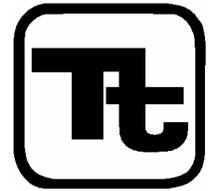


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**APPENDIX G-3**

**MULIWAI SEDIMENT SAMPLING REPORT**



TC K838-0402

## MULIWAI SEDIMENT SAMPLING REPORT

### SUPPORTING THE ENVIRONMENTAL IMPACT STATEMENT ON MILITARY TRAINING ACTIVITIES

### MAKUA MILITARY RESERVATION O'AHU, HAWAI'I

Contract Number GS-10F-0268K  
Delivery Order Number DACA 83-02-F-002

January 2005

*Prepared for:*

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## LIST OF ACRONYMS AND ABBREVIATIONS

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Acronym/Abbreviation	Full Phrase
ASTM	American Society for Testing and Materials
BTEX	benzene, toluene, ethylbenzene, and xylenes
CALFEX	combined arms live fire exercises
CFR	Code of Federal Regulations
CIH	certified industrial hygienist
COC	chain-of-custody
EIS	environmental impact statement
FONSI	finding of no significant impact
GPS	global positioning system
HED	Honolulu Engineering District
ICP	inductively coupled plasma (spectrometry)
kg	kilogram
$\mu$ g	microgram
mg	milligram
MDL	method detection limit
MMR	Mākuā Military Reservation
NIOSH	National Institute for Occupational Safety and Health
OB/OD	open burn/open detonation
OC	organochlorine
OCDD	octachlorinated dibenzo-p-dioxin
OE	ordnance and explosives
PAH	polycyclic aromatic hydrocarbon
ppb	parts per billion
PCDD	polychlorinated dibenzodioxin
PCDF	polychlorinated dibenzofuran
PM	project manager
PRG	preliminary remediation goal
QA	quality assurance
QC	quality control
SEA	supplemental environmental assessment
SAP	sampling and analysis plan
SSHO	site safety and health officer

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## LIST OF ACRONYMS AND ABBREVIATIONS

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Acronym/Abbreviation

Full Phrase

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SSHP  
SVOC

site safety and health plan  
semivolatile organic compound

TCDD  
TEQ  
TOC

tetrachlorinated dibenzo-p-dioxin  
toxicity equivalent  
total organic carbon

USACE  
USEPA

United States Army Corps of Engineers  
United States Environmental Protection Agency

# EXECUTIVE SUMMARY

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Tetra Tech conducted an investigation to determine if sediments in muliwai at the mouths of three streams draining Mākua Valley show evidence of contamination that may be related to past military activities at Mākua Military Reservation (MMR) or other sources. *Muliwai* is the Hawaiian word for pond that sometimes develops naturally during periods of low stream flow in the back-beach depression near the mouth of a stream. Under natural conditions, as a result of storm runoff, the water level in a muliwai rises until a breach develops in the sand dune, after which the pond rapidly drains and the stream discharges directly to the sea. As stream flow decreases, the sand berm builds again and stream water again fills the pond. Depending on the amount of stream flow or recharge from groundwater, the pond may either persist, or dry up entirely, until the next storm event. In some areas of Hawaii, muliwai have been improved and maintained for aquaculture. It is not known if or when the muliwai at Mākua Beach were used for aquaculture.

The most recent storm event large enough to cause the streams that discharge from Mākua Valley to breach the beach dunes occurred on February 14 and 15, 2003. There is no record of the maximum size of the muliwai prior to breaching, but it is known that the streams eventually breached the dunes and discharged unimpeded to the sea during the February storm event.

Recent aerial photographs of Mākua Beach confirm that ponds form at the mouths of each of the three streams that drain Mākua Valley: Punapahaku Stream (designated as the “dry muliwai” in this report), Mākua Stream (designated as the “north muliwai” in this report), and the stream emanating from Kaiahi Gulch (designated as the “south muliwai” in this report). The aerial photographs were used to delineate the areas in which sediment samples were to be collected, as described in the sampling plan prepared for the investigation (Tetra Tech 2003). At the time the field work for this investigation was performed, from May 19 through May 21, 2003, the muliwai had receded and the beach dune had reformed. The approximate extent of the muliwai ponds at the time of sampling were superimposed on the historic aerial photographs.

The largest pond at the time of sampling was the south muliwai. The north muliwai contained water, but was smaller than the south muliwai. The dry muliwai did not contain any water.

Sediment samples were also collected and analyzed from near the mouths of streams draining the watersheds immediately north and south of Mākua Valley, for comparison to the sediments collected from the muliwai. No other muliwai outside of Mākua Valley were identified in reconnaissance of the project region. The north and south background sampling sites were chosen because the depositional environments would be similar to the muliwai, but in watersheds where there has not been recent military training activity. The same stream sediment locations were used as reference sites in a previous study of muliwai sediments conducted by the US Environmental Protection Agency (USEPA).

A total of 49 sediment samples were collected from the muliwai and the two background locations. Twenty-two samples were collected from the north muliwai, 17 from the south muliwai, four samples were collected from the dry muliwai, and three samples each were collected from the north background location and the south background location. In addition, five duplicate samples were collected. All of the samples were analyzed for metals and energetic compounds (explosives). Ten samples and two duplicates were analyzed for an extended suite of analyses that included benzene, toluene, ethylbenzene, total xylenes (BTEX), organochlorine (OC) pesticides, chlorinated herbicides, semivolatile organic compounds (SVOCs), dioxins and furans, nitrate, nitrite, cyanide, perchlorate, total organic carbon (TOC), and particle size.

The samples were collected at depths ranging from 0-12 inches to as deep as 44-inches. Depth-integrated composites were prepared in the field by mixing the soil manually and then collecting subsamples of the composited soil for submittal to contract laboratories. The field geologist logged the sampled sediment in the field according to the Unified Soil Classification System. Sample locations were identified in the field using a geographic positioning system (GPS) instrument accurate to about three meters, and the positions were confirmed visually from comparison to the aerial photographs of the site.

Based all of the field observations and the analytical results of the muliwai sediment sampling program the following conclusions were made:

- A wide range of sediment types, in terms of grain size and TOC content, were encountered in the three muliwai and two background areas. No correlation was observed between the grain size, the locations or depths of the samples, and the TOC or nitrate concentrations.
- Concentrations of metals detected in the muliwai were within the ranges found in the background samples.
- Arsenic and chromium were detected at concentrations above USEPA Region IX soil preliminary remediation goals (PRGs), but within background concentration ranges.

- All of the twelve samples that were analyzed for BTEX contained one or more of these compounds at trace concentrations. All of the concentrations of the BTEX chemicals in these samples were far lower than respective USEPA Region IX residential soil PRGs.
- Six of twelve sediment samples analyzed for the full suite of organic compounds contained one or more of the chemicals of concern, (with the exception of BTEX, which was detected more frequently). One sample contained one of the explosive compounds, and one sample contained one OC pesticide compound. Three chlorinated herbicides and three SVOCs were found in four samples. The detected concentrations were far below USEPA Region IX residential soil PRGs.
- Trace concentrations of two dioxin isomers were detected in two of the twelve muliwai sediment samples analyzed for dioxins and furans. The 2,3,7,8-TCDD isomer was detected at a concentration above the USEPA Region IX industrial soil PRG in one sample from the south muliwai, collected at a depth of 2.5 feet. The toxicity equivalent of the octa-CDD isomer found in the other sample, from the north muliwai, did not exceed the USEPA Region IX residential soil PRG.
- The results were also compared to U.S. EPA Generic Soil Screening Levels for protection of groundwater, to Hawaii Tier I Soil Action Levels, and to U.S. EPA Region 5 Ecological Screening Levels, in accordance with the Sampling and Analysis Plan. While some of these comparison values were exceeded in some of the samples, careful scrutiny of the specific exceedances revealed no additional basis for further investigation or study that was not already suggested by comparison to the U.S. EPA Region IX soil PRGs.

# SECTION 1

## INTRODUCTION

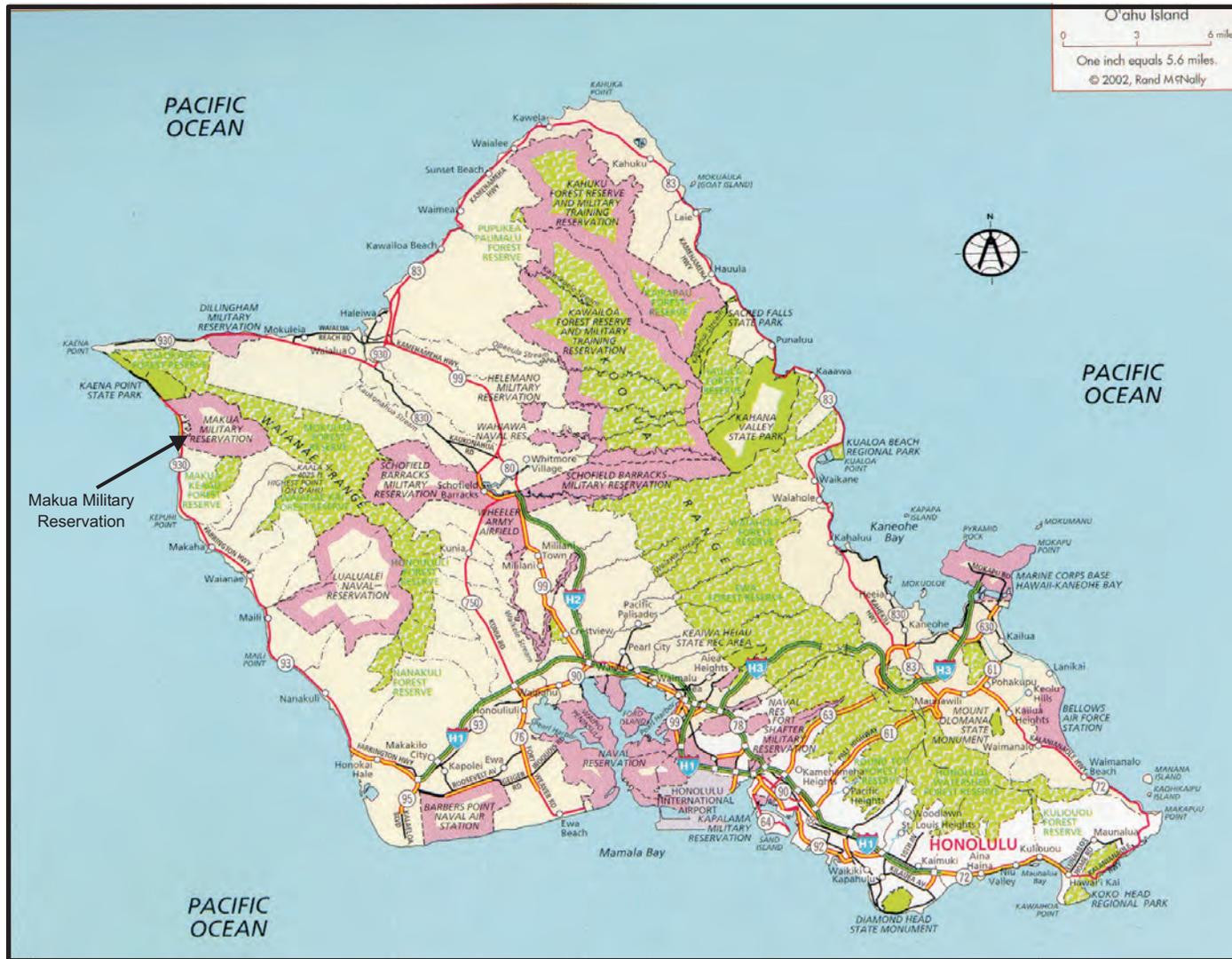
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*Muliwai* is the Hawaiian word for a stream mouth that is isolated from the sea. Analytical data of the sediments in the muliwai adjacent to the Mākua Military Reservation (MMR, the site), on O‘ahu, Hawai‘i, were determined to be a data gap for the environmental impact statement (EIS) for military training activities at the reservation. This muliwai sediment sampling report presents the purpose, scope of work, strategy, methodology, field changes to the methodology, and the results and findings of the sampling program to fill this data gap. Tetra Tech, Inc., is preparing the EIS under contract number GS-10F-0268K, delivery order number DACA83-02-F-0002 for the United States Army Corps of Engineers (USACE), Pacific Ocean Honolulu Engineer District (HED).

### 1.1 SITE DESCRIPTION

MMR is approximately 38 miles northwest of Honolulu, on the western shore of O‘ahu, near Ka‘ena Point, and is in the adjoining Mākua and Kahanahāiki valleys (Figure 1-1). MMR is bordered on the west by the Pacific Ocean and is surrounded by the Wai‘anae Mountains on the north, east, and south. MMR borders Farrington Highway and extends west from the Wai‘anae Mountains ridgeline to the Pacific Ocean; Mākaha, the nearest township, is approximately three miles south. The installation encompasses almost 4,190 acres and is arid, with annual rainfall ranging from about 50 inches towards the head of the valley, to less than 15 inches at the mouth of the valley. The high, precipitous valley walls surrounding the installation reach heights of 2,100 to 2,900 feet. The broad range in rainfall and topography results in a diversity of vegetation types within the valley.

Of the total acreage at MMR, the US Army owns 170 acres in fee simple and 1.64 acres by license, leases 782.35 acres from the state of Hawai‘i, and has the use of 3,236.48 acres of ceded lands. These are lands that were originally controlled by the Kingdom of Hawai‘i and were transferred to the US in 1898, when Hawai‘i was annexed as a territory. These ceded lands were subsequently granted to Hawai‘i in 1959 upon



Source: Rand McNally 2002

## Site Location Map

Mākuā Military Reservation  
O'ahu, Hawai'i

Figure 1-1

statehood. In 1964 a series of real estate actions resulted in the current 4,190-acre mixture of leased, ceded, and fee-simple land holdings. The State of Hawai'i lease, which expires in 2029 and includes the 782.35-acre parcel along Farrington Highway, requires the US Army to allow employees of the Hawai'i Board of Land and Natural Resources to enter the leased premises when necessary. Additionally, it grants the right to develop public use of Kāneana Cave, including a foot trail and parking area associated with the cave. The terms of the lease also allow public access to Mākua Beach, which lies between Farrington Highway and the shoreline.

The muliwai that were sampled for this task are within the Mākua Beach area. Water flows over Mākua Valley only during heavy rainfall. Water flowing from Mākua Valley or from incoming high tides collects in muliwai ponds located just inland along the beach. Typically, muliwai ponds are completely flushed each year by heavy rainfall.

## **1.2 SITE BACKGROUND**

Use of Mākua Valley by US armed forces dates back to the 1920s when three parcels on the upper Mākua Valley floor were purchased for howitzer emplacements. After the bombing of Pearl Harbor in 1941, the Army used its authority under martial law to take over the entire Mākua-Ka'ena Point area for security and training. In 1942, the Army issued a real estate directive for 6,600 acres of land at Mākua that were already being used. Private parcels within the property were taken by condemnation, whereas territorial lands were conferred by the territorial governor's consent. In 1943, the territorial government granted a revocable permit for the military to use 6,600 acres "to assist in the present war effort extending for the duration of the present war and six months thereafter." The site was used extensively for bombing and infantry training, but no records of ordnance expended on Mākua were kept; it has remained under Army control ever since. After Hawai'i was granted statehood in 1959, the federal government exercised its option to set aside lands for its continued use.

In September 1998, the Army temporarily suspended training at MMR due to several wildland fires that burned outside the southern firebreak road. The Army then began an extensive investigation into the potential effects of wildland fires on the environment and reevaluated its fire management plan and training procedures. The Army consulted with the US Fish and Wildlife Service, pursuant to Section 7 of the Endangered Species Act, and discussed ways to identify, evaluate, and reduce the impact of Army activities on threatened and endangered species. Fish and Wildlife ultimately issued an opinion that the Army's resumption of modified training at MMR would not jeopardize endangered and threatened species.

## **1.3 PROJECT DESCRIPTION**

In 1998, Earthjustice filed a lawsuit on behalf of Mālama Mākua seeking to compel preparation of an EIS addressing all of the Army's training and related operations at MMR. In 2000, the Army announced the completion of its supplemental environmental assessment (SEA) and finding of no significant impact (FONSI). In December 2000, Mālama Mākua sued the Army and challenged the SEA and FONSI and the Army's decision not to prepare an EIS for the resumption of training. In July 2001, the US

District Court for the District of Hawai'i granted a preliminary injunction enjoining the Army from training at MMR until the court issued its decision on the merits of the lawsuit. Following the events of September 11, 2001, a settlement agreement and stipulated order between Mālama Mākua and the US Department of Defense was issued in October 2001. The agreement allowed the Army to return to a limited number of training exercises until an EIS is completed and the record of decision is published in the *Federal Register*, no later than October 2004. The US Army will be permitted to carry out combined live arms fire exercises at MMR in the three years immediately following court approval of the agreement.

In support of the settlement agreement, the USACE HED contracted with Tetra Tech to prepare an EIS addressing, among other things, the potential direct, indirect, and cumulative environmental impacts associated with the proposal to continue military training activities at MMR. The EIS development process will be conducted in accordance with the aforementioned settlement agreement. The EIS areas of interest for evaluation will be the environmental, cultural, and socioeconomic effects at MMR and the adjacent community. For the cumulative impacts analysis portion of the EIS, Tetra Tech will assess existing conditions and trends in surrounding ecosystems and landscapes, privately owned lands, and the surrounding communities within the region of influence. In general, Tetra Tech's on-site activities at MMR will be noninvasive, consisting primarily of field testing, monitoring, and evaluating cultural, historical, and natural resources.

#### **1.4 PREVIOUS INVESTIGATIONS**

A number of studies have been performed relating to MMR, including, but not limited to the Halliburton NUS study (1994), The Mākua SEA (Onyx 2001), the muliwai sampling conducted by the US Environmental Protection Agency during 1999 (USEPA 1999a). In addition, a few studies have been performed along the leeward coast that include or apply to Mākua Valley, including US Geological Survey Professional Paper 1412B (Hunt 1996) and Hydrologic Investigation HA-358 (Takasaki 1971). Two recent reports to the Earthjustice Legal Defense Fund completed by consultants are also available that critiqued the SEA and the Halliburton report; these are "The Geohydrologic Setting of Mākua Valley and Contaminant Transport from Mākua Military Reservation by Overland Flow and via the Ground Water System," by William Meyer (Meyer 2001), and "Review of the Supplemental Environmental Assessment for Routine Training at Mākua Military Reservation and PFC Pīlilā'au Range Complex, Hawai'i, including the Potential for Off-Site Transport of Contaminants," by Eric De Carlo (De Carlo 2001).

The USEPA sampled the muliwai ponds at the Mākua Valley and an adjacent dry streambed for background data during 1999. They concluded that "further investigation does not appear warranted at this time because the overall concentrations of the metals of concern are relatively low, and do not tend to indicate a significant adverse impact on ecoreceptors" (USEPA 1999a).

## 1.5 OBJECTIVES AND SCOPE OF WORK

### 1.5.1 Objectives

The primary objectives of Tetra Tech's muliwai sediment sampling program at MMR include the following:

- To determine if inorganic and organic contaminants, primarily explosives and metals, are present in the muliwai sediments;
- To assess if contamination from the open burn/open detonation (OB/OD) area or the range complex at MMR has migrated off-site; and
- To provide data necessary to comply with the terms of the September 11, 2001 settlement agreement, and to support preparation of Tetra Tech's EIS.

### 1.5.2 Scope of Work

The proposed scope of work was performed to meet the objectives of the sampling program and includes the following elements:

- ***Preliminary activities.*** Tetra Tech reviewed the findings of the previous studies and assessments available for the muliwai ponds at MMR and related military training sites. Tetra Tech also obtained basic information (e.g., maps, soil data, munitions compositions, and historic site activities) and obtained permission to enter MMR and the adjacent properties.
- ***Sampling and analysis plan.*** Tetra Tech assessed detectable muliwai sediment quality impacts from military training activities at MMR by preparing and implementing a site-specific sampling and analysis plan (SAP). Identifying potential impacts at MMR could assist in complying with the requirements of federal and state statutes and rules, Hawai'i Revised Statutes and Hawai'i Administrative Rules.
- ***Site safety and health plan.*** Tetra Tech followed the site safety and health plan (SSHP) during on-site sampling (Tetra Tech 2002b). The SSHP was implemented in compliance with 29 Code of Federal Regulations (CFR) 1910.120 and USACE guidance document, Safety and Health Requirements Manual (EM 385-1-1), to address the potential for hazardous materials that could be encountered during field work at the muliwai ponds.
- ***Site visits.*** Tetra Tech visited the site, under authorization of MMR personnel, to locate and map appropriate sampling locations at the muliwai ponds.
- ***Sample collection and analysis.*** Tetra Tech collected muliwai sediment samples, in accordance with quality control (QC) requirements of the SAP (Tetra Tech 2003), and arranged for the samples to be delivered to certified contract laboratories for analysis.

- ***Muliwai sediment sampling report.*** Tetra Tech has prepared this muliwai sediment sampling report, based on an evaluation of site conditions and on the results of laboratory analyses. The report includes a description of the methods and procedures used to collect and analyze the samples, along with the results and observations of the sampling and analysis.