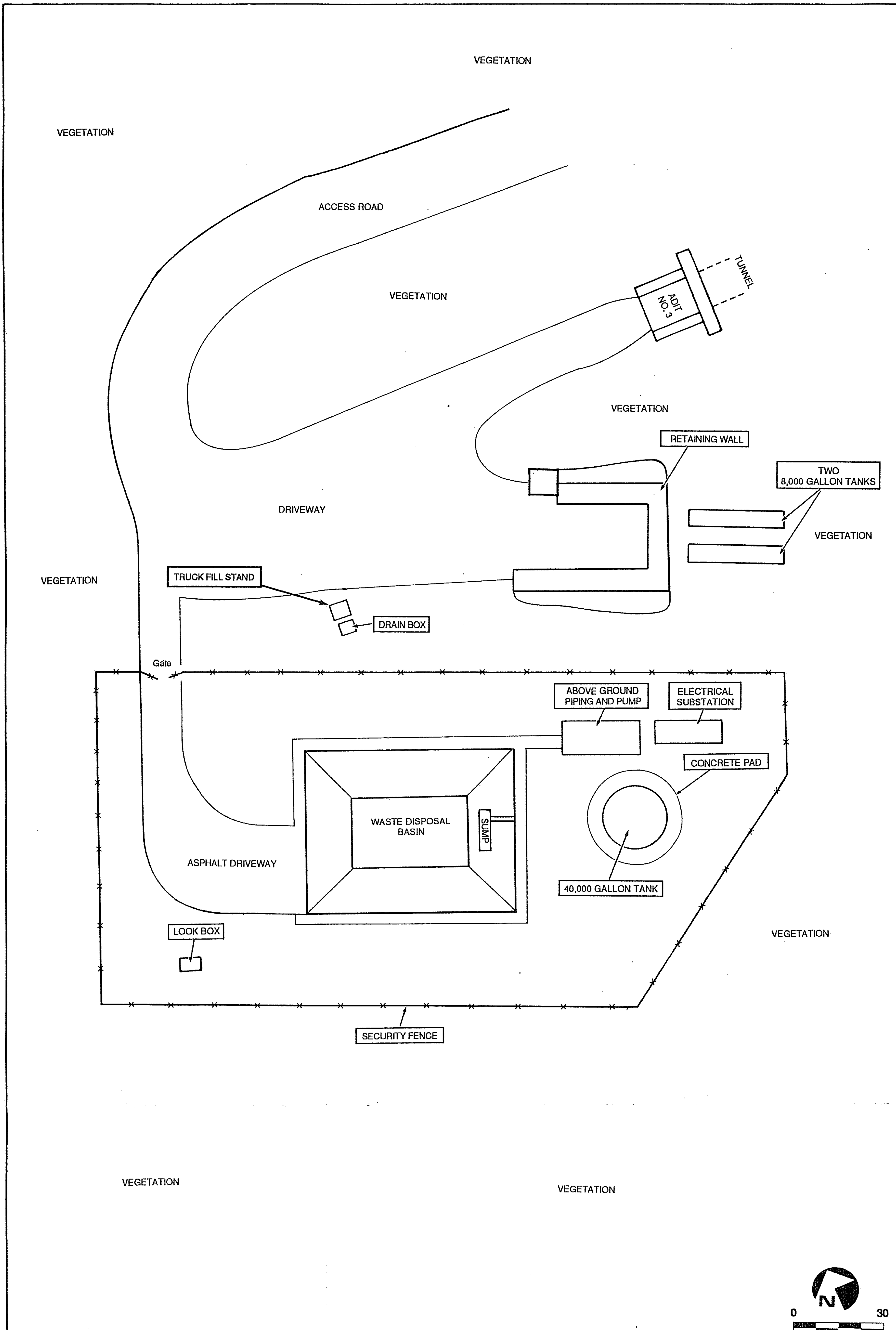
The Navy began construction of a new waste disposal system at the site in approximately 1971. By 1972, construction of the new system had been completed, and included a new pit, which was referred to as a "stilling basin", and a 40,000 gallon aboveground water storage tank. The facility layout of this new system is shown on Figure 2-27, while the associated piping system is shown on Figure 2-28. A security fence was also installed along the perimeter of the site.

The new Stilling Basin was constructed in approximately the same location as the old pit, but oriented in an approximate northwest/southeast direction instead of the west/east orientation of the old pit. The relationship between the locations of the old and new pits is shown on Figure 2-13. The Stilling Basin had a base dimension of approximately 25 feet by 40 feet, a surface dimension of approximately 55 feet by 70 feet, and an approximate depth of 10 feet. A plan view of the Stilling Basin is shown in Figure 2-29, while cross-sections are shown in Figure 2-30.

The Stilling Basin was asphalt-lined with a coal-tar emulsion and a filler coat (Gammon, 1989). A 1972 aerial photograph showing the basin is presented in Figure 2-31. It is assumed that the Stilling Basin was constructed in the same location as the old pit in order to minimize the amount of grading necessary, since it is believed that the topographic depression associated with the old pit still existed at the time of the stilling basin construction; however, this has not been confirmed.

According to a former NSC employee, Mr. James Jensen, the asphalt lining of the Stilling Basin began to crack shortly after its construction. The basin was subsequently drained, and the bottom sludges were removed and placed into 55 gallon drums. These drums were taken a short distance west of the basin, to a koa bush area, and then were emptied onto the surface soils. The Stilling Basin was then reconstructed using a concrete lining. This former employee also reported that, on at least one occasion following the reconstruction of the new basin, improper valve operation at the basin resulted in a significant amount of sludge and water being discharged directly to South Halawa Stream (Jensen, 1989).

Besides the off-site discharges of waste mentioned in the preceding paragraph, one other off-site discharge was reported to have taken place. This discharge apparently occurred in

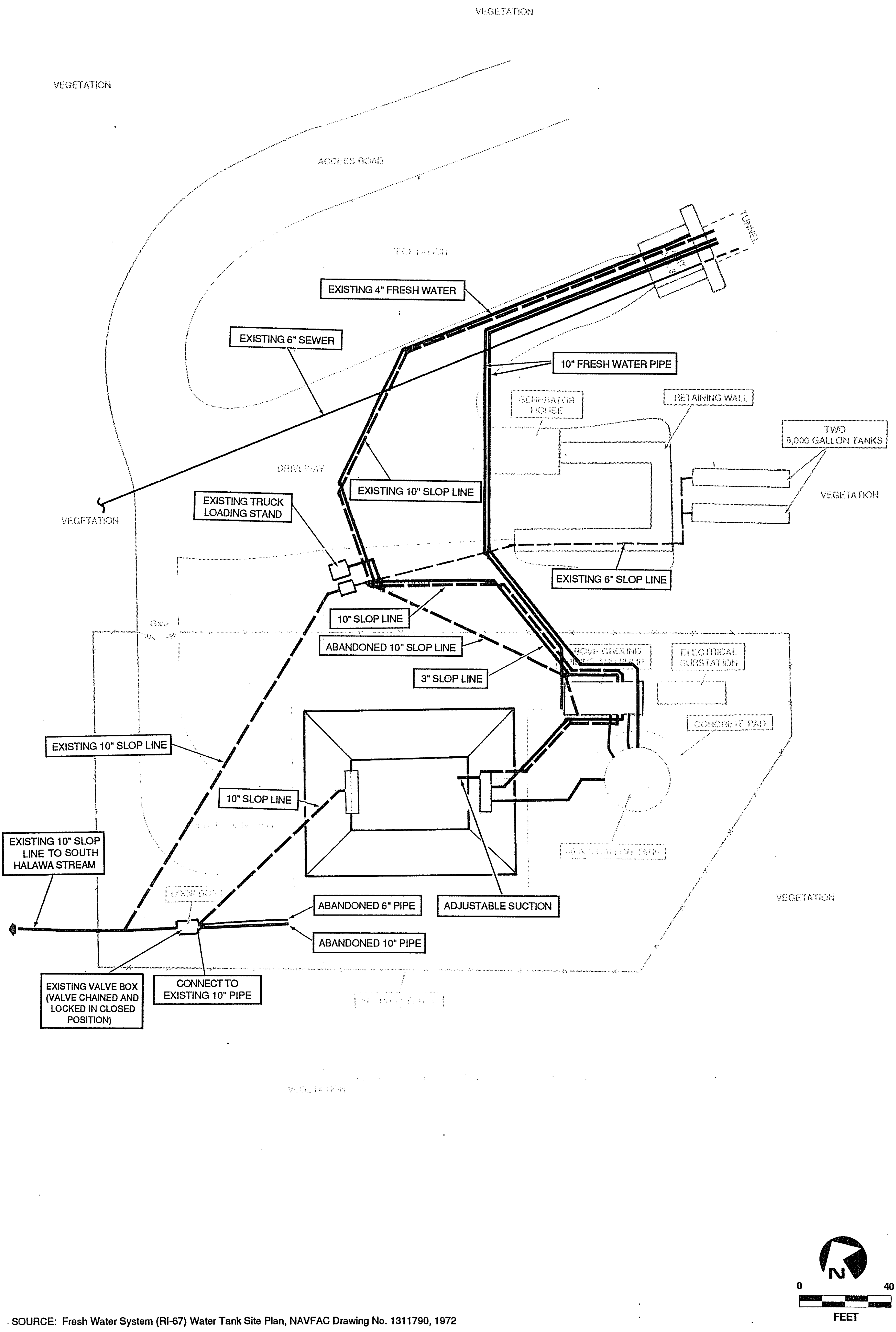


SOURCE: Fresh Water System (RI-67) Water Tank Site Plan, NAVFAC Drawing No. 1311790, 1972

ERCE

Facility Layout, 1972

FIGURE 2-27

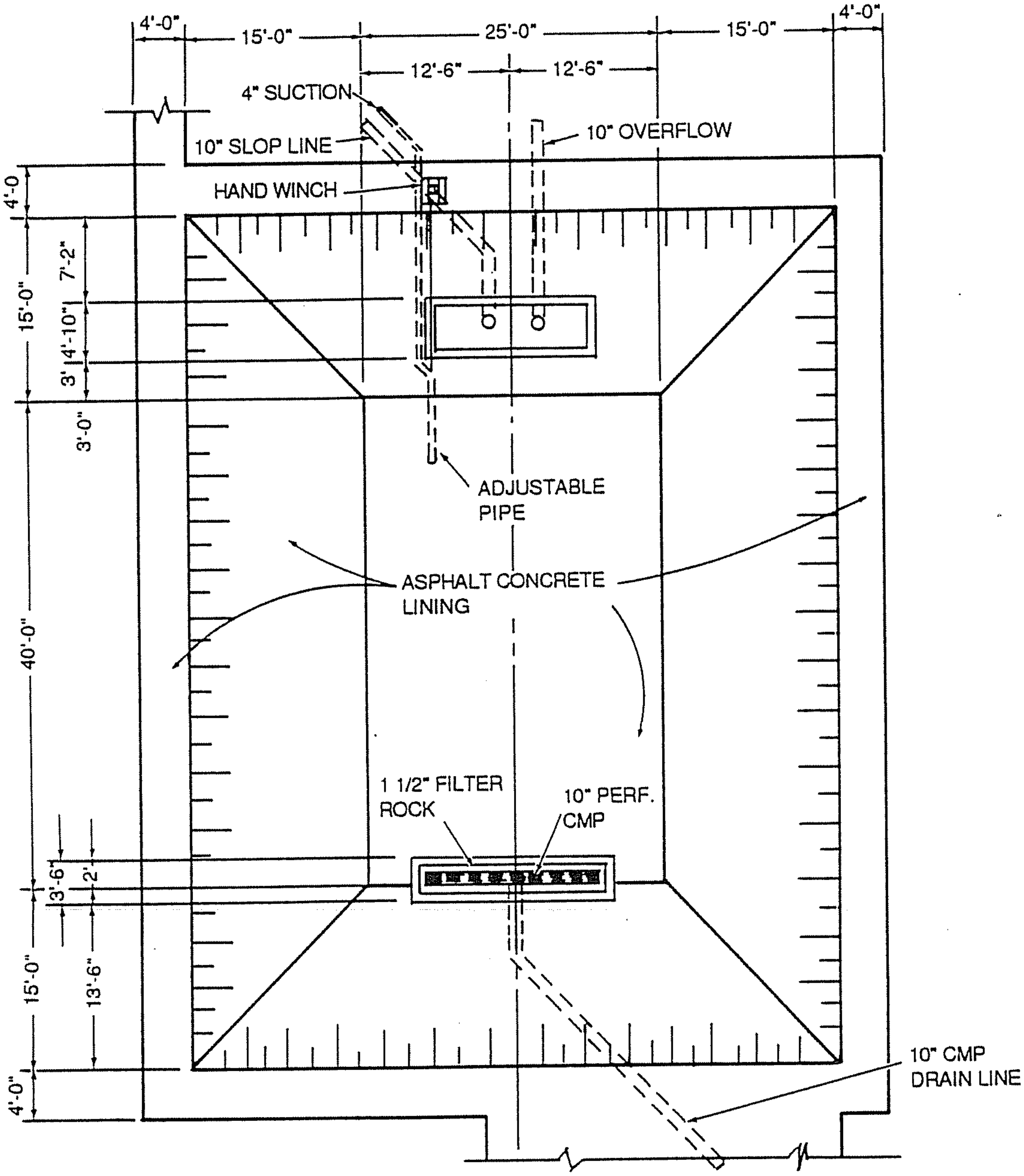


SOURCE: Fresh Water System (RI-67) Water Tank Site Plan, NAVFAC Drawing No. 1311790, 1972

ERCE

Piping System Diagram, 1972

FIGURE 2-28

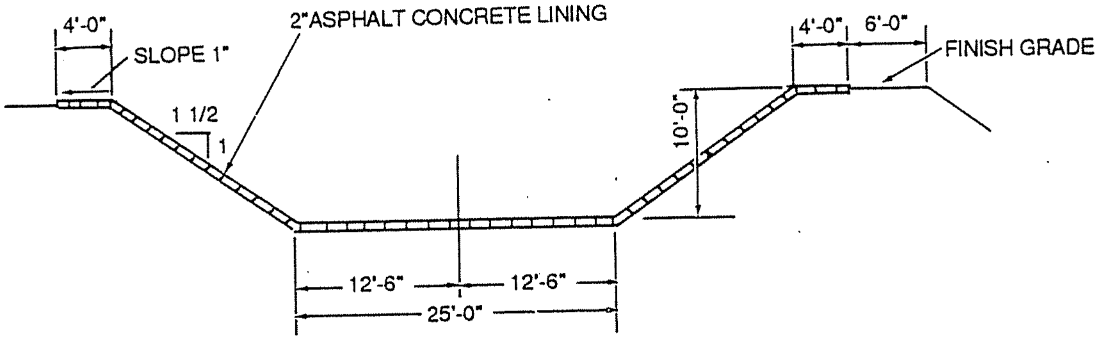


SOURCE: Fresh Water System (RI-67) Miscellaneous Details,
U.S. Naval Supply Center Pearl Harbor, Oahu, Hawaii, Drawing#1-311-793

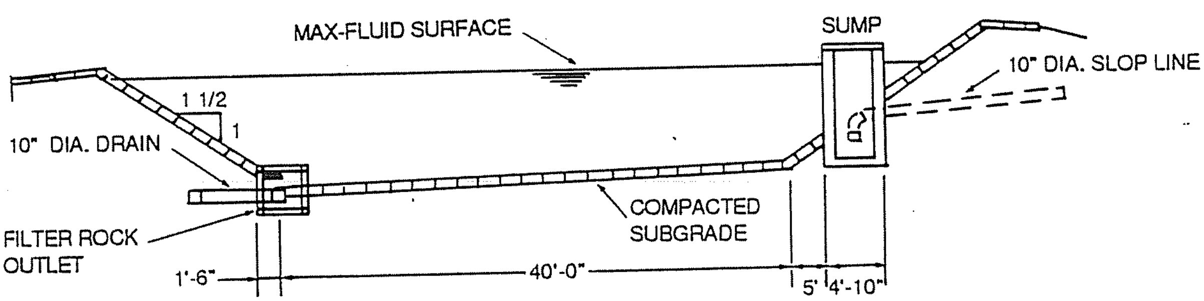
ERCE

Plan View of Stilling Basin, 1972

FIGURE 2-29



FRONT TO BACK VIEW



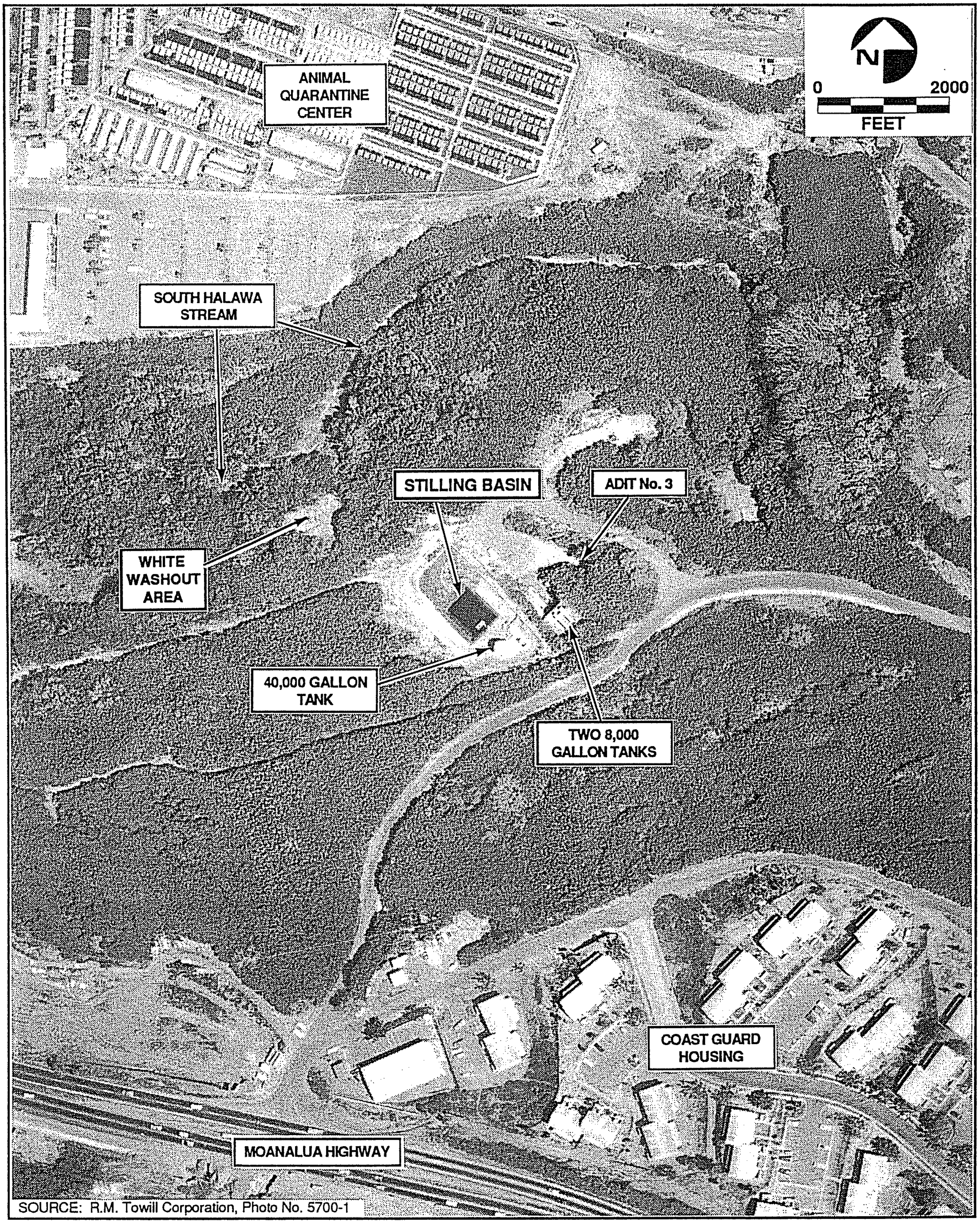
SIDE VIEW

SOURCE: Fresh Water System (RI-67) Miscellaneous Details,
U.S. Naval Supply Center Pearl Harbor, Oahu, Hawaii, Drawing#1-311-793

ERCE

FIGURE 2-30

Cross-Section of Stilling Basin, 1972



ERCE

Aerial Photograph of Site, April 25, 1972

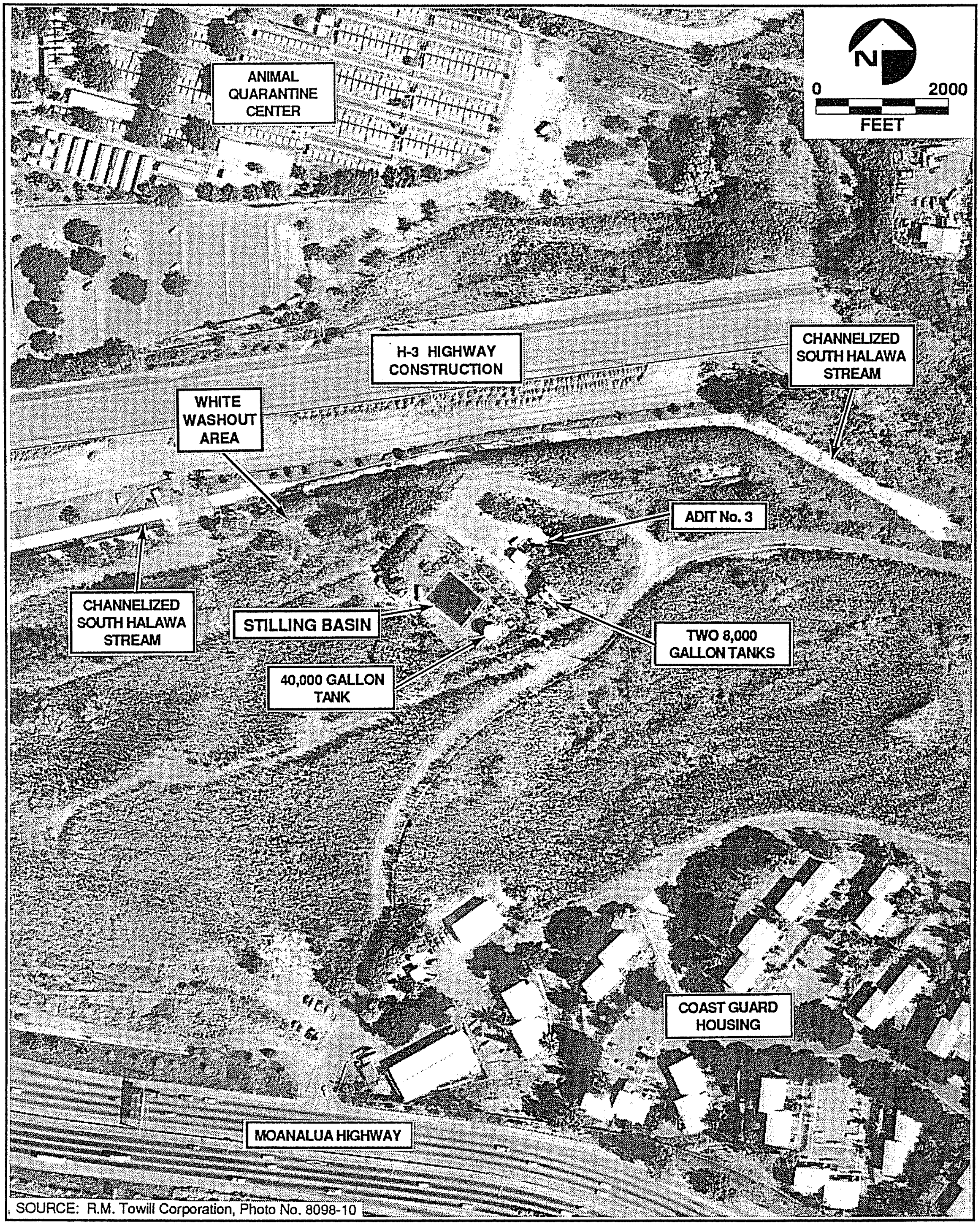
FIGURE **2-31**

the early 1980s. According to a current NSC employee, Mr. James Gammon, a subcontractor responsible for hauling wastes from the Red Hill Site to the NSC Oil Reclamation Plant facility was discovered dumping waste material via a hose into a heavily vegetated area located about 100 to 150 feet southwest of the Stilling Basin (Gammon, 1989). The possible existence of sludge pumping to this location was also documented previously by ATT (1988). A slight topographical depression is present in this area, which is located between the site security fence and South Halawa Stream. Neither the duration nor the quantity of material discharged by the subcontractor are known. Following discovery of the unauthorized dumping, the Navy directed the subcontractor to stop the improper disposal of oily waste and resume hauling wastes to the NSC Fuel Reclamation Facility (FRF).

The Stilling Basin was designed and built to separate water from the tank bottom sludges generated during tank cleaning activities, prior to transportation of the sludges to the NSC FRF for further processing. The Red Hill underground fuel storage tanks were apparently cleaned, and the bottom sludges removed, once every five or six years (NEESA, 1983). Methods of cleaning the tanks included hosing with water, wiping with diesel fuel, rinsing with solvent, wiping down, wire brushing and soap washing (Bechtel, 1949). It has previously been estimated that about one foot of sludge, representing a volume equivalent to approximately 50,000 gallons, accumulated in each tank between cleanings, leading to an estimate of a total of 5 million gallons of waste materials having been disposed of at the site (NEESA, 1983). It appears these estimates may have been high, at least with respect to the waste pits, because the old waste pit was apparently only in operation for five years.

The most recent aerial photograph available of the site is presented in Figure 2-32. Current site photographs of the Stilling Basin and the 40,000 gallon tank are shown on Figures 2-33 and 2-34.

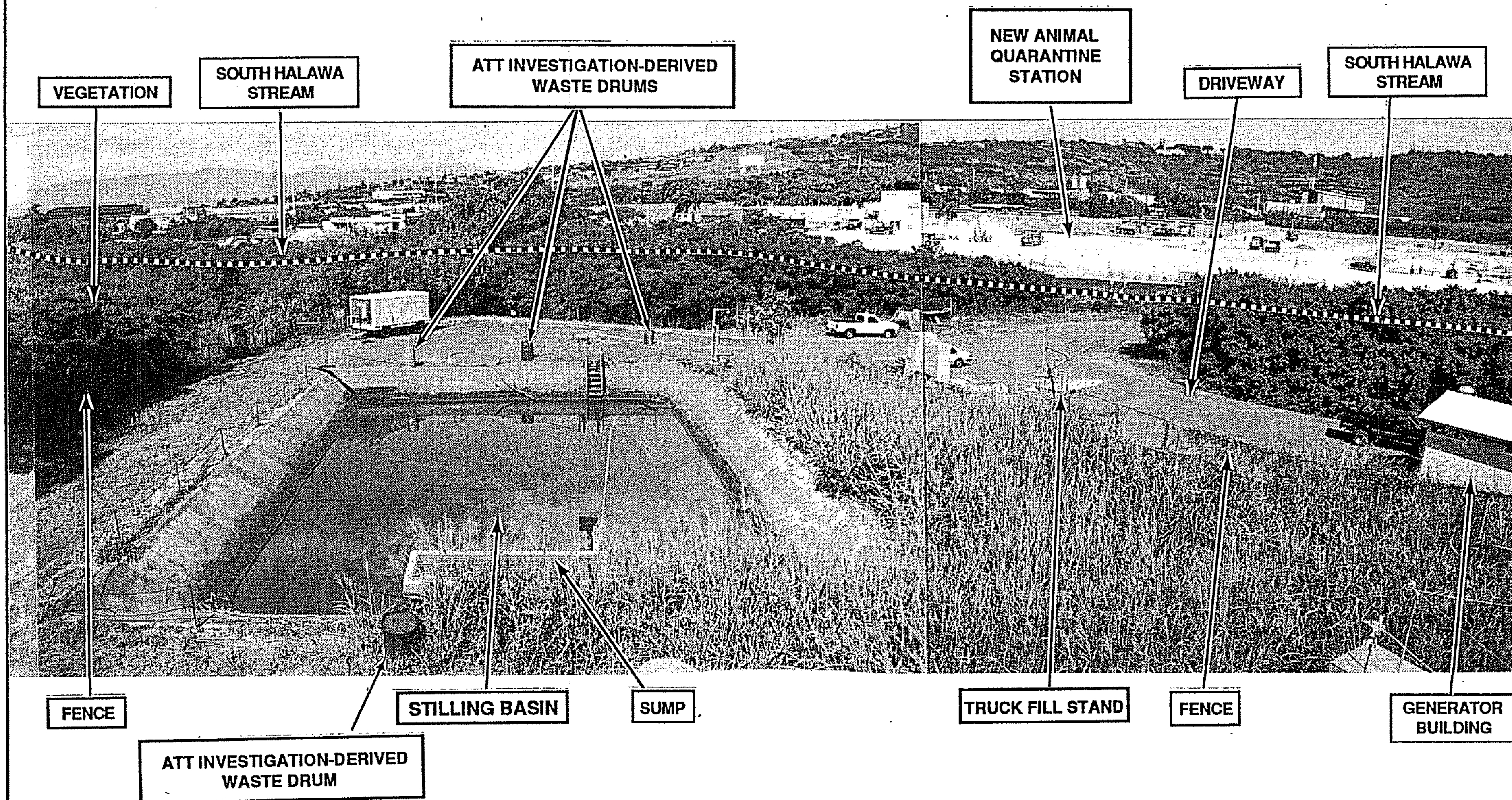
The discovery of potential contamination at the Red Hill Site (ATT, 1988) led to the Navy's decision to discontinue use of the Stilling Basin and the two 8,000 gallon aboveground tanks. The waste disposal system in current use at the site incorporates only the 40,000 gallon tank and associated piping for waste storage and transfer purposes. Oily wastes contained within this tank are currently pumped to the truck fill stand immediately north of the Stilling Basin and transferred to vehicles for transport to the NSC FRF. The current



ERCE

Aerial Photograph of Site, September 11, 1981

FIGURE **2-32**

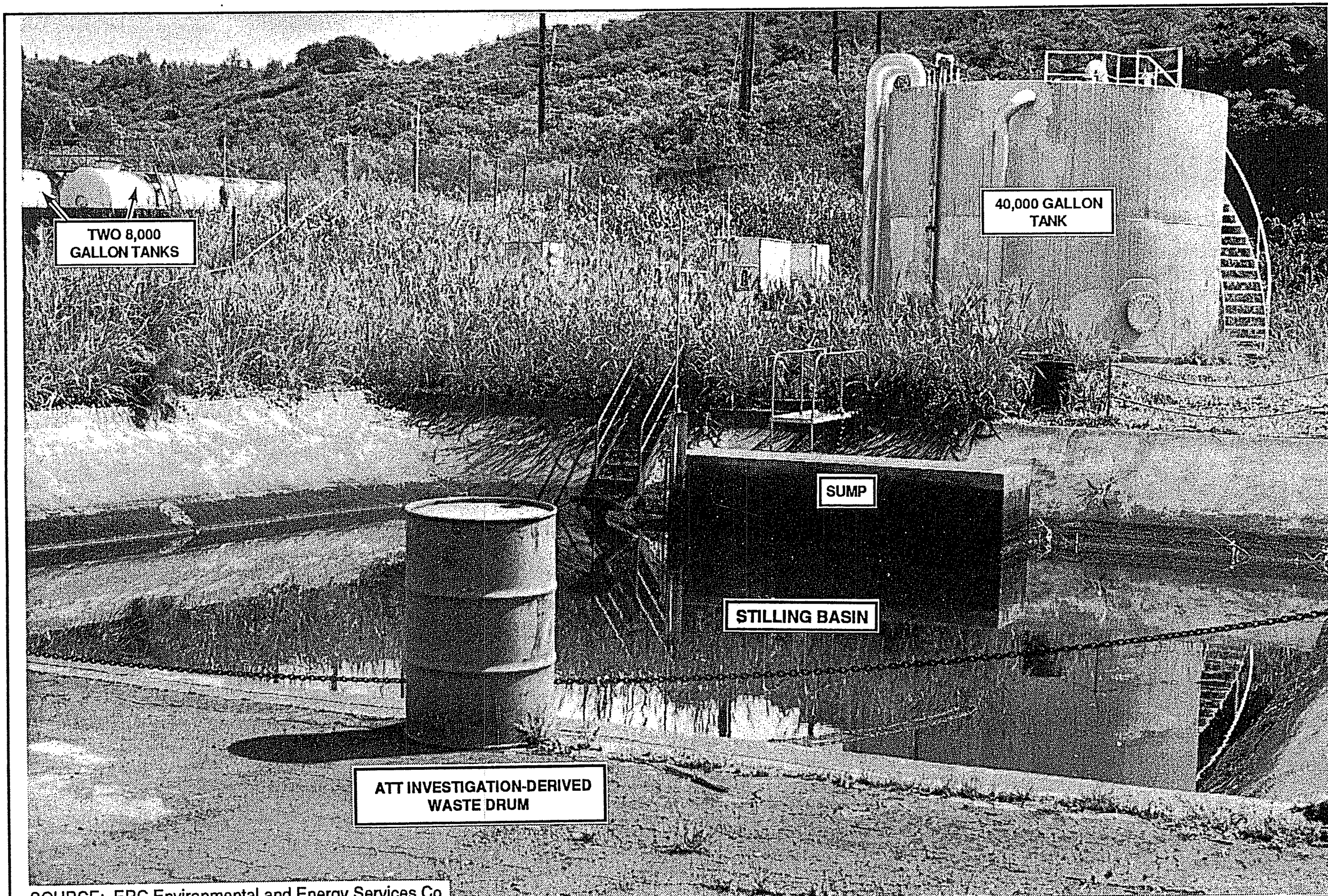


SOURCE: ERC Environmental and Energy Services Co.

ERCE

Photograph of Stilling Basin and Surrounding Site, November 1989

FIGURE 2-33



SOURCE: ERC Environmental and Energy Services Co.

ERCE

Photograph of Stilling Basin, 40,000 Gallon Tank and Two 8,000 Gallon Tanks, November 1989

FIGURE 2-34

facility layout has apparently not changed since it was constructed in 1972, although its use is somewhat different. The current facility layout is shown on Figure 2-2.

2.3 Summary of Previous Investigations

There have been two known previous investigations in which environmental samples were collected at the site and subsequently analyzed. The first was performed by Rockwell International in 1983 as part of an effort designed to characterize oily sludges generated at Navy installations. The results of this effort are presented in a report entitled *Physical, Chemical, and Toxicological Characterization of Oily Sludges Generated at Naval Installations* (Rockwell, 1983). The second was the verification study of the site performed by ATT. The results of this effort are presented in a report entitled *Verification Phase Confirmation Study, Site 6 - NSC Pearl Harbor Red Hill Oily Waste Disposal Pit, Pearl Harbor Naval Base, Oahu, Hawaii* (ATT, 1988). This section summarizes the results obtained during the two investigations and assesses their validity.

The sampling performed at the site in association with the Rockwell investigation was limited in nature. A Bacon bomb sampler was used for collecting two samples of the sludge on the bottom of the pit. Two samples were also collected from the light, non-aqueous phase liquid (LNAPL) oil surface (referred to as "surface scum" in the report) that floated on the water surface in the Stilling Basin. The method used to collect these samples was not documented.

The two "top layer" and the two "bottom layer" samples (as they are referred to in the Rockwell report) were analyzed for free and dissolved oil, inorganic and organic solids, polynuclear aromatic hydrocarbons (PNAs), phenols, heavy metals, and volatile hydrocarbons. The results of these analyses are shown in Table 2-1. Elevated concentrations of PNAs and phenols were found in both the top and bottom layers, with the concentrations in the top layer being approximately an order of magnitude higher than concentrations in the bottom layer. With respect to volatile hydrocarbons and metals concentrations, the situation was reversed, with concentrations an approximate order of magnitude higher in the bottom layer than in the top layer. The Rockwell report concludes that the principal contributors to oily sludge toxicity were PNAs, phenols, and heavy metals.

Table 2-1

OILY WASTE DISPOSAL PIT SLUDGE SAMPLE RESULTS, 1983

Sample	Toxicity EC_{50} (15 min.)	Free Oil (%)	PAHs (ppm)	Phenols (ppm)	Volatile Hydro-carbons (ppm)	Metal Concentrations (ppm)						Inorganic Solids (%)	Organic Solids (%)
						Cd	Cr	Cu	Pb	Ni	Zn		
Bottom Sample 1	49	0.5	158	1,327	50.8	0	46	38	16	3	127	0.2	0
Bottom Sample 2	323	0.6	175	1,094	41.9	0	41	50	18	3	139	0.5	1.6
Top Sample 1	14	30.1	10,134	10,191	3.8	0	7	7	0	0	32	2.3	1.3
Top Sample 2	14	24.0	10,125	8,836	5.9	0	5	8	0	0	34	2.3	1.4

NOTES:

Original Laboratory Results presented in Rockwell International Report, 1983.
PAH = Polycyclic Aromatic Hydrocarbons

Methods of Analysis:

Toxicity	-	using Beckman Instruments Microtox Model 2055 precision photometer
Free Oil, Solids	-	gravimetric
PAHs, Phenols	-	high performance liquid chromatography
Volatile Hydrocarbons	-	gas chromatography
Heavy Metals	-	atomic absorption

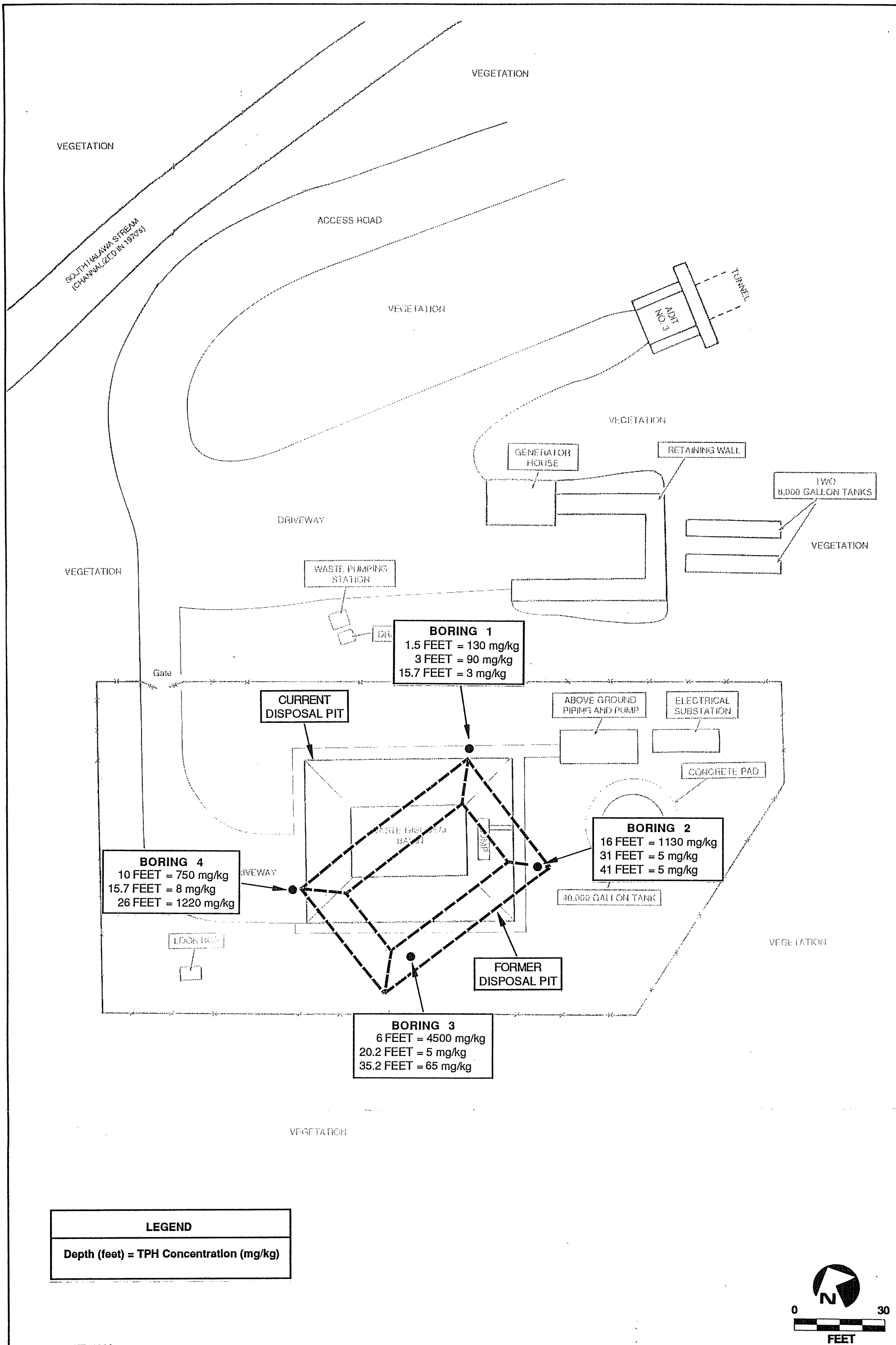
The sampling at the site performed in connection with the ATT verification study was also limited in scope; it was aimed at verifying or denying the presence of contaminants, and not assessment of the lateral or vertical extent of contaminants. Four soil borings were conducted in the immediate vicinity of the pit, and twelve soil samples were collected from these borings. Soil sampling methodologies, sample handling, and transport as described in the ATT report generally followed the guidelines described in *A Compendium of Superfund Field Operations Methods* (EPA, 1987).

One ground-water sample was collected during the ATT verification study. However, the representativeness of this sample is questionable, since the sampling methodology did not follow typical practices. Instead, a temporary casing was placed into one of the soil borings to allow ground-water seepage into the casing. No development or purging activities occurred prior to sampling, and the sampling itself was conducted over a one to two hour time period, during which volatilization of contaminants may have occurred, thereby biasing the results.

All 12 soil samples collected during the ATT study were analyzed for Total Petroleum Hydrocarbons (TPH) using EPA Method 418.1, for organochlorine pesticide/polychlorinated biphenyls (PCBs) using EPA Method 8080, for semi-volatile organic compounds (SVOCs) using EPA Method 8270, and for 17 metals using methods in the EPA 6000/7000 series. All 12 soil samples contained detectable TPH concentrations, ranging from a minimum of 3 milligrams per kilogram (mg/kg) to a maximum of 4,500 mg/kg. The TPH concentrations are presented in Figure 2-35, along with the soil boring locations. At boreholes 1 and 2, the TPH concentration decreased with depth, while at boreholes 3 and 4, TPH concentrations were lowest at the intermediate depth. Boreholes 1 and 4 were located outside the approximate boundaries of the old pit, while boreholes 2 and 3 were located within the approximate boundaries of the old pit.

The ATT report did not present results for PCB/organochlorine pesticide analyses within the text of the report. However, a review of the the original analytical laboratory reports presented in an appendix to the report revealed that all 12 soil samples were analyzed for these parameters and that there were no instances of detection.

The results from the SVOC analyses have been reformatted from Table 3-2 of the ATT verification study for purposes of clarity and so that the detection limits could be included,



SOURCE: ATT, 1988

ERCE

TPH Concentrations In Soil Collected In 1986

FIGURE 2-35

where appropriate. A summary of the results for those SVOCs which were detected in at least one site sample are presented in Table 2-2. PNAs were detected in four of the 12 soil samples, with significant concentrations being detected in sample RHB3-6.0 (8.5 mg/kg naphthalene, 31 mg/kg 2-methylnaphthalene, 2 mg/kg fluorene, and 3 mg/kg phenanthrene) and in sample RHB4-10.0 (2.9 mg/kg naphthalene, 10 mg/kg 2-methylnaphthalene, 0.8 mg/kg acenaphthene, 1.9 mg/kg anthracene, and 0.4 mg/kg pyrene).

A summary of the SVOCs tentatively identified by the EPA Method 8270 testing is presented in Table 2-3. Approximated individual concentrations ranged as high as 30 mg/kg. Virtually all of the tentatively identified compounds were either alkanes or other hydrocarbon compounds. The total extractable hydrocarbons present in the soil samples encompassed compounds possessing carbon ranges of between C_{10} to C_{30} in length. Apparently, none of the soil samples were analyzed for volatile organics or dioxins.

Concentrations of metals in the 12 soil samples are presented in Table 3-3 of the ATT study. The reported concentrations are within the average range of values demonstrated for the type of geologic formations found at the site. A single metals concentration for each of the 17 metals, taken from a literature source, is stated in the report as the basis for reaching this conclusion.

The analytical results for the ground-water sample collected by ATT are presented in Table 2-4. Toluene was detected at a concentration of 1 microgram per liter (ug/L), and various hydrocarbon compounds including alkanes were also tentatively identified. Additionally, traces of the PNA compounds fluorene and phenanthrene, and the base neutral acid extractable compound benzyl alcohol, were detected in the ground-water sample. Metals analyses were also performed on the ground-water sample; barium was the only metal analyte detected, and its presence is attributed to a natural or a background occurrence by the ATT report. No background water quality data were obtained or presented for comparison.

Quality control (QC) results for data collected by ATT are not complete. Surrogate recovery data are reported in Appendix A of the ATT report, but QC results for duplicates and matrix spikes for SVOCs (EPA Method 8270) and volatile organic compounds (EPA Method 602 for the ground-water sample) laboratory analyses are not reported. Since these QC results are necessary to assess the validity of the data, no assessment can be

Table 2-2

SEMI-VOLATILE ORGANIC COMPOUND ANALYTICAL RESULTS FOR SOIL SAMPLES, 1986

Sample Number Depth (feet)	RH B1 1.5	RH B1 3.0	RH B1 15.7	RH B2 16	RH B2 31	RH B2 41	RH B3 6.0	RH B3 20.2	RH B3 35.2	RH B4 10.0	RH B4 15.7	RH B4 26.0
Semi-Volatile <u>Organic Compounds</u>												
Bis (2-ethylhexyl) phthalate	<1.7	<0.17	5	<0.17	<0.17	<0.17	<0.34	<0.17	<0.17	<0.34	<0.17	0.2
Naphthalene	<1.7	<0.17	<0.17	<0.17	<0.17	<0.17	8.5	<0.17	<0.17	2.9	<0.17	<0.17
2-Methylnaphthalene	<1.7	<0.17	<0.17	<0.17	<0.17	<0.17	31	<0.17	<0.17	10	<0.17	<0.17
Fluorene	<1.7	<0.17	<0.17	<0.17	<0.17	<0.17	2	<0.17	<0.17	<0.34	<0.17	<0.17
Phenanthrene	<1.7	<0.17	<0.17	<0.17	<0.17	<0.17	3	<0.17	TR	<0.34	<0.17	<0.17
Acenaphthene	<1.7	<0.17	<0.17	<0.17	<0.17	<0.17	<0.34	<0.17	<0.17	0.8	<0.17	<0.17
Anthracene	<1.7	<0.17	<0.17	<0.17	<0.17	<0.17	<0.34	<0.17	<0.17	1.9	<0.17	<0.17
Pyrene	<1.7	<0.17	<0.17	TR	<0.17	<0.17	<0.34	<0.17	<0.17	0.4	<0.17	<0.17
Fluoranthene	<1.7	<0.17	<0.17	TR	<0.17	<0.17	<0.34	<0.17	<0.17	TR	<0.17	<0.17
Chrysene	<1.7	<0.17	<0.17	TR	<0.17	<0.17	<0.34	<0.17	<0.17	TR	<0.17	<0.17
Benzo (a) anthracene	<1.7	<0.17	<0.17	<0.17	<0.17	<0.17	TR	<0.17	<0.17	TR	<0.17	<0.17
Nitrobenzene	<1.7	NI	<0.17	<0.17	<0.17	<0.17	<0.34	<0.17	<0.17	TR	<0.17	<0.17
Acenaphthylene	<1.7	NI	<0.17	<0.17	<0.17	<0.17	<0.34	<0.17	<0.17	TR	<0.17	<0.17
Benzo (b) fluoranthene	<1.7	<0.17	<0.17	<0.17	<0.17	<0.17	<0.34	<0.17	<0.17	TR	<0.17	<0.17
Benzo (a) pyrene	<1.7	<0.17	<0.17	<0.17	<0.17	<0.17	<0.34	<0.17	<0.17	TR	<0.17	<0.17

Original laboratory reports included in Aqua Terra Technologies Verification Study, Final Report, 1988; Field sampling conducted October-November, 1986.
Values reported in milligrams/kilogram (mg/kg) or parts per million (ppm).
Samples analyzed by EPA Method 8270.
TR = Trace Concentration
NI = Result not included in Aqua Terra Technologies Verification Study Report.

Table 2-3

TENTATIVELY IDENTIFIED SEMI-VOLATILE ORGANIC COMPOUNDS, 1986

GC/MS Scan Number	Compound Name/ Description	Estimated Ground-water Concentration (1)	Estimated Soil Sample Concentration (2)									
		503-RH-B3	503-RHB1-1.5	503-RHB1-3.0	503-RHB1-15.7	503-RHB2-16	503-RHB2-31	503-RHB2-41	503-RHB3-6.0	503-RHB3-35.2	503-RHB4-10.0	503-RHB4-26
1108	Alkane						0.3					
1110	Alkane									1		
1139	Branched Hydrocarbon	20										
1154	Dimethyl-napthalene	50										
1181	Branched Alkane								10			
1195	Alkane						0.1					
1197	Alkane									1		
1223	Unknown Alkane		7									
1298	Alkane								20			
1317	Branched Alkane			0.3								
1318	Hexadecane		10									
1369	Alkane	20										
1375	Alkane									3		
1408	Heptadecane		10									
1414	Branched Alkane		10									
1420	Branched Alkane	20										
1423	Alkane						0.5					
1426	Alkane									3		
1441	Alkane C_{19}-C_{40}								20			
1494	Octadecane		8									
1511	Alkane						0.2					
1514	Alkane									2		
1520	Alkane								30			
1561	A phthalate							0.1				
1580	A phthalate				0.1							
1589	Unknown	10										

Table 2-3 (Continued)

TENTATIVELY IDENTIFIED SEMI-VOLATILE ORGANIC COMPOUNDS, 1986

GC/MS Scan Number	Compound Name/ Description	Estimated Ground-water Concentration (1)	Estimated Soil Sample Concentration (2)									
		503-RH-B3	503-RHB1-1.5	503-RHB1-3.0	503-RHB1-15.7	503-RHB2-16	503-RHB2-31	503-RHB2-41	503-RHB3-6.0	503-RHB3-35.2	503-RHB4-10.0	503-RHB4-26
1786	Branched Hydrocarbon			0.4								
1911	Branched Hydrocarbon			0.9								
1915	Branched Hydrocarbon			0.8								
1934	Organic Acid			4								
N/A	Total Extractable Hydrocarbons	3000	3000			2000			4000	100	2000	1000
	Carbon Range (if noted)	C_{13}-C_{14}				C_{10}-C_{28}				C_{12}-C_{24}	C_{10}-C_{30}	C_{10}-C_{25}

Original laboratory reports included in Aqua Terra Technologies Verification Study, Final Report, 1988; Field sampling conducted October-November, 1986.

(1) Values reported in micrograms per liter (μg/l).

(2) Values reported in milligrams per kilogram (mg/kg). Samples analyzed by EPA Method 8270.

Results for tentatively identified compounds for samples 503-RHB3-20.2 and 503--RHB4-15.7 were not included in the Aqua Terra Technologies Verification Study Report.

Table 2-4

ANALYTICAL RESULTS FOR GROUND-WATER SAMPLE, 1986

	Sample RHB3
Volatile Organic Compounds (EPA Method 624)	µg/L*
toluene	1
Semi-Volatile Organic Compounds (EPA Method 625)	µg/L*
alkane	20E
unknown	10E
branched hydrocarbon	20E
dimethyl naphthalene isomer	50E
branched alkane	20E
total extractable hydrocarbons	3000E
Benzyl Alcohol	TR
Fluorene	TR
Phenanthrene	TR

Samples analyzed by EPA Methods 624 and 625.

E = Estimated concentrations.
TR = Trace concentration.
* = µg/L is generally equivalent to parts per billion (ppb) on a mass per volume basis.

Original laboratory reports included in Aqua Terra Technologies Verification Study, Final Report, 1988; Field Sampling conducted October-November,1986.

made at this time. QC results for analysis of metals was reported and found to meet percent recovery and relative percent difference criteria established in EPA's DQO document. Bis (2-ethylhexyl) phthalate and di-n-butylphthalate, two compounds commonly found in plastic laboratory equipment, were not reported.

SECTION 3
INITIAL EVALUATION

This section presents the results of ERCE's analysis of existing information regarding the physical setting, historical use, and previous investigations of the site. The analysis comprises the initial evaluation portion of the RI/FS process, and consists of the development of a conceptual site model, preliminary remedial action alternatives, and the objectives for the first phase of site characterization activities. Both the conceptual site model and the preliminary remedial action alternatives will be reviewed, and revised if necessary, following each phase of site characterization activities.

3.1 CONCEPTUAL SITE MODEL

A conceptual site model includes descriptions of known and/or suspected sources of contamination, types of contaminants and the affected environmental media, contaminant migration pathways, routes of exposure, and potential human and environmental receptors. Taken collectively, these descriptions are used to develop a conceptual understanding of a site and to evaluate its potential risks to human health and the environment. A summary of these descriptions for the site is presented in Table 3-1 and is discussed below.

3.1.1 Contaminant Sources

There are five major potential contaminant sources (or source-types) which have been present at the site at various times since its original development. These sources will be discussed in the chronological order in which they first appeared. Suspected contaminants arising from these five sources include waste fuel constituents, polynuclear aromatic hydrocarbons (PNAs), phenols, metals, and solvents.

The first potential contaminant source is the old waste disposal pit, which was constructed in 1943 at the time of original development of the site and taken out of service in 1948. In addition to the suspected contaminants listed above, the old waste disposal pit may potentially be a source of dioxins due to the open burning of waste materials. The second potential source is actually a source-type rather than a specific source, and includes the various sumps (such as the "drain box" and the "look box"), piping, and aboveground storage tanks which have existed at the site in various configurations since 1943.

Table 3-1

CONCEPTUAL SITE MODEL

Potential Contaminant Sources	Known or Suspected Contaminants	Potential Migration Pathways	Affected Receptors	Routes of Exposure
Old Waste Disposal Pit (1943-1948)	Waste Fuel Constituents PNAs Phenols Metals Solvents Dioxins	Subsurface Transport	Area Residents	Direct Contact/Ingestion
		Air Transport	Site Visitors/Terrestrial Biota	Inhalation
Sumps/Tanks/Piping (1943-present)	Waste Fuel Constituents PNAs Phenols Metals Solvents	Subsurface Transport	Area Residents	Direct Contact/Ingestion
		Air Transport	Site Visitors/Terrestrial Biota	Inhalation
Discharge to South Halawa Stream (1943-?)	Waste Fuel Constituents PNAs Phenols Metals Solvents	Surface Water Flow	Area Residents/Aquatic and Terrestrial Biota	Direct Contact
			Aquatic and Terrestrial Biota	Ingestion
		Subsurface Transport	Area Residents	Direct Contact/Ingestion
		Air Transport	Site Visitors/Terrestrial Biota	Inhalation
Stilling Basin (1971-present)	Waste Fuel Constituents PNAs Phenols Metals Solvents	Subsurface Transport	Area Residents	Direct Contact/Ingestion
		Air Transport	Site Visitors/Terrestrial Biota	Inhalation

Table 3-1 (Continued)

CONCEPTUAL SITE MODEL

Potential Contaminant Sources	Known or Suspected Contaminants	Potential Migration Pathways	Affected Receptors	Routes of Exposure
Unauthorized Discharges to Ground, Offsite (1940s, early 1980s)	Waste Fuel Constituents PNAs Phenols Metals Solvents	Surface Water Flow	Area Residents/ Aquatic and Terrestrial Biota	Direct Contact/Ingestion
		Subsurface Transport	Area Residents	Direct Contact/Ingestion
		Air Transport	Site Visitors/Terrestrial Biota	Inhalation

The third potential contaminant source is the waste discharge pipe which terminated at South Halawa Stream. This piping system was originally constructed at the same time as the old waste disposal pit and was used to convey fluids, from either the drain box or the old waste disposal pit, to the stream. The piping system may still be in place; however, the year in which its use was discontinued has not yet been determined.

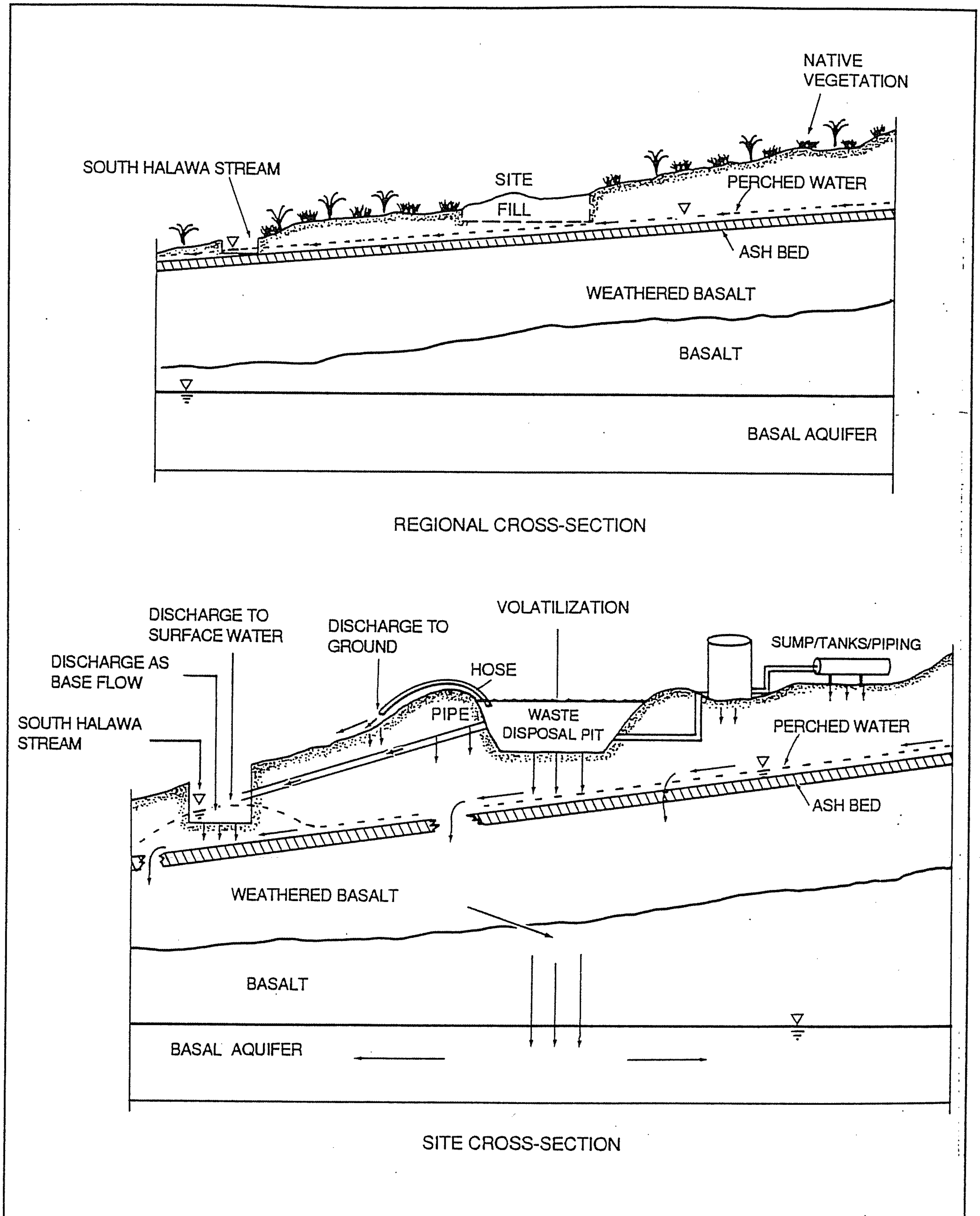
The fourth potential contaminant source is the Stilling Basin, which was constructed in 1972. Use of the stilling basin was discontinued in 1987, but it remains approximately half full of fluid, apparently from accumulation of rain water (Gammon, 1989). The surface of the standing fluid currently exhibits a hydrocarbon sheen, and hydrocarbon odors are noticeable in the vicinity of the basin.

The fifth potential source is the unauthorized discharge to the ground which took place in the early 1980s when a contractor disposed of the Stilling Basin contents by pumping to an off-site depression located west of the site (Gammon, 1989).

3.1.2 Contaminant Migration Pathways

There are three major contaminant migration pathways for site contaminants: air transport, surface water flow, and subsurface transport. These pathways are depicted pictorially in Figure 3-1, and are summarized for each of the five potential contaminant sources in Table 3-1. The air transport pathway is currently undefined, as no air samples have yet been collected and analyzed. However, air transport of site contaminants due to entrainment of contaminated surface soils is assumed to be negligible since all areas on-site are either paved or thickly covered with grasses, and all areas immediately off-site are densely vegetated. The air transport pathway is assumed to be significant for the volatilization of contaminants from the Stilling Basin.

The surface water flow pathway is also currently undefined, as no samples have yet been collected of either on-site or off-site surface soils, surface water, or sediments from either the unchannelized or the channelized portions of South Halawa Stream. The surface water flow pathway is assumed to be significant since the piping system for discharge of fluids directly into South Halawa Stream still exists, and surface water runoff from the northeast portion of the site appears to drain into South Halawa Stream. Also, the off-site unauthorized discharge which occurred in the early 1980s and the reported 1.2 million



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Conceptual Site Model
Contaminant Migration Pathways

FIGURE
3-1

gallon fuel spill in the 1940s may have contributed to contamination of offsite surface soils, which would be significant in terms of surface water transport of contaminants.

The subsurface transport pathway is also currently undefined, although preliminary evidence indicates that there has apparently been some transport of hydrocarbon contaminants through the unsaturated zone (ATT, 1988). Subsurface transport of contaminants may have occurred by infiltration through the unsaturated zone to a perched water table that appears to be present beneath the site. Transport of the contaminants horizontally through the perched zone and subsequent discharge to stream base flow, or vertically through the confining layer underlying the perched zone to the basal aquifer, are both potential subsurface migration pathways. Subsurface transport is assumed to be significant for all five of the major potential contaminant sources.

3.1.3 Routes of Exposure and Affected Receptors

Typical routes of exposure to contaminants include inhalation, ingestion, and direct contact (dermal contact). Each of these routes of exposure are associated with a particular contaminant migration pathway. For each route of exposure/contaminant migration pathway pair, the affected receptors can be identified. The routes of exposure and affected receptors are summarized in Table 3-1.

For the subsurface transport pathway, it is assumed that all exposures arise as a result of contaminants in ground water. The fact that some contaminated ground water may wind up as stream baseflow, or flow to other freshwater or marine bodies, is neglected since these situations are included in the analysis of routes of exposure resulting from surface water transport. The routes of exposure associated with the subsurface transport pathway are ingestion, and direct contact; the affected receptors are area residents.

For the surface water transport pathway, direct contact routes of exposure affect both area residents and aquatic and terrestrial biota, while ingestion routes of exposure affect only aquatic and terrestrial biota. For the air transport pathway, the inhalation route of exposure affects site visitors and terrestrial biota. One possible route of exposure, that of direct contact with the standing fluid in the Stilling Basin, is not included in the table because it does not involve a migration pathway.

3.2 Preliminary Remedial Action Alternatives

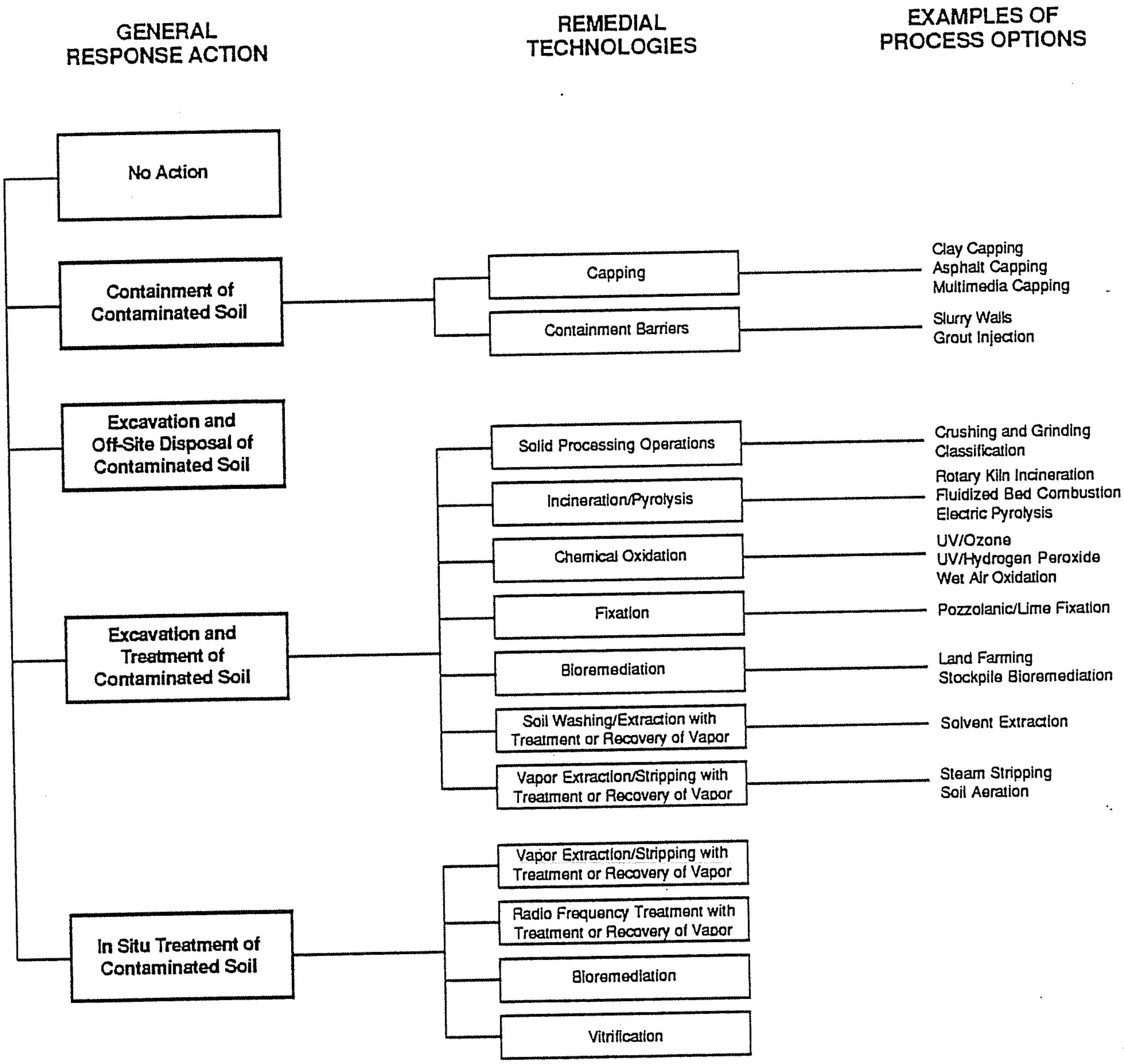
The first step in developing preliminary remedial action alternatives is to identify media-specific general response actions for each of the contaminated media at the site. Subsequent steps involve identifying contaminant-specific potential treatment technologies for each general response action, and the process options associated with each potential treatment technology. The site characterization portion of the RI is then utilized to develop the data necessary to adequately screen these remedial technologies and process options on the basis of technical effectiveness, cost, and implementability.

Review of the information developed during the verification study (ATT, 1988) indicates that soil and ground water at the site may be contaminated with waste fuel constituents, and that soil at the site may be contaminated with PNAs and metals. Review of additional site background information (Rockwell, 1983) indicates that site contaminants may not be limited to the contaminants and media listed above. Until the nature of contamination has been completely determined through site characterization activities, a final identification of treatment technologies and process options appropriate for a particular site cannot be made.

However, an initial identification of general response actions, treatment technologies, and examples of process options can be made for the media-specific contaminants listed above. These initial identifications are shown on Figures 3-2 through 3-5, which are appropriate for soil contaminated with fuel hydrocarbons, soil contaminated with PNAs, soil contaminated with metals, and ground water contaminated with waste fuel constituents, respectively.

In general, different treatment technologies will be required to deal with different contaminants and different media. Many technologies that effectively treat both fuel hydrocarbons and PNAs in soil are ineffective with metal contaminants. For example, incineration technologies will effectively destroy fuel hydrocarbons and PNAs present in soil, but are ineffective in removing metals from soil and impractical for dilute liquid waste streams such as contaminated ground water. Other treatment technologies, such as vapor extraction, can effectively remove fuel hydrocarbons from soil but not PNAs.

For these reasons, the remediation of site contamination will probably have to be accomplished through the use of a combination of technologies. As an example of technology combination, soil that is contaminated with hydrocarbons, PNAs, and metals



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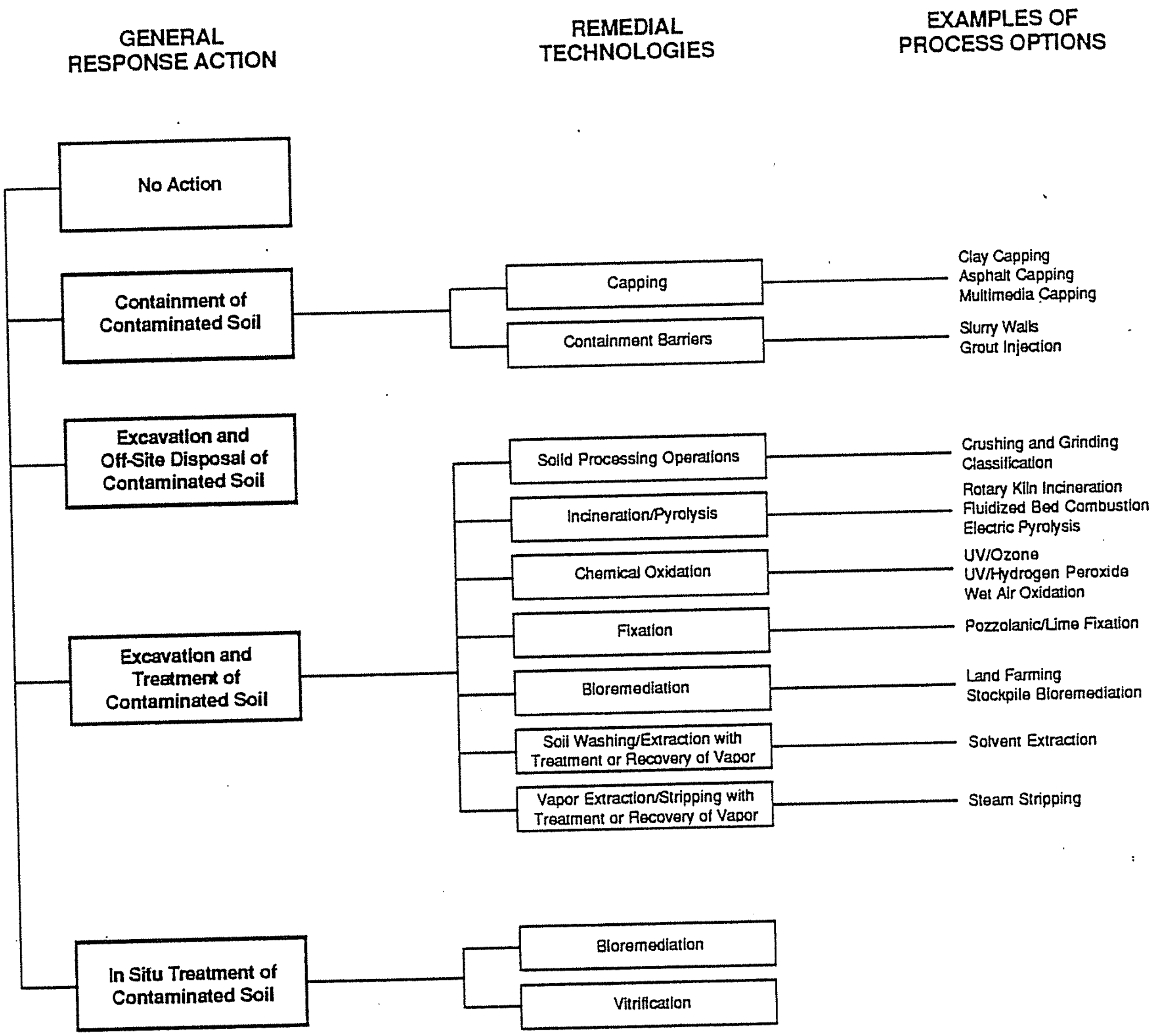
Preliminary Remedial Options for Soil Contaminated with Waste Fuel Constituents

FIGURE 3-2



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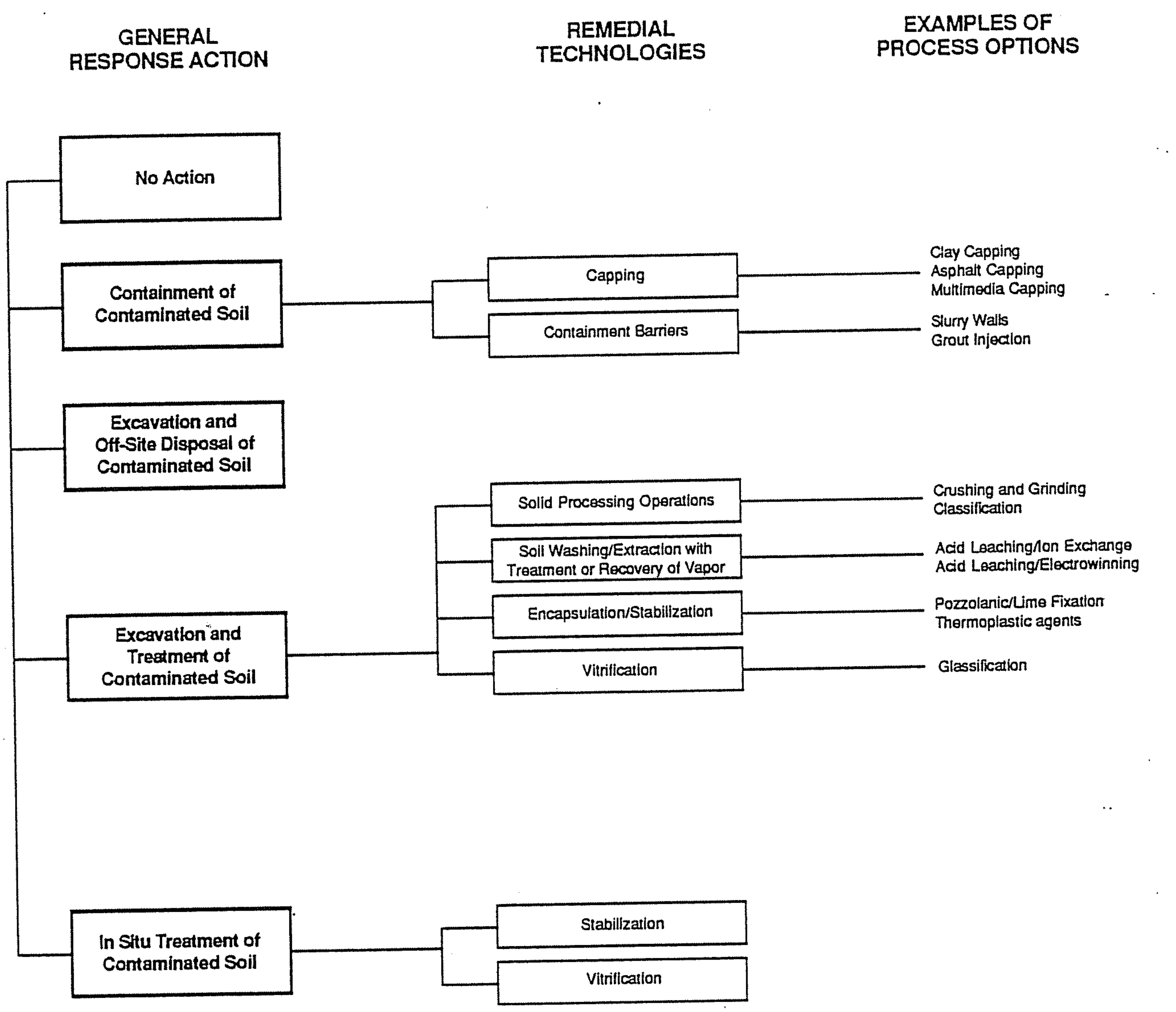
Preliminary Remedial Options for
Soil Contaminated with Polynuclear Aromatics

FIGURE 3-3



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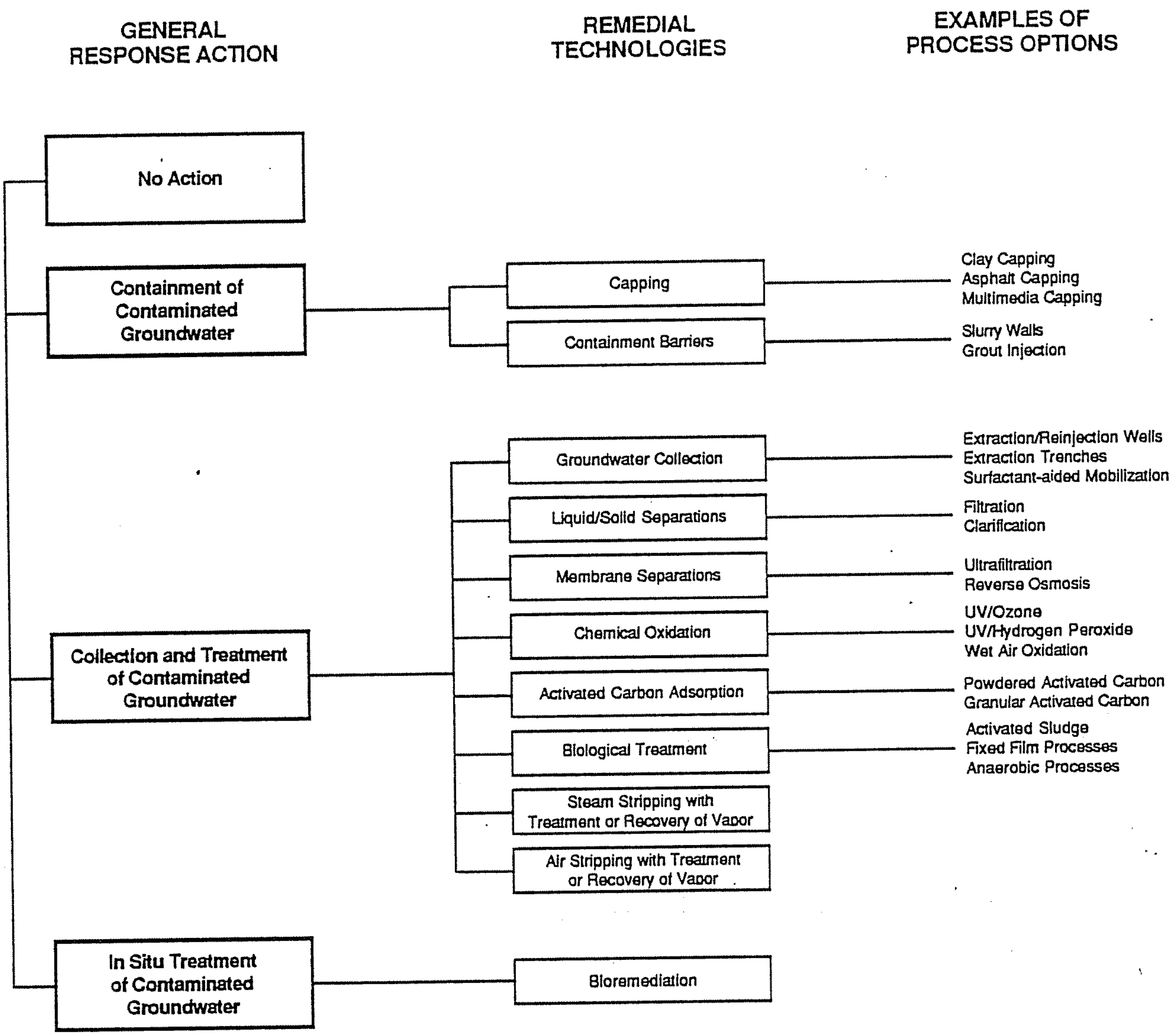
Preliminary Remedial Options for Soil Contaminated with Metals

FIGURE 3-4



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Preliminary Remedial Options for Ground Water Contaminated with Waste Fuel Constituents

FIGURE **3-5**

could be chemically oxidized to remove hydrocarbons and PNAs, followed by a stabilization process designed to fix (treat) the metals. The development and evaluation of remedial action alternatives must consider not only the effectiveness of each of the identified treatment technologies in and of itself, but also the effectiveness of each of the identified treatment technologies as integral components of a combination of technologies. The development and evaluation of remedial action alternatives must also consider applicable or relevant and appropriate requirements (ARARs). A preliminary list of ARARs that have been identified as part of the RI/FS scoping activities are included in Appendix A.

In summary, numerous treatment technologies and process options can be identified for the site contamination problems identified during the verification study. However, it is premature to begin screening the technologies and process options until the nature of site contamination and the media impacted by site contamination have been adequately determined. For example, additional contaminants not currently identified, which are discovered to be present during the first phase of site characterization, may require that additional remedial technologies be considered. Therefore, assuming the first phase of site characterization activities allow the determination of such information, the process of screening remedial technologies and process options and combining media-specific treatment technologies into remedial action alternatives will begin following completion of the first phase of site characterization activities.

3.3 SITE CHARACTERIZATION OBJECTIVES

A successively more detailed screening of treatment technologies and process options will be conducted following each phase of site characterization activities. Following completion of the final phase of such activities, the final screening will be performed and the remedial action alternatives will be formulated that will undergo detailed analysis. While the exact activities for site characterization phases other than the first phase cannot be determined at this time, the objectives for these phases can be approximated based on the principle that each successive phase of site characterization should allow a successively more detailed screening of technologies and process options.

The necessary number of site characterization phases also cannot be determined at this time. For purposes of the following discussion, it has been assumed that a total of four phases of site characterization activities will be required. While the actual number of site characterization phases may eventually be greater or less than the assumed number, it will be necessary to address at some point each of the following objectives.

The objectives for the first phase of site characterization activities will include:

- Verification of the nature of contamination in the old waste disposal pit/Stilling Basin area, including verification of the nature of contaminants in the fluids currently held in the Stilling Basin;

- Assessment of the vertical extent of soil contamination beneath the Stilling Basin to the first water-bearing zone;

- Assessment of the nature of contamination in the shallow perched water table, if it exists, and determination of background water quality (if possible);

- Determination of background metals concentrations in site soils and background surface water quality;

- Evaluation of the surface water migration pathway by obtaining surface soil samples in areas where runoff is observed or suspected to occur;

- Evaluation of the air migration pathway by obtaining site-specific air meteorology data;

- Evaluation of the potential for contamination associated with service piping;

- Verification of the locations of the discharge pipe from the old pit and the Stilling Basin, the location of the unauthorized waste discharge in the early 1980s, and determination of the nature of contamination at these locations, if it exists; and,

- Collection of information on receptors of concern and initiation of a preliminary baseline risk assessment.

These objectives will be accomplished using the methods and procedures described in the field sampling plan portion of the SAP, which is a companion document to this work plan.

Attainment of these objectives will allow the screening of media specific general response actions and the preliminary screening of contaminant/media specific treatment technologies.

The objectives for the second phase of site characterization activities will most likely include:

- Assessment of the vertical and horizontal extent of soil contamination in all areas where identified;
- Assessment of the horizontal extent of contamination of the shallow perched aquifer;
- Evaluation of the potential for ground-water contamination in other high-level water-bearing zones and/or the basal aquifer;
- Evaluation of the subsurface migration pathway by identification of stratigraphic relationships beneath the site, locations of any additional perched zones, and the top of the basal aquifer; and collection of data on the physical properties of all identified lithologies underlying the site;
- Further evaluation of the air migration pathway by performance of ambient air sampling/monitoring if deemed necessary (dependent upon data from Phase I sampling results),
- Collection of additional data on subsurface, surface water, and air migration pathways, including additional data necessary for preliminary screening of remedial technologies and process options, and for initial conceptual design of remedial action alternatives; and,
- Collection of additional information on receptors of concern and continuation of development of preliminary baseline risk assessment.

Attainment of these objectives will allow further screening of contaminant/media specific treatment technologies, and preliminary screening of process options for contaminated soil and ground water.

The objectives for the third phase of site characterization activities will probably include:

- Further assessment of the extent of soil contamination, if necessary;

- Performance of treatability studies for process options for contaminated soil remediation, if necessary;

- Further assessment of the extent of ground-water contamination in the shallow perched aquifer, if necessary;

- Collection of additional data on the subsurface migration pathway by performance of aquifer testing of the shallow perched aquifer;

- Assessment of the horizontal and vertical extent of ground-water contamination in additional perched zones and/or basal aquifer, if necessary; and,

- Coillection of additional information on receptors of concern and completion of preliminary baseline risk assessment.

Attainment of these objectives will allow further screening of process options for contaminated soil and ground water, preliminary identification of remedial alternatives through combinations of technologies, and determination of whether any further treatability studies should be performed prior to conducting the detailed analysis of alternatives.

The objectives for the fourth phase of site characterization activities will probably include:

- Further assessment of the horizontal and vertical extent of ground-water contamination in additional high-level water-bearing zones and/or basal aquifer, if necessary;

- Collection of additional data on the subsurface migration pathway by performance of aquifer testing of additional perched water-bearing zones and/or basal aquifer;

- Performance of additional treatability studies for process options for contaminated soil remediation, if necessary;

- Performance of ground-water flow and subsurface contaminant transport modeling;

- Performance of treatability studies for process options for contaminated ground-water remediation, if necessary.

Attainment of these objectives will allow the detailed analysis of remedial action alternatives to be conducted.

SECTION 4
RI/FS TASKS

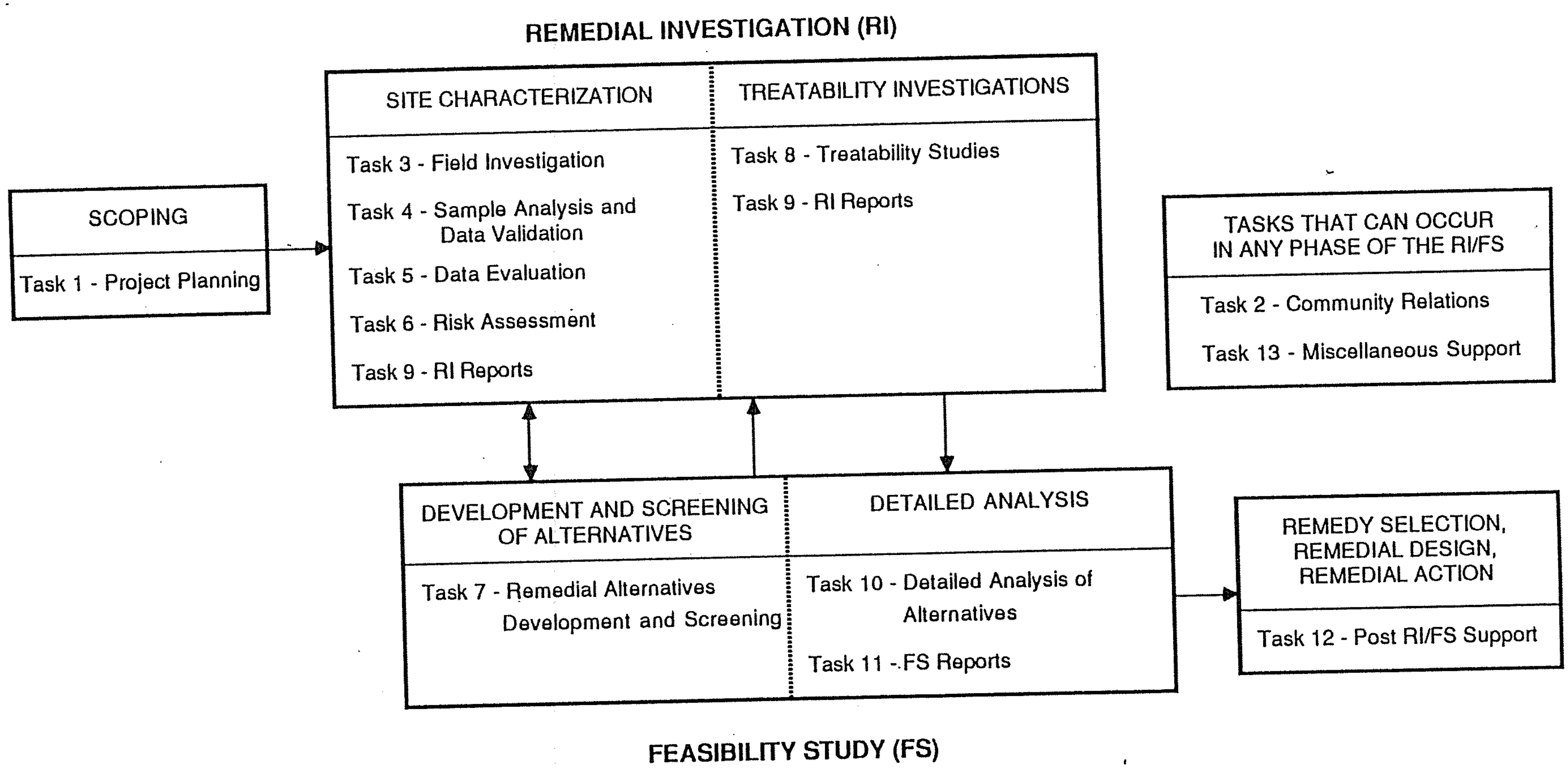
This section discusses the specific tasks necessary to accomplish the RI/FS technical approach previously described in Section 1.3. Thirteen tasks will be required in order to complete the the RI/FS; the task distinctions are similar to those presented in the guidance document entitled *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final* (EPA, October 1988). The relationship of the thirteen tasks to the RI/FS process, and to each other, is illustrated in Figure 4-1.

Certain tasks will be accomplished in a phased approach, as discussed in Section 1.3. Tasks 3, 4, and 5 are tasks which will involve a number of distinct phases. Thus, each phase of the assumed four site characterization phases will have three components: a field investigation component, a sample analysis/data validation component, and a data evaluation component. Following completion of each of the phases of site characterization, the risk assessment will be developed and refined as necessary, and the process of identifying and screening remedial technologies and process options will be conducted on an increasing level of detail. A description of how these tasks interrelate with respect to the project schedule is included in Section 7.

4.1 TASK 1: PROJECT PLANNING

The project planning task provides a sound foundation so that subsequent investigations, studies, and detailed evaluations are accomplished in a logical, environmentally sound, and cost-effective manner. The objective of the project planning task is to identify and review information collected to date on the Red Hill Site, and based on this information, prepare an initial scope of work for the RI/FS. This document and supporting plans represent the result of the project planning task. The following subtasks were performed as part of the overall project planning task:

- Site visit and meetings with personnel from various entities including the Navy Public Works Center, NSC Fuel Department, the USGS, the Hawaii State DLNR, the Honolulu BWS, and the Hawaii State DOH;
- Collection and review of historical site data and photographs;
- Preliminary development of a conceptual site model;



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RI/FS Tasks

FIGURE 4-1

- Preliminary identification of remedial action objectives;
- Identification of the objectives for the site characterization phases of the RI;
- Preliminary identification of ARARs;
- Preparation of supporting plans, including the SAP, which addresses the first phase of site characterization activities, and the HSP;
- Identification of data needs and DQOs; and
- Project planning task management and QC.

4.2 Task 2: Community Relations

ERCE will provide the personnel, services, materials, and equipment to assist the Navy in undertaking the community relations program. The community relations program will be integrated closely with all remedial response activities to ensure that the community is accurately informed of the RI/FS activities at the Red Hill Site, and that issues of community concern are addressed. The planning for the community relations task is documented in the Community Relations Plan (CRP). ERCE will provide task management and quality control reviews for the community relations task. Subtasks performed as part of the community relations task will include:

- Preparation of the CRP;
- Conducting community interviews;
- Preparation of fact sheets for the community;
- Providing public meeting support;
- Providing technical support for the community relations program; and
- Implementation of the community relations program.

The CRP is a companion document to this WP. Deliverables and schedule for the community relations task items are identified in the CRP.

4.3 Task 3: Field Investigations

Aside from the review of already existing site data and information during the project planning task (Task 1), the collection of data begins with the field investigation task. ERCE will conduct those investigations necessary to characterize the Red Hill Site and evaluate the actual or potential risk to human health and the environment posed by contamination at the site. ERCE will provide task management and QC review for all activities conducted as part of the field investigation, which will be conducted in a phased approach.

The activities associated with the first phase of the field investigation and the underlying rationale behind the activities are presented in detail in the SAP. The following are general subtasks which will be performed during the course of the different phases of field investigation:

- Vegetation Clearing - Site clearing will be conducted to allow subsequent field activities to proceed efficiently. This subtask includes obtaining necessary permits (if necessary) procurement of subcontractors, and mobilization efforts.

- Surveying and Mapping of the Site – To support field investigation work and subsequent RI/FS tasks, site maps based on both topography and site use will be prepared. A survey of the site will be conducted and will be supported by the available aerial photographs that have been uncovered during the data collection activities in the project planning task (Task 1). Surface water flow pathways will be identified through the field surveys and topographic maps. Surveying of sample locations and elevations will be performed as necessary following each phase of field investigation. This subtask includes the procurement of subcontractors as necessary to assist in the survey, as well as mobilization efforts.

- Geophysical Survey – ERCE will conduct a geophysical survey prior to each phase of subsurface work, if necessary, in order to provide data to support the selection of sampling locations. All subsurface utilities identified by the geophysical survey will be plotted on the final site survey map. This subtask includes the procurement of subcontractors, as necessary, to assist in the geophysical survey, as well as mobilization efforts.

- Soils Investigation – ERCE will conduct a soils investigation in an effort to begin to determine the lateral and vertical extent of contamination of surface and subsurface soils and sediments. Surface soil sample results will be utilized to aid in evaluation of air and surface water contaminant transport pathways, while subsurface soil sample results will be utilized to evaluate the subsurface contaminant transport pathway. Information on background soil concentrations will be obtained. Results will be used to assess the fate and transport of contaminants in the soil column. This subtask includes procurement of subcontractors as necessary to assist in mobilization and sampling efforts to collect surface and subsurface soil samples.

- Hydrogeologic Investigation – ERCE will conduct a hydrogeologic investigation to determine the nature and potential extent of ground-water contamination in the shallow perched water table aquifer. Results will be used to assess the fate and transport of contaminants in the water-bearing zones. This subtask includes procurement of subcontractors as necessary to assist in mobilization and sampling efforts to collect ground-water samples.

- Surface Water Investigation – ERCE will collect samples of water from surface water bodies adjacent to the site (if present) and, if noted, of surface water runoff from the site itself. Surface water sampling will be conducted in order to estimate the nature, extent, and fate of contaminants transported by the surface water pathway. This subtask includes mobilization efforts for surface water sample collection.

- Air Investigation – ERCE will install a 10-meter (33 foot) tower instrumented to record site-specific meteorological data. The meteorological data will be used in conjunction with the other field sampling data to assess the air pathway transport of potential contaminants. If deemed necessary, air quality modeling analyses and/or perimeter air sampling will be performed during a later site characterization study phase to assess the nature and extent of the contamination. This subtask includes mobilization efforts for meteorological data and air sample collection as well as procurement of necessary instrumentation.

This task will begin when the Navy accepts the WP and the SAP, and the HSP, and gives ERCE the approval to proceed. This task will end when field demobilization is complete, and when the data are deemed adequate to identify and characterize the extent of contamination, develop a preliminary baseline risk assessment, and, if necessary, to support the development and evaluation of remedial alternatives. The information obtained from this task will be summarized and included in the RI/FS report appendixes.

4.4 Task 4: Sample Analysis and Data Validation

ERCE will develop a data management system including field logs, sample management and tracking procedures, and document control and inventory procedures for both laboratory data and field measurements to ensure that the data collected during the investigation are of adequate quality and quantity to support the risk assessment and feasibility study. Collected data will be validated at the appropriate field or laboratory QC level to determine whether it is appropriate for its intended use. This validation will consist of comparing the results to the level of QC specified in the Quality Assurance Project Plan (QAPP), which is a component of the SAP. The information developed as part of this task will be incorporated into the RI/FS report appendices. ERCE will provide task management and QC review for all activities conducted as part of the sampling analysis and validation.

4.5 Task 5: Data Evaluation

Following the data validation efforts performed as part of Task 4, the data will be entered into a personal computer data base management system in order to facilitate use of the data in subsequent tasks. The data will be evaluated and presented in an organized and logical fashion such that the contaminant distribution profiles are clearly evident for each of the affected media at the site. Examples of such presentation formats include:

- Geologic and hydrogeologic cross-sections;
- Potentiometric surface maps; and
- Contaminant concentration contour maps for each water-bearing zone, soil, and air.

The potential for migration of contaminants via the subsurface, surface water, and air pathways to the surrounding populations will then be assessed, along with the expected fate of the contaminants in the environment. This effort will likely require the use of analytical and numerical modeling techniques. Subsequently, the conceptual site model will be correspondingly revised. Compilations of physical properties and other data necessary for the evaluation of remedial action alternatives will also be presented.

This task will begin as soon as the first set of data has been validated. It will be deemed complete when no additional data are required in order to: 1) conduct the preliminary baseline risk assessment, and 2) proceed to the final development and screening of the remedial action alternatives. ERCE will provide task management and QC review for all activities conducted as part of the data evaluation task.

4.6 TASK 6: RISK ASSESSMENT

ERCE will conduct a preliminary baseline risk assessment to assess the potential human health and environmental risks posed by the site in the absence of any remedial action. This effort will involve the following four components:

- Contaminant Identification - ERCE will review the data collected and evaluated in Task 5 for the hazardous substances present at the site, and identify the major contaminants of concern. Contaminants of concern will be selected based on their intrinsic toxicological properties, quantities, and/or potential to enter critical exposure pathways.

- Toxicity Assessment - ERCE will provide a toxicity assessment of those chemicals found to be of concern during site investigation activities. This will involve an assessment of the types of adverse health or environmental effects associated with chemical exposures, the relationships between magnitude of exposures and adverse effects, and the related uncertainties for contaminant toxicity (for example, the weight of evidence for carcinogenicity of a chemical).

- Exposure Assessment - ERCE will identify actual or potential exposure pathways, characterize the potentially exposed populations, and evaluate the actual or potential extent of exposure.

- Risk Characterization - ERCE will integrate information developed during the exposure and toxicity assessments to characterize the current or potential risk to human health and the environment posed by the Red Hill Site contamination. This characterization is intended to identify adverse health or environmental effects for the chemicals of concern and identify any uncertainties associated with contaminants, toxicities, and/or exposure assumptions.

This task will begin as the field investigation data are validated and evaluated. The results of the risk assessment will be incorporated into the RI Report. ERCE will provide task management and QC review for all activities conducted as part of the risk assessment task.

4.7 TASK 7: DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

The first step in the feasibility study is to develop and screen the remedial alternatives that are appropriate to the Red Hill Site. A number of preliminary remedial alternatives have been identified as part of the scoping work efforts presented in this WP (Task 1). The remedial alternatives development and screening task will re-evaluate these preliminary alternatives, and seek to identify additional alternatives that are found to be more appropriate for the site based on the additional information regarding the nature of site contamination made available during the course of the RI.

ERCE will develop a range of remediation alternatives to the extent deemed necessary during the RI. The alternatives will include treatment processes to reduce the quantity and toxicity of the contaminants, containment measures involving little or no treatment, and a no-action alternative.

The following steps will be conducted to determine the appropriate range of alternatives for this site:

- Establish remedial action objectives and general response actions, based on existing general information and site-specific data generated as part of earlier RI/FS tasks. Remedial action objectives will be developed with the goal of protecting human health and the environment.

  Preliminary remediation goals have been established in the Project Planning task (Task 1), based on readily available information. As more information is collected during the remedial investigation, ERCE, in conjunction with the Navy, will refine or modify the remedial action objectives as appropriate.

  General response actions will be developed for each medium of interest, singly or in combination with other response actions, to meet the remedial action objectives. Those volumes of contaminants or areas of the site to which the particular response actions apply will be identified.

- Identify and Screen Technologies - Based on the general response actions that have been developed, remediation technologies and process options will be identified and screened so that only those options which are applicable to specific site characteristics and conditions are evaluated. This screening will be based primarily on ability of an option to effectively address the contaminants at the site (i.e., can the option meet the ARARs identified for the site?), but will also consider the cost and the implementability of the technology. ERCE will select appropriate technologies and process options to evaluate further in the RI/FS. As part of this task, ERCE will further identify the need for treatability testing for each of the selected options.

- Configure and Screen Alternatives - The potential technologies and process options will be combined into media-specific, sitewide alternatives. The developed alternatives will be defined with respect to size and configuration of the representative process options; time required for remediation; rates of flow and/or treatment; spatial requirements; disposal options; and required permits, imposed limitations, and other factors necessary to evaluate the alternatives. If many distinct and viable options are identified and developed, a further screening will be conducted to limit the number of alternatives that are selected to undergo detailed analysis. The alternatives will be screened with respect to their effectiveness, implementability, and cost.

Task 7 will be initiated once sufficient data are available to develop general response actions and begin the evaluation of potential technologies. This task is defined as complete when a final set of alternatives is chosen for detailed evaluation. ERCE will provide task management and QC review for all activities conducted as part of the remedial alternatives development and screening task.

4.8 TASK 8: TREATABILITY STUDIES AND PILOT TESTING

This task includes efforts to prepare and conduct bench- and pilot-scale testing, and treatability studies, based on those technologies and options identified in the previous task. The objective of the treatability studies, and the bench- and pilot-scale testing, is to determine suitability of selected process options for meeting remedial action requirements and collect data that will allow the full-scale processes to be accurately designed and installed. By necessity, the nature of the treatability studies will be different for each process option or technology. The following activities are included in this task:

- Treatability Studies WP Preparation - The treatability studies WP will identify the nature and design of testing to be performed, goals and objectives of the testing, level of effort required, schedule for the testing, and data management requirements.

- Test Facility, Equipment, and Analytical Services Procurement - ERCE will procure equipment, services, and facilities necessary to perform the treatability studies, and batch- and pilot-scale testing. This will include procurement of laboratory analytical services to support the testing.

- Operation of Treatability Testing - ERCE will perform the treatability testing and the batch- and pilot-scale testing in accordance with the treatability studies work plan. ERCE will procure subcontractors as necessary to support this activity.

- Sample Analysis, Validation, and Evaluation of Results - ERCE will collect samples, analyze and validate the data, and evaluate the results in terms of the process performance. ERCE will procure subcontractors and laboratory services as necessary to support this activity.

The results of the treatability studies will be presented in the RI report. Included in the report will be a discussion of the effectiveness of the various process options and technologies that were evaluated, which will define the basis by which the design and evaluation of full-scale treatment units should be made.

Task 8 begins with the development of WPs for conducting the tests and is complete when the testing is effectively accomplished. ERCE will provide task management and quality control review for all activities conducted as part of the treatability studies and pilot testing task.

4.9 TASK 9: REMEDIAL INVESTIGATION REPORT AND RI PROGRESS REPORTS

This task covers all aspects involved in the preparation of reports related to the remedial investigation (Tasks 3, 4, 5, 6, and 8). Activities performed under this task include the following:

- Site Characterization Reports - (Draft and Final prepared for each phase of the site characterization process). These reports will document the findings pertinent to each phase of the field investigation as well as present recommendations for further work.

- Draft RI Report - The draft Remedial Investigation Report will document the results of the data evaluation and the risk assessment. The draft RI Report will discuss:
  - Study area investigation;
  - Physical characteristics of the site;
  - Nature and extent of contamination;
  - Contaminant fate and transport;
  - Preliminary baseline risk assessment; and
  - Recommended remedial action objectives.

- Final RI Report - The final RI Report will document the results of the entire RI process. As necessary, it will reflect updated information pertaining to data evaluation and risk assessment. It will also present the results of the treatability studies. The final RI report will present a framework of information upon which the detailed evaluation of remedial options is performed as the final step of the feasibility study.

- Periodic Progress Reports - Throughout the RI, ERCE will prepare progress reports that detail technical progress at the Red Hill site. Each report will contain the following relevant items:
  - Status of work and the progress to date;
  - Percentage of work completed and schedule status;
  - Problems encountered and corrective actions proposed or undertaken
  - Activities in progress; and

- Changes in key project personnel.

Also included in the monthly progress reports will be a brief summary of the activities performed to date.

Task 9 will begin with the first progress report. ERCE will provide task management and QC review for all activities conducted as part of this task.

4.10 Task 10: Detailed Analysis of Remedial Alternatives

Upon completion of the remedial evaluation, ERCE will conduct a detailed analysis of the remedial alternatives. This task will consist of an analysis of each alternative against a set of nine evaluation criteria, followed by a comparative analysis and ranking of all of the alternatives. The following criteria will be used in this evaluation:

- Overall protection of human health and the environment;
- Compliance with ARARs;
- Long-term effectiveness and permanence;
- Reduction of toxicity, volume, or mobility through treatment;
- Short-term effectiveness;
- Implementability;
- Cost;
- Regulatory acceptance; and
- Community acceptance.

Each specific analysis will include conceptual descriptions of individual alternatives that outline the remediation strategy involved and identify the key ARARs associated with the alternative, and a discussion that profiles the performance of that alternative with respect to each of the evaluation criteria. Once the individual analyses are completed, the alternatives will be compared with one another in terms of each of the evaluation criteria.

Task 10 will begin when the treatability studies have been completed. Included in the task will be the efforts required to manage the task and ensure QC.

4.11 TASK 11: FEASIBILITY STUDY REPORTS

ERCE will prepare the FS Report that presents the results of the development, screening, and detailed analysis of remedial alternatives performed in Tasks 7 and 10. This task will also cover the monthly progress reports that are prepared during the FS. It will cover the efforts and costs associated with writing, printing, and distributing the reports, as well as review meetings with the Navy, and the incorporation of comments into the final FS report. This task also includes the efforts required to manage the task and ensure QC.

4.12 TASK 12: POST RI/FS SUPPORT

This task includes efforts to prepare the remedial action plan (RAP), the responsiveness summary, conduct any predesign activities, and close out the work assignment. All activities occurring after the completion of the FS report will be reported under this task. This task may include the following activities:

- Preparing the predesign report;
- Preparing the conceptual design;
- Attending public meetings;
- Reviewing and providing QC of the work effort; and
- Providing post RI/FS task management and QC.

4.13 TASK 13: MISCELLANEOUS SUPPORT

When requested by the Navy, ERCE will perform tasks which are outside the scope of the Red Hill Site RI/FS as defined in Tasks 1 through 12.

SECTION 5
DATA QUALITY OBJECTIVES

DQOs are statements concerning the quality of data necessary to support remedial alternative decision-making. The process of developing DQOs to govern a particular phase of work is not meant to represent a stand-alone deliverable, but rather to ensure that the necessary consideration is given to data quality requirements based on a given end use of data. Thus, DQOs are established during the planning process for each phase of work to be conducted during the RI/FS. The output of the DQO development process is a strategic sampling and analysis plan for a particular phase of work which ensures the resulting data will be of sufficient quality to meet the objectives of that phase.

DQOs depend on the type and utilization of the data collected. This section discusses the different types of data uses necessary for the successful completion of the RI/FS. It also discusses the appropriate analytical level, or degree of analytical sophistication, which is necessary depending on the identified data use. Finally, it briefly discusses the rationale for the approach proposed in the SAP for the Phase 1 site characterization activities. The approach of this WP to the establishment of DQOs is based primarily on the approach described in the guidance document entitled *Data Quality Objectives for Remedial Response Activities, Development Process* (EPA, 1987a) and the companion guidance document entitled *Data Quality Objectives for Remedial Response Activities, Example Scenario: RI/FS Activities at a Site with Contaminated Soils and Ground Water* (EPA, 1987b). Additional information on DQOs was obtained from the NEESA guidance document entitled *Sampling and Chemical Analysis for the Navy Installation Restoration Program: NEESA 20.2-047B* (NEESA, 1988).

The possible uses of data during the RI/FS include:

- Site characterization;
- Health and safety planning;
- Preliminary baseline risk assessment;
- Evaluation of remedial action alternatives;
- Engineering design of remedial action alternatives; and
- Monitoring during remediation implementation.

These categories do not represent different data qualities, only different data uses which may require data of a given quality. In other words, data collected that is of a given quality may be used for different purposes.

There are five different classifications of analytical QC levels which are appropriate to the various data uses. Levels I, II, III, IV, and V designated by the EPA correspond closely with NEESA QC levels A, B, C, D, and E, respectively. NEESA QC Level A involves the lowest degree of technical sophistication. This QC level, along with NEESA Level B, comprise the two QC levels associated with field analytical methods, while NEESA QC Levels C, D, and E represent increasing degrees of technical sophistication typically associated with the analysis of environmental samples in a stationary laboratory. NEESA QC Level E is typically used when unusual sample matrices, contaminants, or analytical methods are required. A summary of the NEESA QC levels and their limitations versus the various data uses listed above is shown in Table 5-1.

As shown in Table 5-1, more than one analytical level may be appropriate for a particular data use. During site characterization activities, for instance, NEESA QC Level A may be appropriate for field monitoring of hydrocarbon concentrations in ambient air or of pH readings in water samples, while NEESA QC Level C may be necessary for monitoring low levels of organic analytes in samples collected from drinking water wells. Table 5-1 lists examples of different data uses, each requiring different degrees of sophistication. Overall, the data requirements for performing baseline human health risk assessments are the most stringent, while data requirements for monitoring during remedial program implementation are the least stringent, because an adequate job for the latter can usually be completed using field instruments.

The DQO approach adopted for the initial phases of sampling activities at the site can be described in the following manner. One of the major objectives for the first phase of work is to collect data that enables the determination of the nature of site contaminants. Until this determination is made, it would be inefficient to attempt to define the extent of contamination or perform a baseline risk assessment. Therefore, a wide-ranging scan of analytical work will be performed n the initial phase, predominantly of NEESA QC Level C, including GC/MS analysis for Following determination of the nature of contamination, larger numbers of samples will be collected in the second phase of the site characterization in an effort to determine the extent of contamination and characterize the different migration

Table 5-1

SUMMARY OF ANALYTICAL LEVELS APPROPRIATE TO DATA USES

Data Uses	NEESA Analytical Level	Type of Analysis	Limitations	Data Quality
Site characterization, monitoring during implementation	Level A	• Total organic/inorganic vapor detection using portable instruments • Field test kits	• Instruments respond to naturally-occurring compounds	If instruments calibrated and data interpreted correctly, can provide indication of contamination
Site characterization, evaluation of alternatives, engineering design, monitoring during implementation	Level B	• Variety of organics by GC; inorganics by AA; XRF • Tentative ID; analyte-specific • Detection limits vary from low ppm to low ppb	• Tentative ID • Techniques/instruments limited mostly to volatiles, metals	• Dependent on QA/QC steps employed • Data typically reported in concentration ranges
Risk assessment, PRP determination, site characterization, evaluation of alternatives, engineering design, monitoring during implementation	Level C	• Organics/inorganics using EPA procedures other than CLP can be anlalyte-specific • RCRA characteristic tests	• Tentative ID in some cases • Can provide data of same quality as level D	• Similar detection limits to CLP • Less rigorous QA/QC
Risk assessment, PRP determination, evaluation of alternatives, engineering design	Level D	• TCL organics/inorganics by GC/MS; AA; ICP • Low ppb detection limit	• Tentative identification of non-TCL parameters • Some time may be required for validation of packages	• Goal is data of known quality • Rigorous QA/QC

Table 5-1 (Continued)

SUMMARY OF ANALYTICAL LEVELS APPROPRIATE TO DATA USES

Data Uses	Analytical Level	Type of Analysis	Limitations	Data Quality
Risk assessment, PRP determination	Level E	• Non-conventional parameters • Method-specific detection limits • Modification of existing methods • Appendix 8 parameters	• May require method development/modification • Mechanism to obtain services requires special lead time	• Method-specific

Source: NEESA, 1988.

pathways. NEESA QC Level A type field analyses will be used where appropriate in order to reduce the number of samples submitted to analytical laboratories.

A data quality summary table will be prepared prior to the performance of each phase of the site characterization. This table briefly presents the objective of each of the proposed sampling activities, the prioritized data uses, the appropriate analytical level for each of the prioritized data uses, the contaminants of concern, the level of concern, the required detection limits, and any critical samples for which the data must be beyond reproach (for instance, a ground-water sample collected from a public water supply well). In addition, sampling procedures, sample handling and management, analytical methods and instruments, practical quantitation limits, analytical accuracy and precision, and data completeness must all be appropriate and meet criteria to ensure quality of the data. The data use and quality summary table for the first phase of the site characterization activities at the Red Hill Site is shown in Table 5-2.

Table 5-2

DATA QUALITY SUMMARY

Activity	Surface Soil Samples	Subsurface Soil Samples	Surface Water Samples	Sample New Monitor Wells
Objective	Samples will be used to assess surface water, air transport migration pathways, and to see if areas of surface discharge can be determined.	Samples will be used to assess subsurface transport and nature of contamination associated with the old and new pits, and background concentrations in different lithologic horizons	Samples will be used to assess surface water transport pathway and nature of contamination in standing fluids in new pit.	Samples will be used to determine background nature quality, potential for degradation of the basal aquifer and resultant exposure.
Appropriate Analytical Levels	Site Characterization, Risk Assessment	Site Characterization: NEESA Levels B,C,D Risk Assessment: NEESA Levels C,D,E	Site Characterization: NEESA Levels B,C,D Risk Assessment: NEESA Levels C,D,E	Site Characterization: NEESA Levels B,C,D Risk Assessment: NEESA Levels C,D,E
Contaminants of Concern	All but dioxins	TPH, phenols/PNAs, metals, solvents, dioxins	All but dioxins	All but dioxins
Level of Concern	See ARARs	See ARARs	See ARARs	See ARARs
Critical Samples	None	Angle borings near Old Pit	Background water quality	Background water quality

SECTION 6
SCHEDULE

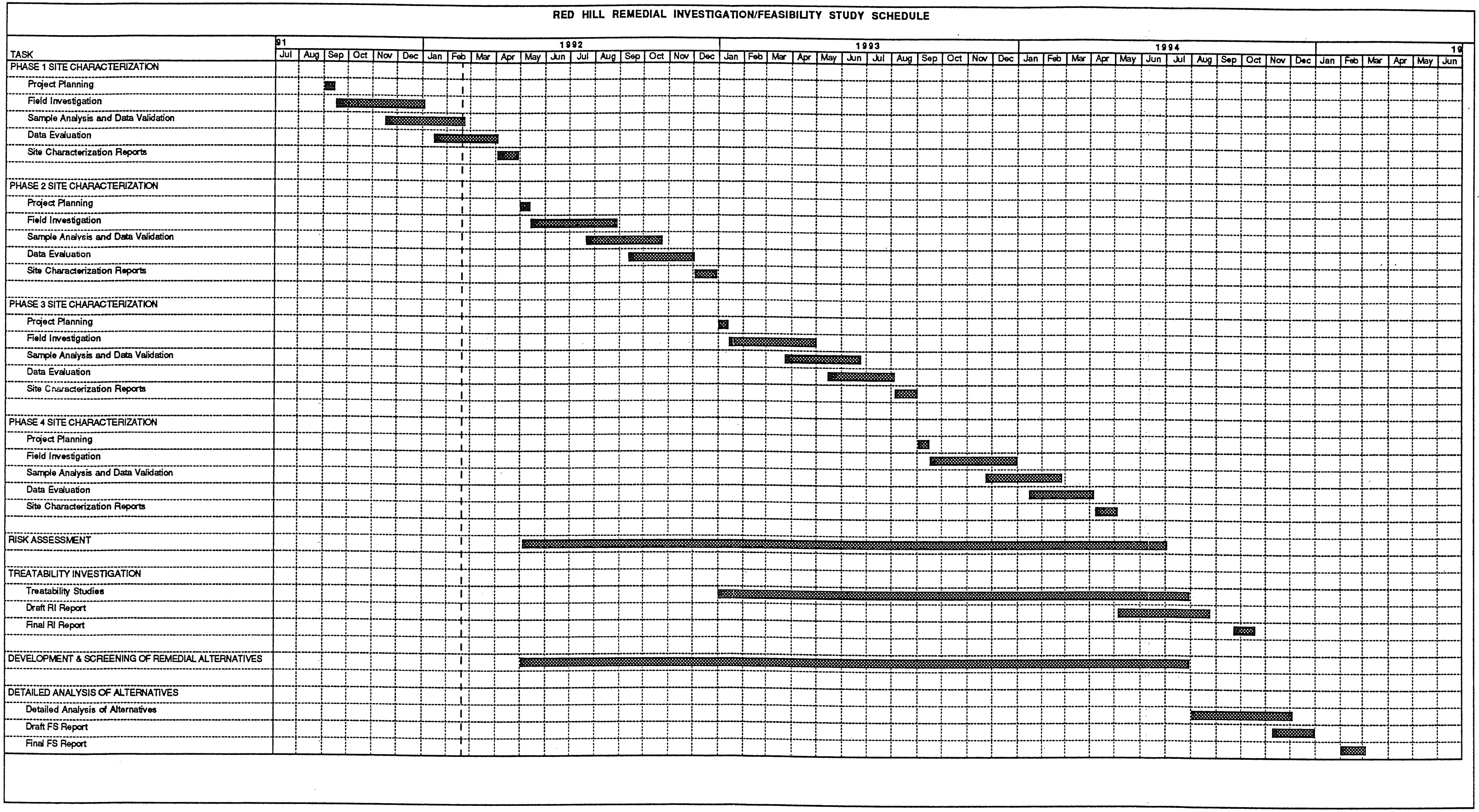
The schedule for the implementation of the RI/FS is presented in Figure 6-1. This schedule represents a preliminary estimate of the duration of the various tasks and may change subject to the results of the RI.

The Field Investigation, Sample Analysis and Data Validation, and Data Evaluation tasks (Tasks 3, 4, and 5) encompass all of the planned four phases of site characterization activities. Each of these four phases is estimated to require a total of approximately seven to nine months. This schedule assumes that after the first phase of the site characterization is completed, the Risk Assessment task of the RI will begin. The Development and Screening of Remedial Alternatives task will also begin at this time. The planning and design of treatability studies task will begin at the end of the Phase 2 Data Evaluation.

The Detailed Analysis of Alternatives task will begin with the completion of the Development and Screening of Remedial Alternatives task. The Detailed Analysis of Alternatives task will incorporate the results of the Treatability Studies task.

The Remedial Investigation Report will be prepared once the Site Characterization tasks have been completed and will incorporate the results of the Treatability Studies task. Preparation of the Feasibility Study Report will begin near the end of the Detailed Analysis of Alternatives task.

The overall duration of the project is anticipated to be approximately 42 months, assuming four phases of site characterization activities.



ERCE

Red Hill Remedial Investigation/Feasibility Study Schedule

FIGURE 6-1

SECTION 7
REFERENCES

Aqua Terra Technologies, March 1988. Final Report: Verification Phase Confirmation Study Site 6 - NSC Pearl Harbor Red Hill Oily Waste Disposal Pit.

Bechtel Corporation, 1949. Engineering Survey of U.S. Navy Petroleum Facilities at Pearl Harbor: Report for U.S. Navy Department, Bureau of Yards and Docks.

Berger, Andrew J., September 1971. Wildlife Study, Prepared for State of Hawaii, Department of Transportation's Final Environmental Statement, Volume III.

COMM14, 1949, Letter from Commander, L.J. Watson, USNR, to Captain C.W. Porter, USN District Public Works Officer, 14th Naval District. Technical Study of Possibility of Contamination of Basal Water Sources from the Red Hill Underground Fuel Oil Storage.

Dale, R.H., and Takasaki, K.J., 1976. Probable effects of increasing pumpage from the Schofield ground-water body, Island of Oahu, Hawaii: USGS WRI 76-47.

Ekern, P.C., and Chang, J., 1985. Pan Evaporation: State of Hawaii, 1894-1983, Report R74: State of Hawaii Department of Land and Natural Resources, Division of Water and Land Development, Honolulu, HI.

Ewart, C.J. 1986. Oahu Island Regional Aquifer-System Study, Hawaii, in: Regional Aquifer-System Analysis Program, Summary of Projects, 1978-1984. U.S. Geological Survey Circular 1002.

Gammon, J., November 1989. Personal Communication.

Giambelluca, T.W., Nullet, M.A., and Schroeder, T.A., 1986. Rainfall Atlas of Hawaii, Report R76: Hawaii State Department of Land and Natural Resources, Division of Water and Land Development, Honolulu, HI.

Hawaii State Department of Land and Natural Resources, 1988. Division of Water and Land Development Driller Logs.

Hawaii State Department of Transportation, 1988. Interstate Route H-3 Construction Plans.

Hawaii Water Authority, 1959. Water Resources in Hawaii.

Hawaiian Agronomics (International), Inc., 1986. Final Report for Flora, Fauna and Water Resources Survey of the Pearl Harbor Area Facilities, Hawaii: Red Hill Fuel Storage Area, prepared for Pacific Division Naval Facilities Engineering.

Honolulu Board of Water Supply, 1981. Municipal Water Use Plan, Pearl Harbor Ground Water Control Area: City and County of Honolulu, Hawaii.

Honolulu City and County Planning Department, 1969. Elevation Contour Map.

Hufen, T.H., Eyre, P., and McConachie, W., 1980. Underground Residence Times and Chemical Quality of Basal Groundwater in Pearl Harbor and Honolulu Aquifers, Oahu, Hawaii: Water Resources Research Center Technical Report No. 129, University of Hawaii.

Jensen, J., November 1989. Personal Communication.

Lau, L.S., Price, S., Ekern, P.C., Pulfrey, R., and Peterson, F.L., 1971. Hydrologic Systems in Hawaii, in: Systems Approach to Hydrology, Proceedings of the 1st Bilateral U.S.-Japan Seminar in Hydrology, East-West Center, University of Hawaii.

Mink, J.F., 1961. Some Geochemical Aspects of Sea-water Intrusion in an Island Aquifer: Internat. Assoc. Sci. Hydrology Comm. of Subterranean Waters Pub. 52, p. 424-439.

Mink, J.F., 1980. State of the Groundwater Resources of Southern Oahu: City and County of Honolulu, HI.

Naval Energy and Environmental Support Activity, October 1983. Initial Assessment Study of Pearl Harbor Naval Base, Oahu, Hawaii.

Naval Energy and Environmental Support Activity. June 1988. Sampling and Chemical Quality Assurance Requirements of the Navy Installation Restoration Program, Second Revision, June 1988.

Naval Supply Center, 1972. Construction Plan for Fresh Water System (R1-67) Miscellaneous Details, NAVFAC Drawing No. 1311793.

Naval Supply Center, 1972. Fresh Water System (R1-67) Water Tank Site Plan, NAVFAC Drawing No. 1311790.

Naval Supply Center, 1954. Construction Plan for Master Shore Station Development Plan Part III-Section 2, General Development Plan.]

Rockwell International, 1983. Physical, Chemical, and Toxicological Characterization of Oily Sludges Generated at Naval Installations, Volumes I and II, prepared for the Naval Civil Engineering Laboratory.

Shallenberger, Robert J., August 1977. Avifaunal Survey of North Halawa Valley, Oahu, Draft Supplement to the Interstate Route H-3 Environmental Impact Statement, Volume V, Prepared for Hawaii State Department of Transportation.

Stearns, H.T., and Vaksvik, K.N., 1935. Geology and Ground-Water Resources of the Island of Oahu, Hawaii: Division of Hydrography, Territory of Hawaii, Bulletin 1.

Stearns, H.T., and Macdonald, G.A., 1940. Supplement to the Geology and Groundwater Resources of the Island of Oahu, Hawaii: Division of Hydrography, Territory of Hawaii, Bull. 5.

Swain, L.A., 1973. Chemical Quality of Ground Water in Hawaii, Report R48: Hawaii State Department of Land and Natural Resources Division of Water and Land Development.

Towill, R.M., 1949-1989. Miscellaneous Aerial Photographs.

U.S. Department of Transportation, 1977. Federal Highway Administration, and State Department of Transportation. Final Supplement to the Interstate Route H-3 Environmental Impact Statement, Volumes I through VII.

U.S. EPA, December 1987. A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001.

U.S. EPA, March 1987a. Data Quality Objectives for Remedial Response Activities, Development Process, EPA/540/G-87/003.

U.S. EPA, March 1987b. Data Quality Objectives for Remedial Response Activities, Example Scenario: RI/FS Activities at a Site with Contaminated Soils and Ground Water, EPA/540/G-87/004.

U.S. EPA, August 1988. CERCLA Compliance with Other Laws Manual: Draft Guidance, EPA/540/G-89/006

U.S. EPA, October 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, EPA/540/G-89/004.

U.S. EPA, August 1989. CERCLA Compliance with Other Laws Manual: Part II, Interim Guidance, EPA/540/G-89/009

U.S. Geological Survey, 1983. Oahu 7.5 minute map series, Pearl Harbor, Map File No. 00191.

U.S. Geological Survey, 1987. Water Resources Data Book, 1987, Hawaii.

U.S. Navy, 1943a. Underground Fuel Storage, General Plan and Profile of Pipeline Tunnel, 1941-1943. Drawing No. 0A-N24-104.

U.S. Navy, 1943b. Plan and Profile on Waste Oil Disposal Pit Showing Pipelines, Y&D Drawing No. 294223.

U.S. Navy, 1943c. Fuel Depot Plan Drawing, South Halawa, Oahu, Underground Fuel Storage, Fourteenth Naval District.

U.S. Navy, 1943d. NSC Fuel Depot, Underground Piping. Drawing No. 293893.

Vischer, F.N., and Mink, J.F., 1964. Ground-Water Resources in Southern Oahu, Hawaii: U.S. Geological Survey Water Supply Paper 1778.

Wentworth, C.K., 1951. Geology and Groundwater Resources of the Honolulu-Pearl Harbor Area Oahu, Hawaii: Board of Water Supply, Honolulu.

Wilson Okamoto and Associates, Inc., June 1983. Revised Environmental Impact Statement for the Halawa Medium Security Facility.

APPENDIX A

PRELIMINARY LIST OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND TO-BE-CONSIDERED (TBC) CRITERIA

APPENDIX A

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND TO-BE-CONSIDERED CRITERIA (TBCs)

In accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 and its 1986 amendments, as promulgated by EPA policy, remedial actions must attain or exceed applicable or relevant and appropriate requirements (ARARs). The following is an overview of ARARs and a description of their consideration during the conduct of the RI/FS Red Hill Site. Guidance used for the preparation of the following has been *CERCLA Compliance with Other Laws Manual*, Draft Guidance (EPA, August 1988), and *CERCLA Compliance with Other Laws Manual: Part II*, Interim Guidance, (EPA, August 1989)

Applicable requirements are defined as those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are defined as those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

These definitions are consistent with the current National Oil and Hazardous Substance Pollution Contingency Plan (NCP) and its proposed revisions. In the determination of whether a requirement is an ARAR for the site, the requirement is evaluated first to determine its applicability; if a requirement is not applicable, consideration must be made to its relevance and appropriateness. If a requirement is relevant but not appropriate, this requirement is not an ARAR for the site.

There are three types of ARARs to be considered in the RI/FS process: chemical-specific, location-specific, and action-specific ARARs. Chemical-specific standards are usually health- or risk-based numerical values or methodologies that are established under several statutes. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in specific locations. Some examples of special locations include floodplains, wetlands, historic places, and sensitive ecosystems or habitats. Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy and since there are usually several alternative actions for any remedial site, very different requirements can come into play.

In addition to the potential site-specific ARARs, To-be-Considered Material (TBCs) must be considered. TBCs are non-promulgated advisories or guidance issues by Federal or State government that are not legally binding and do not have the status of potential ARARs. However, in many circumstances TBCs will be considered along with ARARs as part of the site risk assessment and may be used in determining the necessary level of cleanup for protection of health or the environment.

Potential ARARs for the site include Federal environmental laws administered by EPA and authorized States and by other Federal agencies. Further, the CERCLA Compliance Policy includes the provision that State ARARs must be met if they are more stringent than Federal requirements. Table A-1 presents an overview of federal ARARs/TBCs which may be applicable to the Red Hill Site, while Table A-2 presents an overview of state ARARs/TBCs which may also be applicable to the site.

EPA's *Guidance for Conducting Remedial Investigation and Feasibility Studies under CERCLA*, Interim Final (EPA October 1988) maintains that during the scoping phase of the RI/FS, preliminary identification of ARARs and TBCs should be completed. Also at this stage, coordination between lead and support agencies should be initiated. Early identification of potential ARARs and agency communication will allow effective planning of field activities as well as result in the handling, treatment, or disposal of field investigation-derived wastes in accordance with all Federal and State ARARs.

Throughout the subsequent RI/FS investigations, as a better understanding is gained of site conditions, site contaminants, and remedial action alternatives, the ARARs can be further defined and refined with each RI/FS step in accordance with generated data.

Table A-1

IDENTIFIED POTENTIAL FEDERAL ARARS AND TBCs(1)
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

ARARS/TBCs	Citation
Office of Solid Waste	
• Resource Conservation and Recovery Act of 1976 Applicable for permitted and interum status facilities	42 U.S.C. 6901(2) 40 CFR Part 264, permitted facilities(3) 40 CFR Part 265, interim status facilities
Ground-water Protection	40 CFR 264.90-264.101
Ground-water Monitoring, Subpart F	40 CFR 264.98-264.100(4)
Closure and Post-Closure	40 CFR 264.110-264.120, 265.110-265.120
Containers	40 CFR 264.170-264.178, 265.190-265.177
Tanks	40 CFR 264.190-264.200, 265.190-265.199
Surface Impoundments	40 CFR 264.220-264.249, 265.220-265.230
Waste Piles	40 CFR 264.250-264.269, 265.250-265.258
Land Treatment	40 CFR 264.270-264.299, 265.270-265.282
Land Disposal Restrictions	40 CFR 268.1-268.50
Dioxin-containing Wastes	50 FR 1978(5)
Statutory requirements, including:	
Liquids in Landfills	RCRA 83004(c)
Minimum Technology Requirements	RCRA 83004(o), 3005(j)
Dust Suppression	RCRA 83004(e)
Hazardous Waste Used as Fuel	RCRA 83004(q)
Open Dump Criteria - pursuant to RCRA Subtitle D: criteria for classification of solid waste disposal facilities (For nonhazardous wastes)	40 CFR Part 257
Office of Water	
• The Safe Drinking Water Act	42 U.S.C. 300(f)
Maximum Contaminant Levels (chemicals, turbidity, and microbiological contamination) for drinking water or human consumption	40 CFR 141.11-141.16
Maximum Contaminant Level Goals	40 CFR 141.50-141.51, 50 FR 46936

Table A-1 (continued)

IDENTIFIED POTENTIAL FEDERAL ARARS AND TBCs(1)
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

ARARS/TBCs	Citation
• Safe Drinking Water Act (continued)	
Underground Injection Control Regulations	40 CFR Parts 144, 145, 146, 147
• Clean Water Act	33 U.S.C. 1251
Effluent limitations	Section 301
Effluent limitations	Section 302
Water quality standards, including state water quality standards	Section 303
Federal water quality criteria	Section 304
National performance standards	Section 306
Toxic and pretreatment standards, including Federal pretreatment standards for discharge into publicly owned treatment works, and numeric standards for toxics	Section 307
National Pollutant Discharge Elimination System	Section 402
Ocean discharge criteria	Section 403
Available ambient Water Quality Criteria documents	45 FR 79318, November 28, 1980
	49 FR 5831, February 15, 1984
	50 FR 30784, July 29, 1985
	51 FR 22978, June 28, 1986
	51 FR 43665, December 3, 1986
	51 FR 8012, March 7, 1986
	52 FR 6213, March 2, 1987
• Marine Protection, Research and Sanctuaries Act	33 U.S.C. 1401
• Ocean Dumping Requirements	40 CFR Parts 220-233, Subchapter II
• Discharge of dredged materials into ocean	33 CFR Parts 320-329 40 CFR Parts 122, 123, 125, 131, 230, 231, 233, 400-469
• Incineration at sea requirements	40 CFR Parts 220-225, 227, 228 See also 40 CFR 125.120-125.124

Table A-1 (continued)

IDENTIFIED POTENTIAL FEDERAL ARARS AND TBCs(1) RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

ARARS/TBCs	Citation
• EPA's Statement of Procedures on Floodplains Management and Wetlands Protection	40 CFR Part 6 Appendix A(6)
Office of Air	
• Clean Air Act	42 U.S.C. 7401
National Ambient Air Quality Standards	40 CFR Part 50
National Emissions Standards for Hazardous Air Pollutants	
Asbestos and wet dust particulates	40 CFR 61.140-61.156
Benzene	40 CFR 61.110-61.112
Other hazardous substances	40 CFR Part 61 generally
Effluent limitations and pretreatment standards for Wet Dust Collection	40 CFR 427.110-427.116 and 40 CFR Part 763
State implementation plans for national primary and secondary ambient air quality control standards	42 U.S.C. 7410
Standards of performance for new stationary sources, including new incinerators	42 U.S.C. 7411, 40 CFR Part 60
Other Federal Requirements	
• OSHA requirements for workers engaged in response or other hazardous waste operations	29 CFR 1910.120
• Occupational Safety and Health Act of 1970	29 U.S.C. 651
Occupational Safety and Health standards (General Industry Standards)	29 CFR Part 1910
The Safety and Health Standards for Federal Service Contracts	29 CFR Part 1926
The Shipyard and Longshore Standards	29 CFR parts 1915, 1918
The Health and Safety Standards for employees engaged in Hazardous Waste Operations	50 FR 45654
• National Historic Preservation Act	16 U.S.C. 470
• Protection of Archaeological Resources: Uniform Regulations - Department of Defense	32 CFR Part 229, 229.4

Table A-1 (continued)

IDENTIFIED POTENTIAL FEDERAL ARARS AND TBCs[1]
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

ARARS/TBCs	Citation
Other Federal Requirements (continued)	
Department of the Interior	43 CFR Part 7, 7.4
Federal Land Policy and Management Act (Establishes requirements concerning utilization of public lands, particularly rights of way regulation)	13 U.S.C. 1700 13 U.S.C. 1761
• Land use planning, land acquisition, and disposition, and appropriation of waters on public lands	13 U.S.C. 1711
• Department of Transportation Rules for the Transportation of Hazardous Materials	49 CFR Parts 107, 171.1-172.558
• Endangered Species Act of 1973	16 U.S.C. 1531 Generally, 50 CFR Parts 81, 225, 402
• Wild and Scenic Rivers Act	16 U.S.C. 1271
• Fish and Wildlife Coordination Act	16 U.S.C. 661 note
• Fish and Wildlife Improvement Act of 1978 and Fish and Wildlife Act of 1956	16 U.S.C. 742a Note[7]
• Fish and Wildlife Conservation Act of 1980	16 U.S.C. 2901 Generally, 50 CFR Part 83[7]
• Coastal Zone Management Act of 1972 Air and Water Pollution Control Requirements	16 U.S.C. 1451 Generally, 15 CFR Part 930 15 CFR 923.45
• Farmland Protection Policy Act	7 U.S.C. 4201 Generally, 7 CFR Part 658[7]
• Rivers and Harbors Act	33 U.S.C. 403
To Be Considered Criteria (TBCs)	
• Environmental Protection Agency, "Health Advisories"[8]	
• National Academy of Science, Suggested No-Adverse-Response Levels[8]	
• National Institute for Occupational Safety and Health (TWA's and STELs)	
• American Conference of Governmental Industrial Hygienist (TWA's and STELs)	
• National Oceanographic and Atmospheric Administration, National Status and Trends Program sediment effects data	

Table A-1 (continued)

IDENTIFIED POTENTIAL FEDERAL ARARS AND TBCs(1)
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

ARARS/TBCs	Citation

Notes:

(1) From the CERCLA Compliance With Other Laws Manual Draft Guidance, August 8, 1988 (USEPA).

(2) In authorized States, Federal regulations promulgated under RCRA are not applicable as a State requirement until the State adopts those regulations through its own legislative process, but probably would be relevant and appropriate as a Federal requirement. Federal regulations promulgated pursuant to the Hazardous and Solid Waste Amendments of 1984, however, are effective immediately in all 50 States, and are potentially applicable as Federal Requirements.

(3) 40 CFR Part 264 regulations apply to permitted facilities and may be relevant and appropriate to other facilities.

(4) Only the Subpart F ground-water monitoring requirements under 40 CFR 264 are ARAR. The Subpart F ground-water monitoring requirements under 40 CFR 265 are not ARAR.

(5) Includes the final rule for the listing of dioxin-containing waste

(6) 40 CFR Part 6 Subpart A sets forth EPA policy for carrying out the provisions of Executive Orders 11988 (Floodplains Management) and 11990 (Protection of Wetlands).

(7) May not be applicable or relevant for many sites.

(8) From "A Compilation of Water Quality Goals," F.B. Marshack, February 1991.

Table A-2

POTENTIAL STATE OF HAWAII ARARs AND TBCs
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

Requirement	Citation
<u>ARARs</u>	
Underground Injection Control Act	Hawaii Admin. Rules Title 11-DOH Chapter 23
Hawaii Water Quality Standards (Surface Water)	Hawaii Admin. Rules Title 11-DOH Chapter 54
Air Quality Act	Hawaii Admin. Rules Title 11-DOH Chapter 59
Historical Sites Act	Hawaii Revised Statutes, Organic Laws, Titles 1-5, Chapters 1-42
Hawaii Underground Storage Tanks Act	Hawaii Revised Statutes, Title 19-DOH 342 L
Hawaii Used Oil Act	Hawaii Revised Statutes, Title 19-DOH, Chapter 342N
Hawaii Water Pollution Control Regulations	Hawaii Admin. Rules DOH-Chapter 55
Hawaii Hazardous Waste Management Act	Hawaii Revised Statutes, Title 19-Chapter 342J
Hawaii Coastal Zone Management Law	Hawaii Revised Statutes, Chapter 205A
<u>TBCs</u>	
UST Cleanup Goals	State of Hawaii DOH Solid and Hazardous Waste Branch

During the initial evaluation portion of the RI/FS process for the Red Hill Site, several tasks will be accomplished. The identification of ARARs will be initiated with federal, state and local requirements evaluated to assess potential ARAR status. Other federal and state criteria, advisories, guidance and local ordinances shall also be considered, as necessary. The assistance of the appropriate federal and state agencies will be sought in identification of potential ARARs and in confirming their applicability or relevance and appropriateness. A technical review committee (TRC) will be established in accordance with SARA provisions to communicate information and to provide a channel for evaluating selected remedial processes.

Potential chemical- and location-specific ARARs for the site are appropriate to identify in the scoping phase for the Red Hill Site. Contaminants of concern at the site include waste fuel constituents, polynuclear aromatic hydrocarbons (PNAs), phenols, solvents and metals. Chemical-specific ARARs have been identified for these chemicals and are presented in Table A-3a,b. Additional chemicals will be added to the list if data generated during creates concern for other contaminants. As such, investigation-derived wastes contaminated with these chemicals as well as wastes contaminated with chemicals that are not known in advance will be handled in accordance with identified ARARs. Potential location-specific ARARs have also been identified and are presented as Table A-4. Here again, this preliminary list will be updated based upon the results of each phase of the site characterization process.

Attached are listings of preliminarily identified chemical- and location-specific ARARs relevant to this stage of the investigation.

Beyond the scoping of the RI/FS, these initial tasks can be refined based on generated information. Contaminants of concern, the affected media, potential migration pathways and receptors, and any special physical features will be defined in greater detail after the Site Characterization phase of the RI/FS. Potential action-specific ARARs should be assessed initially after the Site Characterization phase, and identified prior to the feasibility assessment of remedial technologies being considered. A discussion of remedial action ARARs for the Red Hill Oily Waste Disposal Pit site would be most appropriate following site characterization investigations defining and identified with increased certainty as more information regarding the site is developed. The process of identifying ARARs for remedial actions during the remedial investigation may continue through the remedial design phase.

Table A-3a
CHEMICAL SPECIFIC FEDERAL ARARS AND TBCS
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

Compound (1)	ARARS: RCRA Ground-Water Standards: Maximum Concentration Limits (mg/l)	National Drinking Water Standards: Maximum Contaminant Levels (MCLs) Primary (2) (mg/l)	National Drinking Water Standards: Maximum Contaminant Levels (MCLs) Secondary (mg/l)	National Drinking Water Standards: Maximum Contaminant Level Goals (mg/l)	National Water Quality Criteria for the Protection of Human Health: Water and Fish Ingestion (μg/l)	National Water Quality Criteria for the Protection of Human Health: Fish Consumption Only (μg/l)
Inorganics						
Alkalinity	-	-	-	-	-	-
Bicarbonate						
Calcium	-	-	-	-	-	-
Carbonate						
Cation/ Anion Ratio						
Chloride	-	-	250	-	-	-
Conductivity	-	-	-	-	-	-
Copper	-	-	1.0	-	-	-
Fluoride	-	4	2.0	4	-	-
Hardness	-	-	-	-	-	-
Iron	-	-	0.3	-	0.3 mg/l	-
Magnesium	-	-	-	-	-	-
Manganese	-	-	0.05	-	50	100
Nitrates	-	10 (as N)	-	10 (as N)	10 mg/l	-
pH	-	-	6.5 - 8.5	-	-	-
Phosphates						
Potassium	-	-	-	-	-	-
Sodium Sulfates	-	-	250	-	-	-
Surfactants	-	-	-	-	-	-
Total Dissolved Solids	-	-	500	-	-	-
Zinc	-	5.0	5.0	-	-	-
Organics						
Acenaphthene	-	-	-	-	-	-
Acenaphthlene	-	-	-	-	-	-
Acetone	-	-	-	-	-	-
• Aldrin	-	-	-	-	0.074 ng/l (3)	0.079 ng/l (3)
Anthracene	-	-	-	-	-	-
Total Aroclors (PCBs)	-	-	-	-	0.079 ng/l (3)	0.079 ng/l (3)
Aroclor 1016	-	-	-	-	-	-
Aroclor 1221	-	-	-	-	-	-
Aroclor 1232	-	[0.0005]	-	0	-	-
Aroclor 1242	-	[0.0005]	-	0	-	-
Aroclor 1248	-	[0.0005]	-	0	-	-
Aroclor 1254	-	[0.0005]	-	0	-	-
Aroclor 1260	-	[0.0005]	-	0	-	-
• Benzene	-	0.005	-	0	0.86 (3)	40 (3)
Benzo(a)Anthracene	-	-	-	-	-	-

Table A-3a
CHEMICAL SPECIFIC FEDERAL ARARS AND TBCS
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

	ARARS					
	RCRA Ground-Water Standards	National Drinking Water Standards			National Water Quality Criteria for the Protection of Human Health	
		Maximum Contaminant Levels (MCLs)				
Compound (1)	Maximum Concentration Limits (mg/l)	Primary (2) (mg/l)	Secondary (mg/l)	Maximum Contaminant Level Goals (mg/l)	Water and Fish Ingestion (µg/l)	Fish Consumption Only (µg/l)
• Benzo(a)Pyrene	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-	-
Benzo(g,h,i)Perylene	-	-	-	-	-	-
Benzo(k)Fluoanthene	-	-	-	-	-	-
Benzoic Acid	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-
Alpha BHC	-	-	-	-	-	-
Beta BHC	-	-	-	-	-	-
Delta BHC	-	-	-	-	-	-
• Gamma BHC (Lindane)	0.004	[0.0002]	-	0.0002	-	-
BIS (2-Chlorethoxy) Methane	-	-	-	-	-	-
BIS (2-Chloroethyl) Ether	-	-	-	-	0.03 (3)	1.36 (3)
BIS (2-Chloroisopropyl) Ether	-	-	-	-	-	-
BIS (2-Ethylhexyl) Phthalate	-	-	-	-	-	-
Bromomethane	-	-	-	-	-	-
4-Bromophenyl-phenylether	-	-	-	-	-	-
2-Butanone (MEK)	-	-	-	-	-	-
Butylbenzylphthalate	-	-	-	-	-	-
Carbon Disulfide	-	-	-	-	-	-
• Carbon Tetrachloride	-	0.005	-	0	0.4	6.94
• Chlordane	-	[0.002]	-	0	0.46 ng/l (3)	0.48 ng/l (3)
4-Chloro-3-Methylphenol	-	-	-	-	-	-
4-Chloroaniline	-	-	-	-	-	-
Chlorobenzene	-	[0.1]	-	0.1	-	-
Chloroethane	-	-	-	-	-	-
Chloromethane	-	-	-	-	-	-
2-Chloronaphthalene	-	-	-	-	-	-
2-Chlorophenol	-	-	-	-	-	-
4-Chlorophenyl-phenylether	-	-	-	-	-	-
• Chrysene	-	-	-	-	-	-
CIS-1,3-Dichloropropene	-	-	-	-	-	-
O,P'-DDD	-	-	-	-	-	-
P,P'-DDD	-	-	-	-	-	-
P,P'-DDE (O,P)	-	-	-	-	-	-
• P,P'-DDT (O,P)	-	-	-	-	0.024 ng/l (3)	0.024 ng/l (3)
Di-N-Butylphthalate	-	-	-	-	35 mg/l	154 mg/l
Di-N-Octylphthalate	-	-	-	-	-	-
Dibenzo(a,h)Anthracene	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-
1,2-Dichlorobenzene (ortho)	-	[0.6]	-	0.6	-	-

Table A-3a
CHEMICAL SPECIFIC FEDERAL ARARS AND TBCS
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

	ARARS					
	RCRA Ground-Water Standards	National Drinking Water Standards			National Water Quality Criteria for the Protection of Human Health	
		Maximum Contaminant Levels (MCLs)		Maximum Contaminant Level Goals		
Compound (1)	Maximum Concentration Limits (mg/l)	Primary (2) (mg/l)	Secondary (mg/l)	(mg/l)	Water and Fish Ingestion (µg/l)	Fish Consumption Only (µg/l)
1,3-Dichlorobenzene (meta)	-	-	-	-	-	-
1,4-Dichlorobenzene (para)	-	[0.075]	-	0.075	-	-
• 3,3-Dichlorobenzidine	-	-	-	-	-	-
1,1-Dichloroethane	-	-	-	-	-	-
• 1,2-Dichloroethane	-	0.005	-	0	0.94 (3)	243 (3)
1,1-Dichloroethene	-	-	-	-	-	-
2,4-Dichlorophenol	-	-	-	-	3.09 mg/l	-
1,2-Dichloropropane	-	[0.005]	-	0	-	-
• Dieldrin	-	-	-	-	-	-
Diesel	-	-	-	-	-	-
Diethylphthalate	-	-	-	-	350 mg/l	1.8 g/l
Dimethylphthalate	-	-	-	-	313 mg/l	2.9 g/l
2,4-Dimethylphenol	-	-	-	-	-	-
4,6-Dinitro-2-Methylphenol	-	-	-	-	-	-
2,4-Dinitrophenol	-	-	-	-	-	-
2,4-Dinitrotoluene	-	-	-	-	0.11 (3)	9.1 (3)
2,6-Dinitrotoluene	-	-	-	-	-	-
Endosulfan I + II	-	-	-	-	-	-
Endosulfan Sulfate	-	-	-	-	-	-
Endrin	0.0002	0.0002	-	-	1	-
Endrin Aldehyde						
Ethylbenzene	-	[0.7]	-	0.7	1.4 mg/l	3.28 mg/l
Fluoranthene	-	-	-	-	42	54
Fluorene	-	-	-	-	-	-
Gasoline	-	-	-	-	-	-
• Heptachlor	-	[0.0004]	-	0	0.28 ng/l (3)	0.29 ng/l (3)
Heptachlor Epoxide	-	[0.0002]	-	0	-	-
Hexachlorobenzene	-	-	-	-	0.72 ng/l (3)	0.74 ng/l (3)
• Hexachlorobutadiene	-	-	-	-	0.45 (3)	50 (3)
Hexachlorocyclopentadiene	-	-	-	-	206	-
Hexachloroethane	-	-	-	-	1.9	8.74
2-Hexanone (MBK)	-	-	-	-	-	-
Indeno(1,2,3-cd)Pyrene	-	-	-	-	-	-
Isophorone	-	-	-	-	5.2 mg/l	520 mg/l
Meta Xylene	-	-	-	-	-	-
Methoxychlor	0.1	[0.04]	-	0.04	100	-
4-Methyl-2-Pentanone (MIBK)	-	-	-	-	-	-
• Methylene Chloride	-	-	-	-	-	-
2-Methylnaphthalene	-	-	-	-	-	-
2-Methylphenol	-	-	-	-	-	-

Table A-3a
CHEMICAL SPECIFIC FEDERAL ARARS AND TBCS
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

Compound (1)	ARARS					
	RCRA Ground-Water Standards	National Drinking Water Standards			National Water Quality Criteria for the Protection of Human Health	
	Maximum Concentration Limits (mg/l)	Maximum Contaminant Levels (MCLs) Primary (2) (mg/l)	Maximum Contaminant Levels (MCLs) Secondary (mg/l)	Maximum Contaminant Level Goals (mg/l)	Water and Fish Ingestion (µg/l)	Fish Consumption Only (µg/l)
4-Methylphenol	-	-	-	-	-	-
N-Nitroso-Di-N-Dipropylamine	-	-	-	-	-	-
N-Nitrosodiphenylamine	-	-	-	-	4,900 ng/l (3)	16,100 ng/l (3)
Naphthalene	-	-	-	-	-	-
2-Nitroaniline	-	-	-	-	-	-
3-Nitroaniline	-	-	-	-	-	-
4-Nitroaniline	-	-	-	-	-	-
Nitrobenzene	-	-	-	-	19.8 mg/l	-
2-Nitrophenol	-	-	-	-	-	-
4-Nitrophenol	-	-	-	-	-	-
Oil and Grease	-	-	-	-	-	-
Ortho & Para Xylene	-	-	-	-	-	-
Pentachlorophenol	-	-	-	-	1.01 mg/l	-
• Phenanthrene	-	-	-	-	-	-
Phenol	-	-	-	-	3.5 mg/l	-
Pyrene	-	-	-	-	-	-
• Styrene	-	[0.1]	-	0.1	-	-
1,1,2,2-Tetrachloroethane	-	-	-	-	0.017 (3)	10.7 (3)
Tetrachloroethene	-	-	-	-	-	-
Toluene	-	[1.0]	-	1.0	14.3 mg/l	424 mg/l
Total Polynuclear Aromatics (PNAs)	-	-	-	-	-	-
Total Xylenes	-	[10.0]	-	10.0	-	-
Toxaphene	0.005	[0.003]	-	0	0.71 ng/l (3)	0.73 ng/l (3)
Trans-1,3-Dichloropropene	-	-	-	-	-	-
1,2,4-Trichlorobenzene	-	-	-	-	-	-
1,1,1-Trichloroethane	-	0.2	-	0.2	18.4 mg/l	1.03 g/l
• 1,1,2-Trichloroethane	-	-	-	-	0.6	41.8
Trichloroethene	-	-	-	-	-	-
2,4,5-Trichlorophenol	-	-	-	-	2,800	-
2,4,6-Trichlorophenol	-	-	-	-	1.2	3.6
Bromodichloromethane (THM)	-	-	-	-	0.17	10.7
Bromoform (THM)	-	-	-	-	-	-
• Chloroform (THM)	-	-	-	-	0.19	15.7
Dibromochloromethane (THM)	-	-	-	-	-	-
Vinyl Acetate						
• Vinyl Chloride	-	0.002	-	0	2	525

Table A-3a
CHEMICAL SPECIFIC FEDERAL ARARS AND TBCS
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

	ARARs				
	National Ambient Water Quality Criteria for the Protection of Aquatic Life		National Ambient Air Quality Standards (NAAQS)	OSHA	
Compound (1)	Freshwater Acute/Chronic (µg/l)	Marine Acute/Chronic (µg/l)	Primary (ppm)	Permissible Emission Levels (PELs) (mg/m3)	Short-term Exposure Limit (STEL) (mg/m3)
Inorganics					
Alkalinity	- /20,000	-	-	-	-
Bicarbonate					
Calcium	-	-	-	5.0 (CaO)	-
Carbonate					
Cation/ Anion Ratio					
Chloride	19/11	13/7.5	-	1.5	3.0
Conductivity	-	-	-	-	-
Copper	18/12 (6)	2.9/2.9	-	0.1 (fume)/1 (dust)	-
Fluoride	-	-	-	2.5	-
Hardness	-	-	-	-	-
Iron	- /1.000	-	-	10.0 (dust, fume)	-
Magnesium	-	-	-	10.0 (MgO)	-
Manganese	-	-	-	5.0 (at any time)	-
Nitrates	-	-	-	-	-
pH	- /6.5 - 9 pH units	- /6.5 - 8.5 pH units	-	-	-
Phosphates					
Potassium	-	-	-	-	-
Sodium Sulfates	-	-	-	-	-
Surfactants	-	-	-	-	-
Total Dissolved Solids	-	-	-	-	-
Zinc	120/110 (6)	95/86	-	1.0 (ZnCl)/5.0 (ZnO)	2 (ZnCl)/10 (ZnO)
Organics					
Acenaphthene	1,700/520	970/710	-	-	-
Acenaphthlene	-	-	-	-	-
Acetone	-	-	-	1,800	2,400
• Aldrin	3.0/ -	1.3/ -	-	0.25 (skin)	-
Anthracene	-	-	-	-	-
Total Aroclors (PCBs)	2.0/0.014	10/0.03	-	-	-
Aroclor 1016	-	-	-	-	-
Aroclor 1221	-	-	-	-	-
Aroclor 1232	-	-	-	-	-
Aroclor 1242	-	-	-	1.0 (skin)	-
Aroclor 1248	-	-	-	-	-
Aroclor 1254	-	-	-	0.5 (skin)	-
Aroclor 1260	-	-	-	-	-
• Benzene	5,300/ - (5)	5,100/700 (5)	-	1.0 ppm	5 ppm
Benzo(a)Anthracene	-	-	-	-	-

Table A-3a
CHEMICAL SPECIFIC FEDERAL ARARS AND TBCS
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

Compound (1)	ARARs: National Ambient Water Quality Criteria for the Protection of Aquatic Life — Freshwater Acute/Chronic (µg/l)	Marine Acute/Chronic (µg/l)	National Ambient Air Quality Standards (NAAQS) — Primary (ppm)	OSHA — Permissible Emission Levels (PELs) (mg/m3)	Short-term Exposure Limit (STEL) (mg/m3)
• Benzo(a)Pyrene	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-
Benzo(g,h,i)Perylene	-	-	-	-	-
Benzo(k)Fluoanthene	-	-	-	-	-
Benzoic Acid	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-
Alpha BHC	-	-	-	-	-
Beta BHC	-	-	-	-	-
Delta BHC	-	-	-	-	-
• Gamma BHC (Lindane)	-	-	-	0.5 (skin)	-
BIS (2-Chlorethoxy) Methane	-	-	-	-	-
BIS (2-Chloroethyl) Ether	-	-	-	-	-
BIS (2-Chloroisopropyl) Ether	-	-	-	-	-
BIS (2-Ethylhexyl) Phthalate	-	-	-	-	-
Bromomethane	-	-	-	-	-
4-Bromophenyl-phenylether	-	-	-	-	-
2-Butanone (MEK)	-	-	-	590	885
Butylbenzylphthalate	-	-	-	-	-
Carbon Disulfide	-	-	-	12.0 (skin)	36.0 (skin)
• Carbon Tetrachloride	35,200/ - (5)	50,000/ - (5)	-	12.6	-
• Chlordane	2.4/0.0043	0.09/0.004	-	0.5 (skin)	-
4-Chloro-3-Methylphenol	-	-	-	-	-
4-Chloroaniline	-	-	-	-	-
Chlorobenzene	-	-	-	350	-
Chloroethane	-	-	-	-	-
Chloromethane	-	-	-	-	-
2-Chloronaphthalene	-	-	-	-	-
2-Chlorophenol	4,380/2,000 (5)	-	-	-	-
4-Chlorophenyl-phenylether	-	-	-	-	-
• Chrysene	-	-	-	-	-
CIS-1,3-Dichloropropene	-	-	-	-	-
O,P'-DDD	-	-	-	-	-
P,P'-DDD	-	-	-	-	-
P,P'-DDE (O,P)	1,050/ - (3)	14/ - (3)	-	-	-
• P,P'-DDT (O,P)	1.1/0.001	0.13/0.001	-	1.0 (skin)	-
Di-N-Butylphthalate	-	-	-	-	-
Di-N-Octylphthalate	-	-	-	-	-
Dibenzo(a,h)Anthracene	-	-	-	-	-
Dibenzofuran	-	-	-	-	-
1,2-Dichlorobenzene (ortho)	-	-	-	300	-

Table A-3a
CHEMICAL SPECIFIC FEDERAL ARARS AND TBCS
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

	ARARs				
	National Ambient Water Quality Criteria for the Protection of Aquatic Life		National Ambient Air Quality Standards (NAAQS)	OSHA	
Compound (1)	Freshwater Acute/Chronic (µg/l)	Marine Acute/Chronic (µg/l)	Primary (ppm)	Permissible Emission Levels (PELs) (mg/m3)	Short-term Exposure Limit (STEL) (mg/m3)
1,3-Dichlorobenzene (meta)	-	-	-	-	-
1,4-Dichlorobenzene (para)	-	-	-	450	675
• 3,3-Dichlorobenzidine	-	-	-	-	-
1,1-Dichloroethane	-	-	-	400	-
• 1,2-Dichloroethane	118,000/20,000 (5)	113,000/ - (5)	-	-	-
1,1-Dichloroethene	-	-	-	-	-
2,4-Dichlorophenol	2,020/365 (5)	-	-	-	-
1,2-Dichloropropane	-	-	-	-	-
• Dieldrin	-	-	-	0.25 (skin)	-
Diesel	-	-	-	-	-
Diethylphthalate	-	-	-	-	-
Dimethylphthalate	-	-	-	5.0	-
2,4-Dimethylphenol	2,120/ - (5)	-	-	-	-
4,6-Dinitro-2-Methylphenol	-	-	-	0.2 (skin)	-
2,4-Dinitrophenol	-	-	-	-	-
2,4-Dinitrotoluene	-	-	-	-	-
2,6-Dinitrotoluene	-	-	-	-	-
Endosulfan I + II	-	-	-	-	-
Endosulfan Sulfate	-	-	-	-	-
Endrin	0.18/0.0023	0.037/0.0023	-	0.1 (skin)	-
Endrin Aldehyde					
Ethylbenzene	32,000/ -	430/ -	-	435	545
Fluoranthene	3,980 (5)	40/16 (5)	-	-	-
Fluorene	-	-	-	0.2	-
Gasoline	-	-	-	-	-
• Heptachlor	0.52/0.0038	0.053/0.0038	-	0.5 (skin)	-
Heptachlor Epoxide	-	-	-	-	-
Hexachlorobenzene	-	-	-	-	-
• Hexachlorobutadiene	90/9.3 (5)	32/ - (5)	-	-	-
Hexachlorocyclopentadiene	7/5.2 (5)	7/ - (5)	-	-	-
Hexachloroethane	980/540 (5)	940/ - (5)	-	10.0 (skin)	-
2-Hexanone (MBK)	-	-	-	20.0	-
Indeno(1,2,3-cd)Pyrene	-	-	-	-	-
Isophorone	117,000/ - (5)	12,900/ - (5)	-	23.0	-
Meta Xylene	-	-	-	435	-
Methoxychlor	- /0.03	- /0.03	-	10.0	-
4-Methyl-2-Pentanone (MIBK)	-	-	-	-	-
• Methylene Chloride	-	-	-	500 ppm	-
2-Methylnaphthalene	-	-	-	-	-
2-Methylphenol	-	-	-	-	-

Table A-3a
CHEMICAL SPECIFIC FEDERAL ARARS AND TBCS
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

	ARARs				
	National Ambient Water Quality Criteria for the Protection of Aquatic Life		National Ambient Air Quality Standards (NAAQS)	OSHA	
Compound (1)	Freshwater Acute/Chronic (µg/l)	Marine Acute/Chronic (µg/l)	Primary (ppm)	Permissible Emission Levels (PELs) (mg/m3)	Short-term Exposure Limit (STEL) (mg/m3)
4-Methylphenol	-	-	-	-	-
N-Nitroso-Di-N-Dipropylamine	-	-	-	-	-
N-Nitrosodiphenylamine	-	-	-	-	-
Naphthalene	2,300/620 (5)	2,350/ - (5)	-	50.0	75.0
2-Nitroaniline	-	-	-	-	-
3-Nitroaniline	-	-	-	-	-
4-Nitroaniline	-	-	-	3.0 (skin)	-
Nitrobenzene	27,000/ - (5)	6,680/ - (5)	-	5.0 (skin)	-
2-Nitrophenol	-	-	-	-	-
4-Nitrophenol	-	-	-	-	-
Oil and Grease	-	-	-	-	-
Ortho & Para Xylene	-	-	-	435	-
Pentachlorophenol	20/13 (7)	13/7.9 (5)	-	0.5 (skin)	-
Phenanthrene	-	-	-	-	-
Phenol	10,200/2,560 (5)	5,800/ - (5)	-	19.0	-
Pyrene	-	-	-	-	-
• Styrene	-	-	-	215	425
1,1,2,2-Tetrachloroethane	- /2,400 (5)	9,020/ - (5)	-	7.0	-
Tetrachloroethene	-	-	-	-	-
Toluene	17,500/ - (5)	6,300/5,000 (5)	-	375	560
Total Polynuclear Aromatics (PNAs	-	-	-	-	-
Total Xylenes	-	-	-	435	655
Toxaphene	0.73/0.0002	0.21/0.0002	-	0.5 (skin)	1.0
Trans-1,3-Dichloropropene	-	-	-	-	-
1,2,4-Trichlorobenzene	-	-	-	-	-
1,1,1-Trichloroethane	-	31,200/ - (5)	-	-	-
• 1,1,2-Trichloroethane	- /9,400 (5)	-	-	45.0	-
Trichloroethene	-	-	-	-	-
2,4,5-Trichlorophenol	-	-	-	-	-
2,4,6-Trichlorophenol	- /970 (5)	-	-	-	-
Bromodichloromethane (THM)	-	-	-	-	-
Bromoform (THM)	-	-	-	5.0	-
• Chloroform (THM)	28,900/1,240 (5)	-	-	9.78	-
Dibromochloromethane (THM)	-	-	-	-	-
Vinyl Acetate					
• Vinyl Chloride	-	-	-	5 ppm (15 min)	-

Table A-3a
CHEMICAL SPECIFIC FEDERAL ARARS AND TBCS
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

Compound (1)	TBCs: Water: EPA Health Advisories (8,9) (µg/l)	TBCs: Water: NAS S-N-A-R-Ls (9) (µg/l)	TBCs: Air: TLVs: NIOSH TWA (mg/m3)	TBCs: Air: TLVs: NIOSH STEL (mg/m3)	TBCs: Air: TLVs: ACGIH TWA (10,11) (ppm)	TBCs: Air: TLVs: ACGIH STEL (11) (ppm)	TBCs: Air: Immediately Dangerous to Life or Health (IDLH) (mg/m3)	TBCs: Sediments: Low Effects Range Concentration (12) (ppm)
Inorganics								
Alkalinity	-	-	-	-	-	-	-	-
Bicarbonate								
Calcium	-	-	2.0 (as CaO)	-	-	-	-	-
Carbonate								
Cation/ Anion Ratio								
Chloride	[1000]	-	1.5	3.0	0.5	1	30 ppm	-
Conductivity	-	-	-	-	-	-	-	-
Copper	-	-	0.1 (fume)/ 1(dust)	-	-	-	-	70
Fluoride	-	-	2.5	-	2.5 mg/m3	-	500	-
Hardness	-	-	-	-	-	-	-	-
Iron	-	-	5.0 (dust, fume)	-	-	-	-	-
Magnesium	-	-	-	-	-	-	-	-
Manganese	-	-	1	3.0	-	-	3	-
Nitrates	10,000 (10 day)	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-
Phosphates								
Potassium	-	-	-	-	-	-	-	-
Sodium Sulfates	-	-	-	-	-	-	-	-
Surfactants	-	-	-	-	-	-	-	-
Total Dissolved Solids	-	-	-	-	-	-	-	-
Zinc	[4,000]	-	1.0/5.0 (13)	2.0/10.0 (13)	-	-	4,800 (ZnCl)	120
Organics								
Acenaphthene	-	-	-	-	5 mg/m3	-	-	-
Acenaphthlene	-	-	-	-	-	-	-	-
Acetone	-	-	590	-	750	1,000	20,000 ppm	-
• Aldrin	[0.3 (10 day)]	-	0.25 (skin)	-	-	-	100	-
Anthracene	-	-	-	-	-	-	-	-
Total Aroclors (PCBs)	-	-	-	-	-	-	-	50 ppb
Aroclor 1016	100 (10 day)	700	-	-	-	-	-	-
Aroclor 1221	100 (10 day)	700	-	-	-	-	-	-
Aroclor 1232	100 (10 day)	700	-	-	-	-	-	-
Aroclor 1242	100 (10 day)	700	0.001	-	-	-	10	-
Aroclor 1248	100 (10 day)	700	-	-	-	-	-	-
Aroclor 1254	100 (10 day)	700	0.001	-	-	-	5	-
Aroclor 1260	100 (10 day)	700	-	-	-	-	-	-
• Benzene	200 (10 day)	-	0.1 ppm	1.0 ppm	[10]	-	3,000 ppm	-
Benzo(a)Anthracene	-	-	-	-	-	-	-	-

Table A-3a
CHEMICAL SPECIFIC FEDERAL ARARS AND TBCS
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

	TBCs							TBCs
	Water		Air					Sediments
			Threshold Limit Values (TLVs)				Immediately	Low Effects
	EPA Health	NAS	NIOSH		ACGIH		Dangerous to Life	Range
Compound (1)	Advisories (8,9)	S-N-A-R-Ls (9)	TWA	STEL	TWA (10,11)	STEL (11)	or Health (IDLH)	Concentration (12)
	(µg/l)	(µg/l)	(mg/m3)	(mg/m3)	(ppm)	(ppm)	(mg/m3)	(ppm)
• Benzo(a)Pyrene	-	-	-	-	-	-	-	-
Benzo(b)Fluoranthene	-	-	-	-	-	-	-	-
Benzo(g,h,i)Perylene	-	-	-	-	-	-	-	-
Benzo(k)Fluoanthene	-	-	-	-	-	-	-	-
Benzoic Acid	-	-	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-	-	-
Alpha BHC	-	500 (7 day) (16)	-	-	-	-	-	-
Beta BHC	-	500 (7 day) (16)	-	-	-	-	-	-
Delta BHC	-	500 (7 day) (16)	-	-	-	-	-	-
• Gamma BHC (Lindane)	-	500 (7 day) (16)	0.5	-	0.5 mg/m3 (skin)	-	1,000	-
BIS (2-Chlorethoxy) Methane	-	-	-	-	-	-	-	-
BIS (2-Chloroethyl) Ether	-	-	-	-	-	-	-	-
BIS (2-Chloroisopropyl) Ether	300	-	-	-	-	-	-	-
BIS (2-Ethylhexyl) Phthalate	-	-	-	-	-	-	-	-
Bromomethane	10	-	-	-	-	-	-	-
4-Bromophenyl-phenylether	-	-	-	-	-	-	-	-
2-Butanone (MEK)	200	-	590	885	200 C	300 C	3,000 ppm	-
Butylbenzylphthalate	-	-	-	-	-	-	-	-
Carbon Disulfide	-	-	3.0 (skin)	30.0 (skin)	10 (skin)	-	500 ppm	-
• Carbon Tetrachloride	70/300 (7 yr)	200 (7 day)	-	12.6 (60 min)	5 (skin)	-	300 ppm	-
• Chlordane	60 (10 day)	-	0.5 (skin)	-	0.5 mg/m3 (skin)	-	500	0.5 ppb
4-Chloro-3-Methylphenol	-	-	-	-	-	-	-	-
4-Chloroaniline	-	-	-	-	-	-	-	-
Chlorobenzene	100	-	-	-	[75]	-	2,400 ppm	-
Chloroethane	-	-	-	-	-	-	-	-
Chloromethane	[3]	-	-	-	-	-	-	-
2-Chloronaphthalene	-	-	-	-	-	-	-	-
2-Chlorophenol	[40]	-	-	-	-	-	-	-
4-Chlorophenyl-phenylether	-	-	-	-	-	-	-	-
• Chrysene	-	-	-	-	-	-	-	-
CIS-1,3-Dichloropropene	30 (10 day)	-	-	-	-	-	-	-
O,P'-DDD	-	-	-	-	-	-	-	-
P,P'-DDD	-	-	-	-	-	-	-	-
P,P'-DDE (O,P)	-	-	-	-	-	-	-	-
• P,P'-DDT (O,P)	-	-	0.5	-	1 mg/m3	-	-	3 ppb
Di-N-Butylphthalate	-	770	-	-	5 mg/m3	-	-	-
Di-N-Octylphthalate	-	-	-	-	-	-	-	-
Dibenzo(a,h)Anthracene	-	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene (ortho)	600	300 (15)	300	-	-	-	1,000 ppm	-

Table A-3a
CHEMICAL SPECIFIC FEDERAL ARARS AND TBCS
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

Compound (1)	TBCs – Water: EPA Health Advisories (8,9) (µg/l)	TBCs – Water: NAS S-N-A-R-Ls (9) (µg/l)	TBCs – Air: Threshold Limit Values (TLVs), NIOSH TWA (mg/m3)	NIOSH STEL (mg/m3)	ACGIH TWA (10,11) (ppm)	ACGIH STEL (11) (ppm)	Immediately Dangerous to Life or Health (IDLH) (mg/m3)	TBCs – Sediments: Low Effects Range Concentration (12) (ppm)
1,3-Dichlorobenzene (meta)	600	-	-	-	-	-	-	-
1,4-Dichlorobenzene (para)	75	94 (15)	-	-	-	-	1,000 ppm	-
• 3,3-Dichlorobenzidine	-	-	-	-	-	-	-	-
1,1-Dichloroethane	-	-	400	-	-	-	4,000 ppm	-
• 1,2-Dichloroethane	700 (10 day)	-	-	-	10	-	-	-
1,1-Dichloroethene	-	-	-	-	-	-	-	-
2,4-Dichlorophenol	[20]	2,000/7,000	-	-	-	-	-	-
1,2-Dichloropropane	-	-	-	-	75	110	-	-
• Dieldrin	0.5 (10 day)	-	0.25 (skin)	-	0.25 mg/m3 (skin)	-	450	-
Diesel	100 (10 day)	-	-	-	-	-	-	-
Diethylphthalate	-	-	-	-	-	-	-	-
Dimethylphthalate	-	-	5.0	-	5 mg/m3	-	9300	-
2,4-Dimethylphenol	-	-	-	-	-	-	-	-
4,6-Dinitro-2-Methylphenol	-	-	0.2 (skin)	-	-	-	-	-
2,4-Dinitrophenol	-	-	-	-	-	-	-	-
2,4-Dinitrotoluene	-	-	-	-	-	-	-	-
2,6-Dinitrotoluene	-	-	-	-	-	-	-	-
Endosulfan I + II	-	-	-	-	0.1 mg/m3 (skin)	-	-	-
Endosulfan Sulfate	74 (17)	-	-	-	-	-	-	-
Endrin	2	-	0.1 (skin)	-	0.1 mg/m3 (skin)	-	2,000	-
Endrin Aldehyde								
Ethylbenzene	700	-	435	545	100	125	2,000 ppm	-
Fluoranthene	-	-	-	-	-	-	-	-
Fluorene	-	-	0.2	-	-	-	25 ppm	-
Gasoline	-	-	-	-	300	500	-	-
• Heptachlor	5 (7 yr)	-	0.5 (skin)	-	[0.5 mg/m3 (skin)]	-	700	-
Heptachlor Epoxide	0.1 (7 yr)	-	-	-	-	-	-	-
Hexachlorobenzene	50 (10 day)	30 (7 day)	-	-	-	-	-	-
• Hexachlorobutadiene	1	-	-	-	0.02 (skin)	-	-	-
Hexachlorocyclopentadiene	-	-	-	-	0.1	-	-	-
Hexachloroethane	[1]	-	10.0 (skin)	-	[1]	-	300 ppm	-
2-Hexanone (MBK)	-	-	4.0	-	5 (skin)	-	5,000 ppm	-
Indeno(1,2,3-cd)Pyrene	-	-	-	-	-	-	-	-
Isophorone	[100]	-	23.0	-	5 C	-	800 ppm	-
Meta Xylene	10,000	-	435	655	-	-	1,000 ppm	-
Methoxychlor	400	700	-	-	10 mg/m3	-	-	-
4-Methyl-2-Pentanone (MIBK)	-	-	-	-	-	-	-	-
• Methylene Chloride	-	-	lowest feasible	-	50	-	5,000 ppm	-
2-Methylnaphthalene	-	-	-	-	-	-	-	-
2-Methylphenol	-	-	-	-	-	-	-	-

Table A-3a
CHEMICAL SPECIFIC FEDERAL ARARS AND TBCS
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

Compound (1)	TBCs — Water: EPA Health Advisories (8,9) (µg/l)	TBCs — Water: NAS S-N-A-R-Ls (9) (µg/l)	TBCs — Air: Threshold Limit Values (TLVs) — NIOSH TWA (mg/m3)	NIOSH STEL (mg/m3)	ACGIH TWA (10,11) (ppm)	ACGIH STEL (11) (ppm)	Immediately Dangerous to Life or Health (IDLH) (mg/m3)	TBCs — Sediments: Low Effects Range Concentration (12) (ppm)
4-Methylphenol	-	-	-	-	-	-	-	-
N-Nitroso-Di-N-Dipropylamine	-	-	-	-	-	-	-	-
N-Nitrosodiphenylamine	-	-	-	-	-	-	-	-
Naphthalene	[20]	-	50.0	75.0	10	15	500 ppm	-
2-Nitroaniline	-	-	-	-	3 mg/m3 (skin)	-	-	-
3-Nitroaniline	-	-	-	-	-	-	-	-
4-Nitroaniline	-	-	3.0 (skin)	-	-	-	300	-
Nitrobenzene	-	5 (7 day)	5.0 (skin)	-	1 (skin)	-	200 ppm	-
2-Nitrophenol	-	290 (7 day) (14)	-	-	-	-	-	-
4-Nitrophenol	60	290 (7 day) (14)	-	-	-	-	-	-
Oil and Grease	-	-	-	-	-	-	-	-
Ortho & Para Xylene	10,000	-	435	655	-	-	1000 ppm	-
Pentachlorophenol	300 (10 day)	6/21	0.5 (skin)	-	0.5 mg/m3	-	150	-
Phenanthrene	-	-	-	-	-	-	-	-
Phenol	[4,000]	-	19.0 (skin)	-	5 (skin)	-	250 ppm	-
Pyrene	-	-	-	-	-	-	-	-
• Styrene	100	931	215	425	50	100	2000 ppm	-
1,1,2,2-Tetrachloroethane	-	-	7.0 (skin)	-	1 (skin)	-	150 ppm	-
Tetrachloroethene	-	-	-	-	-	-	-	-
Toluene	1,000	340	375	560	100	150	2,000 ppm	-
Total Polynuclear Aromatics (PNAs	200	-	-	-	-	-	-	4,000 ppb
Total Xylenes	10,000	-	435	655	-	-	1,000 ppm	-
Toxaphene	40 (10 day)	8.75	-	-	0.5 mg/m3 (skin)	-	200	-
Trans-1,3-Dichloropropene	30 (10 day)	-	-	-	-	-	-	-
1,2,4-Trichlorobenzene	9	-	-	-	5 C	-	-	-
1,1,1-Trichloroethane	200	3,800	-	-	-	-	-	-
• 1,1,2-Trichloroethane	3	-	45.0 (skin)	-	10 (skin)	-	500 ppm	-
Trichloroethene	-	-	-	-	-	-	-	-
2,4,5-Trichlorophenol	-	-	-	-	-	-	-	-
2,4,6-Trichlorophenol	-	2,500 (7 day)	-	-	-	-	-	-
Bromodichloromethane (THM)	[400/1,300 (7 yr)]	-	-	-	-	-	-	-
Bromoform (THM)	[2,000 (10 day)]	-	5.0 (skin)	-	0.5 (skin)	-	-	-
• Chloroform (THM)	[100/500 (7 yr)]	-	-	9.78 (60 min)	10	-	1,000 ppm	-
Dibromochloromethane (THM)	[20]	18,000 (24 hr)	-	-	-	-	-	-
Vinyl Acetate								
• Vinyl Chloride	10/50 (7 yr)	-	lowest detectable	-	5	-	-	-

Table A-3a
CHEMICAL SPECIFIC FEDERAL ARARS AND TBCS
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

	TBCs							TBCs
	Water		Air					Sediments
			Threshold Limit Values (TLVs)				Immediately Dangerous to Life or Health (IDLH) (mg/m3)	Low Effects Range Concentration (12) (ppm)
			NIOSH		ACGIH			
Compound (1)	EPA Health Advisories (8,9) (μg/l)	NAS S-N-A-R-Ls (9) (μg/l)	TWA (mg/m3)	STEL (mg/m3)	TWA (10,11) (ppm)	STEL (11) (ppm)		

Notes:
(1) Compounds which are suspected or confirmed human carcinogens are marked with "•".
(2) MCLs effective 7/30/92 are provided in brackets.
(3) Human health criteria for carcinogens reported for three risk levels; value presented is the 1 E-6 risk level.
(4) Value reported is in units of bacterial density/100 milliliters (ml) for enterococci.
(5) Insufficient data to develop criteria; value presented is Lowest Observed Effect Level (LOEL).
(6) Hardness dependent criteria - 100 milligrams per liter (mg/l) used.
(7) pH dependent criteria.
(8) Tentative values are presented in brackets.
(9) Values calculated for child and adult are presented as: child value/adult value.
(10) Adopted values (for which changes are proposed) are presented in brackets.
(11) Ceiling limits are labeled with "C".
(12) From the National Oceanographic and Atmospheric Administration (NOAA) National Status and Trends Program, sediment effects data. Values represent the lower 10 percentile in effects-based NOAA data.
(13) Value reported for ZnCl/ZnO.
(14) Value presented is for total mononitrophenols.
(15) Value presented is from 1983 SNARLs; value to be reviewed in future.
(16) Value is sum of all BHC isomers.

Table A-3b

CHEMICAL-SPECIFIC STATE OF HAWAII TBCs RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

Constituent	Cleanup Goal	Cleanup Goal
TBCs	SOIL (mg/kg)	GROUND WATER (mg/l)
TPH as Gasoline	50.0	10.0
TPH as Diesel	50.0	10.0
TPH as Oil and Grease	50.0	10.0
Benzene	0.05	0.005
Ethylbenzene	7.0	0.7
Toluene	20.0	2.0
Total Xylenes	100.0	10.0
Organic Lead	ND	ND
Total Lead	0.5	0.05
Cadmium	0.1	0.01
Chromium	0.5	0.05

ND: Non-Detect

Note: If other constituents are present the water cleanup goal is the existing or proposed maximum contaminant level (MCL) for that constituent, and the soil cleanup goal is ten times the existing or proposed MCL.

Reference: State of Hawaii Department of Health, Solid and Hazardous Waste Branch Underground Storage Tank Cleanup Goals (2/6/91).

Table A-4

POTENTIAL LOCATION-SPECIFIC FEDERAL ARARs
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

Site/Investigation Characteristic Affected by ARAR	Requirements	Prerequisites for Applicability	ARAR Citation
Within area where action may cause irreparable harm, loss, or destruction of significant artifacts	Action to recover and preserve artifacts	Alteration of terrain that threatens significant scientific, prehistorical, historical, or archaeological data	National Historic Preservation Act (16 USC Section 469) 36 CFR Part 65
Critical habitat upon which endangered species or threatened species depends	Action to conserve endangered species or threatened species, including consultation with the Department of the Interior	Determination of the presence of endangered or threatened species,	Endangered Species Act of 1973 (16 USC 1531 et seq.); 50 CFR Part 200, 50 CFR Part 402 Fish and Wildlife Coordination Act (16 USC 661 et seq.); 33 CFR Parts 320-330
Underground storage tank installation, operation, and maintenance	Requires that when a leak is found, the substance in tank to be emptied if emptying the substance does not constitute a greater environmental or health danger; requires proper repair and testing of tank before return to service, requires restoration of environment to a condition and quality acceptable to DOH, requires public participation activities	Covers any underground storage tanks or combination of tanks and piping in use or brought into use on or after May 19, 1986, which are used for the storage, use or dispensing of regulated substances,. and the volume of which is ten per cent or more beneath the ground	Hawaii Underground Storage Tanks Act, Hawaii Revised Statutes, Title 19 DOH Chapter 342L

Table A-4 (Continued)

POTENTIAL LOCATION-SPECIFIC FEDERAL ARARs
RED HILL OILY WASTE DISPOSAL PIT SITE, HAWAII

Site/Investigation Characteristic Affected by ARAR	Requirements	Prerequisites for Applicability	ARAR Citation
NAAQS Attainment Areas	New major stationary sources shall apply best available control technology for each pollutant, subject to regulation under the Act, that the source would have potential to emit in significant amounts.	Major stationary sources as identified in 40 CFR section 52.21(b)(1)(i)(a) that emits, or has the potential to emit, 100 tons per year or more of any regulated pollutant; any other stationary source that emits, or has the potential to emit, 250 tons per year or more of any regulated pollutant.	40 CFR section 52.21(j) (CAA)
	Owner or operator of proposed source or modification shall demonstrate that allowable emissions increases or reductions (including secondary emissions) will not cause or contribute to a violation of the NAAQS or applicable maximum allowable increase over baseline concentrations.		
Coastal zone or an area that will affect the coastal zone	Federal activities must be consistent with, to the maximum extent practicable, State coastal zone management programs.	Wetland, flood plain, estuary, beach, dune, barrier island, coral reef, and fish and wildlife and their habitat, within the coastal zone.	Coastal Zone Management Act (CZMA) 15 CFR section 930.30
	Federal agencies must supply the State with consistency determination.		15 CFR section 930.34 (CZMA)

APPENDIX B

BORING LOGS AND CONSTRUCTION DIAGRAMS OF WELLS IN THE SITE VICINITY

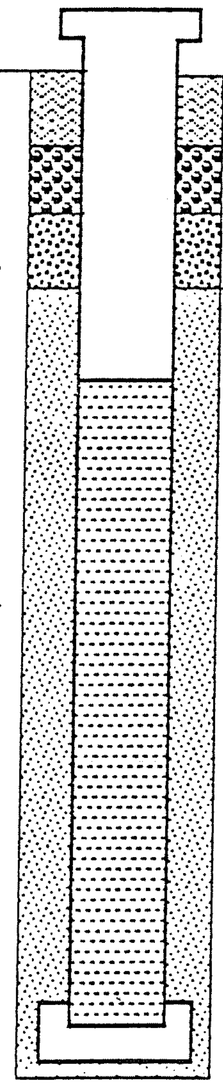
AS BUILT DRAWING OF

GROUNDWATER MONITORING/RECOVERY WELL

Well Number 8067-002

8854-03M

Elevation top of casing ____ ft.



Ground Elevation ____ ft.

CEMENT 0.5 ft.

BENTONITE 2.5 ft.

GRAVEL 3.5 ft.

Hole Diameter 8 in.

SAND 24.5 ft.

END CAP:
Material PVC

SOLID CASING:
- Material PVC
- Length 9.33 ft.
- Diameter 4 in.
- Wall Thick. 0.237 in.

CASING: ☐ Perforated ☒ Screen
- Material PVC
- Length 20 ft.
- Diameter 4 in.
- Wall Thick. 0.237 in.
- Openings 0.02 in.

OPEN HOLE:
- Length 1 ft.
- Diameter 8 in.

Total Depth 31 ft.

DESCRIPTION

Date of report 10-27-88 Person filing report [illegible]

A. OWNER Dept. of Correction WELL NAME 8067-002

B. GENERAL LOCATION Halawa Valley (Halawa Correctional Facility) ISLAND [illegible]

C. DRILLING COMPANY PR Drilling

D. TYPE OF RIG Mobil B40L DRILLING COMPLETED Oct. 1988 (month year) DRILLER Sam Lealaimatafao

E. ELEVATION, msl: Top of drilling platform ______ ft. Bench mark and method used to determine
Height of drilling platform above ground surface ______ ft. elevation: ______

F. HOLE SIZE: 8 inch dia. to 30.0 ft. below drilling platform.
______ inch dia. to ______ ft. below drilling platform.
______ inch dia. to ______ ft. below drilling platform.

G. CASING INSTALLED: 4 in. I.D. x .237 in. wall solid section to TD ft. below drilling platform.
______ in. I.D. x ______ in. wall perforated section to ______ ft. below drilling platform.
Type of perforation 0.02 in. factory slotted PVC

H. ANNULUS: Grouted 0 ft. to 3.0 ft. below drilling platform.
Gravel packed 3.0 ft. to 20.0 ft. below drilling platform.

I. PERMANENT PUMP INSTALLATION:
- Pump type, make, serial no. ______ Capacity ______ g.p.m.
- Motor type, H.P., voltage, r.p.m. ______
- Depth of pump intake setting ______ ft. below ______ which elevation is ______ ft.
- Depth of bottom of airline ______ ft. below ______ which elevation is ______ ft.

HYDROLOGY

J. INITIAL WATER LEVEL 18.3" ft. below drilling platform. Date of measurement ______

K. INITIAL CHLORIDE: ______ ppm, total depth of well ______ ft. below drilling platform ______ Sampling Date

L. PUMPING TESTS: Reference point (R.P.) used: ______ which elevation is ______ ft.

Date					Date				
Start water level ______ ft. below R. P.					Start water level ______ ft. below R. P.				
End water level ______ ft. below R. P.					End water level ______ ft. below R. P.				
Depth of well ______ ft. below R. P.					Depth of well ______ ft. below R. P.				
Elapsed Time (hours)	Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp. °F	Elapsed Time (hours)	Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp. °F
to					to				
to					to				
to					to				
to					to				
to					to				
to					to				

SUBSURFACE FORMATION

M. DRILLER'S LOG:

Depth, ft.	Rock Description & Remarks	Water Level ft.	Depth, ft.	Rock Description & Remarks	Water Level ft.
0 to 4.0	Coarse Bas. Gravel Fill		to		
4.0 to 7.5	Sdy Clay w/ sm. Gravel		to		
7.5 to 16.0	Clay w/50% Bas. Bould.		to		
16.0 to 17.1	F. Sand-C. Gravel		to		
17.1 to 21.0	Gravelly Clay w/ Bas.	18.3"	to		
21.0 to 30.0	Clay & Mud		to		
to			to		
to			to		
to			to		
to			to		
to			to		
to			to		

N. REMARKS: ______

FOR DRILLER'S USE

INSTRUCTIONS: Send three(3) copies to: Manager-Chief Engineer, Divisio...

FOR OFFICIAL USE

AS BUILT DRAWING OF

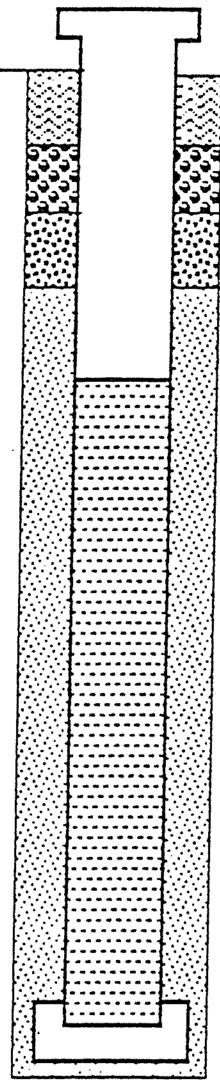
GROUNDWATER MONITORING/RECOVERY WELL

Well Number 8067-001

7754-02M

Elevation top of casing ___ ft.

Ground Elevation ______ ft.



CEMENT 2.0 ft.

BENTONITE 1.0 ft.

GRAVEL 17.0 ft.

Hole Diameter 8 in.

SAND 26.0 ft.

END CAP:
Material PVC

SOLID CASING:
Material PVC
Length 23.0 ft.
Diameter 4 in.
Wall Thick. 0.237 in.

CASING: ☐ Perforated ☒ Screen
Material PVC
Length 22.0 ft.
Diameter 4 in.
Wall Thick. 0.237 in.
Openings 0.02 in.

OPEN HOLE:
Length 1.0 ft.
Diameter 8 in.

Total Depth 46 ft.

DRILLER'S REPORT

DESCRIPTION

Date of report 10-27-88 Person filing report Unitek Environmental Inc.

A. OWNER Dept. of Corrections WELL NAME 8067-001 ISLAND Oahu

B. GENERAL LOCATION Halawa Valley (Halawa Correctional Facility)

C. DRILLING COMPANY PR Drilling

D. TYPE OF RIG Mobil B40L DRILLING COMPLETED Oct. 1988 (month, year) DRILLER Sam Lealaimatatao

E. ELEVATION, msl: Top of drilling platform .... ft. Bench mark and method used to determine
Height of drilling platform above ground surface .... ft. elevation: ....

F. HOLE SIZE: 8 inch dia. to 45.5 ft. below drilling platform.
.... inch dia. to .... ft. below drilling platform.
.... inch dia. to .... ft. below drilling platform.

G. CASING INSTALLED: 4 in. I.D. x .237 in. wall solid section to TD ft. below drilling platform.
.... in. I.D. x .... in. wall perforated section to .... ft. below drilling platform.
Type of perforation 0.02 in. factory slotted PVC

H. ANNULUS: Grouted 0 ft. to 3.0 ft. below drilling platform.
Gravel packed 3.0 ft. to 6.5 ft. below drilling platform.

I. PERMANENT PUMP INSTALLATION:
Pump type, make, serial no. .... Capacity .... g.p.m.
Motor type, H.P., voltage, r.p.m. ....
Depth of pump intake setting .... ft. below .... which elevation is .... ft.
Depth of bottom of airline .... ft. below .... which elevation is .... ft.

HYDROLOGY

J. INITIAL WATER LEVEL 30'4" ft. below drilling platform. Date of measurement ....

K. INITIAL CHLORIDE: .... ppm, total depth of well .... ft. below drilling platform .... Sampling Date

L. PUMPING TESTS: Reference point (R.P.) used: .... which elevation is .... ft.

Date ....
Start water level .... ft. below R. P.
End water level .... ft. below R. P.
Depth of well .... ft. below R. P.

Elapsed Time (hours)	Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp. °F
to				
to				
to				
to				
to				
to				

Date ....
Start water level .... ft. below R. P.
End water level .... ft. below R. P.
Depth of well .... ft. below R. P.

Elapsed Time (hours)	Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp. °F
to				
to				
to				
to				
to				
to				

SUBSURFACE FORMATION

M. DRILLER'S LOG:

Depth, ft.	Rock Description & Remarks	Water Level ft.
0 to 3.0	Coarse Basalt Grav. Fill	
3.0 to 6.0	V. Plastic Clay	
6.0 to 14.5	Lg. Bas. Bould. w/sd.	
14.5 to 45.0	clay & mud	30'4"
to		
to		
to		
to		
to		
to		
to		

Depth, ft.	Rock Description & Remarks	Water Level ft.
to		
to		
to		
to		
to		
to		
to		
to		
to		
to		
to		

N. REMARKS: ....

FOR DRILLER'S USE

INSTRUCTIONS: Send three(3) copies to: Manager-Chief Engineer, Division of Water and Land Development, P. O. Box 373, Honolulu, Hawaii 96809.

FOR OFFICIAL USE

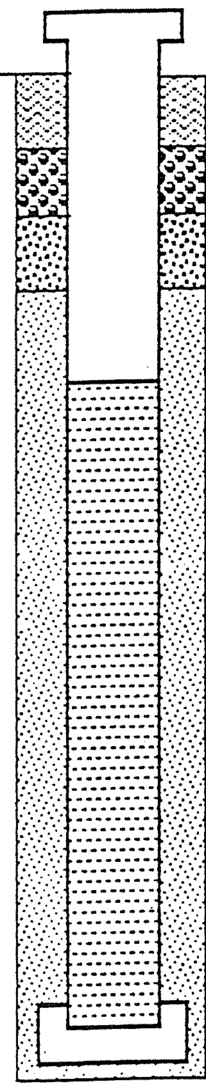
AS BUILT DRAWING OF

GROUNDWATER MONITORING/RECOVERY WELL

Well Number 8067-000
2254-01M

Elevation top of casing ____ ft.

Ground Elevation ____ ft.



CEMENT 1.5 ft.

BENTONITE 2.0 ft.

GRAVEL 3.5 ft.

Hole Diameter 8 in.

SAND 19.0 ft.

END CAP:
Material PVC

SOLID CASING:
- Material PVC
- Length 10 ft.
- Diameter 4 in.
- Wall Thick. 0.237 in.

CASING: ☐ Perforated ☒ Screen
- Material PVC
- Length 15 ft.
- Diameter 4 in.
- Wall Thick. 0.237 in.
- Openings 0.02 in.

OPEN HOLE:
- Length 1.0 ft.
- Diameter 8.0 in.

Total Depth 26 ft.

DRILLER'S REPORT

DESCRIPTION

Date of report 10-27-1988 Person filing report Unitek Environmental Inc.

A. OWNER Dept. of Corrections WELL NAME 8067-000 ISLAND Oahu

B. GENERAL LOCATION Halawa Valley (Halawa Correctional Facility)

C. DRILLING COMPANY PR Drilling

D. TYPE OF RIG Mobil B40L DRILLING COMPLETED Oct. 1988 (month year) DRILLER Sam Lealaimatatao

E. ELEVATION, msl: Top of drilling platform .... ft. Bench mark and method used to determine
Height of drilling platform above ground surface .... ft. elevation: ....

F. HOLE SIZE: 8 inch dia. to 26.5 ft. below drilling platform.
.... inch dia. to .... ft. below drilling platform.
.... inch dia. to .... ft. below drilling platform.

G. CASING INSTALLED: 4 in. I.D. x sched. in. wall solid section to .... ft. below drilling platform.
.... in. I.D. x 40PVC in. wall perforated section to .... ft. below drilling platform.
Type of perforation 0.02in. factory slotted PVC

H. ANNULUS: Grouted 0 ft. to 3.5 ft. below drilling platform.
Gravel packed 3.5 ft. to 7.0 ft. below drilling platform.

I. PERMANENT PUMP INSTALLATION:
Pump type, make, serial no. .... Capacity .... g.p.m.
Motor type, H.P., voltage, r.p.m. ....
Depth of pump intake setting .... ft. below .... which elevation is .... ft.
Depth of bottom of airline .... ft. below .... which elevation is .... ft.

HYDROLOGY

J. INITIAL WATER LEVEL 6'3.5" ft. below drilling platform. Date of measurement ....

K. INITIAL CHLORIDE: .... ppm, total depth of well .... ft. below drilling platform .... Sampling Date

L. PUMPING TESTS: Reference point (R.P.) used: .... which elevation is .... ft.

Date		Date	
Start water level	ft. below R. P.	Start water level	ft. below R. P.
End water level	ft. below R. P.	End water level	ft. below R. P.
Depth of well	ft. below R. P.	Depth of well	ft. below R. P.

Elapsed Time (hours)	Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp. °F	Elapsed Time (hours)	Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp. °F
to					to				
to					to				
to					to				
to					to				
to					to				
to					to				

SUBSURFACE FORMATION

M. DRILLER'S LOG:

Depth, ft.	Rock Description & Remarks	Water Level ft.	Depth, ft.	Rock Description & Remarks	Water Level ft.
0 to 2.5	Highly Org. Top Soil		to		
2.5 to 5.0	Gravelly clay, basalt cobbles		to		
5.0 to 10.0	a.a. w/50% lg. basalt cobbles		to		
10.0 to 26.5	interbedded clay, sdy gravel		to		
to			to		
to			to		
to			to		
to			to		
to			to		
to			to		
to			to		

N. REMARKS: ....

FOR DRILLER'S USE

INSTRUCTIONS: Send three(3) copies to: Manager-Chief Engineer, Division of Water and Land Development, P. O. Box 373, Honolulu, Hawaii 96809.

FOR OFFICIAL USE

AS BUILT DRAWING OF

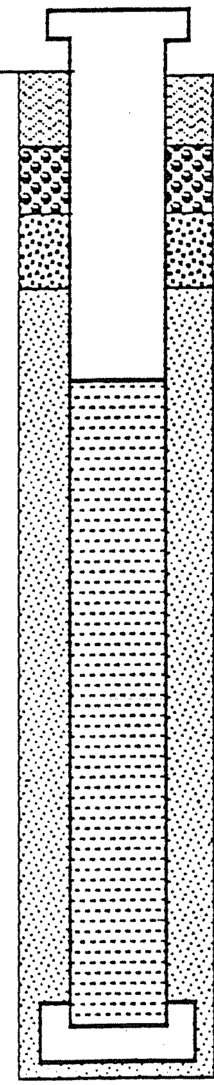
GROUNDWATER MONITORING/RECOVERY WELL

Well Number 8067-005

7753-01M

Elevation top of casing ____ ft.

Ground Elevation ____



CEMENT 1.0 ft.

BENTONITE 1.0 ft.

GRAVEL 6.0 ft.

Hole Diameter 8 in.

SAND 23.0 ft.

END CAP:
Material PVC

Total Depth 31.0 ft.

SOLID CASING:
- Material PVC
- Length 10
- Diameter 4
- Wall Thick. 0.237

CASING: ☐ Perforated ☒
- Material PVC
- Length 20
- Diameter 4
- Wall Thick. 0.237
- Openings 0.02

OPEN HOLE:
- Length 1.0
- Diameter 8

DOWALD Form 71(1)

[redacted]S

DIVISION OF WATER AND LAND DEVELOPMENT

DRILLER'S REPORT

DESCRIPTION

Date of report 10-27-88 Person filing report Unitek Environmental Inc.

A. OWNER Dept. of Corrections WELL NAME 8067-005 ISLAND Oahu

B. GENERAL LOCATION Halawa Valley (Halawa Correctional Facility)

C. DRILLING COMPANY PR Drilling DRILLER Sam Lealaimatafao

D. TYPE OF RIG Mobil B40L DRILLING COMPLETED Oct. 1988 (month, year)

E. ELEVATION, msl: Top of drilling platform ______ ft. Bench mark and method used to determine elevation: ______
Height of drilling platform above ground surface ______ ft.

F. HOLE SIZE: 8 inch dia. to 30.0 ft. below drilling platform.
______ inch dia. to ______ ft. below drilling platform.
______ inch dia. to ______ ft. below drilling platform.

G. CASING INSTALLED: 4 in. I.D. x .237 in. wall solid section to TD ft. below drilling platform.
______ in. I.D. x ______ in. wall perforated section to ______ ft. below drilling platform.
Type of perforation 0.02 in. factory slotted PVC

H. ANNULUS: Grouted 0 ft. to 2.0 ft. below drilling platform.
Gravel packed 2.0 ft. to 8.0 ft. below drilling platform.

I. PERMANENT PUMP INSTALLATION: ______ Capacity ______ g.p.m.
Pump type, make, serial no. ______
Motor type, H.P., voltage, r.p.m. ______ which elevation is ______ ft
Depth of pump intake setting ______ ft. below ______ which elevation is ______ ft
Depth of bottom of airline ______ ft. below ______

HYDROLOGY

J. INITIAL WATER LEVEL 20'1" ft. below drilling platform. Date of measurement ______

K. INITIAL CHLORIDE: ______ ppm, total depth of well ______ ft. below drilling platform ______ Sampling Date

Reference point (R.P.) used: ______ which elevation is ______ ft

L. PUMPING TESTS:

Date					
Start water level	ft. below R. P.				
End water level	ft. below R. P.				
Depth of well	ft. below R. P.				
Elapsed Time (hours)		Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp. °F
to					
to					
to					
to					
to					
to					

Date					
Start water level	ft. below R. P.				
End water level	ft. below R. P.				
Depth of well					
Elapsed Time (hours)		Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp °F
to					
to					
to					
to					
to					
to					

SUBSURFACE FORMATION

M. DRILLER'S LOG:

Depth, ft.		Rock Description & Remarks	Water Level ft.
0	to 3.3	Org. Top Soil	
3.3	to 7.5	clay w/ 50% bas. bould.	
7.5	to 30.0	clay w/ 10% bas. frag.	20'1"
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		

Depth, ft.		Rock Description & Remarks	Water Level ft.
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		
	to		

[signature]

N. REMARKS: ______

FOR DRILLER'S USE

INSTRUCTIONS: Send three(3) copies to: Manager-Chief Engineer, Division of Water and Land Development, P. O. Box 373, Honolulu, Hawaii 96809.
REFERENCES: Chapter 178, entitled "Artesian Wells, Generally," HRS, as ... Board of Water Supply "Rules and

FOR OFFICIAL
Latitude 21° 22
Longitude 157° 5