FINAL DRAFT

FOCUSED FEASIBILITY STUDY TANAPAG VILLAGE, SAIPAN

JUNE 14, 2001

Remediation of Polychlorinated Biphenyl (Aroclor 1254) Contamination
Tanapag Village, Saipan, Commonwealth of the Northern Mariana Islands

U.S. Army Corps of Engineers, Honolulu District
Programs and Project Management Division
Environmental and Special Projects Branch

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

Tables

Figures

Acronyms

APC	Air Pollution Control
ARARs	Applicable or Relevant and Appropriate Requirements
BCD	Base-Catalyzed Dechlorination
C2	Cemetery 2 or Main Cemetery
CFR	Code of Federal Regulations
CNMI	Commonwealth of the Northern Mariana Islands
DEQ	Department of Environmental Quality (CNMI)
DERP-FUDS	Defense Environmental Restoration Program for Formerly Used Defense Sites
^{o}F	degrees Fahrenheit
DOT	Department of Transportation
ECC	Environmental Chemical Corporation
EE/CA	Engineering Evaluation/Cost Analysis
FFS	Focused Feasibility Study
FML	flexible membrane liner
FS	Feasibility Study
GAC	granular activated carbon
Guidance	Guidance for Conducting Remedial Investigations and Feasibility Studies Under the Comprehensive Environmental Response Compensation

	Liability Act, USEPA, October 1988
GPCR	Gas-Phase Chemical Reduction
H	horizontal
HUSEPA	high efficiency particulate air
ITD	indirect thermal desorption
MACT	maximum achievable control technology
Mhos	unit of measurement for electrical conductivity
mg/kg	milligram(s) per kilogram
msl	mean sea level
NEPA	National Environmental Policy Act
NCP	National Contingency Plan
O&M	operations and maintenance
PCB	polychlorinated biphenyl
PRG	Preliminary Remediation Goal
ppb	parts per billion
ppm	parts per million
PPE	personal protective equipment
PWY	Public Works Yard
RCRA	Resource Conservation and Recovery Act
SET™	Solvated Electron Technology
Sites	23 Phase III removal excavation sites at Tanapag Village
SVE	Soil Vapor Extraction
TAT	Technical Assistance Team
TBC	to be considered
TCLP	Toxicity Characteristic Leaching Potential
TSDF	treatment, storage, and disposal facility
TSCA	Toxic Substances Control Act
TTPI	Trust Territory of the Pacific Islands
USACE	United States Army Corps of Engineers
USC	Untied States Code
USEPA	United States Environmental Protection Agency
UXO	unexploded ordnance
V	Vertical

TABLE OF CONTENTS

VOC	Volatile Organic Compound
VTS	vapor treatment system

1.1 INTRODUCTION

This Focused Feasibility Study (FFS) is presented to evaluate remedial action alternatives to address polychlorinated biphenyl (PCB)-contaminated soil stockpiled in Tanapag Village, on the northwestern coastline of the Island of Saipan, Commonwealth of The Northern Mariana Islands (CNMI; Figure 1). Approximately 23 removal project sites (Sites) were identified in locations throughout Tanapag Village during the recent Phase III removal action. It is estimated that approximately 20,000 tons of PCB-contaminated soil were excavated from the 23 Sites and stockpiled in the storage cells located in the Village as depicted on Figure 2. Excavation activities were completed in April 2001.

1.2 SITE DESCRIPTION

The stockpiled soils are located in Tanapag Village, which is along the northwestern coastline of the Island of Saipan, CNMI. The Mariana Islands are located in the Western Pacific at approximately Latitude 15°15’N, Longitude 145°45’E. Tanapag Village covers approximately 1.2 square miles and is situated between West Coast Highway and Tanapag Lagoon, approximately 3 miles northeast of the Town of Garapan. Figure 1 depicts the location of the Island of Saipan and Tanapag Village in the CNMI.

Of the Phase III Sites, the largest Site excavated is located in the Main Cemetery (Cemetery 2 or C2), which is located directly between Tanapag Village and Garapan, approximately 1.6 miles northeast of the Navy Hill intersection in Garapan. C2 is a rectangular area consisting of approximately 2.3 acres. The remaining excavation Sites were in clusters throughout the Village at locations near the shoreline, inland, and to the north of the Village.

The soils excavated during the Phase III removal action from the Sites described above and in Section 1.2.1 are currently stockpiled in the storage cells shown on Figure 2 awaiting remedial action.

The recent Phase III removal action and the EE/CA Investigation have identified the Phase III Removal Sites as follows:

- Cemetery 2 (C2) – Main cemetery area and narrow areas across the road on the west and south;
- Beach/Park Areas in Tanapag Village – Sites near the shoreline, mostly in public areas;
- Public Properties in Tanapag Village – Head Start Center, Cemetery 1, and adjacent Sites;
- Private Residences – Numerous private residences with lots in Tanapag Village; and
- Potted Plants and Planters – Sites to which soil was transported from C2.

1.3 REPORT ORGANIZATION

This report is organized into the following Sections:

- Section 2 Site Background
- Section 3 Site Characteristics

- Section 4 Remedial Action Objectives
- Section 5 Scope of Focused Feasibility Study
- Section 6 General Description of Technology Types
- Section 7 Identification and Analysis of Remedial Alternatives
- Section 8 Comparative Analysis of Remedial Alternatives
- Section 9 References

2.1 SITE BACKGROUND

2.1.1 Site History

The U.S. Armed Forces invaded Saipan during World War II on June 15, 1944 and seized the island from Japanese control on July 8, 1944. Historically, Tanapag Village was the site of the "Banzai Charge," where approximately 5,000 U.S. and Japanese soldiers died (Woodward-Clyde Consultants 1990). U.S. Armed Forces administered the civil government of the former Japanese mandated islands, including Saipan, until 1947. The U.S. Navy began administration of Saipan on July 18, 1947. Following this period, the U.S. US Department of the Interior through the Trust Territory of the Pacific Islands administered civilian affairs on Saipan. On November 4, 1986, the Northern Mariana Islands were declared a commonwealth of the United States.

2.1.2 Surplus Electrical Equipment

In the late 1960s, surplus military equipment (including used electrical equipment) from Kwajalein Atoll, was brought to Saipan. After arriving on island, the surplus equipment was stored at the Public Works Yard (PWY) located at the southernmost end of Tanapag Village in an area referred to as Lower Base (Edward K. Noda and Associates 1999).

Between 1968 and 1974, an unknown number of electrical capacitors were transported from PWY to Tanapag Village, following a request by Mr. Hosei (Joe) Norita (who subsequently became Village Commissioner of Tanapag) to use the capacitors in the Village to form a perimeter around the Village ballpark/community hall area. Some of the electrical capacitors were also used for a barricade against vehicles entering the Village through Tanapag Beach Park. While the exact year that the capacitors were placed in Tanapag Village is not known, several older residents recall their arrival after Typhoon Jean hit the island in 1968-69, and before Mr. Norita became Village Commissioner of Tanapag in 1974. Individuals who were involved in transporting and placing the capacitors in Tanapag Village, including several Boy Scouts for whom Mr. Norita served as troop leader, recall that the capacitors were brought into the Village in 1972. As a result of a typhoon that struck Saipan in the late 1970s, the capacitors became scattered throughout the Village (Edward K. Noda and Associates 1999).

According to a CNMI Division of Environmental Quality (DEQ) Internal Briefing Paper (1991), DEQ was notified of the presence of numerous cylindrical electrical components in Tanapag Village in December 1988. Upon notification, DEQ field technicians conducted an investigation by collecting samples of the liquid contained within the cylinders. These samples were then sent to Guam's Environmental Protection Agency for chemical analysis. Test results showed that approximately 60 percent of the samples had very high concentrations of PCBs, i.e., in excess of 5,000 ppm (parts per million) (Edward K. Noda and Associates 1999). Liquids which contain PCBs equal to or greater that 50 ppm are classified as PCB-contaminated; liquids with a PCB concentration in excess of 500 ppm are classified as PCBs.

In 1988, a U.S. Environmental Protection Agency (USEPA) Technical Assistance Team proceeded to remove the capacitors from Tanapag Village, bringing them to the PWY for storage in 55-gallon drums to await proper disposal. A total of 53 capacitors were removed in 1988; another two were removed from the Village by DEQ in 1991 (Woodward-Clyde Consultants

1993). The capacitors (Type LX100R) are cylindrical ceramic vessels containing phenolic windings soaked in Aroclor (PCB mixture), and are approximately 4 feet long with an 18-inch diameter.

The USEPA Region IX Office of the Pacific Islands and Native American Programs determined that the capacitors found in Tanapag Village were manufactured for military use. USEPA correspondence identified Cornell-Dubilier Electrical Corporation as the manufacturer of the capacitors found at Tanapag Village (letter from Jim Branch (USEPA) to Cornell-Dubilier on December 20, 1988). The U.S. military subsequently purchased the capacitors from Continental Electronics of Texas. According to Cornell-Dubilier, the capacitors were used in the U.S. Army's Nike-Zeus radar system to operate high-frequency transmitters in Dallas, New Mexico, and Kwajalein. Global Construction Company dismantled system equipment on Kwajalein in April 1967. Based on USEPA's findings, the U.S. Department of Defense agreed to conduct limited response actions related to the capacitors that USEPA had collected and placed in the storage area at Tanapag Village under Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS) authority (Edward K. Noda and Associates 1999).

2.1.3 Previous Investigation and Remediation Activities

The U.S. Army began a preliminary assessment of Tanapag Village and initiated removal of the capacitors from Saipan in 1990. In August 1992, the Army initiated Phase I soil removal from Tanapag Village at Site locations identified during preliminary assessment sampling activities, including the Lower Base Yard Excavation. Off-site disposal of 180 tons of PCB-contaminated soils mixed with capacitor debris was completed during Phase I.

In March 1994, the Army began Phase II of the response action and removed an additional 1,730 tons of contaminated soil from Tanapag Village and C2. This soil was treated on site using a Thermal Blanket Process and PCB Destruction by a thermal oxidation process. Remediated Sites were backfilled with quarry-supplied crushed, coral fill, or the treated soil. Approximately 4,000 cubic yards of contaminated soil was left in place at C2 and covered by a layer of crushed coral. Five hundred and forty nine tons of soil were disposed of off site (U.S. mainland). Twenty Sites were identified during Phase II. The C2 Site was the only remaining Site with PCB contamination greater than 10 parts per million (ppm).

USEPA collected additional soil samples identifying new areas of PCB contamination in May 2000. Phase III of the project initiated shortly thereafter with ECC performing characterization at various sites in Tanapag Village, under the direction of USACE (ECC 2001). This removal action was undertaken by the USACE pursuant to a decision to conduct a time critical removal action in an Action Memorandum signed by the Division Commander, Pacific Ocean Division on July 21, 2000. Phase III included excavation of all identified PCB-contaminated soils and stockpiling of the material from approximately 23 Sites identified during Phase III removal activities. The amount of contaminated soil stockpiled and awaiting treatment and/or disposal is approximately 20,000 tons. Two samples were collected from each stockpile. The PCB concentrations average less than 10 ppm.

3.1 SITE CHARACTERISTICS

3.1.1 Land Use

Most of Tanapag Village is located on several hundred acres of low-lying coastal areas, which were partially filled and developed with single-family residences. Surface elevations range from sea level to approximately 12 feet above sea level. Some village residences and farms are located in the hills, East of the West Coast Highway. It is here where elevations are higher. The landscape slopes gently to the west towards the ocean. The Village covers an area of approximately 1.2 square miles along the northwestern coast of Saipan (Figure 1). Primarily a residential community, current census data show that Tanapag is the smallest village on Saipan, with 323 households and a population of 1,747 (Department of Commerce & Labor Statistics 1995). The Village has a school, church, cemetery, Head Start Center, and a beach park. Many of its present residents are genetically related, sometimes with as many as four generations living in one household. The community is largely Catholic and economic pursuits of village residents are similar to most other Saipan villages, with people involved in government employment, tourism, fishing, agriculture, and transportation (Edward K. Noda and Associates 1999).

The Village roads are mostly coral-covered with some interspersed paved roads. Many residences have rooftop rain-collection systems. Residents raise chickens, pigs, goats, and cattle, and grow vegetables such as taro roots and yams. Various perennial fruit-bearing trees, including breadfruit, banana, coconut, lime, guava, papaya, sour sap, and betel-nut thrive within Tanapag Village and are a source of food for the residents. Land crabs are frequently collected and consumed, and clams and several species of fish are harvested from Tanapag Lagoon.

Tourism is an important source of income, and many visitors are taught scuba diving at the public beach area in the park in Tanapag Village. Many archeological sites exist in the Tanapag area close to the shoreline where World War II burials, artifacts, and buried ordnance are located within the top 2 feet of soil.

3.1.2 Physiography and Soil

A large barrier reef and lagoon border the western side of Saipan. Tanapag Village lies on a coastal plain approximately ½ mile wide, extending from sea level to 40 feet above mean sea level (msl) east of the West Coast Highway. To the southeast, the hilly core of the island rises behind a linear, fault-defined, topographic front. The central ridge of the island lies about ½ mile southeast of the topographic front and reaches elevations of 600 to 700 feet above msl.

Five major soil types occur in the Tanapag area:

- *Shioya Loamy Sand*, an excessively drained soil formed on water-deposited coral sand. Typically, the surface layer is very dark gray, loamy sand about 7 inches thick. The loamy layer is underlain by about 60 inches of very pale brown lime sand, which overlies cemented sand, coral rubble, or porous bedrock. This soil occurs in the area immediately inland from the shoreline. Permeability of the Shioya soil is very high.
- *Inarajan Clay*, a poorly drained soil that forms on mixed alluvium derived from limestone and volcanic uplands. Typically, the surface layer is black clay about 7 inches thick. Below

the surficial layer is about 9 inches of mixed very dark gray to very dark grayish brown clay with reddish brown mottles. Below this layer to a depth of 60 inches is brown to dark yellowish brown clay with prominent gray mottles. Permeability of the Inarajan soil is low.

- *Saipan Clay*, a well drained soil formed in sediment overlying porous, coralline limestone. Typically, the surface layer is dark brown clay about 4 inches thick over dark reddish brown clay about 3 inches thick. The subsoil to a depth of 45 inches is reddish brown and yellowish red silty clay and clay. Permeability of the Saipan clay is moderate.
- *Laolao Clay* forms on residuum derived dominantly from volcanic rocks. Typically, the surface layers consist of dark reddish brown clay about 6 inches thick. The subsoil is red clay that is underlain by strongly weathered volcanic material to a depth of about 30 inches. Permeability of the Laolao clay is moderate.
- *Mesei Variant Muck* is a very deep, poorly drained soil that forms in depressed areas on the coastal plain. Typically, the surface layer is black muck about 8 inches thick. Below this to a depth of about 23 inches is a very dark gray mucky, gravelly loam to very dark olive gray mucky, sandy loam. The substratum is gray, very gravelly sandy loam (gravel is angular shells and coral fragments). Permeability is moderate to a depth of 23 inches and very high below this depth (Woodward-Clyde Consultants 2001).

3.1.3 Geology and Hydrology

Saipan and the other islands of the Mariana Chain are situated in a double-arc, convergent plate margin setting. Large-magnitude, deep focus earthquakes and volcanism are still common throughout the northern portion of the Mariana Islands. Island arc volcanism is characterized by pyroclastic eruptions of andesitic and dacitic composition. Geological studies of the Mariana Chain indicated that the frontal arc of the system consists of Eocene to Miocene age volcanic rocks that are locally interbedded, and overlain by shallow water limestone and other sediments (Woodward-Clyde Consultants 2001).

The volcanic rocks on Saipan were placed into four formations by Cloud et al. (1956). Three of the four volcanogenic formations (Sankakuyama, Hagman, and Densinyama) comprise the “basement” rock encountered on Saipan. The Fina Sisu formation volcanics were placed in the middle of the stratigraphic section above the Matansa limestone unit (Woodward-Clyde Consultants 2001).

The majority of the volcanic material exposed on Saipan erupted in a submarine environment. Volcanism on Saipan is believed to have ended in the Oligocene epoch (25 to 38 million years before present). Because of the island’s location within the arc system, the island has undergone significant tectonic uplift. Subsequent subaerial exposure of the volcanic basement rock led to erosion and reworking of the original volcanic material to produce clastic sediments. These sediments have become cemented to form sandstones, conglomerates, and breccias of low porosity. Tectonic uplift of the island has also led to the formation of thick fringing limestone units that are exposed at elevations up to 1,540 feet above msl on the summit of Mount Tagpochau. Thus, the island consists of an andesitic-dacitic volcanic core overlain by sandstones, conglomerates, and breccias which are, in turn, capped by limestone. Roughly 90 percent of the surface of the island is currently mantled with limestone (Woodward-Clyde Consultants 2001).

According to Cloud et al. (1956), recently emerged limestone sands underlie the Tanapag coastal plain. The southeastern area of the coastal plain consists of a low terrace of quartz-rich tuffaceous sands and gravel that are mapped as "younger terrace deposits." These two units form a thin veneer (10 to 230 feet thick) that increases in thickness inland, and overlies the Pleistocene Tanapag Limestone. The Tanapag Limestone overlies the Miocene Tagpochau Limestone, a pink, white, and variegated, clastic limestone that is generally free of volcanic debris.

3.1.4 Regional Hydrology

Groundwater in the northern portion of Saipan occurs as an unconfined brackish water lens that overlies saltwater. The regional aquifer at the subject site is made up of the coral and coral-derived material of the Tanapag formation. Due to the high permeability of this limestone unit, the water levels within this aquifer fluctuate with ocean tides. Historically, limited amounts of generally brackish water have been exploited by dug wells along the coastal plain.

At the inland margin of the study area, the Tanapag Limestone is overlain by alluvium derived from the weathering of the Hagman Formation Volcanics that are exposed in the upland region of the study area. Extensive faulting of the limestone and the volcanic units has occurred in these inland areas. The volcanic units have low permeabilities and are not typically exploited as sources of groundwater on Saipan. Springs in the Talafofo area appear to emanate from local, slightly permeable units within the volcanics. The Japanese constructed small catchment reservoirs at two springs in the area, one at Bobo Agatan and the other at Bobo Mames (Woodward-Clyde Consultants 2001).

3.1.5 Climate

The climate in Saipan is warm and humid throughout the year, and is classified as tropical marine, with an average temperature of about 75 to 80 degrees Fahrenheit (°F) and mean annual rainfall of about 80 inches (van der Brug 1985). Rainfall in Tanapag Village is seasonal and averages about 75 to 80 inches per year. The wet season is typically from July through November, followed by a dry season from December through June. Infiltration of rainwater on Saipan is high because the limestone that constitutes 90 percent of the island surface is highly permeable and is generally covered by only a thin veneer of soil (Woodward-Clyde Consultants 2001).

Afternoon temperatures are normally about 85°F and night temperatures are approximately 70°F with a relative humidity of about 70 percent. The dominant winds in the Northern Mariana Islands are trade winds, which blow from the east or northeast. The trade winds are strongest and most constant during the dry season, when wind speeds of 15 to 25 miles per hour are common. During the rainy season, the trade winds often break down, and on some days the weather may be dominated by westerly moving storm systems that bring heavy showers or steady, sometimes torrential rains (Woodward-Clyde Consultants 2001).

The CNMI is situated about 600 miles east of an area in the western Pacific Ocean that is considered the breeding area of cyclonic disturbances. As a result, the CNMI is in "Weather Condition Four" at all times, signifying that 74-mile-per-hour winds are possible within 72 hours.

The native ecosystem on Saipan has been drastically altered from centuries of human occupation. Many of the current plant species on Saipan were introduced as a result of human influx. The majority of the land (approximately 65 percent) on Saipan is not suitable for agricultural use. These lands are composed of marshland, land with steep slopes, very shallow soil, or rocky surfaces. The remaining 35 percent of the land is suitable for cultivation or grazing lands. Common plant types on Saipan consist of vines, shrubs, ferns, grasses, and savanna. The common tree types are coconut, flame tree, Formosan koa, ironwood, banyan, papaya, tangan-tangan, and bamboo. Several protected landmark trees exist in the Beach and Park areas. Wetlands and mangroves exist in Tanapag Village and at or adjacent to the Sites near the shore, and are considered sensitive resources. Vegetation in Tanapag Village and at or adjacent to the Sites consists of tangan-tangan, hibiscus, wild chili peppers, mango, high grass, and various cultigens including pepper leaf, banana, etc. (Ogden 1999)

Tanapag Lagoon borders the Sites. The lagoon is protected by a barrier reef that is approximately ½ mile north of the beach area. The depth in the lagoon ranges from 3 feet (closer to the shore) to 30 feet (further away). Dozens of fish species and other aquatic biota are a steady food supply for the residents of Tanapag Village.

3.1.6 Archeological Investigations

A review of archeological investigations in Tanapag Village indicates that significant pre-historic and historic cultural deposits are present in the Tanapag area. Thompson (1978) uncovered human remains and numerous pottery fragments while testing at Tanapag. Butler and DeFant (1991) also identified a significant cultural deposit in Tanapag, which is reported to be one of the oldest recorded sites in the Marianas (1200 to 600 BC). Swift et al. (1991) located both pre-historic and historic resources in the area. (Ogden 1999)

At least three mass Japanese graves have been uncovered and are associated with the battles that took place on Saipan between June 15, 1944, and July 8, 1944 (Russell and Fleming 1991; Swift et al. 1991; and Adams and Denfeld 1995). While these remains have been removed, it is highly likely that other remains associated with World War II are present (Ogden 1999).

“Evidence of a Japanese mass grave was also encountered in January 2001 at Tanpag Beach Park where the excavation of PCB-contaminated soil was being performed. The skeletal remains of four individuals were recovered, cleaned and prepared for repatriation to the Japan Government. Additional skeletal remains representing at least three more individuals were left undisturbed as they were observed to be beyond the PCB-contaminated are a (Cleghorn et al., 2001).”

4.1 TREATMENT OBJECTIVES

Treatment Objectives for the Phase III Removal Action include the following:

- Reduce PCB concentrations in stockpiled soil to 1 ppm; and
- Comply with the USEPA Order issued December 20, 2000.

4.2 ARARs

Applicable or Relevant and Appropriate Requirements (ARARs) that contain criteria, standards, or limitations for the hazardous substances and circumstances of this remedial action are identified in this section and have been considered during the evaluation of the remedial action. Executive orders, policies, to be considered (TBC) actions, or other guidance documents were also considered during the remedial action evaluation and selection process, as outlined in Sections 7 and 8, but are not discussed in this section.

Federal ARARs identified for this remedial action include:

- **Toxic Substances Control Act (TSCA) (15 United States Code (USC) Section 2605), & 40 Code of Federal Regulations (CFR) Section 761.61-PCB Remediation Waste and other appropriate sections.**

  Non-liquid PCB remediation waste containing less than 50 ppm may be sent off-site for disposal in either a TSCA incinerator, traditional TSCA chemical waste landfill, traditional (Resource Conservation and Recovery Act) Subtitle C landfill, or a state-approved landfill. PCB remediation waste with concentrations at or above 50 ppm may be sent off-site for disposal to a TSCA incinerator, TSCA chemical waste landfill, or Resource Conservation and Recovery Act (RCRA) Subtitle C landfill. If using Subtitle C or state approved landfills, there are waste characterization and notification requirements in 40 CFR 761.61 that must be met. Soil with less than 1 ppm PCBs is considered unregulated waste for disposal under TSCA, whether on-site or off-site. Bulk PCB remediation waste greater than 25 ppm, but less than 50 ppm may be retained at a low occupancy area, if secured with a fence and marked. Bulk PCB remediation waste with greater than 25 ppm but less than or equal to 100 ppm may remain, if the site is capped.

4.3 CLEANUP CRITERIA

The Final Administrative Order, issued December 20, 2000, by the USEPA established a cleanup standard of 1 milligram/kilogram (ppm) PCBs for soil or other materials to be treated and released in unrestricted areas on Saipan. This standard would not apply to soil or other materials, which are disposed of off site at a disposal facility or encapsulated in a waste management unit off-site.

Approximately 20,000 tons of soil containing PCBs have been excavated during prior removal actions and consolidated into one stockpile location. The locations of the soil stockpile cells are shown on Figure 2. The objective of this focused feasibility study is the development, screening, and detailed analysis of remedial action alternatives to remediate the stockpiled soil. The remediation of the stockpiled soil will be the final remedial action to be taken by the Department of Defense (DOD), for PCB contaminated soils in or near Tanapag Village, Saipan, CNMI.

This Focused Feasibility Study (FFS) is designed to provide screening of a focused list of applicable remedial technologies followed by a detailed evaluation of remedial action alternatives. The objective of the FFS is to select the most appropriate remedial alternative for the site-specific conditions. The detailed evaluation of alternatives involves the analysis of a wide variety of factors and the exercise of best professional judgement.

This FFS has been prepared in accordance with the Guidance for Conducting Remedial Investigations and Feasibility Studies Under the Comprehensive Environmental Response Compensation Liability Act (United States Environmental Protection Agency [USEPA], October 1988), herein referred to as the Guidance. However, as this is an FFS rather than a more comprehensive FS, the processes of identifying general response actions, screening technologies, and process options have been streamlined in a manner consistent with those described in the USEPA guidance on presumptive remedies (USEPA, 1993). As with the USEPA's presumptive remedy initiative, the objective of the FFS is to use past experience with similar contaminant conditions to expedite selection of a preferred remedial alternative. In this case, an FFS generally eliminates the steps in an FS where the broad universe of remedial technologies and process options are identified and screened for retention in the detailed alternative analysis.

As the Guidance indicates, the purpose of the FFS is not the unobtainable goal of removing all uncertainty, but rather to gather information to support an informed risk management decision on the most appropriate remedial action for the site. The approach described in the Guidance has been tailored to site-specific circumstances and modified to consider the inherently unique aspects of conducting remedial activities in Saipan.

The FFS consists of two general steps as listed and described briefly below:

1. Identification and screening of a focused list of potentially applicable remedial technologies; and

2. Assembly and detailed evaluation of remedial alternatives using process options within viable technology types.

In the first step, technology types are identified, screened, and eliminated from further consideration on the basis of effectiveness, implementability, and cost. The identification and screening of technology types is presented in Section 6. In the second step, process options are assembled into the site-specific remedial alternatives that are described and evaluated in Section 7. Process options are techniques within each remedial technology. For example, for the chemical destruction remedial technology, there are three process options evaluated in detail herein: Fenton-like Process, Solvated Electron Technology, and Gas-Phase Chemical Reduction. The detailed evaluation of process options has been performed under the second step of the FFS process.

6.1 GENERAL DESCRIPTION OF TECHNOLOGY TYPES

A screening evaluation was conducted to determine remedial technologies that may be effective components for the remedial action alternatives. Technologies were identified in this FFS through experience with similar projects and information available in published literature, particularly the *Remediation Technologies Screening Matrix and Reference Guide* (USEPA 1994), *Technology Alternatives for Remediation of PCB-contaminated Sediment* (USEPA 1993), and *Guidance on Remedial Actions for Superfund Sites with PCB Contamination* (USEPA 1990). In-situ processes were excluded from evaluation and a total of 12 technologies were screened using the following criteria (USEPA 1988):

- **Effectiveness** - Short-term and long-term protection of human health and the environment, the degree of protection as it relates to the treatment objectives, the degree of destruction or immobility achieved as it relates to the treatment objectives, and reliability of the considered technology.
- **Implementability** - The degree of difficulty in implementing the technology due to Site-specific circumstances, the associated risks and limitations of the technology, feasibility, and limitations of the available technology or process options considered.
- **Cost –** Implementation costs, including capital, operations and maintenance (O&M), and monitoring costs.

Table 1 includes a description of each technology and a general evaluation of the technology based on the three screening criteria above (effectiveness, implementability, and cost). Technologies were either retained for further evaluation, or discarded as described below.

- **No Action**

The NCP and the USEPA guidance require inclusion of the No Action alternative for an FS. According to the NCP, the level of treatment achieved by the other alternatives must be compared to the required expenditures of time and materials as an integral part of the remedy selection process. To achieve this comparison, the NCP requires the inclusion of the No Action alternative to serve as a baseline by which to compare the other potential alternatives.

- **Off-Site Landfill**

Off-site disposal is an effective method, and may be implementable with further evaluation, as discussed in Section 7.

- **Off-Site Encapsulation**

Off-site encapsulation is an effective method, and may be implementable with further evaluation, as discussed in Section 7.

- **Biological Treatment (general)**

The U.S. Army Corps of Engineers performed a pilot test of biological treatment on PCB-contaminated soils from Saipan and achieved unsatisfactory results. Due to the persistence of PCBs, low treatment standard of 1 ppm, and lack of available PCB-acclimated organisms, this technology has been deleted from further evaluation.

- **Soil Vapor Extraction**

Due to physical characteristics of PCBs (i.e., low vapor pressure) this technology will not achieve treatment goals and has been deleted from further evaluation.

- **Soil Washing**

Because the PCBs will not be sufficiently destroyed during the treatment process, the PCB-laden water will need to be treated and disposed of. Furthermore, it may be difficult to develop an effective treatment solution. This technology has been deleted from further evaluation.

- **Solidification/Stabilization (general)**

Although it reduces mobility and hence bioavailability, contaminant mass is not reduced nor are PCBs destroyed. Therefore, this technology does not comply with the treatment standard of 1 ppm and has been deleted from further evaluation by itself. It is, however, discussed in combination with off-site encapsulation in Section 7. This Technology is an effective pretreatment for contamination and soil that will be encapsulated because it reduces the potential for contaminants to leach in the event the encapsulation fails.

- **Chemical Reduction/Oxidation**

This technology has been retained for further evaluation in Section 7. Three process options are evaluated as part of remedial alternatives and are described in the following section.

- **Dehalogenation/Dechlorination**

This technology has been retained for further evaluation in Section 7 as part of remedial alternatives.

- **Thermal Desorption**

This technology has been retained for further evaluation in Section 7. Two process options have been evaluated as part of remedial alternatives.

- **Incineration**

This technology has been retained for further evaluation in Section 7 as part of remedial alternatives.

- **Solvent Extraction**

It is uncertain whether this technology will be effective at achieving treatment objectives. The PCBs are transferred from the soil phase to the solvent phase, so mass reduction is not achieved as required by the ARARs. Furthermore, costs may be high and permitting may be difficult. This technology has been deleted from further evaluation.

6.2 REMEDIAL TECHNOLOGIES RETAINED FOR FURTHER EVALUATION

As described above, the following remedial technologies have been retained after screening for effectiveness, implementability, and cost:

- Off-Site Landfill
- Off-Site Encapsulation

- Chemical Reduction/Oxidation
- Dehalogenation/Dechlorination
- Thermal Desorption
- Incineration

6.3 DEVELOPMENT OF REMEDIAL ALTERNATIVES

The retained remedial technologies identified in Section 6.2 were combined in a logical fashion to form remedial alternatives. The pretreatment, treatment, and post-treatment components of each remedial alternative are described and evaluated in Section 7.

The developed alternatives are grouped into four categories based on common pretreatment or treatment components. Alternative 1 is the No Action alternative. Alternatives 2A (Off-Site Disposal) and 2B are grouped together based on the use of an off-site technology for treatment. In the remaining two groups of alternatives (i.e., the groups of Alternatives 3 and 4), the selected pretreatment processes were coupled with options for destruction of PCBs, and the complete treatment systems were evaluated for each alternative.

6.4 SUMMARY OF REMEDIAL ALTERNATIVES

The following ten remedial alternatives, organized into four groups, were evaluated for the Phase III Tanapag Village Remedial Action:

- Alternative 1: No Action
- Alternatives 2A (Off-Site Disposal) and 2B: Off-Site Disposal, and Off-Site Encapsulation
- Alternatives 3A and 3B: On-Site Treatment by Thermal Blanket and Thermal Oxidation, and On-site Treatment by Incineration
- Alternatives 4A through 4E: On-Site Treatment by Indirect Thermal Desorption coupled with four PCB destruction process options (Fenton-like Process, Solvated Election Technology, Gas-Phase Chemical Reduction, and Base-Catalyzed Dechlorination), or Off-Site disposal.

Each one of these remedial alternatives is a complete alternative for the remedial action. Each alternative contains common and optional components. Each of the alternatives is described in detail in Section 7.

This section of the FFS provides a description of each of the developed remedial alternatives and an evaluation of the alternatives individually using the nine USEPA FS evaluation criteria (USEPA 1988).

7.1 EVALUATION CRITERIA

The criteria used in evaluating the remedial alternatives are the following:

1. Overall protection of human health and the environment
2. Compliance with ARARs
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, or volume
5. Short-term effectiveness
6. Implementability
7. Cost
8. CNMI acceptance
9. Community acceptance

The first two criteria are categorized as “Threshold Criteria” that each alternative must meet to be eligible for further evaluation. The third through seventh criteria represent the primary criteria upon which the analysis is based. The last two criteria are discussed herein with respect to each individual alternative; however, comparative analysis will be further addressed following comments on the FFS and Proposed Plan by the commenting public agencies. The evaluation and comparative analysis of alternatives provides the rationale for the selection of the preferred remedial alternative to be implemented at the site.

The costs of each alternative are considered preliminary since they are based on a conceptual remedial design. The estimated cost for each alternative is provided in Table 2.

The isolated location of the island of Saipan poses distinct limitations to transportation and resource options in evaluating the implementability of alternatives. Within the implementability criteria, due consideration is given to minimizing the risk of failure of any element of the remedial action due to local resource or ocean transportation limitations. Mobilization, complexity of technology, reliability of process, local resource availability, and transportation elements were strongly emphasized in this evaluation to minimize the chance of unsuccessful implementation of a remedial action.

Shipping of PCB-contaminated materials or hazardous wastes from Saipan is complicated by the requirements of the Jones Act, which limits the number of available shippers, and the Japanese ban on PCBs entering Japanese ports. The Jones Act requires that a U.S. flag carrier be used to transport shipments between U.S. ports. Matson and Sealand are the only U.S. flag carriers that serve the Marianas, and then only ship to and from Guam. The loaded containers would be transported from Saipan to Guam by barges at a rate of 24 per week. It has been estimated that 1,000 containers would be required to remove the excavated soil. Matson would only be able to accept 100 containers at a time due to other shipping commitments. Approximately 10 months would be required to remove 1000 containers from Saipan.

Total destruction of the PCBs (i.e., permanent reduction of toxicity, mobility, or volume) and on-site treatment were primary considerations in the evaluation process. Where possible, demonstrated technologies were favored over less proven technologies. Innovative technologies were considered, and where the perceived risks were limited, such technologies were retained for further consideration.

The ability of an alternative to achieve the treatment standard of 1 ppm PCBs for treated material to be released in unrestricted areas, as specified in the USEPA Order was essentially evaluated under the criteria of "reduction of toxicity, mobility, or volume" and "implementability," because this treatment standard is the primary measure of the reduction of toxicity of the soil and represents an administrative feasibility issue.

7.2 DETAILED ANALYSIS OF ALTERNATIVES

This section provides a detailed analysis of each alternative on the basis of the nine USEPA FS evaluation criteria listed in Section 7-1. A comparative analysis of the retained alternatives is provided in Section 8.

7.2.1 Alternative 1: No Action

Description of Alternative

The No Action response consists of implementing no remedial technology or process to reduce or minimize the volume, toxicity or mobility of the PCBs in the soil, but may include environmental monitoring and/or institutional controls. In this particular case, the No Action alternative includes the covering the 11 existing soil stockpiles at their present location with additional high-density polyethylene (HDPE) and a 6-inch layer of crushed coral, and maintaining them at this location indefinitely. The stockpiles would require a certain degree of maintenance for the life of the alternative. Such maintenance could include repairs of the plastic containment system and control of surface water and erosion. Installing a network of monitoring wells that are sampled on a periodic basis would monitor impacts to underlying groundwater. The designated stockpile area would need to be secured by fencing to prevent the public from entering the area. Furthermore, the designated area may have to be appropriated for ownership by the government for the life of the alternative. The implementation of this alternative is assumed to be exempt from any permit requirements in accordance with CERCLA.

Evaluation of Alternative

- **Overall protection of human health and the environment**

  PCB-impacted soils have been excavated in the Village, thereby partially satisfying the threshold criterion of being protective of human health and the environment in the Village. However, the PCB-impacted soils would remain in ex-situ stockpiles within the Village that do not represent engineered containment systems, thereby presenting a long-term threat to human health and the environment.

- **Compliance with ARARs**

  This alternative is not compliant with the requirements for a TSCA-approved disposal facility, thus it does not comply with the ARARs.

- **Long-term effectiveness and permanence**

  The PCB-impacted soils would remain in ex-situ stockpiles within the Village. These stockpiles do not represent engineered containment systems. Thus, the stockpiles would present a long-term threat to human health and the environment. The stockpiles would have to remain in this state indefinitely, thus this alternative does not truly constitute a permanent and effective remedy.

- **Reduction of toxicity, mobility, or volume**

  This alternative effectively reduces the toxicity, mobility and volume of contaminated soil in the Village, though not at the stockpile location area. This alternative is contrary to the statutory preference for treatment as a principal element of the alternative. This alternative does not eliminate long-term liability, nor does it mitigate long-term risks. Long-term liability and long-term risks due to releases of contaminants at the stockpile location area will remain indefinitely. This alternative is contrary to the FFS preference for on-site treatment and USEPA preference for permanent destruction of PCBs.

  The NCP further limits this preference for treatment to principal-threat wastes (i.e., those of high concentration that are not appropriate for direct land disposal). Because the PCB-contaminated soils under consideration may already comply with TSCA land disposal standards, the soils would not likely be considered principal-threat wastes that must be considered for treatment.

- **Short-term effectiveness**

  This alternative is effective with respect to the protection of effects on human health and environment during the actual physical activities associated with this alternative (e.g., installation of wells, maintenance of stockpiles, etc.). Furthermore, the soil has already been excavated, thus the majority of this alternative has already been implemented.

- **Implementability**

  This remedial alternative is readily implementable since it relies on manpower, equipment and materials that are available in Saipan.

- **Cost**

  The total cost for Alternative 1 is estimated at $1,039,500 or about $52 per ton. This includes planning, administration, installation, and O&M of soil stockpiles.

- **CNMI acceptance**

  CNMI acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

- **Community acceptance**

  Community acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

7.2.2 Alternative 2A: Off-Site Disposal

Description of Alternative

Alternative 2A (Off-Site Disposal) consists of off-site disposal of the stockpiled soils to an appropriate disposal facility. The quantity of PCB-impacted soil is estimated to be 20,000 tons or approximately 13,333 loose cubic yards based on an estimated average loose unit weight of approximately 1.5 tons per cubic yard. The contaminated soil would be packaged in US Department of Transportation (DOT)-rated containers or sacks, typically with a rated capacity of 1-1½ cubic yards. The individual sacks would be loaded into 20-foot shipping containers. A 20-ft. shipping container has a volume of 47.4 cubic yards. Because the containers will be hauled over the road when they arrive in the United States, therein cargo capacity will be limited to 20 tons in order to comply with gross vehicle weight restrictions. The containers will be transported by ocean carrier to the U.S. mainland for disposal at an appropriate disposal facility.

Stockpiled soil and asphalt/concrete debris will be characterized for PCBs following applicable federal and state regulations. Soil and debris will be disposed of as follows:

- Soil and concrete/asphalt debris that have PCBs at a concentration of less than 50 ppm are considered a solid waste and will be transported and disposed of at a RCRA Subtitle D facility.
- Soil and asphalt/concrete debris that have PCBs at a concentration of greater than or equal to 50 ppm will be taken from the site for disposal at a TSCA-approved PCB disposal facility.

Evaluation of Alternative

- **Overall protection of human health and the environment**

  PCBs are removed from the Village, therefore meeting the threshold criterion of being protective of human health and the environment in the Village.

- **Compliance with ARARs**

  This alternative complies with ARARs.

- **Long-term effectiveness and permanence**

  Off-site disposal at a permitted facility is considered to have a long-term effectiveness and permanence at the Site and is an acceptable alternative under the USEPA FS guidance.

- **Reduction of toxicity, mobility, or volume**

  This alternative effectively reduces the toxicity, mobility, and volume of contaminated soil at the Site. This alternative does not eliminate long-term liability, nor does it mitigate long-term risks. However, as long as there are legally permitted disposal facilities for these soils and the USEPA off-site rule in 40 CFR 300.440 is followed to ensure that any selected disposal facility is operating in compliance with its permit, the off-site risk is not a basis for rejecting off-site disposal as not complying with this FS criterion.

The NCP further limits this preference for treatment to principal-threat wastes (i.e., those of high concentration that are not appropriate for direct land disposal). Because the PCB-contaminated soils under consideration may already comply with TSCA land disposal standards, the soils would not likely be considered principal-threat wastes that must be considered for treatment.

- **Short-term effectiveness**

The soil loading can be effectively implemented in a very short timeframe (i.e., less than one month), however the transport of the soil off of Saipan is limited by the availability of barges resulting in a 10-month implementation period. Short-term impacts to the environment, such as spills, may result from the loading and transportation of the contaminated soil from the stockpile area to the designated disposal facility. These can be avoided through careful handling practices, and in the event of a spill, implementation of timely response procedures. Air monitoring, dust, noise and traffic control, personal protective equipment (PPE) and a safety-training program for workers can be implemented to mitigate potential short-term human health impacts.

Implementability

This remedial alternative is readily implementable. Mobilization includes field personnel, equipment, and supplies. Packaging and loading soil filled in containers or sacks into shipping containers is a common construction industry practice. Shipping of PCB-contaminated materials or hazardous wastes from Saipan is complicated by the regulations of the Jones Act, which limit the number of available shippers and the Japanese ban on PCBs entering Japanese ports. Presently, only one shipper is available for the off-site transport of contaminated materials from Saipan. In evaluating the implementability of this alternative, it was assumed that 4 containers per day could be loaded or 24 containers per week. Containers are shipped by barge from Saipan to Guam at the rate of 24 per week. Cargo ship service to the West Coast of the United States is monthly. The ships in transit from Guam to the United States should be able to carry 100 + containers per month. Given these assumptions 10 months would be required to complete this alternative.

- **Cost**

The capital cost for Alternative 2A (Off-Site Disposal) is estimated at $18,456,900, or about $923 per ton. This includes planning, administration, transportation, and disposal of contaminated soil on the mainland. Shipping costs can be extremely high and variable due to the limited number of available shippers from Saipan. The cost estimate for shipping alone exceeds $12 million for this alternative.

- **CNMI acceptance**

CNMI acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

- **Community acceptance**

Community acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

7.2.3 Alternative 2B: Off-Site Encapsulation

Description of Alternative

Alternative 2B consists of the off-site disposal of stockpiled soils to a RCRA Subtitle D-like waste management unit constructed on Saipan to permanently contain PCB-impacted soils.

In this alternative, the PCB-impacted soil would be packaged in DOT-rated containers or sacks, typically with a rated capacity of 1-1½ cubic yards. The individual sacks would be loaded onto trucks and transported to the engineered disposal facility on Saipan.

The waste management unit would be designed to permanently store PCB soils. The base of the waste management unit would be designed with a primary and secondary flexible membrane liner (FML) system consisting of 60-mil high density polyethylene (HDPE), and leachate collection and leak detection and removal systems. The size of the waste management unit considered for the containment of approximately 20,000 tons of stockpiled PCB-impacted soil would be approximately 185 feet by 185 feet at surface grade with side slopes of 3-horizontal to 1 vertical (3H:1V), and a disposal depth of approximately 14 feet. The actual size and depth of the waste management unit can vary to the point where no waste soils are above grade. This condition would require a large surface area on which to construct the waste management unit. The disposal unit would be capped at a maximum height of 10 feet above ground surface. Waste soils would be placed within the disposal unit at approximately 90 percent relative compaction such that the estimated volume reduction would be approximately 20 percent. The disposal cover would be designed with 4H:1V side slopes. The cover system would consist of a single layer of 60-mil HDPE, surface water collection and removal system, and a four-foot thick vegetative cover soil layer. The thickness of the vegetative cover is related to the severity of storms that pass through the area. Alternatively, the vegetative cover could be replaced with a reinforced concrete cover to provide additional protection.

This alternative could be combined with ex-situ solidification/stabilization of the waste soils before disposal in the waste management unit. This process would be implemented on PCB-impacted soils to reduce the potential for leaching, and thereby reducing mobility and bioavailability. The effectiveness of the process would be based on a performance objective determined by analytical tests. The solidification/stabilization process would consist of a mixture of an inorganic binder consisting of Portland cement, fly ash, and/or pozzolanic materials and water. This process would require bench scale testing to evaluate the effectiveness of the process, and analytical confirmation testing using the USEPA Toxicity Characteristic Leaching Procedure (TCLP) test method. The addition of binder materials will increase the waste soil volume approximately 5 to 10 percent.

Evaluation of Alternative

- **Overall protection of human health and the environment**

  PCBs are removed from the Village, therefore meeting the threshold criterion of being protective of human health and the environment in the Village. Encapsulation of soils at an off-site location would also be protective of human health and the environment at that location since exposure pathways would be eliminated through engineered systems.

- **Compliance with ARARs**

  This alternative complies with the ARARs.

- **Long-term effectiveness and permanence**

  Off-site disposal at an engineered facility in Saipan is considered to have a long-term effectiveness and permanence with respect to the Site itself and is an acceptable alternative under the USEPA FS guidance.

- **Reduction of toxicity, mobility, or volume**

  This alternative effectively reduces the toxicity, mobility, and volume of contaminated soil at the Site. This alternative does not eliminate long-term liability; nor does it mitigate long-term risks in Saipan. Long-term liability and long-term risks due to releases of contaminants at the disposal facility will remain because this alternative would transfer the contaminated soil from one location to another in Saipan. However, as long as there is a legally permitted disposal facility for these soils and the USEPA off-site rule in 40 CFR 300.440 is followed to ensure that the disposal facility is operating in compliance with its permit, the off-site risk is not a basis for rejecting off-site encapsulation as not complying with this FS criterion.

  The NCP further limits this preference for treatment to principal-threat wastes (i.e., those of high concentration that are not appropriate for direct land disposal). Because the PCB-contaminated soils under consideration may already comply with TSCA land disposal standards, the soils would not likely be considered principal threat wastes that must be considered for treatment.

  The double-lined waste management unit would offer sufficient protection to human health and the environment. Incorporation of solidification/stabilization with off-site encapsulation will greatly reduce contaminant mobility. Neither encapsulation nor solidification/stabilization will decrease contaminant concentration. Long-term liability and risk due to potential release(s) of contaminants from the waste management unit will remain, but at an infinitesimally small level if encapsulation is implemented with solidification/stabilization.

- **Short-term effectiveness**

  Engineering plans and specifications would be prepared prior to construction. The design phase would require approximately four to six weeks plus time for the regulatory approval process. Waste management unit construction would require ten to twelve weeks to complete. Soil solidification/stabilization could be implemented in parallel with cell construction, and temporarily stockpiled until transferred to the waste management unit for permanent disposal. Thus, this alternative can be effectively implemented in a relatively short timeframe (3 to 4 months). Short-term impacts to the environment, such as spills, may result from the loading and transportation of the contaminated soil from the stockpile area to the engineered disposal facility. This can be avoided through careful handling practices, and in the event of a spill, implementation of timely response procedures. Air monitoring, dust, noise and traffic control, personal protective equipment (PPE) and a safety-training program for workers can be implemented to mitigate potential short-term human health impacts.

- **Implementability**

This remedial alternative is readily implementable, depending upon the location of the waste management unit, using a combination of imported and native materials and manpower. The implementability of this alternative may be reduced by the choice of location for the waste management unit.

Although the Army is working under a RCRA 7003 Order issued by the USEPA, it is executing and funding the Tanapag cleanup under the Defense Environmental Restoration Program (DERP), which is authorized by Congress at 10 USC 2701 to 2708. Activities under this program must be carried out subject to, and in a manner consistent with, section 120 (relating to federal facilities) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Section 120 requires federal agencies to comply with CERCLA to the same extent as non-federal entities. CERCLA Section 121 and the National Contingency Plan (NCP) at 40 CFR 300.400(e) provide that permits are not required for federal agency removal or remedial actions conducted entirely on site, and when such response action is selected and carried out in compliance with CERCLA.

The NCP, in 40 CFR 300.400(e), provides that all such federal agency response actions are subject to the permit exclusion and further provides that the term *on site* means the areal extent of the contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action. Thus the areal extent of the site and contiguous areas necessary to complete the work are not subject to permit requirements, although the substantive requirements that would have applied must be satisfied. For the purpose of this remedial action the “site” is defined as Tanapag Village and contiguous areas necessary to implement the response action. As long as a suitable location for the waste management unit can be located on the “site,” then no permit will be required from the USEPA. There may be suitable locations for the Waste Management Unit located in the area once occupied by Naval Operating Base, Tanapag, Aviation Gasoline Tank from directly east of Tanapag and east of the West Coast Highway. There may be suitable locations elsewhere in Saipan as well.

If the Army is forced to go off site to implement the response action, it will be required to apply for and receive a permit from the CNMI Department of Environmental Quality for the waste management unit on Saipan, since there are no RCRA- or TSCA-permitted disposal sites on Saipan. The required NEPA compliance activities as well as the CNMI permitting process would likely require much more time to complete than the current project schedule contemplates. Compliance with the schedule in the RCRA 7003 Order will be impossible without substantial extension of time, and additional delays to project execution will be certain. The implementability of this alternative will be affected because of the potential delays to project execution it presents.

Cost

The cost for Alternative 2B is estimated at $1,449,300, or about $75 per ton. The addition of solidification/stabilization would cost approximately $3,000,000, or $150 per ton. The combined total cost for the waste management unit with soil solidification/stabilization is estimated at $4,449,300, or about $225/ton. These costs include planning, administration, design, transportation, placement of soil, and operation and maintenance of an engineered waste management unit on Saipan. Operations and maintenance for a waste management unit of this type consist of periodic inspection of the cap for signs of erosion, especially during the rainy season, and periodic checks (weekly) of the leachate monitoring system. These costs do not include post-closure operations and maintenance.

- **CNMI acceptance**

  CNMI acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

- **Community acceptance**

  Community acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

7.2.4 Alternative 3A: On-Site Treatment by Thermal Blanket and Thermal Oxidation

Description of Alternative

The thermal blanket process has been used successfully in the U.S. This technology was also used for the Phase II removal action in 1994-98. The ex-situ thermal desorption system is modular and consists of 32 thermal panels, a vapor treatment system (VTS), power trailer, and control trailer. Typically, each blanket is an 8- by 20-foot steel box. Suspended from the base of the box is a layer of stainless steel webbing, through which heating-element rods are threaded to transfer heat into the soil below the blanket. A 12-inch layer of insulation fills the box to conserve heat. Eight blankets are lined up side by side to create a treatment cell, which accommodates a 12 to 18-inch lift of contaminated soil (approximately 42 cubic yards). The power supplied to the heating elements raises the temperature of the soil to a target temperature of 750°F (degrees Fahrenheit), and is maintained for a minimum of 24 hours, the time expected for the PCBs to be completely volatilized from the soil.

Contaminant vapors are withdrawn from the soil by a vacuum system that feeds a trailer-mounted VTS to oxidize residual PCBs, discharging carbon dioxide and water vapor into the atmosphere. The VTS consists of a flameless thermal oxidizer and a vapor phase granular activated carbon (GAC) filter. The GAC adsorbs the vaporized contaminants that are not destroyed by oxidation. Spent GAC is regenerated or disposed of off the Island of Saipan.

This is a batch treatment system. The most efficient treatment rate during the Phase II operations was approximately 1 ton per hour per treatment cell. Additionally, one day is required for cool down and a second day for loading/offloading of each cell.

Evaluation of Alternative

- **Overall protection of human health and the environment**

  This alternative would be protective of human health and the environment.

- **Compliance with ARARs**

  This alternative complies with ARARs.

- **Long-term effectiveness and permanence**

Contaminant emissions in field tests for a nationwide TSCA permit exceeded 99.9999 percent destruction efficiency for PCBs, and the principal substances released to the atmosphere were carbon dioxide and water. However, when this process was used in Phase II of the Tanapag soil removal action, some soil batches did not achieve the 10 ppm treatment goal of the Phase II removal action.

- **Reduction of toxicity, mobility, or volume**

This alternative uses oxidation to destroy the PCBs, discharging carbon dioxide and water vapor into the atmosphere, thereby reducing the toxicity of the soil.

The thermal blanket system is effective within particular operating parameters. The target values and upper and lower boundaries for major operating parameters have been established through research and development and field demonstrations previously conducted for this technology. The PCB concentration in treated soil permits evaluation of the performance of the system.

This process successfully treated 1,181 tons of PCB contaminated soil from an initial concentration of 10,000 ppm to 1 ppm. However, actual operation of the thermal blanket technology by TerraTherm Corporation at the Tanapag Village sites indicated that this technology could result in a higher than acceptable need for retreatment of soils to meet the treatment standard of 1 ppm (ECC 1999).

- **Short-term effectiveness**

Given the low anticipated batch treatment rates and possible need to retreat soils to meet the treatment standard of 1 ppm, a relatively long implementation time (3 to 6 months) could be required to meet the remedial action objectives.

The implementation of this alternative does not present unreasonable risks of the impacts to human health and the environment. The use of standard hazardous waste site worker health and safety procedures and environmental mitigation measures would be in place to avoid such risks.

- **Implementability**

The system is portable and is modular in design, allowing for conventional ocean transportation. A total of 12 shipping containers would be required to move the system to Saipan. On-site fabrication of treatment cells would be required. Site setup is expected to be 30-45 days at project outset. The same is expected at project tear down.

- **Cost**

This alternative is estimated at a minimum total cost of $18,564,766. For 20,000 tons, the unit cost would be about $928 per ton. This includes planning, administration, and other relevant costs associated with implementing the alternative.

- **CNMI acceptance**

CNMI acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

- **Community acceptance**

Community acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

7.2.5 Alternative 3B: On-Site Treatment by Incineration

Description of Alternative

In this alternative, soil treatment is accomplished by incineration, which is a technique that uses high temperatures to volatilize and thermodynamically break down contaminants to non-hazardous components.

The incineration process typically proceeds in two stages. First, the contaminated soil is introduced into a directly fired rotary kiln, where it is exposed to a flame to volatize and partially combust its organic content. The soil exits the kiln at temperatures that exceed 1,000º F. Vapors from the kiln are then introduced into a secondary combustion chamber for incineration. The incineration phase oxidizes the PCBs to non-hazardous compounds, principally water and carbon dioxide. Often, this phase produces some acid gas, which is scrubbed or removed by other means.

On-site treatment of excavated soil by incineration has two very beneficial characteristics. Firstly, incineration results in total destruction of contaminants and, secondly, it permits unrestricted reuse of the treated soil. Incineration leaves very little residue and fully treats the waste on site. The equipment accepts soil by a continuous feed system and must be operated 24 hours a day to be economical.

The incineration system is portable and can be set up at remote sites. It primarily requires only fuel, water, and power for operation. The incinerator can be configured to meet the required treatment standards for the site (1 ppm PCBs in soil). Incinerators are required to meet stringent emission standards for offgas treatment. This generally results in high mobilization costs associated with the demonstration of compliance with regulatory emission standards.

Evaluation of Alternative

- **Overall protection of human health and the environment**

  On-site treatment by incineration is protective of human health and the environment as it is a proven technology for the permanent destruction of PCBs.

- **Compliance with ARARs**

  This alternative complies with ARARs.

- **Long-term effectiveness and permanence**

  With adequate controls, incineration is an effective alternative. Incineration permanently and completely removes contaminants from soil. Incinerators have demonstrated compliance with the lowest treatment standards for contaminants in soil.

- **Reduction of toxicity, mobility, or volume**

  This alternative uses incineration for permanent destruction of PCBs.

- **Short-term effectiveness**

  After completion of a review period (which may take over one year), an incinerator can be installed and operated within two months, and can treat soil quite rapidly, at rates typically between 10 and 50 tons per hour. Implementation of this alternative represents a risk of release of incineration by-products like dioxins. However, new incinerators must comply with the maximum achievable control technology (MACT) standard of 0.2 ng/dscm of dioxin/furans from the stack, and they undergo rigorous testing, control, and monitoring to achieve such a standard.

- **Implementability**

  Incineration is a demonstrated technology and can be easily implemented following demonstration of compliance with regulatory emission standards and approval. The approval of an incineration alternative can take over one year, which may make this alternative unacceptable for this remedial action. The testing and demonstration process would satisfy Article VIII, Section 1.B of the Final Administrative Order, dated December 20, 2000.

- **Cost**

  Excluding the cost of mobilization, incineration has demonstrated quite low treatment costs on the order of $100-150 per ton for treatment alone. If consideration is given to the cost of demonstration testing, these costs have rarely been below $250 per ton on very large projects. The estimated cost of this alternative is $7,830,680 or about $392 per ton for 20,000 tons. This includes planning, administration, and other relevant costs associated with implementing the alternative.

- **CNMI acceptance**

  CNMI acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

- **Community acceptance**

  Community acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

7.2.6 Alternative 4A: On-Site Treatment by Indirect Thermal Desorption and PCB Destruction by Fentons-Reaction

Description of Alternative

This alternative involves the process of indirect thermal desorption (ITD) as the method of soil treatment, followed by a Fentons Reaction for destruction of PCBs from the resulting residue (see Figure 3). ITD has been successfully utilized as a treatment method for 15 years as the process effectively removes PCBs and a variety of other toxic materials from contaminated soils. ITD by itself is a separation process intended to concentrate wastes for further treatment by other processes. The ITD technology is based on desorption principles as presented in Alternative 3A (Thermal Blanket).

The ITD process for this alternative is a continuous-feed system rather than a batch system, and is implemented in a rotary dryer to achieve higher temperatures via more effective heat exchange with faster resulting treatment rates.

The contaminated soil and debris are crushed and screened to greater than 2 inches and passed through the dryer. The feeder is operated with a variable-speed drive and allows plant operators to vary the feed rate. A heat source (fuel oil-fired burner) transfers heat through a metal shell to the soil as it contacts the metal. Material is processed in a triple dryer that is indirectly heated with a flame source. The material can be heated to temperatures as high as 1,000°F, which completely volatizes the PCBs. The rotary dryer treats the soil rapidly (usually in 30 minutes). The triple dryer has demonstrated treatment rates in excess of 20 tons per hour on material contaminated with PCBs.

Soil exiting the dryer passes through a double tipping valve arrangement that maintains the air/vapor seal on the output end of the dryer. The material is then transferred to an auger for conditioning with water, completing the treatment process. The material is conveyed to soil bins for temporary storage through a radial stacker.

The PCB-laden vapors are lifted from the soil in a carrier gas and transferred to a condenser. The soil is contaminant-free at this point. The volatilized PCBs and water vapor are separated from the soil and condensed at near room temperature. The air pollution control (APC) equipment is used to remove particulate matter, and to condense steam and organic vapors produced during soil treatment. All offgases are cooled in the scrubber, venturi, and spray tower assemblies. The Recirculation Blower moves the subcooled gases through a high efficiency particulate air (HEPA) filter and vapor phase GAC polishing system. An Induced Draft Blower located after the HEPA filter allows the APC train and the dryer to be operated under negative pressure.

Water used in the APC train is treated to remove oils, organic compounds, and solids. A blowdown stream of this water is polished through carbon and used to rehydrate treated material in the soil conditioner auger arrangement. The contaminated water from the scrubber, venturi, and spray tower sumps is passed through a clarifier to separate oils and solids from the water. Polymer additives are used in the clarification process to further enhance the oil/water/solid separation process.

The ITD system considered is fully instrumented. A programmable logic controller is used to manage the process information collected from the instrumentation. Man-machine interface software provides operator and remote monitoring and data logging capabilities. Automatic waste feed shutoffs are activated for noncompliance conditions. Shutoff conditions include, at a minimum, high offgas temperature, low scrubber flow out of compliance stack emissions, high scrubber temperature, high dryer pressure, and high oxygen content.

The 20,000 tons of soil are estimated to be reduced to 400 tons of ITD residue for treatment. The PCB concentration in the residue will need to be evaluated in ITD tests on the subject soils.

The PCB contaminant residue from the ITD can be treated by Fentons Reaction to destroy the PCBs. The Fenton chemical process has been known for about a hundred years. In the classic Fenton process, hydrogen peroxide and iron (catalyst) are added to a solution at low pH forming hydroxyl radicals that attack and break down the chlorine-to-carbon chemical bonds of PCBs.

Once the bonds have been broken, the same hydroxyl radical attacks the carbon-to-carbon bonds that form the phenolic ring. Peroxide then oxidizes the molecules to water and carbon dioxide.

Fenton reactions occur in a water slurry mixture of contaminants and solids in a batch process. All reactions are done in a water slurry mixture at about 110°F. The residual peroxide is consumed in chemical oxidation of the waste and decomposed to water and oxygen. The capacity of the Fentons Reaction unit that has been considered in this alternative is 3 to 4 tons per day.

Evaluation of Alternative

- **Overall protection of human health and the environment**

  The ITD soil treatment unit process will achieve the 1 ppm treatment standard for the soil. Treated soils would be tested for compliance with this standard prior to placement in an appropriate location on Saipan, thereby being protective of human health and the environment. This alternative can be fully protective of human health and the environment as long as the Fentons Reaction can be designed and operated effectively to achieve the 1 ppm treatment standard for the ITD residues.

- **Compliance with ARARs**

  This alternative complies with ARARs.

- **Long-term effectiveness and permanence**

  This alternative utilizes the Fentons Reaction to permanently destroy PCBs. The magnitude of the long-term residual risk is a function of the ability to achieve the treatment standard of 1 ppm for the ITD residues which is addressed under reduction of toxicity, mobility, or volume.

- **Reduction of toxicity, mobility, or volume**

  This alternative satisfies the statutory preference for treatment as a principal element. The ITD soil treatment unit process will achieve the 1 ppm treatment standard for the soil. However, Fentons Reaction has not been demonstrated at being effective in achieving the treatment standard of 1 ppm on ITD residue. The effectiveness of Fentons Reaction is dependent on the concentrations of naturally occurring chemicals that may be in the soil. Bench-scale treatability tests of the Fentons Reaction process are required to evaluate the suitability of the process for site materials.

- **Short-term effectiveness**

  The process provides high rates of treatment and has the potential to achieve the objectives of the remedial action in a relatively short period of time (i.e., 3 to 6 months)

  This alternative requires the usage of fairly large volumes of peroxide at the site. The usage of such chemicals presents a short-term risk due to their transportation, handling, and storage.

- **Implementability**

  The ITD technology is a well established, proven technology that has been applied in remote and urban areas. The equipment would be modular, portable for importation, and capable of delivering high treatment rates with minimum risk of implementation. The unit that has been considered in this evaluation has a 7 to10 ton per hour processing capacity.

Coupling the Fenton-like process with the ITD is technically feasible, as both processes are aqueous and the equipment and materials needed to operate the systems are readily available on Saipan or via importation.

The equipment would be located in a secured location on Site, and necessary utilities would be routed from the nearest available location (e.g., Cemetery 2).

Article VIII, Section 1.B, of the Final Administrative Order, dated December 20, 2000, specifies that the treatment methodology proposed in this alternative must comply with relevant regulatory requirements and be approved by USEPA. USEPA approval will be contingent upon a testing and demonstration phase for the thermal desorption process to confirm that the thermal desorption unit meets all relevant regulatory requirements. This Article further requires that USACE perform laboratory-scale investigations of the feasibility and practicability of using Fentons Reaction. Bench tests of the Fentons Reaction process are being performed on site materials to verify the implementability of the process and process rates; however, to date this process has not been demonstrated to be capable of achieving the 1 ppm treatment standard for the subject contaminant residue.

- **Cost**

  Implementation of this alternative will cost approximately $6,895,680 (around $345 per ton). This includes planning, administration, and other relevant costs associated with implementing the alternative. The cost of treatability tests to evaluate the Fentons Reaction is included in this total cost estimate.

- **CNMI acceptance**

  CNMI acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

- **Community acceptance**

  Community acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

7.2.7 Alternative 4B: On-Site Treatment by ITD and PCB Destruction by Solvated Electron Technology

Description of Alternative

As with the previous alternative, Alternative 4B begins with initial treatment by ITD. The pretreatment ITD process is described in Section 7.2.6. In this alternative, post-treatment is PCB destruction by Solvated Electron Technology (SET^{TM}). To couple the two processes, a low temperature dryer (mini ITD) unit would also be required prior to treatment by the SET^{TM} unit (see Figure 4). This additional effort is thus required for filtration, sludge, and GAC treatment of the aqueous liquid before the carry-over solids are processed in the Gas-Phase Chemical Reduction reactor unit.

The SET™ process is based on a scientific phenomenon first observed by Sir Humphrey Davy in the early 19th century. The process uses a solution of ammonia and metal, such as sodium, calcium, lithium, or potassium (solvated electron solution), to chemically reduce toxic compounds like PCBs, pesticides, and other halogenated compounds into non-hazardous chemicals (salts).

The SET™ process contains various steps that transfer, store, heat, compress, and recover the ammonia for reuse. The unit can be transported to field sites for ex-situ treatment. The SET™ is a batch system that contains a sodium transfer station, which heats sodium contained in shipping drums to a liquid state, and then pumps the liquid to the solvator tank. The tank is filled with anhydrous ammonia from an ammonia storage container. The sodium dissolves in the ammonia, creating a solvated solution that is then discharged into the reactor vessel.

The treatment process begins by placing the contaminated material (in this alternative, the carry-over solids from the ITD unit) into the reactor vessel. When the conductivity in the vessel drops to 200 Mhos, the feed is stopped. The destruction is very fast and is essentially diffusion controlled. Removing the ammonia vapor controls the temperature and pressure in the vessel, and results in lowering the temperature. The feed rate is typically less than a ton of material per day.

The treated material is discharged to a waste storage vessel. At this point, the treated material may be removed, pH adjusted, and disposed of as non-hazardous material. After the reaction in the reactor vessel is complete, the solution is transferred to the separator tank using the natural pressure of the ammonia as the motive force. In the separator vessel, the ammonia is heated to approximately 125°F, and is pumped in vapor form to a condenser for recycling.

Evaluation of Alternative

- **Overall protection of human health and the environment**

  This alternative is protective of human health and the environment.

- **Compliance with ARARs**

  This alternative complies with ARARs.

- **Long-term effectiveness and permanence**

  The PCB destruction process requires dry materials; if a batch of treated material failed the treatment standard, the material would be subjected to a hydration step for the batch ITD separation of PCBs and a dehydration step for retreatment in the SET™ reactor. This alternative satisfies the preference for on-site treatment and PCB destruction.

- **Reduction of toxicity, mobility, or volume**

  Commodore, owner of the process, claims that their SET™ system can effectively decontaminate soil, sludge, sediment, oil, hand tools, and PPE, including total destruction of PCBs. Some materials can be treated without special conditioning. For other materials, water removal, size reduction, washing, and pH adjustment may be necessary.

- **Short-term effectiveness**

The process provides high rates of treatment and has the potential to achieve the objectives of the remedial action in a relatively short period of time (i.e., 3 to 6 months).

The implementation of this alternative does not present unreasonable risks of impacts to human health and the environment. The use of standard hazardous waste site worker health and safety procedures and environmental mitigation measures would be in place to avoid such risks.

- **Implementability**

  The SET™ system equipment can be transported to field sites for treatment. In addition, USEPA has issued a nationwide TSCA treatment permit for the SET™ system for mobile treatment and chemical destruction of PCBs in soil, metals, oil, organic material, and debris.

  This alternative is a non-aqueous PCB destruction process coupled with the aqueous ITD pretreatment technology, introducing additional time-consuming steps.

  Article VIII, Section 1.B of the Final Administrative Order, dated December 20, 2000, specifies that the treatment methodology proposed in this alternative must comply with relevant regulatory requirements and be approved by USEPA. USEPA approval is contingent upon field pilot testing that demonstrates that the treatment method is capable of destroying PCBs to less than 1 ppm.

- **Cost**

  The cost of this alternative is estimated at $7,632,680 (or about $382 per ton). This includes planning, administration, and other relevant costs associated with implementing the alternative.

- **CNMI acceptance**

  CNMI acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

- **Community acceptance**

  Community acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

7.2.8 Alternative 4C: On-Site Treatment by ITD and PCB Destruction by Gas-Phase Chemical Reduction

Description of Alternative

This alternative is coupled with the continuous-feed ITD technology. The PCBs in the condensate from the ITD component are destroyed by the Gas-Phase Chemical Reduction (GPCR) process. In this coupling, however, the GPCR unit also has a front-end batch ITD unit to vaporize the PCBs in ITD residues before destruction by the hydrogen-gas-based process (see Figure 5).

The pretreatment ITD process is described in Section 7.2.6.

The GPCR process is a patented technology that has been successfully used to treat PCB-contaminated waste. The GCPR process has three major components:

- Batch ITD unit, where contaminants in the residue from the continuous-feed ITD are separated and converted to vapor phase,
- Reactor, where the contaminants in vapor phase are injected with steam and reduced in a hydrogen atmosphere, and
- Gas Scrubber and Compressor, where process waste is separated from gas mixture including hydrogen, methane, carbon monoxide, and light hydrocarbons.

Other auxiliary components include the boiler (steam generation) and the heat exchanger (for heating water feed into the reactor) compressed hydrogen storage unit, and carbon filters for treating water effluent.

Following the pre-treatment ITD process, the contaminant separation is done in a batch ITD processor where organic compounds are desorbed before being fed into the reactor; steam is used in the reactor for heat transfer. Organic compounds are reduced in a reactor vessel by hydrogen at temperatures of 850°C or greater into methane, hydrogen chloride, and some minor amounts of low molecular weight hydrocarbons.

Gas leaving the reactor is scrubbed to remove acids, water, fine particulate matter, aromatic compounds, and carbon dioxide. Some of the cooled and scrubbed product gas is reheated and circulated back into the reactor. The excess gas is removed from the system, compressed, and stored. The stored gas is continually analyzed and subsequently used as fuel to heat the boiler or burned off.

Evaluation of Alternative

- **Overall protection of human health and the environment**

  This alternative is protective of human health and the environment.

- **Compliance with ARARs**

  This alternative complies with ARARs.

- **Long-term effectiveness and permanence**

  This alternative destroys PCBs. The process has effectively treated dielectric fluid but process capacity is limited, and has not been coupled to a large-capacity front-end ITD as is being considered for this remedial action.

- **Reduction of toxicity, mobility, or volume**

  PCBs would be destroyed as the GPCR process has demonstrated effective removal of PCBs from a vapor.

- **Short-term effectiveness**

  The implementation period for this alternative is uncertain given the process complexities, though it is anticipated to be effective in a 3 to 6 month timeframe. Because no commercial source for hydrogen exists on Saipan, a hydrogen gas reformer will be needed, which can pose a safety hazard in the event of an upset condition. Hydrogen gas use poses an explosive hazard to workers and the community. Implementation of hazardous waste site worker health and safety procedures should minimize such risks.

- **Implementability**

  The system has mechanical and process problems reducing its implementability and reliability rating. The patent owner will license the technology but does not operate any processes. The process has successfully treated oils but process capacity is limited, and has not been coupled to a large-capacity front-end ITD as is being considered for this remedial action. The coupling of the process could occur in the solid residue step after the continuous-feed ITD, where the residue would undergo a batch ITD extraction of PCBs before treatment in the reactor unit. Additional effort is then required for filtration, sludge handling, and GAC treatment of the aqueous liquid before the carry-over solids are processed in the GPCR reactor unit.

  Article VIII, Section 1.B of the Final Administrative Order, dated December 20, 2000, specifies that the treatment methodology proposed in this alternative must comply with relevant regulatory requirements and be approved by USEPA. USEPA approval is contingent upon field pilot testing that demonstrates that the treatment method is capable of destroying PCBs to less than 1 ppm.

- **Cost**

  The cost of the GPCR treatment component, excluding mobilization and all other costs, is $5,000 per ton of residuals to be treated. Mobilization costs would be quite high as a hydrogen reformer and an additional small batch ITD unit would be required, in addition to the mobilization costs associated with the primary ITD unit. With all components of the remedial action, including the pre-treatment ITD process, the estimated cost of this alternative is $9,480,680 (or about $474 per ton). This includes planning, administration, and other relevant costs associated with implementing the alternative.

- **CNMI acceptance**

  CNMI acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

- **Community acceptance**

  Community acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

7.2.9 Alternative 4D: On-Site Treatment by ITD and PCB Destruction by Base-Catalyzed Dechlorination

Description of Alternative

The treatment method for this alternative is composed of the continuous-feed ITD technology, followed by Base-Catalyzed Dechlorination (BCD). The ITD process is described in Section 7.2.6.

The BCD batch process is coupled to the ITD; the PCBs concentrated in the condensate and solids by the ITD are destroyed in the BCD unit (see Figure 6). A strong base material (typically sodium hydroxide) is blended with a catalyst and organic waste and heated under pressure to about 300°C for a few minutes, which causes the chlorine to be replaced with hydrogen. The end product is an organic oil material that contains no PCBs.

The process operates in a batch mode and is best suited for liquid oils. The BCD process must be operated free of water, and solids must be at low concentrations. The BCD can be coupled to an ITD, but requires a low temperature dryer (mini ITD) to remove soil moisture before treatment by BCD.

Since the ITD uses a condenser to capture the organic waste, the condensate is a mixture of water, contaminants, and particulate matter. In removing the water, the waste is typically bound to the solids. Sacrificial oil such as nonane or bunker oil is mixed with the solids at ratio of 15% oil to solids, and the slurry is fed into the batch BCD reactor for treatment. The resultant material is an asphalt mixture with generally low concentrations of PCBs.

Evaluation of Alternative

- **Overall protection of human health and the environment**

  This alternative is not protective of human health and the environment. Since the BCD process is not capable of destroying PCBs in the ITD residue to meet 1 ppm treament standard.

- **Compliance with ARARs**

  This alternative complies with the ARARs.

- **Long-term effectiveness and permanence**

  This process is not capable of destroying PCBs to the level required for this remedial action.

- **Reduction of toxicity, mobility, or volume**

  This process is not capable of destroying PCBs to the minimum treatment standard of 1 ppm required for this remedial action.

- **Short-term effectiveness**

  This alternative will not achieve the treatment standard, thus the implementation period is irrelevant.

  The implementation of this alternative does not present unreasonable risks of impacts to human health and the environment. The use of standard hazardous waste site worker health and safety procedures and environmental mitigation measures would be in place to avoid such risks.

- **Implementability**

  The BCD process is an oil-based technology and the pretreatment ITD system is water-based. Additional steps are necessary to effectively couple the ITD and the BCD processes, making the alternative difficult to implement. The BCD process has low treatment rates, making the cost very high. This alternative is questionable for treating solids.

  Article VIII, Section 1.B of the Final Administrative Order, dated December 20, 2000, requires that the excavated soils and contaminated debris be treated by a USEPA-approved methodology that is capable of removing PCBs to less than 1.0 ppm. This process is not capable of destroying PCBs to the level specified in the Final Administrative Order.

- **Cost**

  The cost of the BCD treatment component, excluding mobilization and all other costs, is $5,000 per ton of residuals to be treated. With all components of the remedial action, including the pretreatment ITD process, the estimated cost of this alternative is $10,184,680 or about $509 per ton. This includes planning, administration, and other relevant costs associated with implementing the alternative. With limited PCB destruction, the soils would have to be retreated, thus increasing the cost and duration of the remedial action.

- **CNMI acceptance**

  CNMI acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

- **Community acceptance**

  Community acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

7.2.10 Alternative 4E: On-Site Treatment by ITD and Off-Site Disposal

Description of Alternative

This alternative couples the continuous-feed ITD technology with off-site disposal of treated PCB-contaminated residuals resulting from the ITD process. The ITD process is described in Section 7.2.6.

In this alternative, the contaminated residuals would be packaged in DOT-rated containers or sacks, typically with a rated capacity of 1-1½ cubic yards. The individual sacks or containers would be loaded into 20-foot shipping containers and transported by ocean carrier to the U.S. mainland for disposal at an appropriate disposal facility.

The estimated 400 tons of ITD contaminated residuals will be characterized for PCBs in accordance with applicable federal and state regulations, and disposed of as follows at regulated facilities:

- Materials with PCBs at a concentration of less than 50 ppm are considered a solid waste and will be transported and disposed of at a RCRA Subtitle D facility.
- Materials with PCBs at a concentration of greater than or equal to 50 ppm will be taken from the site for disposal at a TSCA-approved PCB disposal facility.
- There are no RCRA Subtitle D or TSCA-approved PCB disposal facilities in Saipan though they are available on the mainland for this purpose. The PCB concentrations in the ITD residues will need to be evaluated in ITD tests on the subject soils.

Evaluation of Alternative

- **Overall protection of human health and the environment**

  This alternative would be protective of human health and the environment at the Site. Off-Site disposal of the contaminated residuals removes risks at the Site.

- **Compliance with ARARs**

  This alternative complies with the ARARs.

- **Long-term effectiveness and permanence**

  Off-site disposal at a permitted facility is considered to have a long-term effectiveness and permanence at the Site itself and is an acceptable alternative under the USEPA FS guidance.

- **Reduction of toxicity, mobility, or volume**

  This alternative reduces the volume of contaminated material from 20,000 tons to approximately 400 tons of contaminated residuals to be shipped offsite to a permitted TSCA-approved facility. The contaminated material will be permanently removed from Tanapag. This alternative partially satisfies the statutory preference for treatment as a principal element of the alternative. This alternative is contrary to the FFS preference for on-site treatment and USEPA preference for permanent destruction of PCBs. However, as long as there are legally permitted disposal facilities for these residuals and the USEPA off-site rule in 40 CFR 300.440 is followed to ensure that any selected disposal facility is operating in compliance with its permit, the off-site risk is not a basis for rejecting off-site disposal as not complying with this FS criterion.

- **Short-term effectiveness**

  On-site treatment of soil and off-site transport of residuals can be effectively implemented in a short timeframe (i.e., 3 to 6 months).

  The implementation of this alternative does not present unreasonable risks of impacts to human health and the environment. The use of standard hazardous waste site worker health and safety procedures and environmental mitigation measures would be in place to avoid such risks.

- **Implementability**

  The ITD technology is a well established, proven technology that has been applied in remote and urban areas. The equipment would be a mobile unit. The unit is modular, portable, and capable of delivering high treatment rates with minimum risk of implementation.

  Packaging and loading solid residues in containers into shipping containers is a common industry practice. Shipping of PCB-contaminated materials from Saipan is complicated by the regulations of the Jones Act, which limit the number of available shippers as discussed under Alternative 2A. As noted earlier herein, recent changes to TSCA regulations by the USEPA allow remediation waste with PCBs to be transported to the mainland from CNMI for treatment or disposal.

- **Cost**

The capital cost for Alternative 4E is estimated at $6,764,120, or about $338 per ton. This includes planning, administration, and other relevant costs associated with implementing the alternative. The estimated cost assumes that all 400 tons of ITD residue would require disposal in a TSCA-approved disposal facility.

- **CNMI acceptance**

  CNMI acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

- **Community acceptance**

  Community acceptance will be addressed in the Record of Decision following public comments on the FFS report and the Proposed Plan.

7.3 ALTERNATIVES RETAINED FOR COMPARATIVE ANALYSIS

Each of the developed alternatives has been described and evaluated on the basis of the nine USEPA FS evaluation criteria. Alternatives 1 (No Action), 2A (Off-Site Disposal), 2B (Off-Site Encapsulation), 3B (On-Site Incineration), and 4E (On-Site ITD/ Off-Site Disposal)) are considered acceptable for further evaluation on a comparative basis in Section 8 of this FFS, whereas the other alternatives are not retained for further analysis for the reasons cited below.

Article VIII, Section 1.B, of the Final Administrative Order, dated December 20, 2000, specifies that the proposed treatment methodology must comply with relevant regulatory requirements and be approved by USEPA. This Article further requires that USACE perform laboratory-scale investigations of the feasibility and practicability of using a treatment process.

Bench-scale tests of the Fentons Reaction (Alternative 4A) are being performed on site materials to verify the implementability of the process and process rates; however, to date this process has not been demonstrated to be capable of achieving the 1 ppm treatment standard for the contaminated residuals. To date, successful bench-scale tests also have not been performed on the contaminated residuals for the treatment processes in Alternatives 3A (On-Site Thermal Blanket), 4B (On-Site ITD/ SET), 4C(On-Site ITD/ GPCR), or 4D (On-Site ITD/BCD). Because these processes have not been proven to be capable of achieving the treatment standard to date, these alternatives are not evaluated in Section 8 of this FFS as viable stand-alone remedial alternatives. However, given that the Fentons Reaction has the potential to be demonstrated to be effective in laboratory-scale investigations in the near future, this technology should be retained as an option to off-site disposal in Alternative 4E (On-Site ITD/Off-Site Disposal).

In Section 7, the various remedial alternatives were described and evaluated individually for suitability for the Phase III Tanapag Village Removal Action. In this section, the retained alternatives are compared with each other using the nine USEPA evaluation criteria. Table 3 shows a comparison of the alternatives using the nine evaluation criteria, and the retained alternatives are discussed below under each criterion.

The retained alternatives are compared to evaluate the relative merits and deficiencies of each alternative relative to one another so that the better alternatives can be identified and ranked in terms of the various evaluation criteria.

The retained alternatives evaluated comparatively are referred to as follows:

- **Alternative 1:** No Action**;**
- **Alternative 2A**: Off-Site Disposal;
- **Alternative 2B**: Off-Site Encapsulation;
- **Alternative 3A**: On-Site Treatment by Thermal Blanket and Thermal Oxidation - **Not retained for comparative analysis as noted in Section 7.3**
- **Alternative 3B**: On-Site Treatment by Incineration;
- **Alternative 4A**: On-Site Treatment by ITD coupled with Fenton-like process **– Not retained for comparative analysis as noted in Section 7.3**.
- **Alternative 4B**: On-Site Treatment by ITD coupled with Solvated Electron Technology - **Not retained for comparative analysis as noted in Section 7.3**.
- **Alternative 4C**: On-Site Treatment by ITD coupled with Gas-Phase Chemical Reduction - **Not retained for comparative analysis as noted in Section 7.3**.
- **Alternative 4D**: On-Site Treatment by ITD coupled with Base-Catalyzed Dechlorination - **Not retained for comparative analysis as noted in Section 7.3**.
- **Alternative 4E**: On-Site Treatment by ITD coupled with Off-Site Disposal.

8.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternative 1 (No Action) does not meet the threshold criterion of being protective of human health environment. Alternatives 2A (Off-Site Disposal), 2B (Off-Site Encapsulation), 3B (On-Site Incineration), and 4E (On-Site ITD/ Off-Site Disposal) meet the threshold criterion. Consistent with USEPA (1988) guidance, further assessment of the alternatives on the basis of this criterion is reserved for the more detailed analyses covered under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

8.2 COMPLIANCE WITH ARARs

Alternative 1 (No Action) does not comply with ARARs. Alternatives 2A (Off-Site Disposal), 2B (Off-Site Encapsulation), 3B (On-Site Incineration), and 4E (On-Site ITD/ Off-Site Disposal) comply with the threshold criterion of meeting the ARARs.

8.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 1 (No Action) retains PCB contaminated soil in temporary stockpiles for an indefinite period of time. Long-term storage under temporary storage conditions presents a long-term threat to human health and the environment in Tanapag. Alternative 2A (Off-Site Disposal) permanently removes PCBs from Tanapag. Alternative 2B (Off-Site Encapsulation) will permanently contain the PCBs Alternative 4E (On-Site ITD/ Off-Site Disposal) is not a destruction remedy, however the PCBs are effectively and permanently removed from Tanapag. Alternative 3B (On-Site Incineration) destroys PCBs (see discussion under Reduction of Toxicity, Mobility, or Volume criterion), thus making this alternative rank very high under this criterion.

8.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME

Alternative 1 (No Action) effectively reduces toxicity, mobility and volume of contaminated soil within Tanapag, except for at the temporary storage location in Cemetery 2. Alternative 3B (On-Site Incineration) permanently destroys PCBs.

Alternatives 2A (Off-Site Disposal) and 4E (On-Site ITD/ Off-Site Disposal) effectively reduce the toxicity, mobility, and volume of contaminated soil at the sites. Alternative 2B (Off-Site Encapsulation) reduces toxicity and mobility, but if the contents within the waste management unit are solidified or stabilized, the volume will increase by 5 to 10 percent.

8.5 SHORT-TERM EFFECTIVENESS

Alternatives 1 (No Action), 2A (Off –Site Disposal), 2B (Off-Site Encapsulation) Alternative 3B (On-Site Incineration) and 4E (On-Site ITD/Off-Site Disposal) are essentially equally protective of site workers and the community. The hazards associated with moving, treating and loading contaminated soils are manageable through the application of appropriate work plan controls and monitoring.

Alternative 1 (No Action) is immediately effective because it has been completed. Alternative 2A (Off-Site Disposal) will require 10 months to be effective. The 10 months is the estimated times necessary to ship 1000 containers of contaminated soil to Guam for eventual shipment to the United States. Alternative 2B (Off-Site Encapsulation) can be effective within 2 to 3 months if a suitable site can be located where no permit is required from the CNMI. If a permit is required, the time for Alternative 2B (Off-Site Encapsulation) to be effective will be 2 years or more. Alternative 3B (On-Site Incineration) will require more than 1 year to be effective, due mainly to the time required to secure an EPA permit for PCB incineration. Alternative 4E (On-Site ITD/ Off-Site Disposal) can be effective in 3 to 6 months depending upon the time necessary to gain EPA approval required by the RCRA order.

8.6 IMPLEMENTABILITY

Alternative 1 (No Action) is the most easily implementable alternative.

Alternative 2A (Off-Site Disposal) is technically, very easily implementable. However, shipping constraints decrease the overall implementability rating.

Alternative 2B (Off-Site Encapsulation) is readily implementable subject to the location of a suitable site for the encapsulation cell. Potential permit requirements would reduce the implementability rating.

Alternative 4E (On-Site ITD/Off-Site Disposal) is technically implementable. However, shipping constraints decrease the overall implentability rating.

Alternative 3B (On-Site Incineration) may take over 1 year for approval and implementation, thus making this alternative rank low on implementability.

8.7 COST

The most cost-effective alternatives are Alternative 1 (No Action). Alternative 2B (Off-Site Encapsulation) at $1,039,500 and $1,499,300 respectively.

Alternative 3B (On-Site Incineration) and Alternative 4E (On-Site ITD/Off-Site Disposal) leave costs in the mid-range at $7,830,680 and $6,764,120, respectively.

The most costly is Alternative 2A (Off-site Disposal) at $18,456,900.

8.8 CNMI ACCEPTANCE

CNMI acceptance will be addressed in the Record of Decision following comments on the FFS report and the Proposed Plan.

8.9 COMMUNITY ACCEPTANCE

Community acceptance will be addressed in the Record of Decision following comments on the FFS report and the Proposed Plan.

Adams, Jim and D. Colt Denfeld. 1995. Test Excavation of a World War II Japanese Mass Grave at Achugao, Saipan, Commonwealth of the Northern Mariana Islands. Draft Report. International Archaeological Research Institute, Inc.

Butler, B.M. and D.G. DeFant. 1991. Archeological Survey on the Leeward Coast of Saipan: Garapan to Oleai. Micronesian Archaeological Survey Report 27. Historic Preservation Division, Saipan.

Cloud, P.E., R.G. Schmidt, and H.W. Burke, 1956. Geology of Saipan, Marianas Islands. United States Geological Survey Professional Paper 220-A.

Department of Commerce and Labor. 1995. Summary of General Characteristics of Persons, Households and Families, CNMI: 1995. Department of Commerce and Labor, Commonwealth of the Northern Mariana Islands, Saipan.

Division of Environmental Quality Briefing Paper. 1991. Tanapag PCB Clean-up Project. F. Russell Mechem II, Chief, DEQ, Saipan.

Edward K. Noda and Associates, Inc. 1999. Final Report, Human Health Evaluation of PCB Contamination, Tanapag Village, Saipan, Commonwealth of the Northern Mariana Islands.

Environmental Chemical Corporation (ECC). 1999. Remedial Action Tanapag Village Contamination Phase II Tanapag, Island of Saipan, Commonwealth of the Northern Mariana Islands. September.

ECC. 2001. Revised Work Plan, Phase III Removal Action, Tanapag Village, Island of Saipan, CNMI. March 1.

ECC. 2001 Draft Final Engineering Evolution/ Cost Analysis, Phase III Removal Action, Tanapag Village, Saipan CNMI, January 25.

Ogden Environmental and Energy Services Company, Inc. 1999. Draft Report, Archeological and Ethnographic Investigations at the Tanapag Fuel Farm, Tanapag Village, Saipan, Commonwealth of the Northern Mariana Islands.

Russell, Scott and Michael Fleming. 1991. A Bulwark in the Pacific: An Example of World War II Archaeology on Saipan. In *Archaeological Studies of World War II*, Monograph No. 10 (13-28); DUSEPArtment of Anthropology, University of Missouri-Colombia, Edited by W. Raymond Wood.

United States Army Corps of Engineers. 2000. Memorandum: Request for Approval of a Time Critical Removal Action at Tanapag Village, Island of Saipan. July.

United States Environmental Protection Agency (USEPA). 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. Interim Final. USEPA/540/G-89/004. October.

USEPA. 1990. Guidance on Remedial Actions for Superfund Sites with PCB Contamination. USEPA/540/G-90/007. August.

USEPA. 1993. Technology Alternatives for Remediation of PCB-Contaminated Sediment. USEPA/540/S-93/506. October.

USEPA. 1994. Remediation Technologies Screening Matrix and Reference Guide. October.

van der Brug, Otto, 1985. Compilation of Water Resources Development and Hydrologic Data of Saipan, Mariana Islands. U.S. Geological Survey Water-Resources Investigation Report 84-4121.

Woodward-Clyde Consultants. 1990. Defense Environmental Restoration Program for Formerly-Used Sites Inventory Project Report, Tanapag Village PCB Contamination, Tanapag Village, Saipan, Commonwealth of the Northern Mariana Islands.

Woodward-Clyde Consultants, 1993. Draft Summary Report PCB Soil Cleanup at Department of Public Works Lower Base Yard and Tanapag Village, Saipan, Commonwealth of the Northern Mariana Islands. Prepared for Industrial Technology, Honolulu, HI.

Woodward-Clyde Consultants. 2001. Final Report-Site Investigation, Tanapag Fuel Farm, Saipan Island, Commonwealth of the Northern Mariana Islands, Project No. H09CN039802. Prepared for United States Army Corps of Engineers, Honolulu Engineer District, Fort Shafter, HI.

Table 1
SCREENING OF REMEDIATION TECHNOLOGIES FOR PCB CONTAMINATED SOILS
Tanapag Removal Action

TECHNOLOGY	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING STATUS
GENERAL ACTIONS					
No Action	The No Action response consists of implementing no remedial technology or process to reduce or minimize the volume, toxicity or mobility, but may include environmental monitoring and institutional controls.	Does not meet ARARs.	Readily implementable.	Low cost.	**Retain only as baseline for comparitive evaluation.**
EX SITU TECHNOLOGIES					
Off-site Landfill	Transport contaminated materials to a permitted off-site treatment and disposal facility.	Permanent remedy, though it does not include destruction.	Easy to implement. Shipping of PCB contaminated materials or hazardous wastes from Saipan is complicated by the regulations of the Jones Act and the Japanese ban on PCBs entering Japanese ports.	High capital cost for transport and disposal of soil at landfill. No O&M cost.	**Retain for further evaluation.**
Off-site Encapsulation	Transport contaminated materials to an engineered disposal facility on Saipan.	Permanent remedy, though it does not include destruction.	Ease of implementation dependent on specifics of selected location and potential permitting requirements.	Low capital cost for transport and construction of engineered facility. Low O&M cost.	**Retain for further evaluation.**
Biological Treatment (general)	Microbiological processes are used to degrade or transform chemicals to less toxic or non-toxic forms.	Biological treatment is limited due to the chemical and physical characteristics of PCBs. PCBs are known to be some of the more persistent chemicals in the environment due to their toxicity to organisms and their lack of genetic capability to use these chemicals as a source of carbon and energy. Degradation of PCBs requires the alteration of the environmental conditions of the soils, and the addition of microbes acclimated to the chemicals. May not be effective at achieving the treatment objectives. U.S. Army Corps of Engineers performed a pilot test on PCB contaminated soils from Saipan with unsatisfactory results.	Ease of implementation dependent on specific soil and chemical properties of the contaminated materials and the microbiological process chosen.	Low capital cost. Low to moderate O&M cost for nutrients and labor to mix soil or treat in batches.	Due to persistence, low treatment goal, and lack of available PCB acclimated organisms, this technology has been deleted from further evaluation.
Soil Vapor Extraction (SVE)	A vacuum is applied to a network of above-ground piping to encourage volatilization of organics from the excavated media. The process includes a treatment system for handling off-gases.	Proven effective for Volatile Organic Compounds (VOCs) and lighter fraction hydrodrocarbons. Minimal effectiveness on low volatility compounds like PCBs.	Easy to implement using slotted pipes in soil pile and blower. Operation and monitoring will be required.	Low capital cost. Low to moderate O&M cost.	Due to physical characteristics of PCBs (i.e., low vapor pressure) this technology will not achieve treatment goals and has therefore been deleted from further evaluation.
Soil Washing	Contaminants sorbed onto soil particles are separated from soil in an aqueous-based system. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chlelating agent to help remove organics and heavy metals.	Can be effective for PCBs using a combination of washing agents. Additional site data and treatability testing is required to develop an appropriate aqueous based solution.	Requires special equipment. Requires treatment for fluids and fines. Soils treated rapidly.	High capital cost associated with purchase or rental and mobilization of equipment. Moderate O&M cost associated with use of agents and treatment of fluids and fines.	Since the PCBs will not be destroyed during the treatment process, the PCB latent water will need to be treated and disposed of. Furthermore, it may be difficult to develop an effective treatment solution. This technology has been deleted from further evaluation.
Solidification/ Stabilization (general)	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or a chemical reaction is induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	Particularly effective for metals, but can be adapted for organics, including PCBs. Long-term effectiveness has not been proven, thus there is a potential long-term liability as chemicals remain on site in immobilized state.	Requires locally available soil handling equipment and stabilizing agents. More innovative agents may require importation. Treatability study required to determine proper mix.	Low to moderate capital cost. Moderate O&M cost is a function of amount and type of agents.	Although it reduces bioavailability, contaminant mass is not reduced. Therefore, it does not comply with treatment objectives and has been deleted from further evaluation. It is, however, discussed in combination with off-site encapsulation.
Chemical Reduction/Oxidation	Reduction/oxidation processes chemically convert hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert.	Effectiveness is dependent on contaminant concentrations and soil chemistry.	Equipment for chemical reduction/oxidation processes are mobile and implementable in Tanapag.	Low to moderate capital cost. High O&M cost but for short duration.	**Retain for further evaluation.**
Dehalogenation/ Dechlorination	Contaminated media is mixed with chemicals and heated to decompose and volatilize the contaminants or replace the molecules to result in reduction of toxicity.	Can be effective for PCB reduction for soils, but total destruction is not likely and therefore may not meet treatment objectives.	Coupled with a pre-treatment system, this may require additional steps to implement the process.	Moderate capital cost. Moderate to high O&M cost but for short duration.	**Retain for further evaluation.**
Thermal Desorption	Wastes are heated (200 - 800 degrees F) to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to a PCB destruction treatment component.	Thermal desorption has been successfully utilized for many years for effectively extracting PCBs from soil. The contaminant residue can be treated with various destruction processes.	Indirect thermal desorption equipment is portable and capable of delivering high treatment rates with minimum risk of implementation. Equipment and fuel must be imported and operators must be skilled. Potential nuisance by noise, dust, and odors.	High capital cost. Moderate to high O&M cost but for short duration.	**Retain for further evaluation.**
Incineration	High temperatures (1,600 - 2,200 degrees F) are used to volatilize and combust (in the presence of oxygen) organic constituents in hazardous wastes.	Complete removal and destruction of PCBs. Air emissions must meet compliance standards.	Equipment and fuel to run equipment must be imported and operators must be skilled. Potential nuisance by noise, dust and odors. Regulatory acceptance may be difficult.	High capital cost. High O&M cost but for short duration. Cost effectiveness increases with volume to be treated.	**Retain for further evaluation.**
Solvent Extraction	Waste and solvent are mixed in an extractor, dissolving the organic contaminant into the solvent. The extracted organics and solvents are then placed into a separator, where the contaminants and solvent are separated for treatment or further use.	Capable of removing PCBs. Ability to achieve target treatment levels is not certain.	Equipment must be imported and operators must be skilled. Solvent must be sourced, securely stored and recycled.	High capital cost. High O&M cost but for short duration. Cost effectiveness increases with volume to be treated.	It is uncertain whether this technology will be effective at achieving treatment objectives. The PCBs are transferred from the soil phase to the solvent phase, so mass reduction is not achieved as required by the ARARs. Furthermore, costs may be high and permitting may be difficult. This technology has been deleted from further evaluation.

Table 2
Estimated Costs of Remedial Action Alternatives
Phase III, Tanapag Village, Saipan, CNMI
USACE Contract DACW62-00-D-0001, D.O. # 0002

Description	Quantity	Unit	Unit Cost ($)	Item Cost ($)
ALTERNATIVE 1 : No Action				
Maintenance of Soil Stockpiles	30	year	$20,000.00	$600,000.00
Installation of Groundwater Monitoring Network	4	well	$5,000.00	$20,000.00
Groundwater Monitoring	30	year	$10,000.00	$300,000.00
Installation of Security System	1	LS	$25,000.00	$25,000.00
Miscellaneous (fees, insurance) - estimate 10% of costs	1	EA	$94,500.00	$94,500.00
			TOTAL COST - ALTERNATIVE 1 :	**$1,039,500**
ALTERNATIVE 2A : Off-Site Disposal				
Design/Submittals	1	LS	$50,000.00	$50,000.00
Mobilization/Demobilization	1	LS	$50,000.00	$50,000.00
Packaging	20,000	TONS	$112.00	$2,240,000.00
Transportation to TSCA-approved landfill	20,000	TONS	$614.00	$12,280,000.00
Waste Disposal at TSCA-approved landfill	20,000	TONS	$100.00	$2,000,000.00
Import backfill, Site Restoration	20,000	TONS	$7.95	$159,000.00
Miscellaneous (fees, insurance) - estimate 10% of costs	1	EA	$1,677,900.00	$1,677,900.00
			TOTAL COST - ALTERNATIVE 2A :	**$18,456,900**
ALTERNATIVE 2B : Off-Site Encapsulation				
Design/Submittals	1	LS	$50,000.00	$50,000.00
Mobilization/Demobilization	1	LS	$100,000.00	$100,000.00
Site Preparation	1	LS	$210,000.00	$210,000.00
Bottom Liner Installation	1	LS	$248,000.00	$248,000.00
Hauling and Loading of Cell	1	LS	$480,000.00	$480,000.00
Operation and maintenance of Cell	30	year	$5,000.00	$150,000.00
Cell Closure	1	LS	$175,000.00	$175,000.00
Miscellaneous (fees, insurance) - estimate 10% of costs	1	EA	$136,300.00	$136,300.00
			TOTAL COST - ALTERNATIVE 2B :	**$1,499,300**
ALTERNATIVE 3A : On-Site Treatment by Thermal Blanket Process and PCB Destruction by Thermal Oxidation				
Design/Submittals	1	LS	$500,000.00	$500,000.00
Mobilization/Demobilization	1	LS	$300,000.00	$300,000.00
Thermal Blanket and Thermal Oxidation Treatment	20,000	TONS	$800.00	$16,000,000.00
Placement of Treated Soil - On Island	20,000	TONS	$3.44	$68,800.00
Disposal of spent carbon (GAC) - on Mainland	10	EA	$826.00	$8,260.00
Miscellaneous (fees, insurance) - estimate 10% of costs	1	EA	$1,687,706.00	$1,687,706.00
			TOTAL COST - ALTERNATIVE 3A :	**$18,564,766**

Table 2
Estimated Costs of Remedial Action Alternatives
Phase III, Tanapag Village, Saipan, CNMI
USACE Contract DACW62-00-D-0001, D.O. # 0002

Description	Quantity	Unit	Unit Cost ($)	Item Cost ($)
ALTERNATIVE 3B : On-Site Treatment by Incineration				
Design/Submittals	1	LS	$800,000.00	$800,000.00
Mobilization/Demobilization	1	LS	$250,000.00	$250,000.00
On-Site Incineration	20,000	TONS	$300.00	$6,000,000.00
Placement of Treated Soil - On Island	20,000	TONS	$3.44	$68,800.00
Miscellaneous (fees, insurance) - estimate 10% of costs	1	EA	$711,880.00	$711,880.00
		TOTAL COST - ALTERNATIVE 3B :		**$7,830,680**
ALTERNATIVE 4A : On-Site Treatment by Indirect Thermal Desorption (ITD) and PCB Destruction by Fenton Process				
Design/Submittals	1	LS	$50,000.00	$50,000.00
Mobilization/Demobilization	1	LS	$250,000.00	$250,000.00
On-Site Indirect Thermal Desorption	20,000	TONS	$275.00	$5,500,000.00
On-Site PCB Destruction (Fenton Process)	400	TONS	$1,000.00	$400,000.00
Placement of Treated Soil - On Island	20,000	TONS	$3.44	$68,800.00
Miscellaneous (fees, insurance) - estimate 10% of costs	1	EA	$626,880.00	$626,880.00
		TOTAL COST - ALTERNATIVE 4A :		**$6,895,680**
ALTERNATIVE 4B : On-Site Treatment by ITD and PCB Destruction by Solvated Electron Technology (SET™)				
Design/Submittals	1	LS	$50,000.00	$50,000.00
Mobilization/Demobilization	1	LS	$600,000.00	$600,000.00
On-Site Indirect Thermal Desorption	20,000	TONS	$275.00	$5,500,000.00
On-Site PCB Destruction (SET™)	400	TONS	$1,800.00	$720,000.00
Placement of Treated Soil - On Island	20,000	TONS	$3.44	$68,800.00
Miscellaneous (fees, insurance) - estimate 10% of costs	1	EA	$693,880.00	$693,880.00
		TOTAL COST - ALTERNATIVE 4B :		**$7,632,680**
ALTERNATIVE 4C : On-Site Treatment by ITD and PCB Destruction by Gas-Phase Chemical Reduction (GPCR)				
Design/Submittals	1	LS	$50,000.00	$50,000.00
Mobilization/Demobilization	1	LS	$1,000,000.00	$1,000,000.00
On-Site Indirect Thermal Desorption	20,000	TONS	$275.00	$5,500,000.00
On-Site PCB Destruction (GPCR)	400	TONS	$5,000.00	$2,000,000.00
Placement of Treated Soil - On Island	20,000	TONS	$3.44	$68,800.00
Miscellaneous (fees, insurance) - estimate 10% of costs	1	EA	$861,880.00	$861,880.00
		TOTAL COST - ALTERNATIVE 4C :		**$9,480,680**

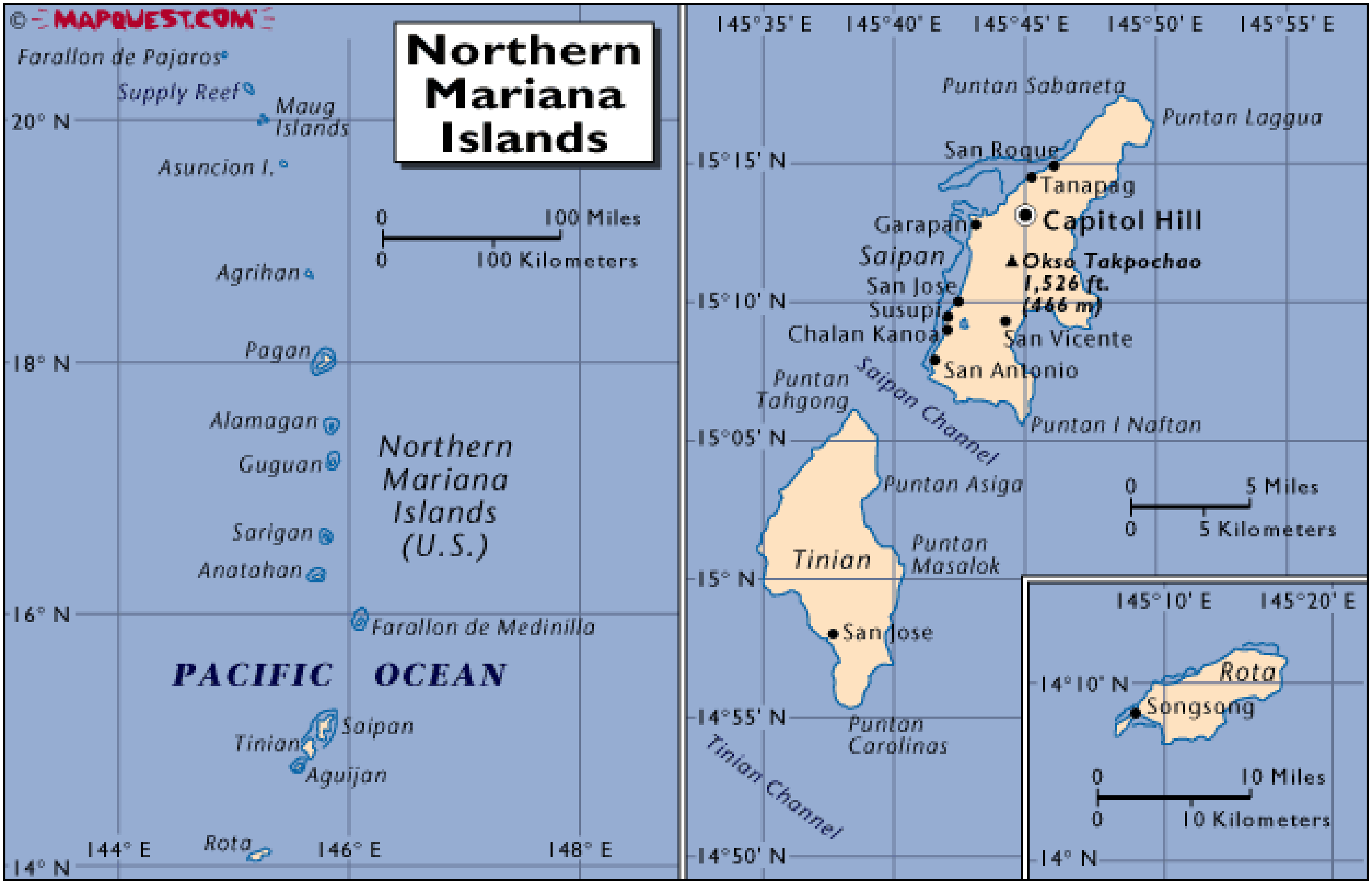
Table 2
Estimated Costs of Remedial Action Alternatives
Phase III, Tanapag Village, Saipan, CNMI
USACE Contract DACW62-00-D-0001, D.O. # 0002

Description	Quantity	Unit	Unit Cost ($)	Item Cost ($)
ALTERNATIVE 4D : On-Site Treatment by ITD and PCB Destruction by Base Catalyzed De-chlorination (BCD)				
Design/Submittals	1	LS	$50,000.00	$50,000.00
Mobilization/Demobilization	1	LS	$600,000.00	$600,000.00
On-Site Indirect Thermal Desorption	20,000	TONS	$327.00	$6,540,000.00
On-Site PCB Destruction (BCD)	400	TONS	$5,000.00	$2,000,000.00
Placement of Treated Soil - On Island	20,000	TONS	$3.44	$68,800.00
Miscellaneous (fees, insurance) - estimate 10% of costs	1	EA	$925,880.00	$925,880.00
			TOTAL COST - ALTERNATIVE 4D :	**$10,184,680**
ALTERNATIVE 4E : On-Site Treatment by ITD and Off-Site Disposal of PCB Residuals				
Design/Submittals	1	LS	$50,000.00	$50,000.00
Mobilization/Demobilization	1	LS	$250,000.00	$250,000.00
On-Site Indirect Thermal Desorption	20,000	TONS	$275.00	$5,500,000.00
Packaging	400	TONS	$112.00	$44,800.00
Transportation to TSCA-approved landfill	400	TONS	$614.00	$245,600.00
Waste Disposal at TSCA-approved landfill	400	TONS	$100.00	$40,000.00
Placement of Treated Soil - On Island	20,000	TONS	$3.44	$68,800.00
Miscellaneous (fees, insurance) - estimate 10% of costs	1	EA	$614,920.00	$614,920.00
			TOTAL COST - ALTERNATIVE 4E :	**$6,764,120**

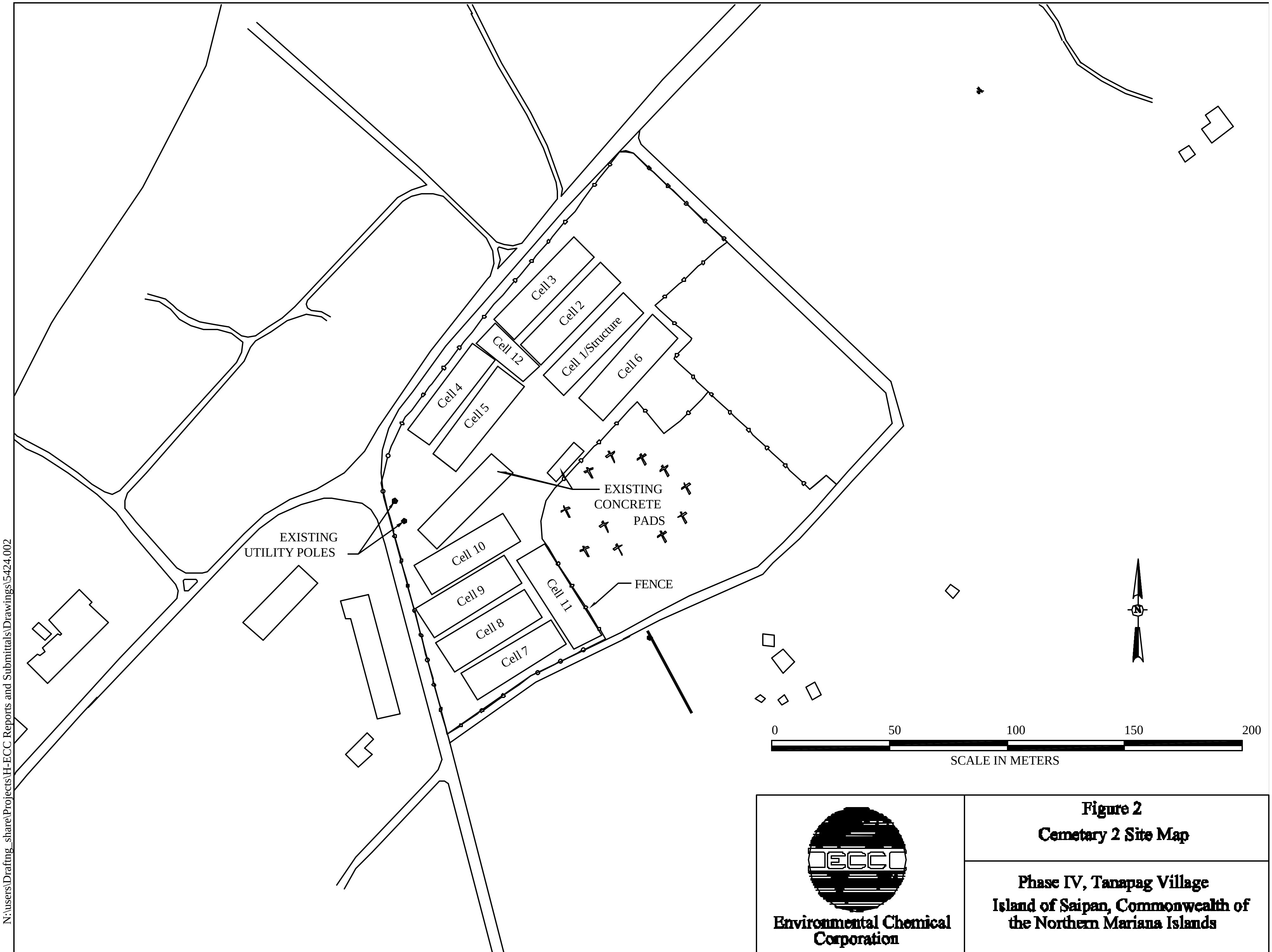
Notes:
Costs of annual O&M items have been estimated and have not been calculated on a present worth basis.
Annual O&M costs for indefinite period items have been estimated on the basis of a 30-year project life for consistency.

Table 3
Comparison of Remedial Action Alternatives
Phase III, Tanapag Village, Saipan, Commonwealth of the Northern Mariana Islands
USACE Contract DACW62-00-D-0001,D.O. # 0002

Alt. No.	Alternative Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Implementability	Cost
1	No Action	NO	NO	Neither permanent nor effective in long-term.	Does not reduce toxicity, mobility, or volume of contaminated soils on Saipan	Protective of Site Workers and Community	Readily implementable.	Low $52/ton
2A	Off-Site Disposal	YES	YES	Permanent removal. Does not destroy PCBs	Reduces toxicity, mobility, and volume	Protective of Site Workers and Community	Implementable, shipping constraints.	Highest $923/ton
2B	Off-Site Encapsulation	YES	YES	Permanent containment. Does not destroy PCBs	Reduces toxicity and mobility	Protective of Site Workers and Community	Implementable, potential location and permitting issues.	Low $75 - $225/ton
3B	On-Site Treatment by Incineration	YES	YES	Destroys PCBs	Destroys PCBs	Potentially less protective due to risk of dioxin release. May require more time due to required demonstration of technology.	Implementable, potential lengthy approval process.	Middle $392/ton
4E	On-Site Treatment by ITD and Off-Site Disposal	YES	YES	Permanent removal. Does not destroy PCBs	Reduces toxicity, mobility, and volume	Protective of Site Workers and Community	Implementable, shipping constraints.	Middle $338/ton



ENVIRONMENTAL CHEMICAL CORPORATION / URS	LOCATION OF PHASE III TANAPAG VILLAGE SITES Project No. 51-00170007.00	PHASE III REMOVAL ACTION TANAPAG VILLAGE, ISLAND OF SAIPAN COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS	FIGURE 1



Environmental Chemical Corporation

Figure 2

Cemetary 2 Site Map

Phase IV, Tanapag Village

Island of Saipan, Commonwealth of the Northern Mariana Islands

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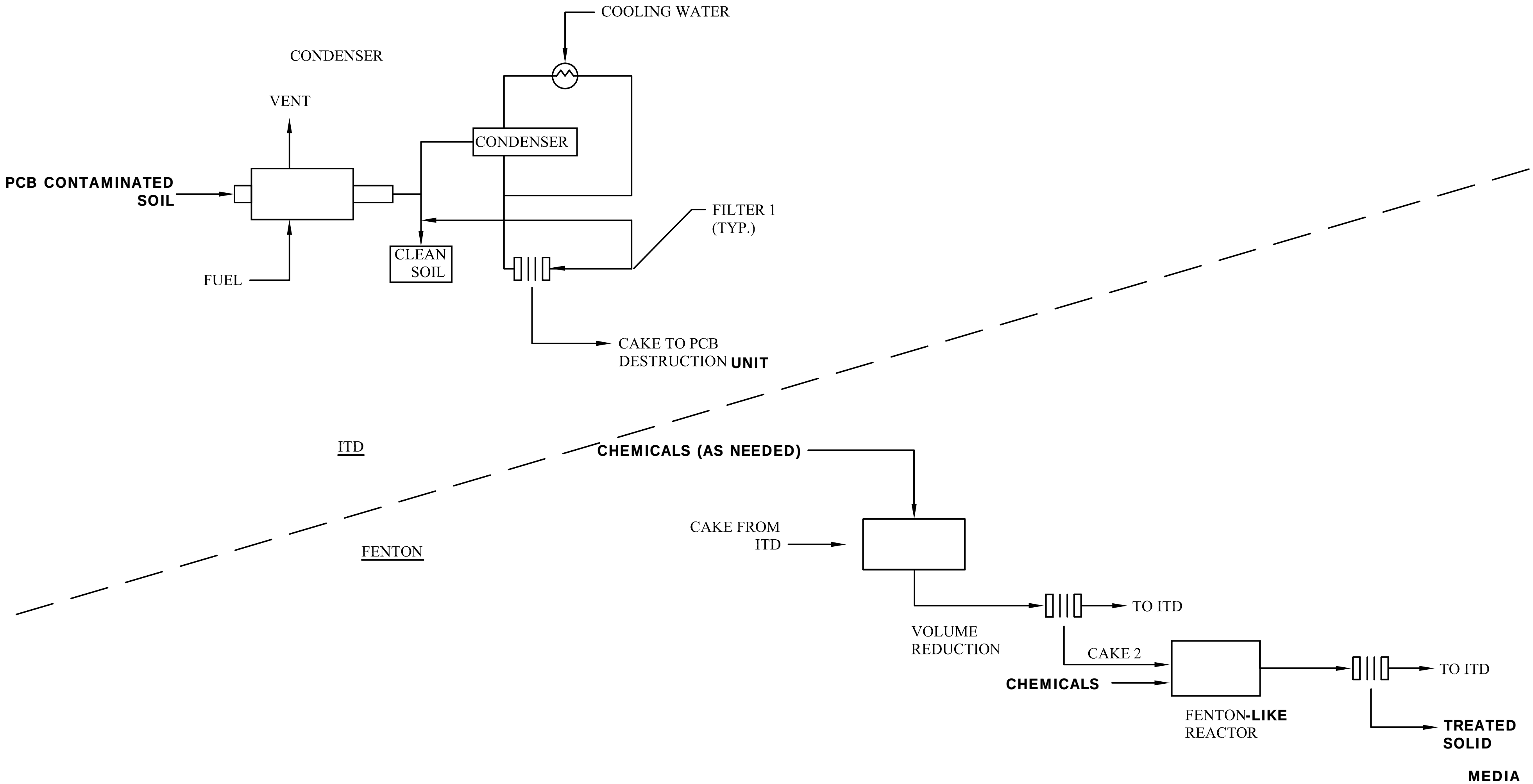


ENVIRONMENTAL CHEMICAL CORPORATION

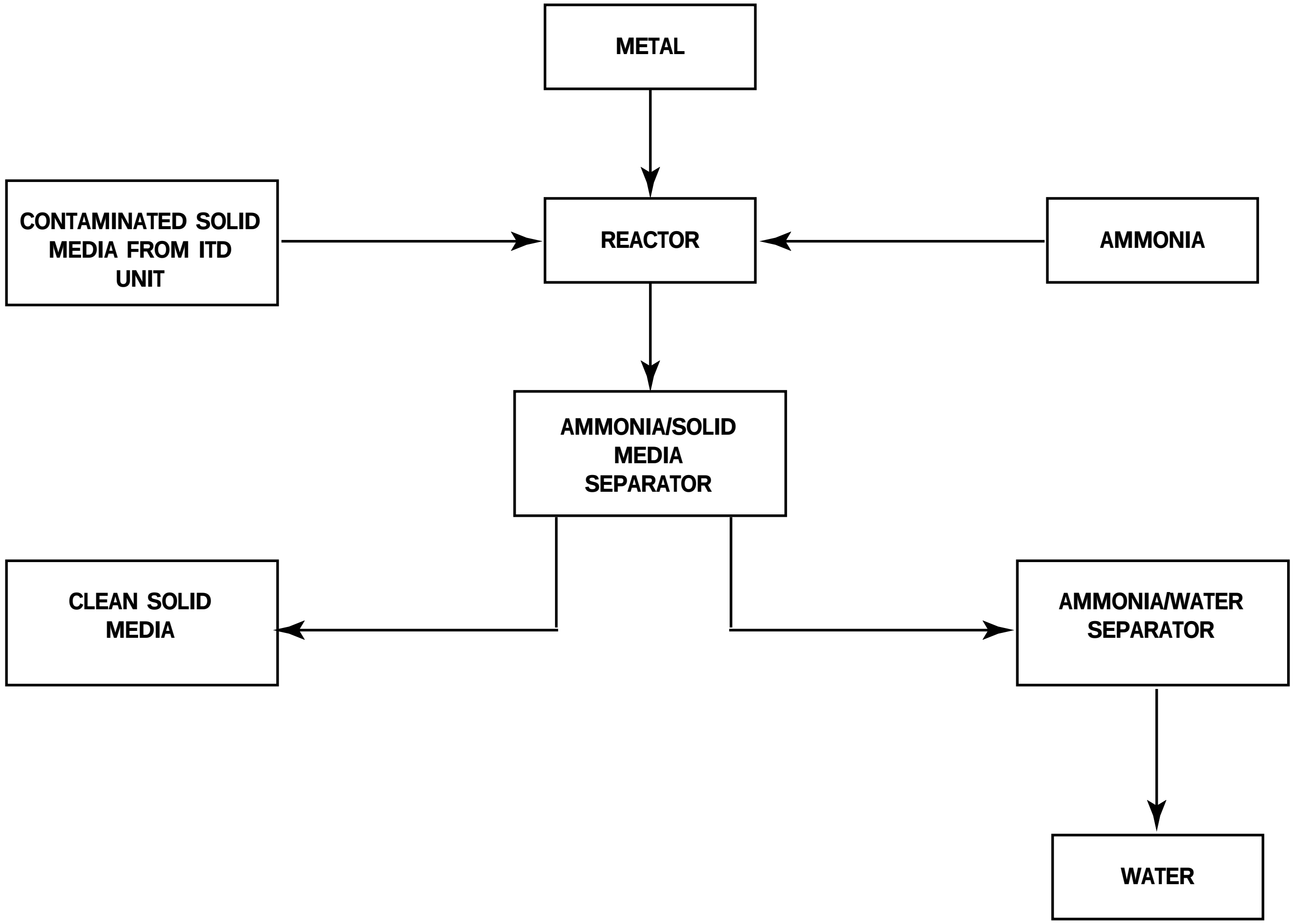
URS

BLOCK DIAGRAM FOR ITD WITH FENTON-LIKE PROCESS

Project No. 51-00170007.00

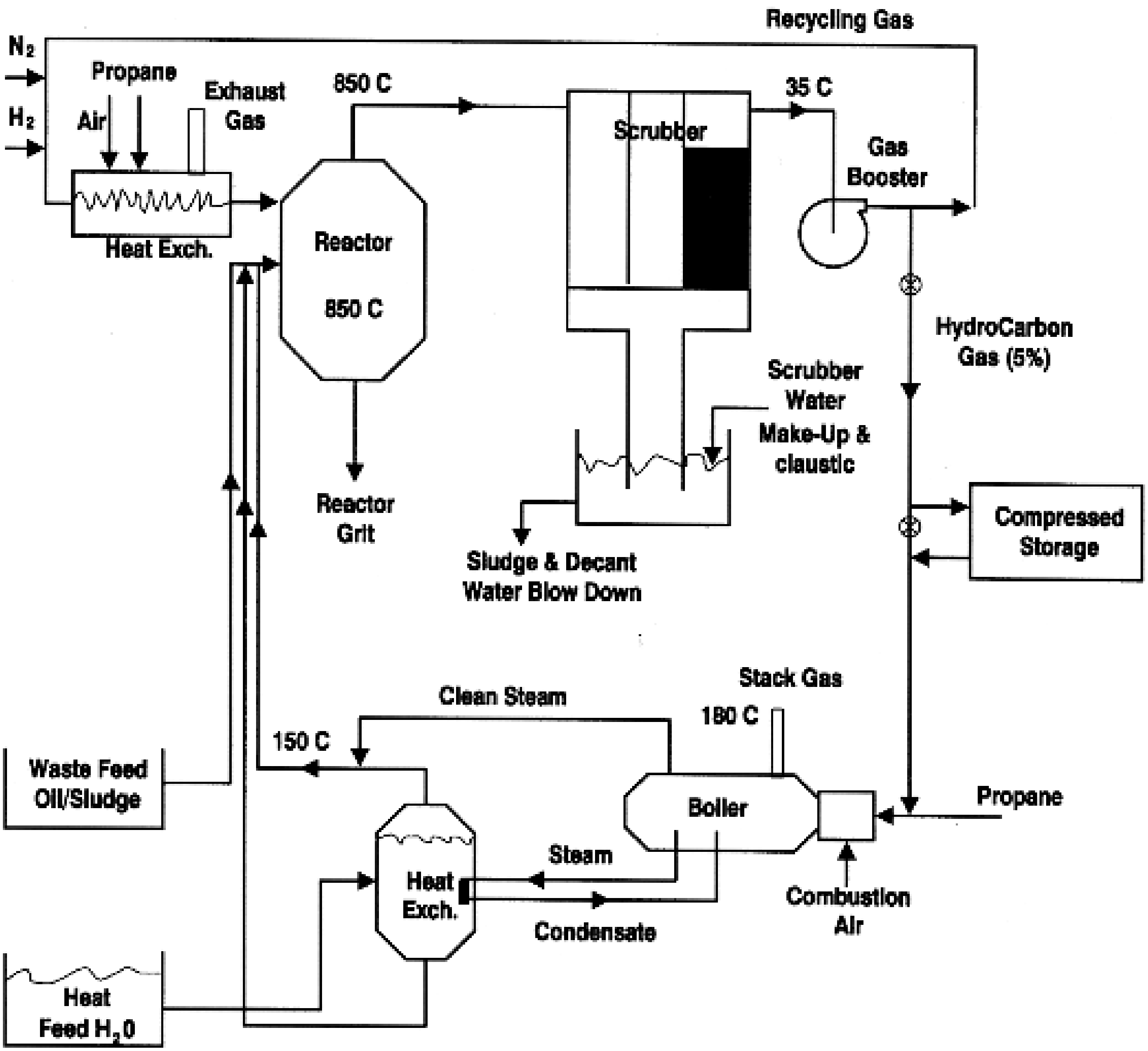
PHASE IV TANAPAG VILLAGE, ISLAND OF SAIPAN COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

FIGURE 3



SCHEMATIC DIAGRAM
Solvated Electronic Technology (SET)™ Remediation System
Commodore Applied Technology, Inc.

ENVIRONMENTAL CHEMICAL CORPORATION URS	BLOCK DIAGRAM FOR ITD WITH SET PROCESS Project No. 51-00170007.00	PHASE III REMOVAL ACTION TANAPAG VILLAGE, ISLAND OF SAIPAN COMMONWEALTH OF THE NORTHEN MARIANA ISLANDS	FIGURE 4



Schematic Diagram
Gas-Phase Chemical Reduction (GPCR) Reactor System
Eco Logic International, Inc.

ENVIRONMENTAL CHEMICAL CORPORATION

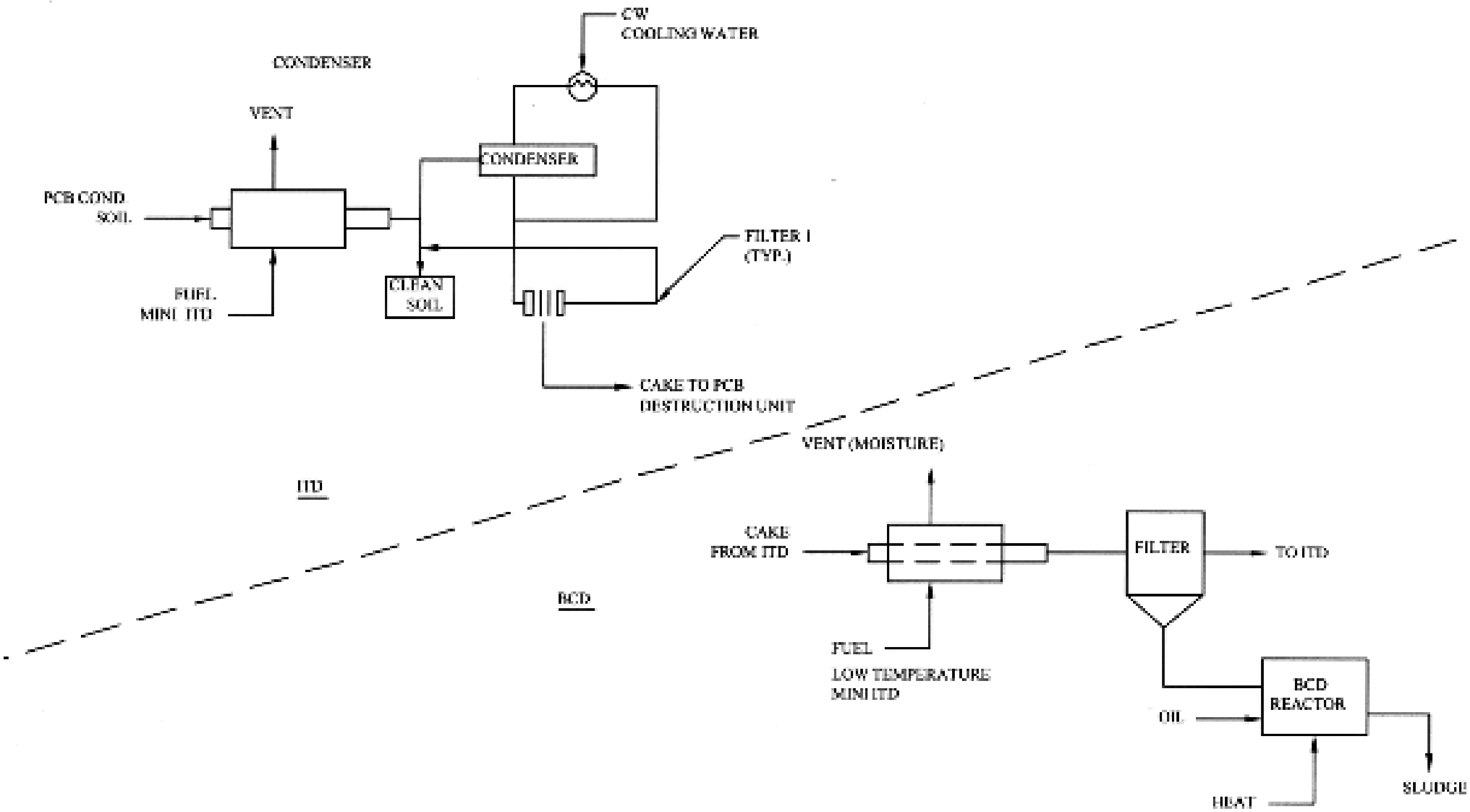
URS

BLOCK DIAGRAM FOR ITD WITH GPCR PROCESS

Project No. 51-00170007.00

PHASE III REMOVAL ACTION
TANAPAG VILLAGE, ISLAND OF SAIPAN
COMMONWEALTH OF THE
NORTHERN MARIANA ISLANDS

FIGURE 5



ENVIRONMENTAL CHEMICAL CORPORATION

URS

BLOCK DIAGRAM FOR ITD WITH BCD PROCESS

Project No. 51-00170007.00

PHASE III REMOVAL ACTION
TANAPAG VILLAGE, ISLAND OF SAIPAN
COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

FIGURE 6